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Utilizing virtual surgical planning and three-dimensional-printed osteotomy guides in fibular free flap reconstruction can achieve a better result in mandibular osteoradionecrosis patient

KEYWORDS

Osteoradionecrosis of the jaw;
Virtual surgical planning;
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Mandibular reconstruction;
Fibular free flap

Osteoradionecrosis of the jaw (ORNJ) is an uncommon and intractable complication after radiotherapy for patients with head and neck cancer.¹ The most severe consequence of uncontrolled ORNJ is pathologic fracture. The difficulty in treating this problem is because of not only the malocclusion and facial deformity but also the poor blood supply and severe loss of tissue volume. The fibular free flap reconstruction is the most common treatment of choice for this situation.² However, the post-operative profile and jaw relationship sometimes are compromised. Here we presented our experience in reconstructing an ORNJ patient with a major mandibular defect by virtual surgical planning system and three-dimensional (3D)-printed osteotomy guides. The poor patient's esthetic demand was fulfilled successfully.

This 56-year-old male patient was diagnosed as having pT1N1M0 squamous cell carcinoma (SCC) of the right buccal mucosa in 2014 and pT1N2bM0 SCC of left tongue border in

2017. After multiple surgeries and concurrent chemotherapy and radiotherapy, ORNJ and pathologic fracture were diagnosed due to malocclusion and facial deformity in January 2020 (Fig. 1A). Through a series of physical and radiographic examinations, the major part of the mandible, from the right mandibular angle to the left body, could not be preserved anymore (Fig. 1B). Mandibulectomy and a fibular free flap reconstruction were suggested to the patient. In consideration of the post-operative profile, the patient asked for virtual surgical planning (VSP). By using VSP (Proplan CMFTM, Materialise), we could reposition the displaced mandibular fragments to the original position and rebuild the mandibular contour (Fig. 1C). The range of mandibulectomy and the fibular free flap was then decided and the cutting guides could be designed accordingly (Fig. 1D and E). Different fibular segment numbers and wedge designs were evaluated on the VSP system for choosing the best solution in this stage. The optimal combination of linear and wedge osteotomies could be decided and intergraded into one fibular osteotomy guide (Fig. 1F). A fibular bone placing guide was also made to have an accurate plating process (Fig. 1G). After carefully executing the operations with these guides on April 8, 2020, the post-operative profile and jaw relationship were alike our predictions and the patient was satisfied with his result with good healing (Fig. 1H).

Presurgical VSP and performing osteotomy with a 3D-printed surgical guide is a mature concept and has been widely accepted in cosmetic bone surgery.^{3–5} Many ORN patients suffered from facial deformity due to pathologic fracture and tissue loss. With VSP, surgeons can virtually reproduce the patient's profile before surgery and simulate the possible curvature of the fibular flap. Although

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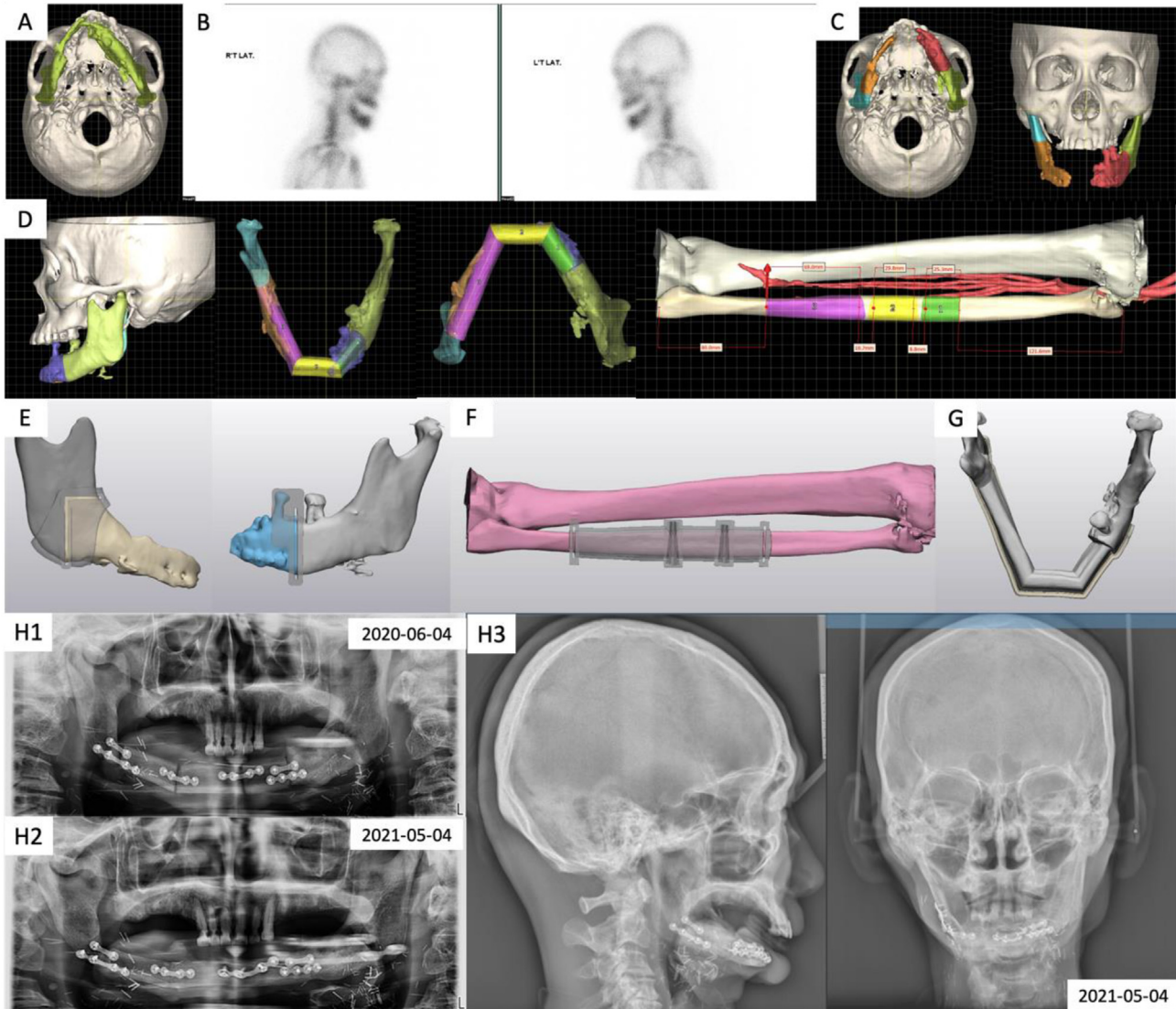


Figure 1 (A) Preoperative 3D virtual models showing mandible fracture with displacement. (B) Preoperative right lateral and left lateral whole body bone scan showing osteonecrosis area (enhance region). (C) The illustration of virtual surgical planning (VSP) of repositioning the mandible fragments to restore emergency profile. (D) The illustration of VSP of the reconstructed mandible (lateral view, superior view, inferior view) and the range of fibular free flap. (E) Mandibular cutting guides of the right mandibular angle and the left mandible body. (F) Fibular osteotomy guide used to perform osteotomies. (G) Fibular bone placing guide for the fibular free flap. (H1) Two-month postoperative panoramic radiographs. (H2) One-year postoperative panoramic radiographs showing the well-healed fibular bone. (H3) One-year postoperative lateral (left) and postero-anterior (right) cephalometric radiographs showing satisfied profile and jaw relation.

more fibular segments could attribute to better curvature for reproducing the original mandibular contour, it also increased the risk of microvascular failure.² With VSP, surgeons can find out the best surgical solutions such as the number of segments and avoid unnecessary risk. The jaw relation and occlusion can also be evaluated at the same time. Therefore, shorter operation time and a better esthetic result can be expected. However, this protocol was still not consistently carried in cancer-related reconstructive surgery. This might be due to the long operation time and high cost for the surgery.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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