

Research Article

## Composite Mandibular Reconstruction with Liquid Nitrogen-Treated Autograft and Pectoralis Major Flap

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### Abstract

Segmental mandibular defects are typically reconstructed with vascularized bone grafts. Free transfer grafts require microvascular anastomosis, which may be difficult in vessel-depleted necks and high-risk patients. We report a case of squamous cell carcinoma of the lower gingiva involving the mandibular bone. We performed a combination of frozen autograft and pectoralis major (PM) flap to reconstruct the mandibular defect. The tumor was resected en bloc with a mandibular segment. To reconstruct the oral defect, we used liquid nitrogen-treated autograft. The PM flap was wrapped around the reconstructed mandible. Frozen autograft and PM flap combined is both oncologically and cosmetically a good procedure in contemporary oral and maxillofacial surgery.

**Keywords:** Liquid Nitrogen; Autograft; Mandibular Reconstruction

### Introduction

Several procedures are currently used to reconstruct bony and soft tissue defects after segmental bone resection of an oral malignancy [1]. Functional and aesthetic outcomes depend on good reconstruction of both the soft tissue and bone [2]. The use of free vascularized bone, such as fibula osteoseptocutaneous flap or iliac crest, represents a general procedure for reconstructing soft tissue and bony defects in oral and maxillofacial surgery with the maturation of microvascular surgery techniques [3,4]. The bone reshaping required to obtain a good morphological result and optimal occlusion is not easy, and has been associated with severe donor site morbidity [5]. Free transfer flap also requires recipient vessels, at least 1 artery and 1 vein for microsurgical anastomosis. However,

a major limitation is the availability of suitable recipient vessels in patients with a vessel-depleted neck after multiple neck surgeries.

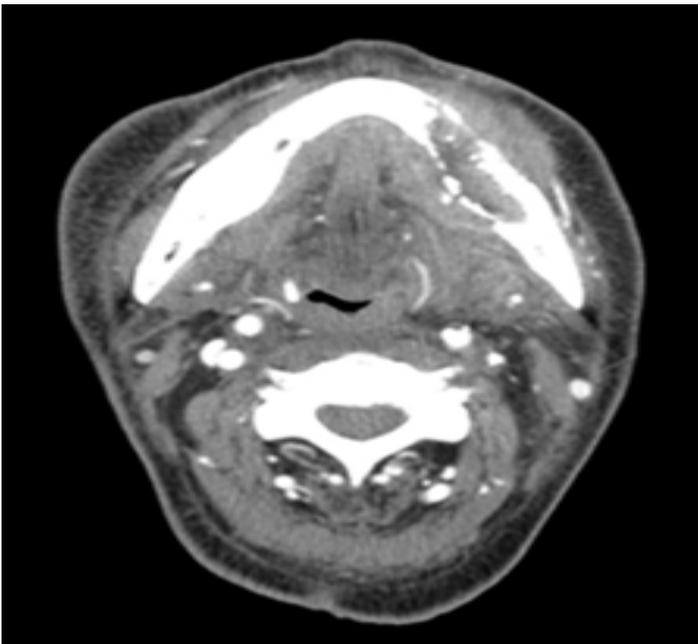
Cryosurgery, immediate mandibular reconstruction using tumor-bearing autografts treated with liquid nitrogen, was performed in the 1970s [6]; however, local failure occurred in 70% of cases due to salivary contamination. Sealing the oral cavities of patients with well-vascularized flaps may overcome these problems [7].

We performed a combination of frozen autograft and pectoralis major (PM) flap to reconstruct a mandibular defect in a patient with a vessel-depleted neck after multiple neck surgeries. This procedure was approved by the Internal Review Board of

Kanazawa University Hospital.

## Case report

A 67-year-old male was referred to our hospital complaining of pain and bleeding in the left lower gingiva for two months. His past medical history was considerable for laryngeal cancer. He underwent neck surgeries several times, including total laryngectomy, salvage anterolateral thigh flap reconstruction due to a salivary fistula, and pharyngectomy with free jejunal graft reconstruction because of severe pharyngeal stenosis. Squamous cell carcinoma of the lower gingiva was diagnosed based on pathological examination. Computed tomography revealed osteolytic invasion of the mandibular bone (Figure 1).



**Figure 1.** Cervical computed tomography. Carcinoma of the gingiva invading the mandibular bone.

The tumor was resected en bloc with a mandibular segment. The soft tissue and tumor attached to the mandible were removed (Figure 2A). Multiple fenestrae were drilled in the bone to facilitate revascularization. The bone segments thus prepared were then immersed in liquid nitrogen at  $-196^{\circ}\text{C}$  for 20min (Figure 2B), thawed for 15min at room temperature, and submerged in distilled water for 15min. The mandibular segment was reimplanted into its normal anatomical position and fixed with a single titanium reconstruction plate (Figure 2C, D). The PM flap was elevated and pulled through a tunnel created from the submandibular region to the intraoral mucosal defect to cover the mucosal defect (Figure 2E). The PM flap was wrapped around the reconstruction mandible and sutured to the surrounding oral mucosa to avoid exposure of the mandibular reconstruction plate (Figure 2F). The pedicle of PM flap was resected one month after the first surgery. CT

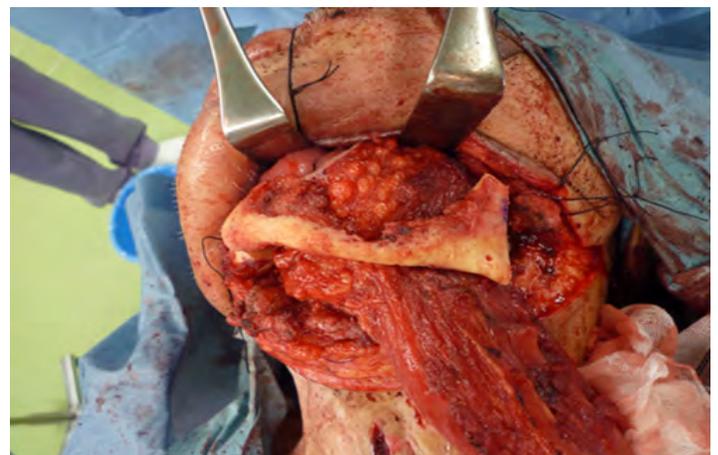
showed that the reimplanted grafts survived with no loss of thickness one month after surgery. The patient was able to eat soft food and drink.



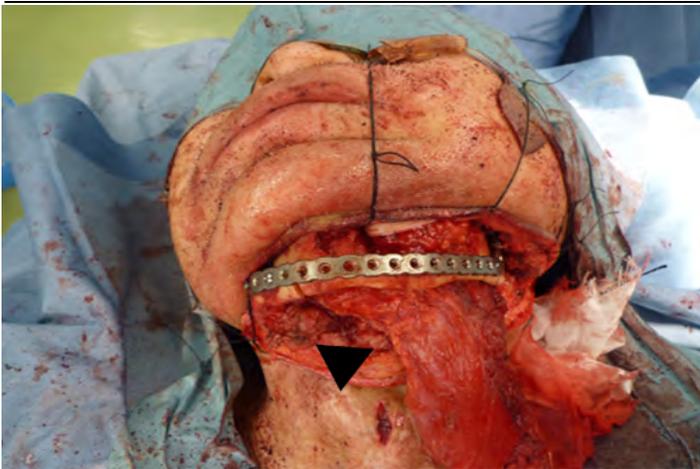
**Figure 2A.** The resected mandibular segment. The soft tissue and tumor attached to the mandible was removed.



**B:** Liquid nitrogen treatment. Bone segments were immersed in liquid nitrogen at  $-196^{\circ}\text{C}$ .



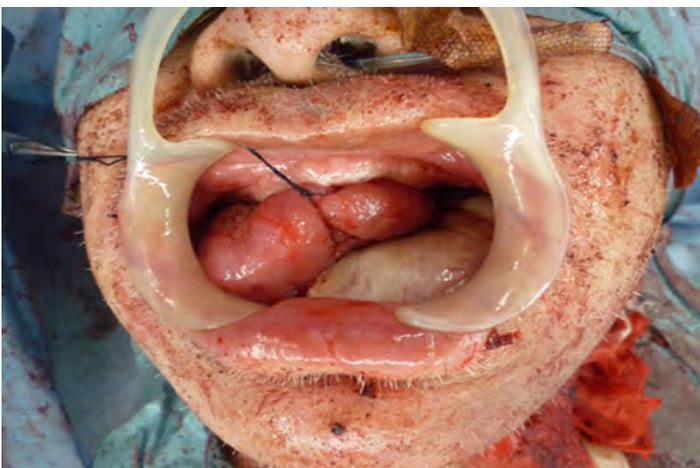
**C:** The mandibular segment was reimplanted into its normal anatomical position.



**D:** The autograft was fixed with a single titanium reconstruction plate. The PM flap (arrow head) was wrapped around the reconstructed mandibular bone.



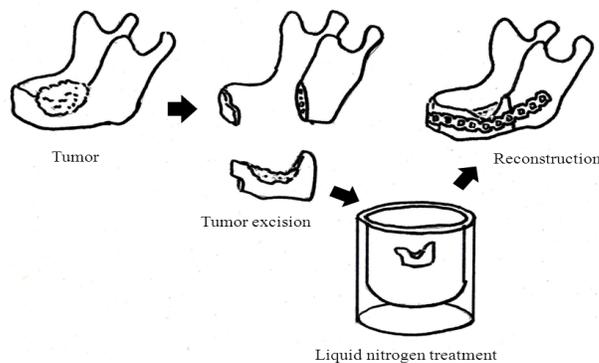
**E:** The PM flap was pulled through a tunnel created from the submandibular region to the intraoral mucosal defect.



**F:** The PM flap was wrapped around the reconstruction mandible.

### Discussion

Segmental mandibular defects are typically reconstructed with vascularized bone grafts. Free transfer grafts require microvascular anastomosis, which may be difficult in vessel-depleted necks and high-risk patients. Plate reconstruction or leaving a free-floating mandible with only soft-tissue reconstruction was previously regarded as well tolerated [8]. However, plates with PM flap reconstructions always carry the risk of infection and plate exposure. To overcome these problems, we performed frozen autogenous mandibular graft and PM flap to reconstruct the bony and soft tissue defect. Frozen autogenous lesioned mandibles act as a supporting framework for the surgical defect (Figure 3).



Cryosurgery selectively destroys tissue by the controlled use of alternating freezing and thawing, which may form ice crystals between cells. These crystals may induce intracellular dehydration, leading to cell death. Another possible cause of cell death during cryosurgery is ischemic infarction due to thrombosis in the microcirculation [9]. The use of frozen autogenous mandibular grafts to reconstruct surgical defects has advantages over other methods. Firstly, the bone graft is autogenous and, therefore, non-antigenic. Secondly, optical morphological results are commonly obtained because the shape of the bone graft coincides with the surgical defect. Thirdly, this method is relatively simple. Other oncological sterilization methods including autoclaving [10], irradiation [11], and pasteurization [12] require special equipment or strict thermal control. Finally, no donor site morbidity occurred by avoiding bone grafts from other parts of the body [7,13]. However, possible risk factors for frozen grafts include mandibular fracture and sequestrum [13]. Histological examination of resected mandibular bone is impossible. No cancer recurrence in the bone has been reported following the insertion of frozen autogenous bone grafts, which indicates that the technique is oncologically safe [14].

The clear advantage of this procedure is that PM flap reconstruction eliminates the need for microvascular anastomosis,

which may be difficult and unsafe in vessel-depleted necks [15]. As a result of previous ablative surgery, our case underwent PM flap reconstruction due to the non-availability of suitable vessels for anastomosis. PM flap provides excellent cover for the implanted mandibular graft and plate. It is important to preserve sufficient well-vascularized soft tissue around the reimplanted graft [7].

In summary, frozen autograft and PM flap combined is a good procedure for selected indications in contemporary oral and maxillofacial surgery. There are many techniques for mandibular reconstruction which are accompanied with various pros and cons. This method cannot be recommended as a standard procedure for mandibular reconstruction because various free flaps works very good in reconstruction. However, frozen autograft and PM flap combined is one of the most suitable techniques currently available to reconstruct medium-sized bony and soft tissue defects in the oral cavity and achieves good functional and aesthetic outcomes in vessel-depleted necks and high-risk patients.

### Conflict of interest

We declare that we have no conflicts of interest to disclose.

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