

Mandibular Reconstruction using Simulation Surgery with 3D RP Model in Osteoradionecrosis Patient: A Case Report

Tae-Jun Park, D.D.S., Hong-Joon Kim, D.D.S., Kang-Min Ahn, D.D.S., M.S.D., Ph.D

Department of Oral and Maxillofacial Surgery, College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea

One of the most serious complications after head and neck radiation is osteoradionecrosis (ORN) of the jaw. The etiology of ORN is extraction, minor dental procedure or dental implant surgery. When ORN of the jaw progressed to stage III, free fibular flap is the most useful methods for reconstruction. In this case report, a 67-year-old ORN patient who underwent fibular free flap reconstruction using simulation surgery with 3-dimensional rapid prototype (3D RP) model was reviewed. After partial mandibulectomy, a osteocutaneous fibula flap was used for reconstruction. Oro-cutaneous fistula was resolved after operation. Patients reported improved food intake after operation without pus discharge. Functional and esthetic results showed successful reconstruction.

Key Words 3D RP model · Simulation surgery · Fibula free flap · Reconstruction · Osteoradionecrosis.

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Address for correspondence: Kang-Min Ahn, D.D.S., M.S.D., Ph.D.

Department of Oral and Maxillofacial Surgery, College of Medicine, University of Ulsan, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea

Tel: 82-2-3010-5901, **Fax:** 82-2-3010-6967, **E-mail:** ahnkangmin@hanmail.net

Introduction

One of the most serious complications after head and neck radiotherapy is osteoradionecrosis (ORN) (1, 2). The common causes of ORN are dental extraction, minor oral surgery, dental implant and denture wearing (3). Extensive ORN of the jaw involving inferior border or oro-cutaneous fistula need segmental resection of the jaw bone and free flap reconstruction. Free fibula flap is the most useful flap for maxilla-mandibular hard and soft tissue reconstruction especially in mandibular reconstruction (4-7). However, free fibula reconstruction needs such a long period of operation time and is classified in high-technology operation with high risk. Neck incision, exposure of the mandible, fibula flap harvests and bending of the straight fibula bone require at least 5-7 hours. Microsurgery in the neck with one peroneal artery and two veins also require at least 30-60 minutes. Especially in ORN patient, irradiated neck usually showed vessel depletion and is very hard to dissect. The most efficient ways to reduce operation time is to do repeated microsurgical experiment

and simulation surgery with virtual 3-dimensional (3D) model (8). Surgical stent and 3D rapid prototype (RP) model give lots of ideas and concepts before surgery. Titanium reconstruction plate could be bended before surgery with 3D RP model which is made just the same size with patient's original mandible. Prebended plate could easily be adapted during surgery.

In this case, ORN patient who underwent mandibulectomy and osteocutaneous fibular free flap reconstruction using simulation surgery was reviewed.

Case Report

A 67-year-old female was referred from local dental clinic for treating delayed healing of the extraction socket in the left mandible. Patient had undergone left side tonsillectomy and radiotherapy in 2006. After her first treatment, tonsil cancer was completely resolved. She did not have any medical diseases except tonsil cancer. Total radiation dose was 60 cG without intensity modulation. During 6 years after radiotherapy, she showed no

discomfort such as trismus, pus discharge or fistula.

In December 2012, #37 tooth was fractured and she visited local dental clinic. Her second molar was extracted under local anesthesia. Extraction socket did not heal spontaneously after extraction. She had taken antibiotics for 2 months after extraction. Her local dentist recommended to receive hyperbaric oxygen (HBO) therapy. She had dived 40 times at 2.4 atm for 90 minutes. Her symptom had not improved after HBO therapy. Initial panoramic radiograph showed bone destruction in the #37 area with irregular margin (Fig. 1).

Saucerization of the #37 area under general anesthesia was performed in September 2014 (Fig. 2). During operation, necrotic bone and loss of vascularity were found in the left mandible. Collagen plug (Ateloplug, Bioland co., Cheonan city, Korea) was inserted and sutured.

One month after operation, extraoral fistula on the mandibular angle was found. Pus discharge, numbness of the lip and pain were accompanied. Computed tomograph (CT) scan and panoramic radiograph showed aggravated bone destruction in the mandible. After consultation with radiation oncologist, operation was performed under general anesthesia in December 2014.

For simulation surgery for mandibular reconstruction, 3D



Fig. 1. Initial panoramic radiograph taken in September 2013. Bone destruction is found in #37 tooth extraction site.



Fig. 2. Saucerization of the left mandible. Empty bone marrow space is observed.

rapid prototype (RP) model was made with 3D computed tomographic (CT) scan data. The extent of the mandibular resection was determined by the CT scan evaluation and clinical examination. Five centimeter of bone was planned to remove and free fibular flap was chosen for reconstruction. Surgical stent was made with acrylic resin. Reconstruction plate made of titanium (Leibinger, Stryker, San Diego, USA) was bended for fixation according to the 3D RP model.

Skin incision was performed in the neck including skin fistula. Mandible was exposed and resected according to the simulation surgery. Reconstruction plate was applied and fixed with bicortical screws. Left side osteocutaneous fibular free flap was harvested (Fig. 3). According to the angiography, right side vessels were depleted because of the previous neck dissection.

Free fibula flap was inserted into the mandibular defect and fixed with bicortical screws. Right side facial artery was used for feeding artery and the facial vein and external jugular vein were anastomosed with venae comitantes accompanying with peroneal artery. Skin island in the fibula flap was sutured with



Fig. 3. Left side osteocutaneous fibula flap harvest.



Fig. 4. Intraoral healing two months after operation.



Fig. 5. Panoramic radiograph of mandibular reconstruction with a free fibula flap (postoperative one year).

intraoral mucosa with absorbable sutures. Total operation time was 4 hours and 28 minutes. Postoperative healing was uneventful. Overnight intubation was performed without tracheostomy. One day intensive care unit care was enough for immediate postoperation recovery. Patient was discharged 10 days after operation. Gait was not completely recovered until 2 months. Intraoral healing in two months after operation showed complete matching with mucosa without any discomfort (Fig. 4).

Panoramic radiograph of one year after operation showed reconstructed mandible with fibular flap fixed with reconstruction plate and bicortical screws without any bone resorption (Fig. 5). Patient showed good occlusion and could eat any foods including meat and Korean dish.

Discussion

Stage III ORN involves the basal bone of the mandible and causes pathologic fracture, pus discharge and cutaneous fistula (6, 9). Surgical intervention of BRONJ should be approached prudently. Debridement is easy with surgical bur, however primary closure is hard to achieve. The inflamed tissues are not easy to suture and usually shortage of the soft tissue always cause re-exposure of the bone. In the maxilla, buccal fat could be lined over the bone and layered suture is possible. In the mandible, usually primary suture is not easy and exposure of the bone causes progression of ORN. The ultimate solution for stage III ORN is free flap reconstruction. The choice of flap depends on the extent of the tissue defect, surgeon's experience and facility of the hospital. For mandibular reconstruction, fibula bone is the flap of the choice because of its advantages such as long bone available, long pedicle, simultaneous hard and soft tissue harvest, and customized osteotomy for mandibular contour (4, 7, 10).

However, complication rate of the fibula free flap reconstruction in ORN patient is higher than other oncologic patients because of vessel depletion (11). Ipsilateral side anastomosis is not possible if the neck was dissected and irradiated. To use the contralateral side vessels, long pedicle should be harvest during

surgery. To get long pedicle, 5 cm of fibula in the proximal bone was left in this patient. The pedicle was 12 cm in total. Dissection in radiated skin and neck is quite difficult due to skin adhesion. Preoperative angiograph is necessary to evaluate the possible feeding vessels. In this patient, contralateral side facial artery was dissected and anastomosed with the peroneal artery. To get as long pedicle as possible is mandatory and it should be planned before fibula harvest. To avoid nerve damage in the proximal site of the fibular bone, at least 5 cm of bone should be remained and preserved. Selection of the fibula bone is also quite important in contralateral side fibula flap. When we plan intraoral skin island with contralateral side anastomosis, ipsilateral side fibular should be harvested because of the vascular pedicle. If ipsilateral side fibula bone has been harvested, the vascular pedicle is located in the distal side of the flap which makes it easier to suture with contralateral side feeding vessels.

In this patient, there was no complication after operation. Patient was satisfied with their results and function of the mandible was restored. Total operation time was less than five hours from skin incision to suture. Operation could be reduced because of the simulation surgery and prebending of the reconstruction plate. Recently, digital work for mandibular reconstruction was performed in many institutions (8, 12-14). Further study with digital technology could make operation more efficient and quicker compared with conventional methods.

Conclusion

Simulation surgery using 3D RP model in mandibular reconstruction of ORN patient makes operation efficient and accurate. Functional and esthetic results were successful in this female patient.

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