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HUTECH
University of Technology

Virtual Workshop

DATA-DRIVEN MACHINE LEARNING METHODOLOGY FOR ADDITIVE MANUFACTURING

10 January 2022

https://zoom.us/j/5869532904?pwd=cU90M0R3M0Vzamp3cHZRblFtYWV2Zz09

hutech.edu.vn

WELCOME MESSAGE

Dear Colleagues,

Additive manufacturing (AM) technology, also known as 3D printing, is a key theme along with other trending technologies of Industry 4.0 such as cloud computing and machine learning. These technologies play a crucial role in transforming the manufacturing industry in the next 50 years. In the last decade, AM technology has been applied extensively in high-value manufacturing applications in many interdisciplinary industrial sectors with a market value of around $17 billion in 2021. It is estimated that the market value of the AM technology will reach up to $70 billion by 2028. For example, the global 3D printing construction market is expected to reach a compound annual growth rate of 114.8% from 2020 to 2027. The aerospace and mechanical engineering market is the main driving force of the 3D printing evolution which covers 21.17% of the total 3D printing market. The biomedical market also plays an important role in the growth of 3D printing by covering 16.3% of the total 3D printing market. The AM technology is, however, not a simple process, particularly when dealing with complex mathematical modeling of multi-scale and multi-physics problems that require large-scale computation. Numerous control parameters need to be managed and a large amount of output data needs to be examined thoroughly in order to achieve a consistent design/specification for all working parts of the AM technology.

The optimization of the AM process, which may include optimal design, material tuning, process optimization, in situ monitoring, cloud service, and cybersecurity, can offer great economic advantages for suppliers and customers. Hence, it is important to establish a real-time control for the whole AM system. Data-driven machine learning analysis can be applied to the AM process to save time and improve the quality of the products.

This workshop on Data-driven Machine Learning Methodology for Additive Manufacturing aims to establish an international forum for academic and industrial researchers to exchange ideas on recent advances in fields related to additive manufacturing, large-scale computational methods, numerical modeling & simulation, optimization, and machine learning techniques. It will offer presentations on a wide range of topics to facilitate the interdisciplinary exchange of ideas in engineering and science areas, and foster various types of academic collaborations.

It is our great pleasure to welcome you to the workshop which will be held virtually via Zoom on January 10th, 2022 by Ho Chi Minh City University of Technology (Ho Chi Minh City University of Technology (HUTECH)), Vietnam. We would like to thank all members of the organizing committee, and supporters who have been working diligently in order to make this workshop possible. We would like to express our gratitude to the invited speakers for their meaningful contributions to the workshop.

Nguyen Xuan Hung

Workshop Chair

CIRTech Institute, Ho Chi Minh City University of Technology (HUTECH)

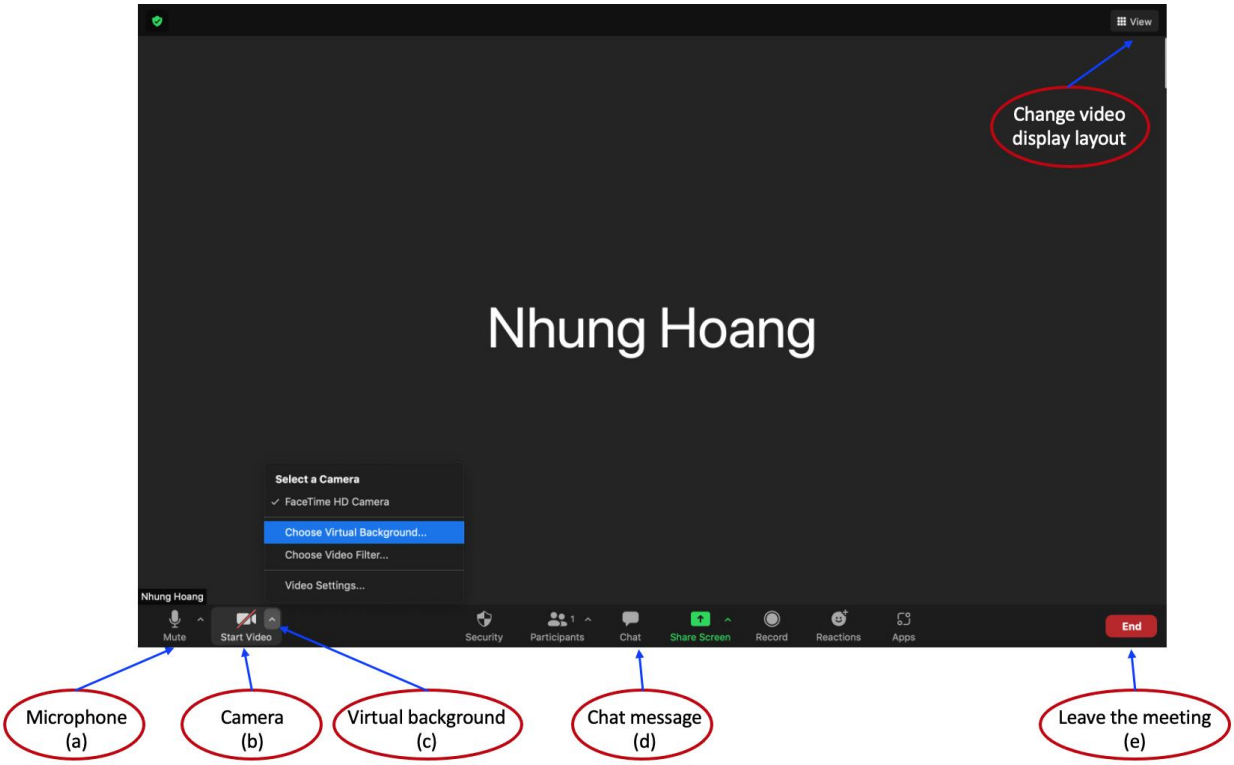
WORKSHOP DETAILS

The time used in this handbook is based on the Indochina Time Zone (ICT). Please take note of the time zone differences.

No.	Country/Region	Time
1	Vietnam	14:00 – 21:30
2	USA	02:00 – 09:30
3	Australia	18:00 – 01:30
4	Belgium	08:00 – 15:30
5	Germany	08:00 – 15:30
6	India	12:30 – 20:00
7	Singapore	15:00 – 22:30
8	Thailand	14:00 – 21:30

Our workshop platform is Zoom. All attendees must download and install zoom at the link:

Please test various functions of Zoom before attending the online workshop:



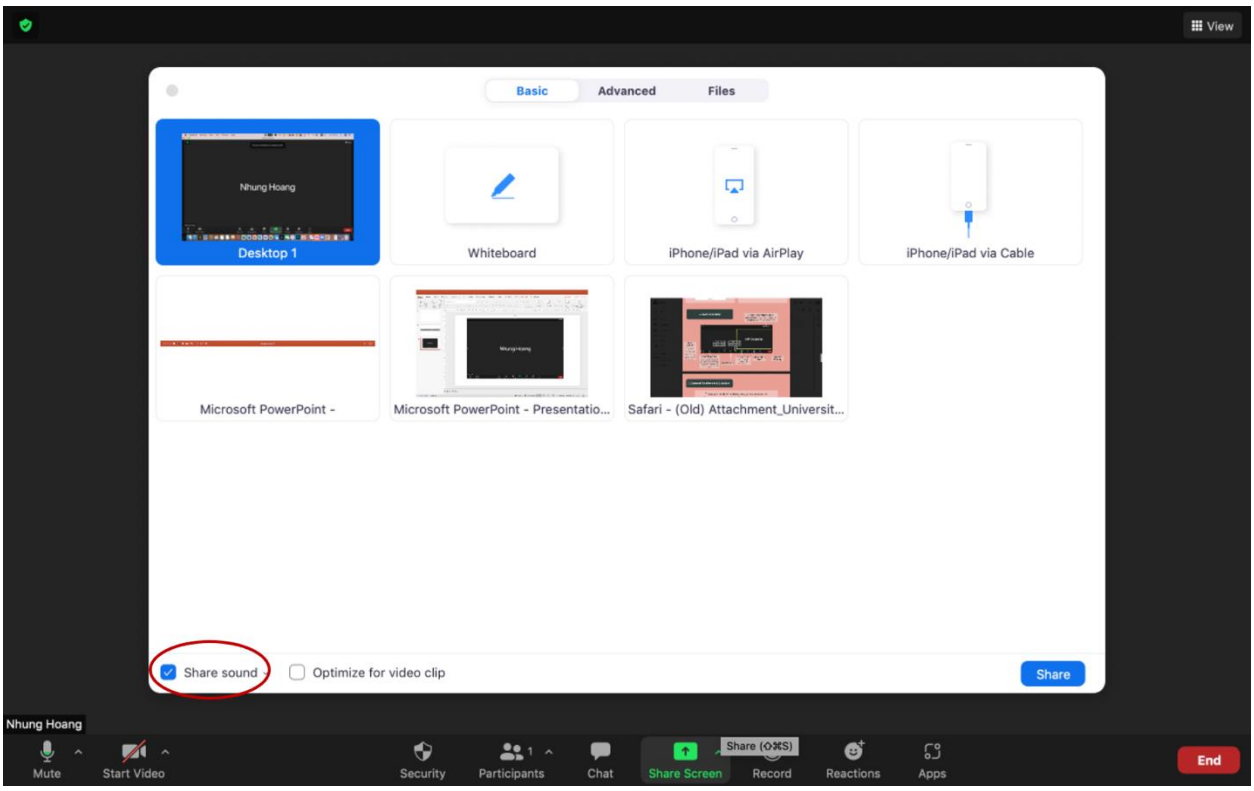
a. Mute when you are not speaking and unmute to speak;

b. You should turn on your webcam with Start Video when you speak;

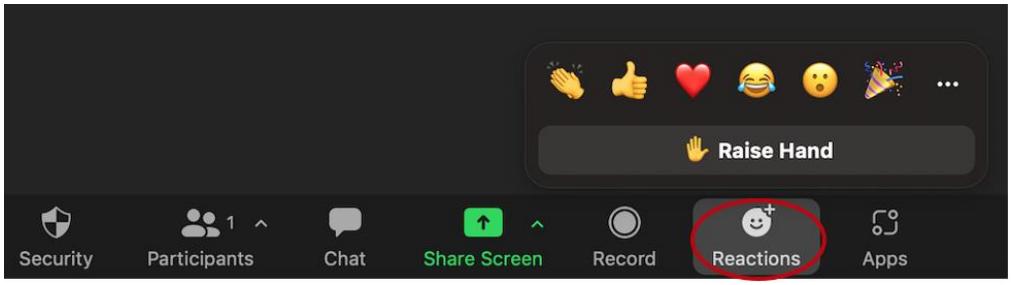
c. Virtual background;

d. If you wish, you may also send your comments or contact the Session Chair in the Chat during the workshop; Share Screen for your presentation;

e. Leave the meeting.



Click on “Share Screen” and then choose your presentation. Please click on “Share sound” if you want to share a video on your presentation.



Raise hand to ask questions during the presentation.

ORGANIZING COMMITTEES

- **Nguyen Xuan Hung**, Ho Chi Minh City University of Technology (HUTECH)
- **Nguyen Quoc Hung**, Vietnamese-German University
- **Le Van Canh**, International University - VNUHCM
- **Nguyen Trung Kien**, Ho Chi Minh City University of Technology (HUTECH)
- **Jonathan Tran**, RMIT University
- **Hoang Ngoc Nhung**, Ho Chi Minh City University of Technology (HUTECH)
- **Sundararajan Natarajan**, Indian Institute of Technology Madras
- **Hoang Van Nam**, Vietnam Maritime University
- **Ha Thi Huyen Trang**, Ho Chi Minh City University of Technology (HUTECH)

PROGRAM SCHEDULE

GENERAL SESSION (14:00 – 14:10)

Location: https://zoom.us/j/5869532904?pwd=cU90M0R3M0Vzamp3cHZRblFtYWV2Zz09

Time	Content (Title)	Speaker	Affiliation
14:00 – 14:05	Welcome address by President of Vietnamese Association of Mechanics	Nguyen Tien Khiem	President of VAM
14:05 – 14:10	Opening address by Workshop Chairman	Nguyen Xuan Hung	HUTECH

SESSION 1: ADDITIVE MANUFACTURING

Chair: **Kun Zhou**

Location: https://zoom.us/j/5869532904?pwd=cU90M0R3M0Vzamp3cHZRblFtYWV2Zz09

Time	Content (Title)	Speaker	Affiliation
14:10 – 14:40	Multi Jet Fusion additive manufacturing of fiber-reinforced polymer composites	Kun Zhou	Nanyang Technological University, Singapore
14:40 – 15:10	Bioinspired 3D Printing – Unravel the Secret behind Porcupine Quill Structure	Jonathan Tran	RMIT University, Australia
15:10 – 15:40	Using 3D printing for preoperative planning in Maharat Nakhon Ratchasima Hospital, Thailand: A case report of mandibular reconstruction	Boonserm Nerysungnoen	Suranaree University of Technology, Thailand
15:40 – 16:10	Proportional topology optimization – A gradient-free algorithm and its applications in 3D printing	Tran Tuan Minh	Vietnamese-German University, Vietnam
16:10 –16:20	Break		

SESSION 2: OPTIMIZATION & ADDITIVE MANUFACTURING

Chair: **Klaus Hackl**

Location: https://zoom.us/j/5869532904?pwd=cU90M0R3M0Vzamp3cHZRblFtYWV2Zz09

Time	Content (Title)	Speaker	Affiliation
16:20 – 16:50	Model-free data-driven simulation of inelastic materials using tangent space information	Klaus Hackl	Ruhr-Universität Bochum, Germany
16:50 – 17:20	Multiscale modelling and optimization of flexoelectric nano structures	Xiaoying Zhuang	Leibniz Universität Hannover, Germany
17:20 – 17:40	A parallel differential evolution with cooperative multi-search strategy on the CPU with C-CUDA	Ha The Viet	Vietnamese-German University, Vietnam
17:40 – 18:00	Modelling of Meta Concrete Structures Manufactured by 3D Printing	Nguyen Van Vuong	RMIT University, Australia
18:00 – 18:20	Mechanical and hydrodynamic characteristics of emerged porous gyroid breakwaters based on triply periodic minimal surfaces	Dang Bao Loi	Ghent University, Belgium
18:20 – 18:30	Break		

SESSION 3: MACHINE LEARNING & OPTIMIZATION

Chair: **Timon Rabczuk**

Location: https://zoom.us/j/5869532904?pwd=cU90M0R3M0Vzamp3cHZRblFtYWV2Zz09

Time	Content (Title)	Speaker	Affiliation
18:30– 19:00	Prediction of optimal design based on data-driven geometries	Hoang Van Nam	Vietnam Maritime University, Vietnam
19:00 – 19:30	Thermodynamic topology optimization and its application to additive manufacturing	Dustin R. Jantos	Leibniz Universität Hannover, Germany
19:30– 20:00	Surface texture characterization and prediction using machine learning approaches for additive manufacturing	N. Arunachalam	Indian Institute of Technology Madras, India
20:00 – 20:30	Machine learning based solutions of PDEs	Timon Rabczuk	Bauhaus University Weimar, Germany
20:30 – 21:00	Model-constrained deep learning approaches for inference, control, and uncertainty quantification	Tan Thanh Bui	The University of Texas at Austin, USA
21:00 – 21:30	Machine Learning Boosted Data-driven Modeling and Simulation of Additive Manufacturing: Process, Structure and Property	Lei Chen	University of Michigan-Dearborn, USA

CLOSING REMARK

USING 3D PRINTING FOR PREOPERATIVE PLANNING IN MAHARAT NAKHON RATCHASIMA HOSPITAL, THAILAND: A CASE REPORT OF MANDIBULAR RECONSTRUCTION

Boonserm Nerysungnoen[1,*] , Wiwat Chatwongwan[2], Pujjai Nuengkota[2], Siriparinya Poontananggoon[3], Jessada Tanthanuch[4]

[1]Department of Radiological Technology, Faculty of Allied Health Sciences, Thammasat University, Thailand

[2]Department of Dentistry, Maharat Nakhon Ratchasima Hospital, Thailand

[3]Department of Radiology, Maharat Nakhon Ratchasima Hospital, Thailand

[4]School of Mathematics, Institute of Science, Suranaree University of Technology, Thailand

[*]Email: booncartoongm@gmail.com

Abstract

Currently, the 3D printing is applicable in many fields. The objective of this case report is to show the application of 3D printing to oral and maxillofacial surgery planning at Maharat Nakhon Ratchasima Hospital, Thailand, which is used as a role model for the treatment of oral and maxillofacial surgery patients. The proposed processes are constituted as follows. The patient's CT image was processed into 3D STL image file. The obtained 3D image was symmetrically manipulated to be a new 3D image of normal structure face. The edited 3D image was validly checked by a radiologist and then it was printed out by the 3D printer. Finally, the dentists, oral and maxillofacial surgery, used the 3D model for planning in the surgery operation of mandibular reconstruction. The patient had successfully undergone surgery to replace the right lower jaw. The surgery with the 3D printing aid reduced the processing time to 6 hours, while it took 7.5 hours in a traditional surgery without 3D printing supporting. This case will be further used as a role model for a treatment of patients.

Keywords: 3D printing, 3D model, mandibular reconstruction, oral and maxillofacial surgery.

Biography

Education:

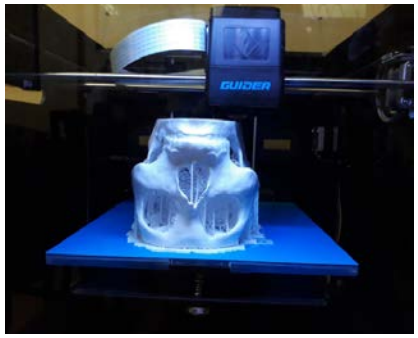
- (2016) Doctor of Information Science (Information Technology), Suranaree University of Technology, Thailand.
- (2013) Master of Science (Mathematics and Technology for Teaching), Nakhon Ratchasima Rajabhat University, Thailand.
- (2008) Master of Science (Medical Imaging), Chulalongkorn University, Thailand.
- (2005) Bachelor of Science (Radiological Technology), Khon Kaen University, Thailand.

Work:

- A lecturer at Department of Radiological Technology, Faculty of Allied Health Sciences, Thammasat University, Thailand.

Research Area of Interest: Image Processing; Artificial Intelligence**;** Diagnostic Radiography.

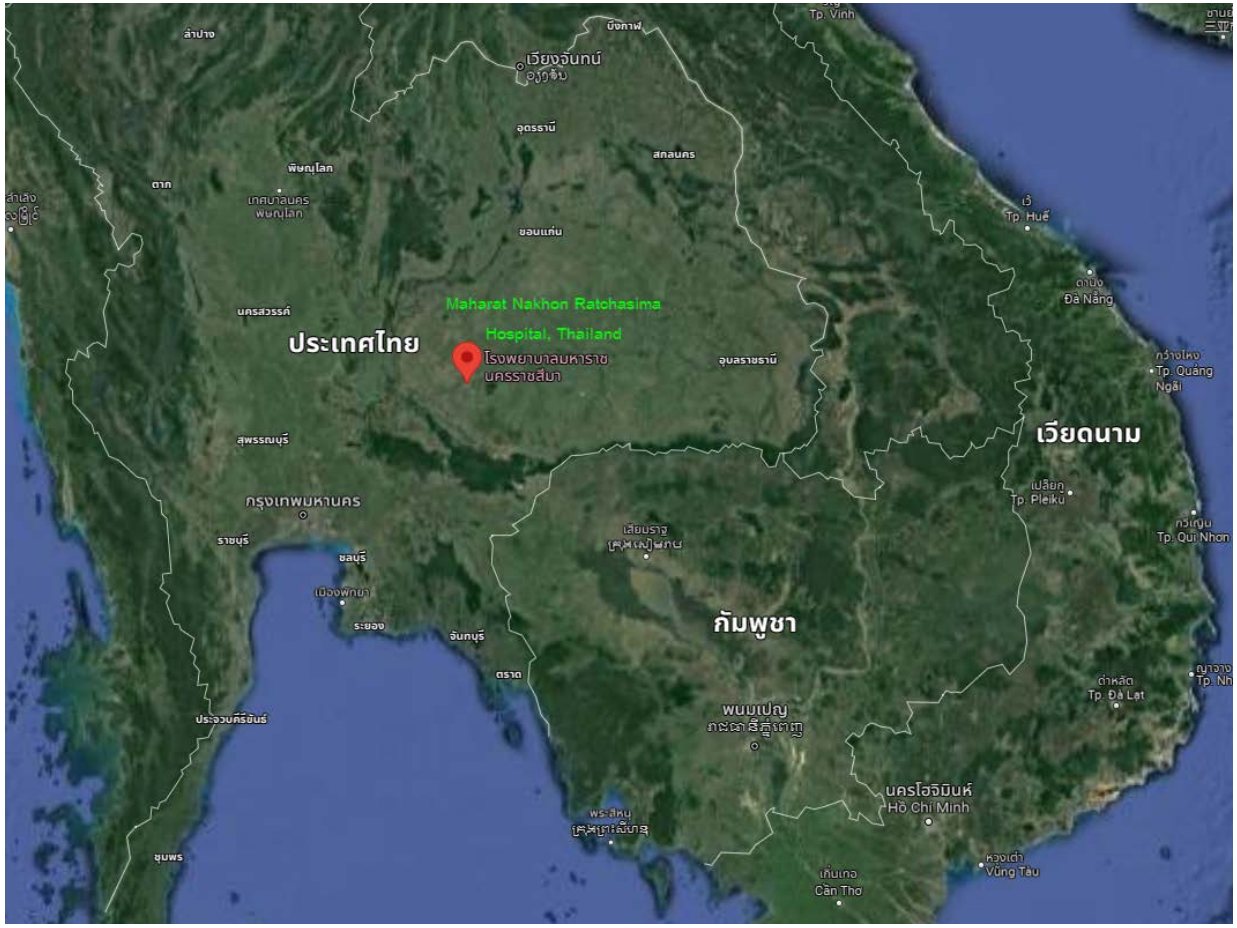
Using 3D printing for preoperative planning in Maharat Nakhon Ratchasima Hospital: A case report of mandibular reconstruction



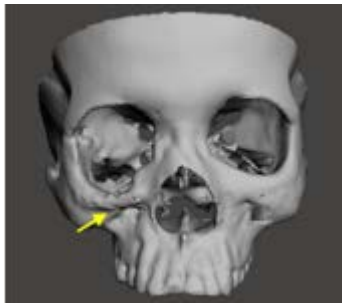
Boonserm Nerysungnoen[1], Wiwat Chatwongwan[2], Pujjai Nuengkota[2], Siriparinya Poontananggoon[3], and Jessada Tanthanuch[4]

[1]Department of Radiological Technology, Faculty of Allied Health Sciences, Thammasat University, Thailand
[2]Department of Dentistry, Maharat Nakhon Ratchasima Hospital, Thailand
[3]Department of Radiology, Maharat Nakhon Ratchasima Hospital, Thailand
[4]School of Mathematics, Institute of Science, Suranaree University of Technology, Thailand

Background and Rationale



Oral and maxillofacial surgery patients

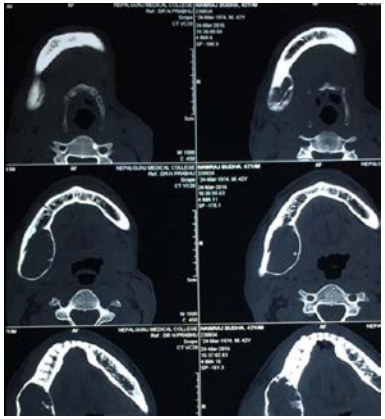


An accident patient

The cancer patient

Congenital abnormalities

The traditional surgery: planning without 3D printing

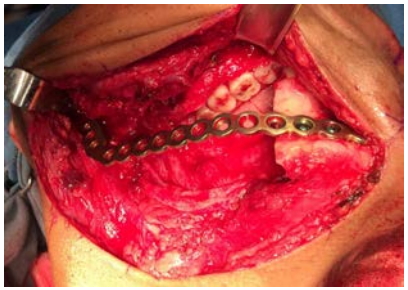


Planning

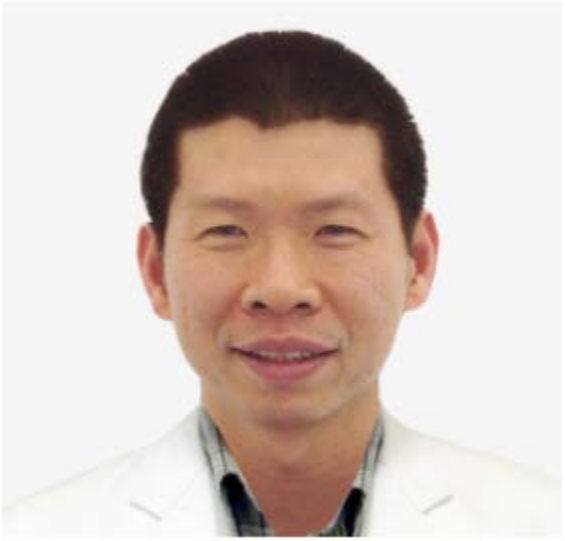
Titanium plate

Fibula bone

The traditional surgery: mandibular reconstruction

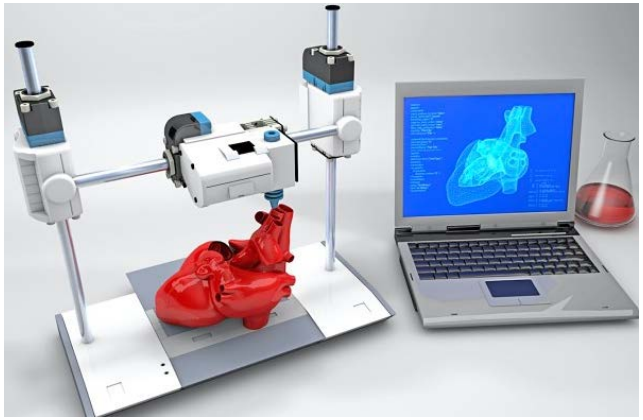


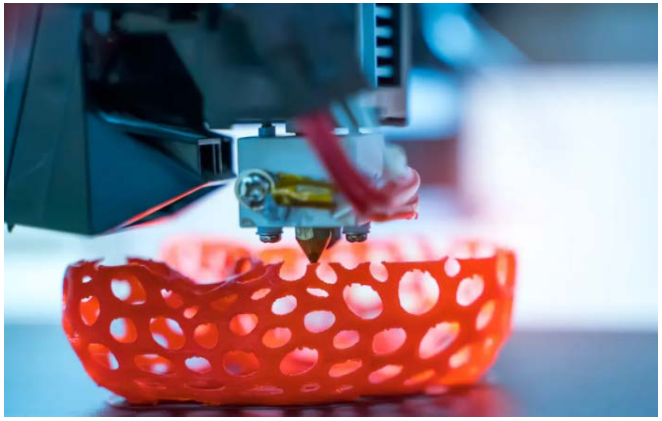
The dentists, oral and maxillofacial surgery



Wiwat Chatwongwan, DDS
Department of Dentistry,
Maharat Nakhon Ratchasima Hospital, Thailand

3D Printing

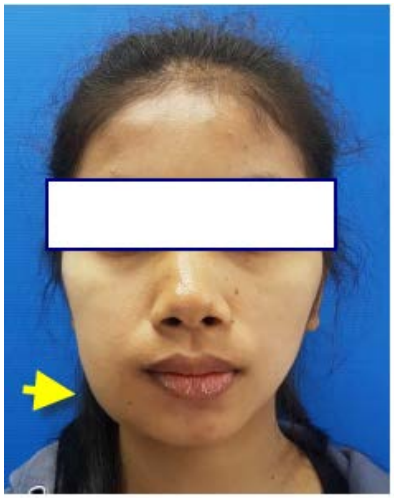


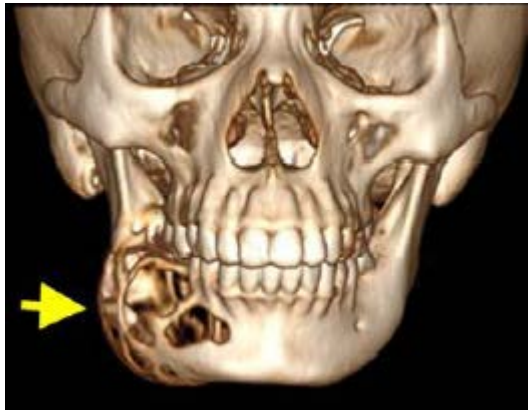


The objective

To show the application of 3D printing to oral and maxillofacial surgery planning at Maharat Nakhon Ratchasima Hospital, Thailand, which is used as a role model for the treatment of oral and maxillofacial surgery patients.

A case report of mandibular reconstruction

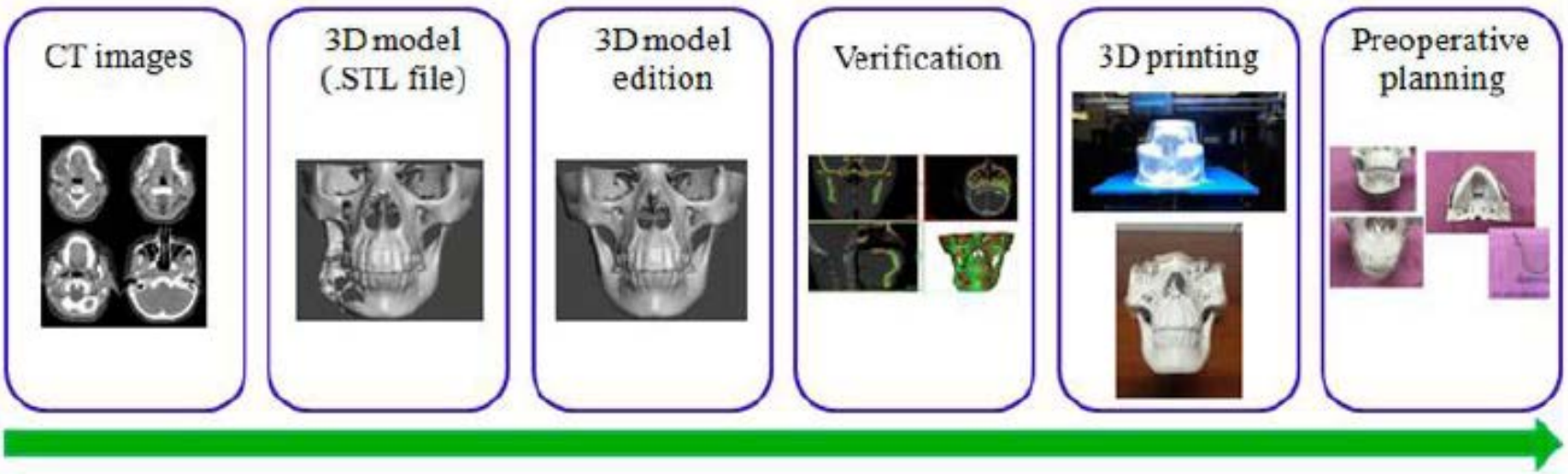




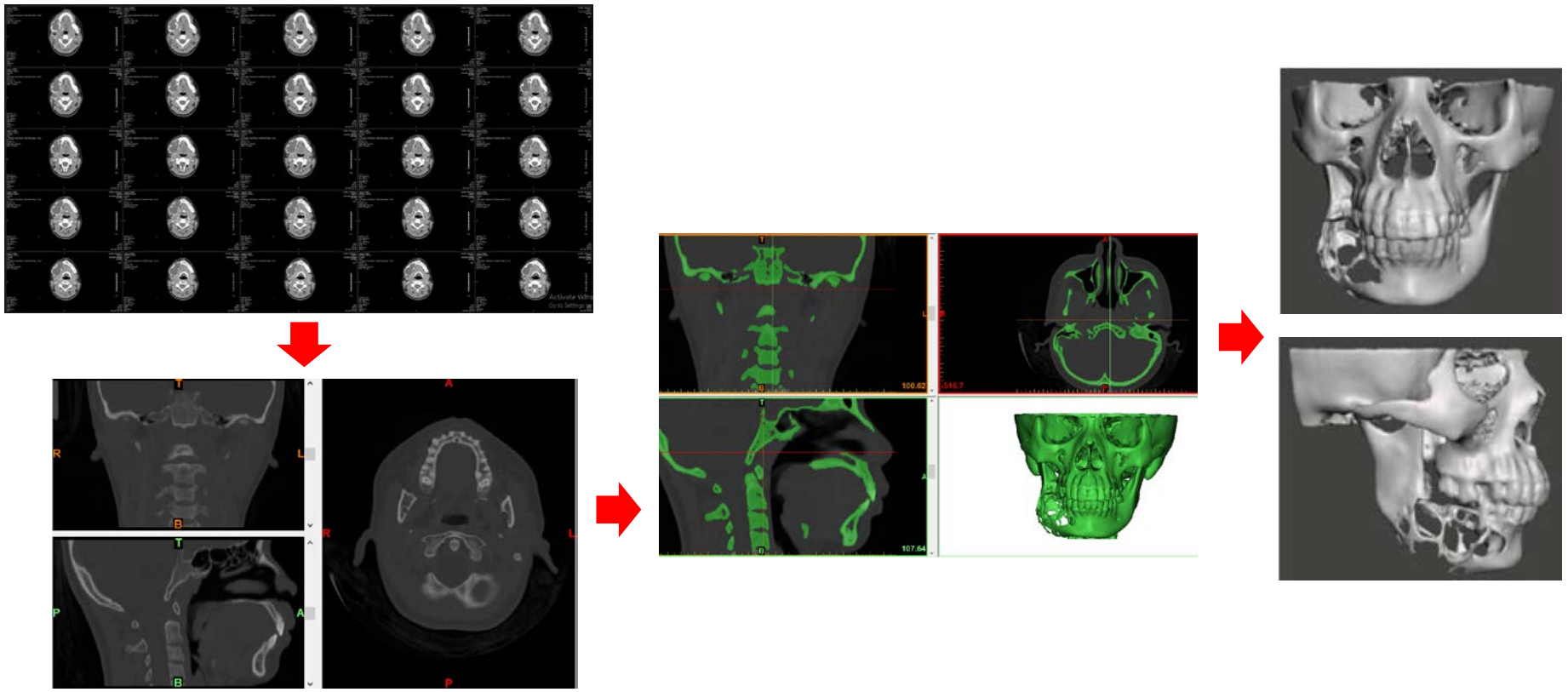
Lab test

Ameloblastoma, solid type at right mandible

Process:
Using 3D printing for preoperative planning

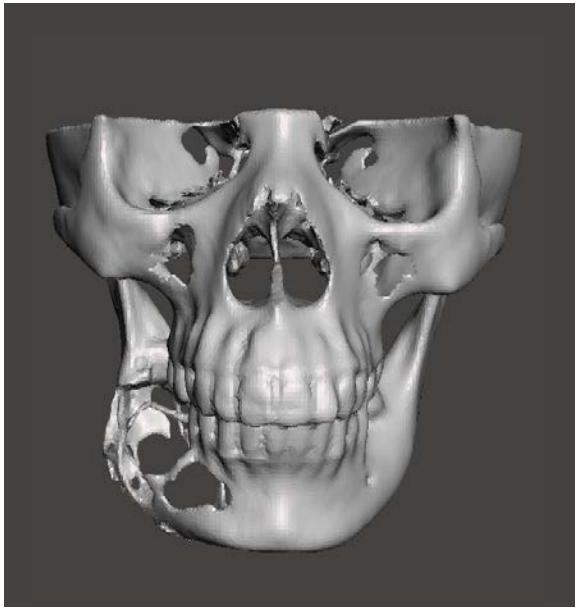


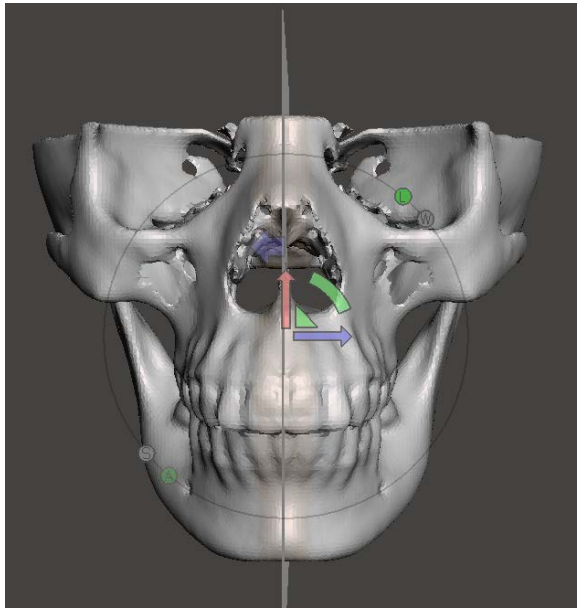
CT images to 3D model (STL file)



Computer Aided Design; CAD

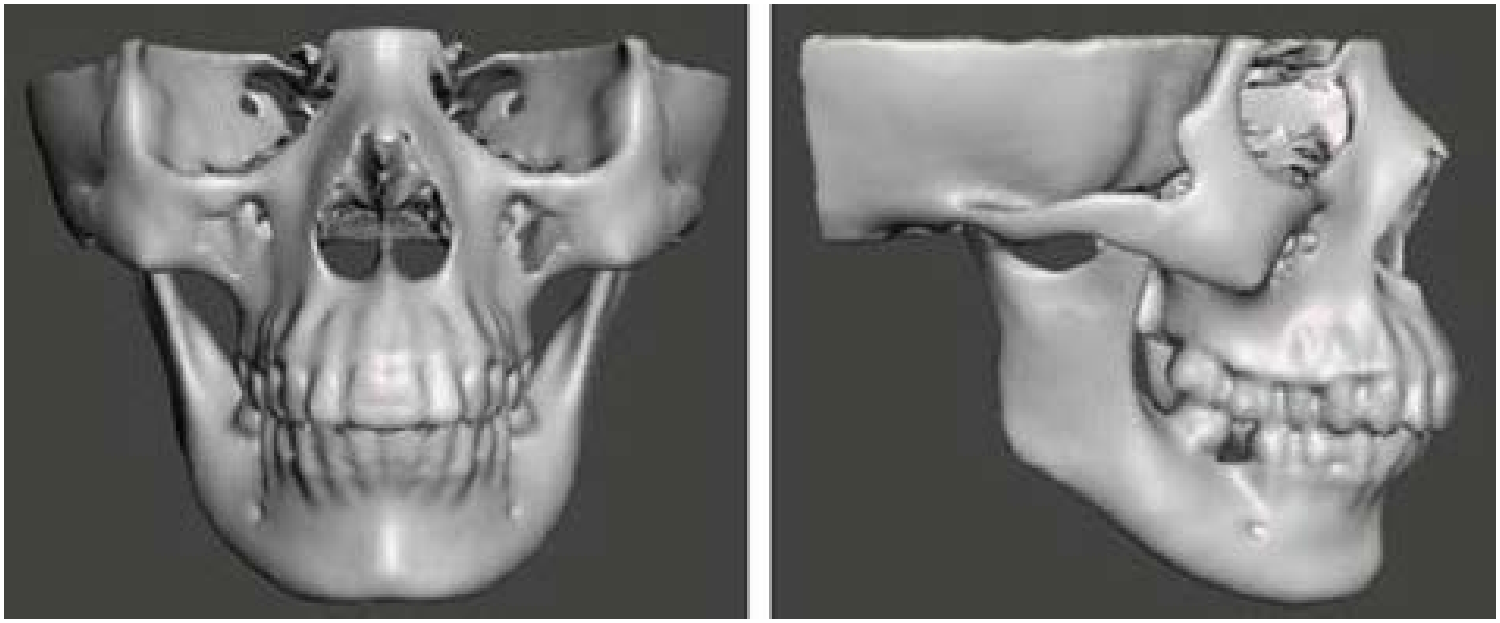
Edited 3D model





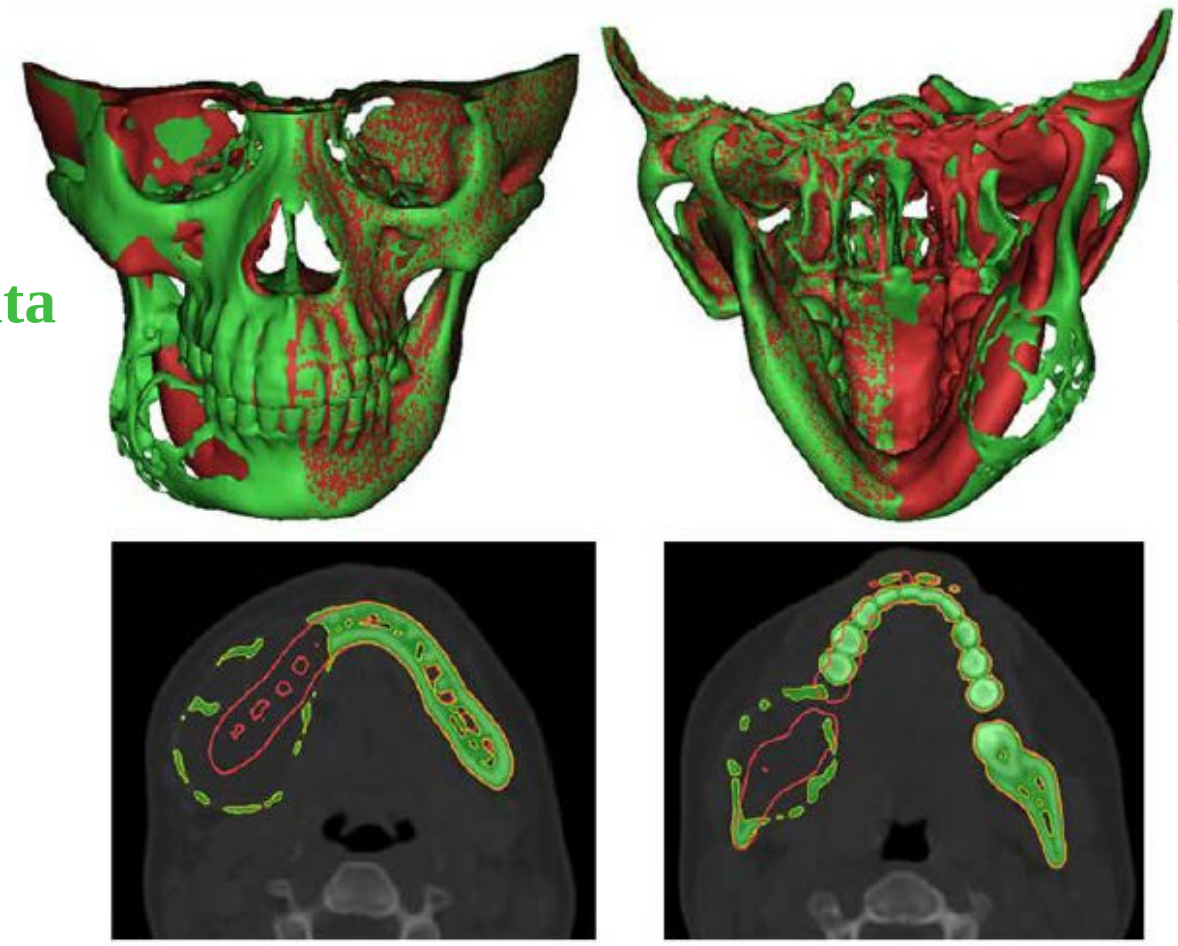
Mirror tool

Edited 3D model



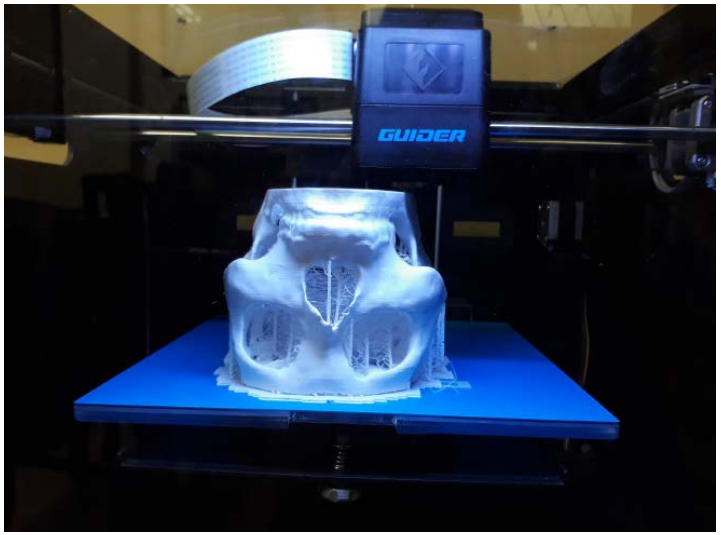
Verification

Patient's data



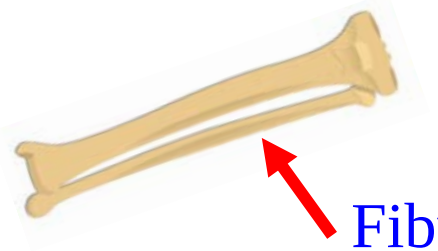
Edited data

3D printing



Preoperative planning

Titanium plate



Fibula bone

The surgery operation of mandibular reconstruction

April 29, 2018

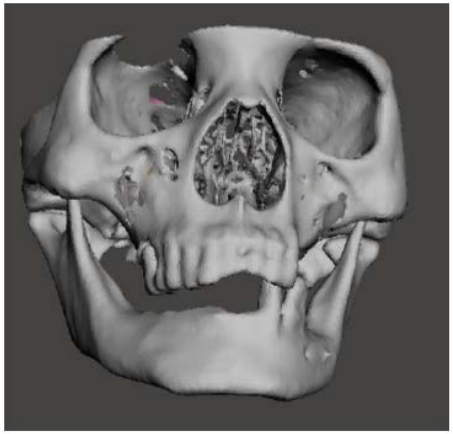
Duration of operation
Using 3D printing = 6 hours
Traditional surgery ≈7.5 hours

Postoperative images

2 days after surgery

45 days after surgery

Later patient

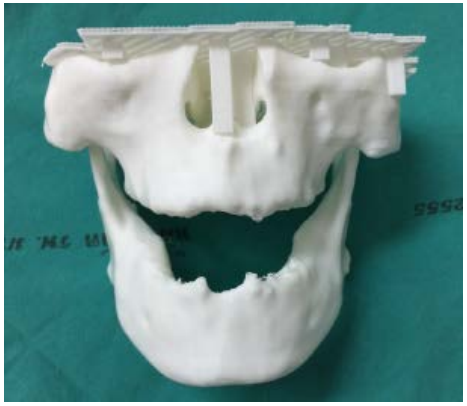


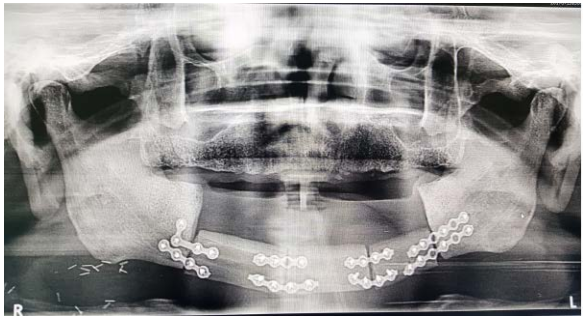
Later patient

Later patient

Later patient

Later patient





Thank you for your attention