



Revolutionizing Jaw Reconstruction through Computer-Assisted Surgery: Delivering Excellence with Patient-Specific Solutions

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Summary of the Impact

1. This case study has revolutionized jaw reconstruction surgery for oral cancer patients by transitioning from traditional computer-assisted surgery (CAS) to the seamless integration of surgeon-dominated virtual surgical planning (VSP) and 3D-printed patient-specific surgical guides and plates (VSP-3DP).
2. This innovative VSP-3DP has enabled precision surgery with streamlined workflows, shorter surgery times, and successful outcomes in over 95% of operated patients.
3. Beyond that, the impact has extended beyond oral and maxillofacial surgery and is demonstrated by the increasing investment in patient-specific surgical plates worldwide.
4. Finally, the case has expedited the digitalization of oral and maxillofacial surgery by leveraging multiple innovative technologies.

Underpinning Research

1. Computer-assisted surgery (CAS) serves as an innovative solution to carefully design the location and orientation of bone segments for optimal jaw reconstruction. The research team innovatively developed the 3D-printed patient-specific surgical plates that serve as a link to transfer the virtual surgical planning to the surgical site (VSP-3DP). This approach streamlines surgical workflows and improves patient outcomes.

Underpinning Research

2. Our research has been initiated since 2016. Ever since then, we have published a total of 25 high-quality peer-reviewed articles, got 4 external grants and 1 HKU platform grant.
3. Prof. Su has hosted a series of international and regional conferences to disseminate this cutting-edge technology. He has been invited to give lectures on this field in USA, Germany, Korea, Japan, India, Malaysia, Taiwan, Malaysia, Indonesia, and Mainland China

Underpinning Research

4. The streamlined workflow significantly increases the efficiency, with each case taking only around **1 week**, much faster than the other centres around the world that usually takes 6 weeks. This shortened preparation is crucial for cancer patients whose surgical intervention cannot be delayed.
5. The innovative approach emphasizes active surgeon participation in preoperative preparation, leading to improved adherence to surgical plans compared to plans generated by companies. Our success rate is as high as **95%**, compared to the 80% success rate in another famous centre in Belgium.

Underpinning Research

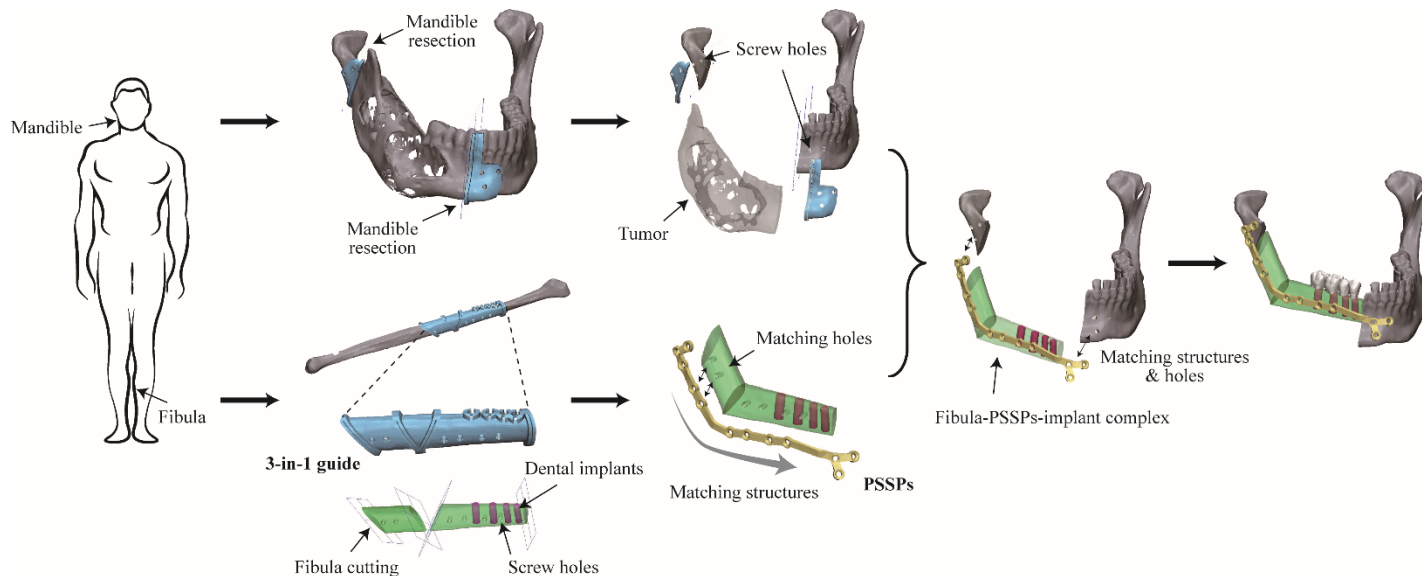
6. The most significant benefit of this approach is the robust clinical accuracy at the **millimeter level** in bone resection and jaw reconstruction, as demonstrated by a series of clinical studies, which is crucial in ensuring adequate oncological survivorship.
7. Another significant functional achievement facilitated by the patient-specific surgical plate is the **simultaneous placement of dental implants** to restore a patient's occlusion on the same day as tumour resection, reducing the need for multiple surgeries and enabling patients to return to their normal lives much earlier.

Underpinning Research

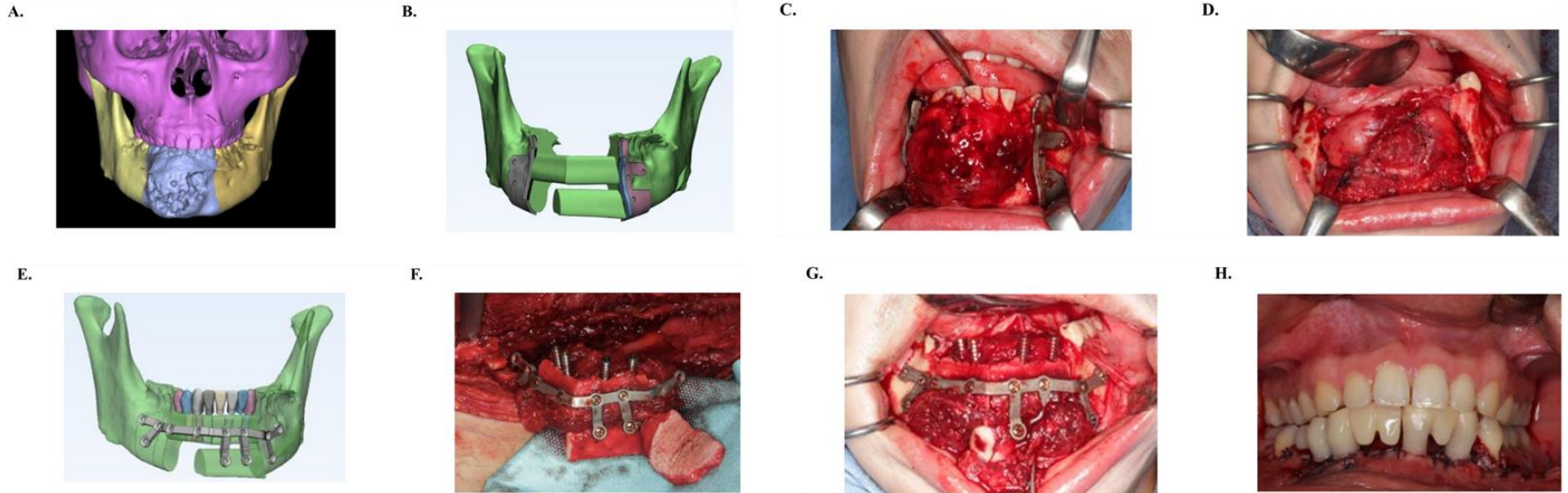
8. The command of key technology has supported our continuous excellence in jaw reconstruction, leading to multiple patient-specific innovations that have refined the surgery, such as the “one-piece” surgical plate for “double-barrel” fibula reconstruction, malleolus-capped surgical guide, “3-in-1” surgical guide”, and various lightweight porous implants.
9. The knowledge and expertise in CAS have driven the research for an integrated technology platform for jaw reconstruction: AI, AR, VR, personalized musculoskeletal modelling, and python scripting, which are expediting the digital transformation of oral surgery.

Knowledge to be Exchanged

This clinically-oriented project has established a streamlined workflow as the routine practice for oral cancer patients, and also for patients with dentofacial deformity, sleep apnea, dentoalveolar abnormalities, which have direct benefits on patients, surgeons, and the healthcare services.

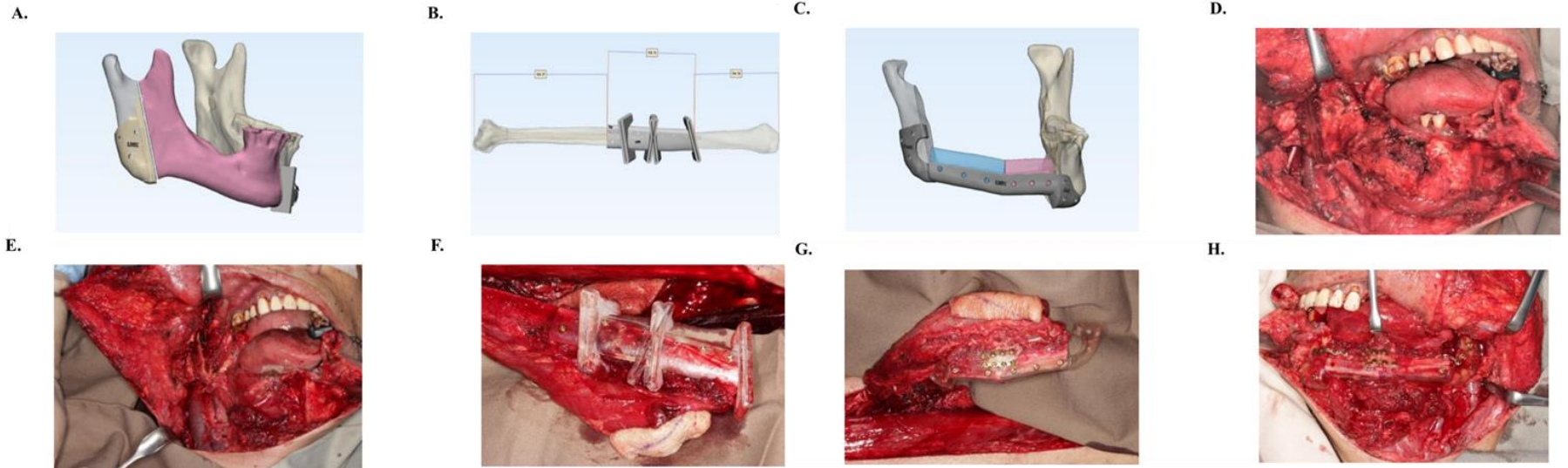


Approach 1: 3D-printed patient-specific titanium surgical plates



A case illustration of a patient using 3D-printed patient-specific surgical plate. A 32-year-old male with ossifying fibroma in the anterior mandible.

Approach 2: 3D-printed patient-specific repositioning surgical guide



A case illustration of a patient in the control group using repositioning surgical guide. A 68-year-old male with squamous cell carcinoma of right mandible.

Engagement

1. This clinically-oriented project has established a streamlined workflow in our centre, the patient-specific solutions have become the routine practice. More than 100 oral cancer patients in our centre have been treated with this cutting-edge approach.
2. This workflow has become the standard of care at our centre and is the mandatory training for all specialist trainees. The knowledge and expertise of CAS can be applied to other practices including dentoalveolar surgery and orthognathic surgery.

Engagement

3. Prof. Su has chaired a series of regional and international webinars to promote this streamlined clinical workflow to specialists in otorhinolaryngology, plastic surgery, and orthopaedic surgery, etc., extending the impact by advancing healthcare services.
 - i. Chair of AO CMF Advance Course-Maxillofacial Plastic and Reconstructive Surgery, 12-14 Aug, 2022, Hong Kong
 - ii. Chair of Global Oral Oncology and Reconstruction Symposium, Mar 19-20, 2021. This is a joint international conference hosted by AOCMF and IAIO (International Academy of Oral Oncology), two major international professional bodies for Oral and Maxillofacial Surgery, Otolaryngology-Head and Neck Surgery, and Plastic surgery. More than 4000 participants from 85 countries attended the conference.
 - iii. Chair of AOCMF Asia Pacific Virtual Conference “State of the Art in Orthognathic Surgery”, Oct 15-16, 2021.
 - iv. Chair of AOCMF Webinar “3D printing in Oral and Maxillofacial Surgery”, May 24, 2020, Hong Kong.
 - v. Chair of AOCMF advanced course “Advances in TMJ arthroscopy and open surgery with anatomical specimens” in May 2018 in Hong Kong.

Engagement

4. Prof. Su has been invited to give lectures in this field in USA, Germany, Korea, Japan, India, Malaysia, Taiwan, Malaysia, Indonesia, and Mainland China, to disseminate the knowledge to international centres.
5. With our accumulating experience in CAS, we have been collaborating with multidisciplinary experts from mechanical engineering, computer science, biomedical science, thereby promoting the research, development, and application of innovative patient-specific solutions.

Engagement

6. We have been collaborating with some high-tech medical device companies in the development of 3D-printed patient-specific devices. The knowledge in designing, manufacturing, post-processing, and quality control have empowered the companies to be ready for industrialization and large-scale production.

Impacts Achieved

Impact on patients:

1. The streamlined workflow has provided patient-specific solutions to more than 100 patients in our centre since 2016.
2. More than half of these patients underwent reconstruction with simultaneous dental implants, significantly reducing the time required for the complete dental restoration.
3. Patient outcomes have been improved in regard of the TMJ function, occlusion, aesthetics, quality of life, and the more comprehensive stomatognathic functions.
4. Overall, the advanced technique has shown a substantial impact on patient outcomes. Up till now, the success rate of this technology has reached over 95%.
5. The technology has been promoted to Queen Mary Hospital, United Christian Hospital, and Prince of Wales Hospital.

Impacts Achieved

Impact on clinical evidence:

1. Our research has provided evidence-based best practices for oral and maxillofacial surgeons and streamlined workflows for healthcare providers.
2. Surgeons have benefited from the increased accuracy and precision of CAS, resulting in improved patient outcomes and reduced costs associated with surgical complications and revisions.
3. Our research findings have been disseminated through publications and presentations at both regional and international conferences, as well as through close collaborations with other research institutions and clinical teams.
4. The research team has been invited to give lectures on this field in USA, Germany, Korea, Spain, Japan, India, Malaysia, Indonesia, Hong Kong, Taiwan, and Mainland China.
5. Our work has been widely cited in the literature as evidence of our excellence in the clinical application of 3D printing technology, including being cited in a recent *Consensus* on orthopaedic trauma surgery and a *News & Views* on CAS published in *Science Bulletin* (impact factor 20.577).

Impacts Achieved

Impact on industrialization:

1. Through continuous research in the field of jaw reconstruction, numerous innovative patient-specific solutions have been developed, leading to significant benefits for patients.
2. One notable solution, the malleolus-capped surgical guide, had been granted patents in both the US and China, while other patents are currently under application.
3. Furthermore, the long-term collaboration with some high-tech companies has allowed for the accumulation of manufacturing capabilities for patient-specific titanium surgical plates, encompassing diverse technologies in 3D printing, post-processing, and quality control. These technologies are now fully developed and ready for industrialization.
4. Finally, the impact on industrialization has also been demonstrated by increasing investment in patient-specific surgical plates worldwide, indicating that there is growing recognition of the importance and potential impact of the patient-specific solutions in jaw reconstruction and even a wider field of surgery.

Maximum no. of slides:

20

(including the title slide)