



Pedicle ossification following mandibular reconstruction using fibular free flap in a patient with osteoradionecrosis of the jaw: a case report

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Abstract (J Korean Assoc Oral Maxillofac Surg 2024;50:356-360)

Pedicle ossification is a rare but significant complication following mandibular reconstruction using a fibular free flap (FFF), a technique widely employed in maxillofacial surgery due to its reliable vascularized bone supply and low donor site morbidity. The FFF supports dental implantation and prosthetic rehabilitation, with its vascularized periosteum enhancing osteogenic potential. Despite these advantages, unexpected ossification of the flap's vascular pedicle may occur, potentially mimicking tumor recurrence and causing diagnostic uncertainty. This case report describes a 38-year-old male with left buccal squamous cell carcinoma treated by wide excision, modified radical neck dissection, and reconstruction using a radial forearm free flap. Postoperative radiotherapy led to complications including trismus and alveolar bone exposure, culminating in a pathological mandibular fracture. Mandibular reconstruction was performed using an FFF. Over 4 years of follow-up, computed tomography revealed ossification within the vascular pedicle. Notably, the patient remained asymptomatic, maintaining normal speech and swallowing without functional impairment. Pedicle ossification may present radiographically as a suspicious bony change misinterpreted as tumor recurrence. Routine follow-up imaging such as computed tomography is essential for differentiation. Although trismus, bony swelling, or pain may occur, surgical intervention is typically deferred unless symptoms develop. Therefore, careful clinical assessment and monitoring remain crucial.

Key words: Fibula, Free flap, Pedicle ossification, Osteoradionecrosis, Mandibular reconstruction

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I. Introduction

Since its first description by Hidalgo¹ in 1989, the fibular free flap (FFF) has become a cornerstone in oromandibular reconstruction due to its high success rate and minimal donor site morbidity. The FFF allows transplantation of a segment of fibula bone that can be sculpted to precisely fit the surgical defect through strategic osteotomies, while maintaining the vital connections between the bone's blood supply and the surrounding muscle and periosteum. Despite its widespread success, rare complications such as pedicle ossification have

been noted, primarily in FFF reconstructions.

This case report presents a patient who developed pedicle ossification following mandibular reconstruction with an FFF after an osteoradionecrosis-induced mandibular fracture—a phenomenon reported for the first time in Korea. The report provides valuable insights into the clinical outcomes associated with this reconstructive technique and emphasizes the importance of differentiating pedicle ossification from tumor recurrence. Institutional Review Board approval was waived due to the retrospective case report (National Cancer Center, No. NCC2024-0295). Informed consent was not required for the case report.

II. Case Report

1. Initial presentation and treatment

A 38-year-old male patient was diagnosed with squamous cell carcinoma of the left buccal mucosa and first presented to

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our hospital on December 1, 2014. He underwent wide resection, modified radical neck dissection, and reconstruction using a left radial forearm free flap on December 9, 2014. The final histopathological staging was pT1N2b. Consequently, postoperative radiotherapy was administered from January 21, 2015, to March 6, 2015. He received a total dose of 6,300 cGy over 30 fractions.

2. Post-radiotherapy complications

Following radiotherapy, the patient developed dysphagia and exposed mandibular bone in the oral cavity. These complications were managed conservatively with dietary modifications and local wound care to prevent infection and promote healing.

3. Subsequent treatment and surgical intervention

On September 9, 2017, the patient sustained a mandibular fracture and was admitted to our hospital. On October 31, 2017, he underwent reconstructive surgery using a left FFF harvested using conventional methods. Due to prior use of the ipsilateral cervical vessels during the initial surgery, vascular anastomoses were performed to the contralateral superior thyroid artery, anterior jugular vein, and external jugular vein.(Fig. 1) Postoperatively, intravenous dexamethasone was administered for 3 days to manage swelling.

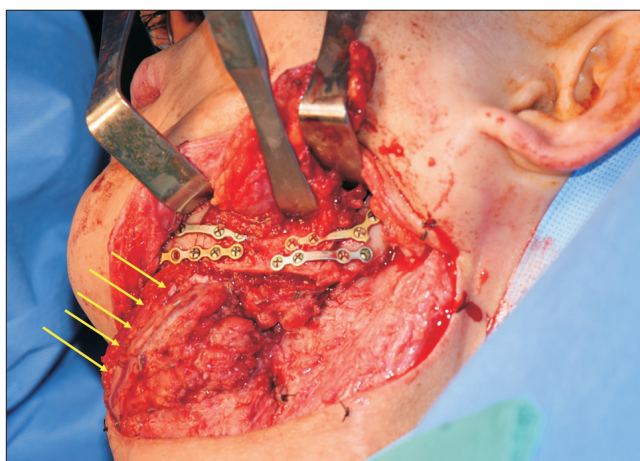


Fig. 1. Intraoperative view. Mandibular reconstruction with fibular free flap (FFF) showing elongated pedicle. The cuff of periosteum and muscle is left attached to the entire length of pedicle (see arrows), which has to be removed to prevent pedicle ossification in the modified FFF harvest technique.

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4. Follow-up and radiological findings

One month post-surgery, a follow-up computed tomography (CT) scan revealed pedicle ossification of the FFF (Fig. 2), although the patient reported no clinical symptoms. Two years 6 months later, the patient returned for follow-up. He had normal swallowing and no clinical symptoms except a palpable bony mass in the lower left mandible and neck. Further CT imaging confirmed definitive ossification in the pedicle area.(Fig. 3, 4) Since the patient did not experience any discomfort, we opted for observation without surgical intervention.

5. Late presentation and surgical resolution

One year later, the patient returned to our hospital with pain in the lower jaw during neck movement. Despite no changes in the CT images compared to the previous visit, the patient experienced pain whenever he moved his neck, which necessitated surgical intervention. On May 31, 2021, under general anesthesia, a cervical approach was used to remove the ossified tissue around the pedicle.(Fig. 5) Histopathological examination confirmed the tissue as a benign bony fragment.

III. Discussion

The FFF is commonly used to reconstruct oral and maxillofacial defects, particularly to restore mandibular continuity. While pedicle ossification is described as rare in some studies, varying incidence rates have been reported. For instance, Glastonbury et al.² reported ossification in 16 of 32 patients

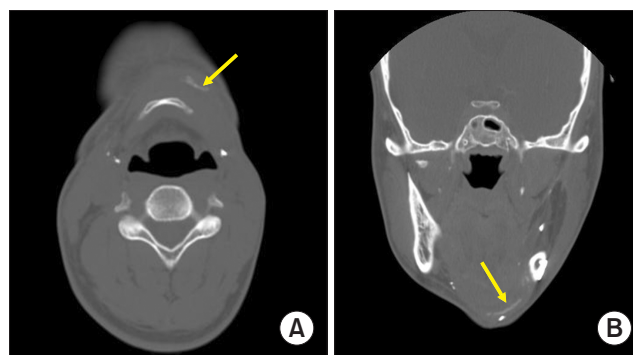


Fig. 2. Postoperative 1-month computed tomography. (A) Axial and (B) coronal images showing linear bonelike structure along the route of pedicle (see arrows).

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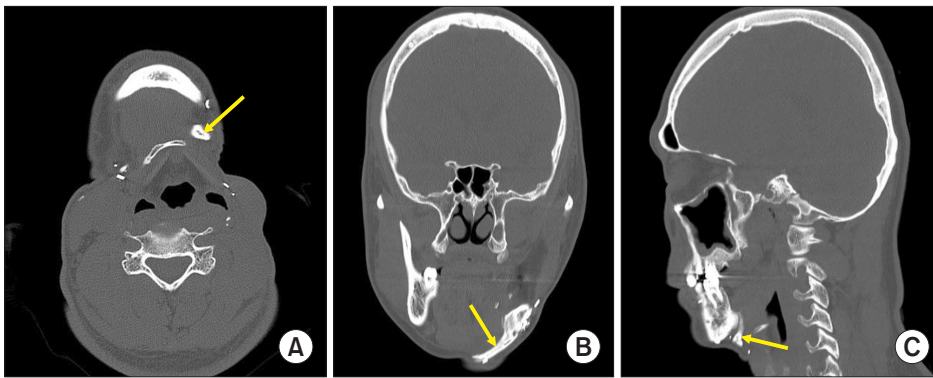


Fig. 3. Postoperative 2-year and 6-month computed tomography. (A) Axial, (B) coronal, and (C) sagittal images showing increased size of ossified pedicle in comparison with Fig. 1. See arrows.
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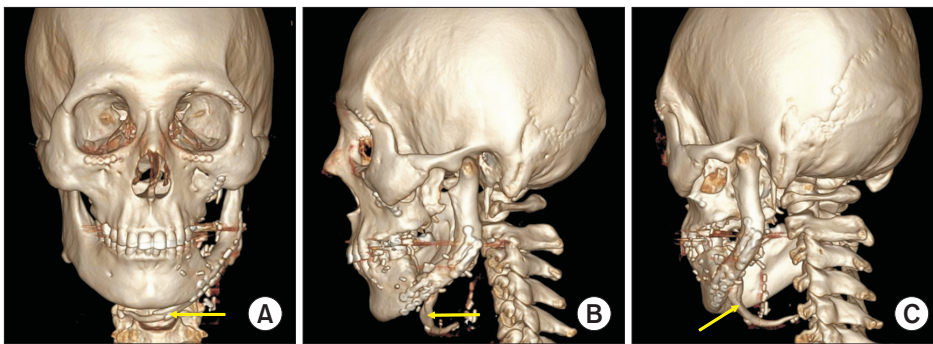


Fig. 4. Postoperative 2-year and 6-month three-dimensional reconstruction images. (A) Frontal, (B) lateral, and (C) postero-lateral images. See arrows.
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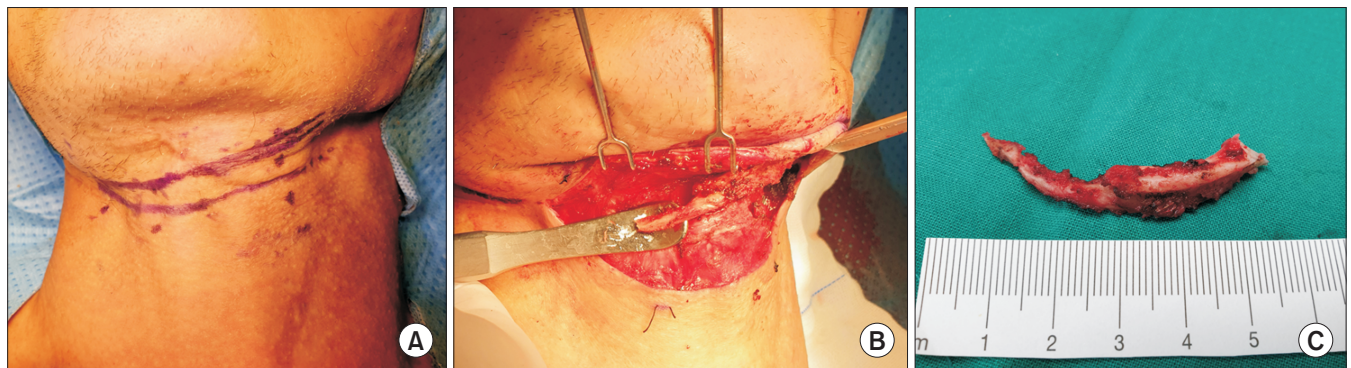


Fig. 5. Surgical progression and outcome of pedicle ossification in fibular free flap reconstruction. A. Preoperative marking: the surgical site in the neck is marked before the procedure, delineating the planned incision and flap area. B. Intraoperative observation: bone formation around the pedicle is evident during the surgery, illustrating signs of ossification. C. Postoperative result: after the removal of the ossified tissue, a newly formed bone segment approximately 5 cm in length is visible, indicating the extent of ossification.
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(50%). Other studies have reported incidences ranging from 4% to 27%, suggesting that pedicle ossification may not be as rare as previously thought³⁻⁵. Usually, pedicle ossification is discovered incidentally in asymptomatic patients during routine radiological examinations, such as panoramic radiographs or CT scans^{2,6,7}.

Several hypotheses have been proposed to explain the pathogenesis of pedicle ossification in FFFs. The periosteal theory suggests that the osteogenic potential of vascularized

periosteum plays a pivotal role, possibly enhanced by local factors like bone morphogenetic proteins (BMPs)^{8,9}. The fracture repair theory posits that bony contact at osteotomized sites serves as a source of osteoprogenitor stem cells involved in normal bone healing¹⁰. Additionally, the blood flow theory proposes that enhanced perfusion from the leg to the cervical area contributes to ossification¹¹. Multivariate analysis by Wood et al.⁷ supports the periosteal theory, highlighting FFF as a significant factor in the development

of pedicle ossification.

The role of pharmacological agents such as dexamethasone in the context of FFF reconstruction also deserves consideration. While typically associated with bone density reduction in chronic clinical use, dexamethasone has been shown to promote osteogenic activity under specific experimental conditions. A study by Tenenbaum and Heersche¹² demonstrated that dexamethasone stimulates osteogenesis in chick periosteum cultures *in vitro* by increasing markers of osteoblastic differentiation and mesenchymal cell proliferation. This finding suggests that using dexamethasone postoperatively for its anti-inflammatory properties could inadvertently contribute to ossification in FFF reconstruction.

In this case, the pedicle was anastomosed to the contralateral superior thyroid artery due to the prior use of ipsilateral vessels in earlier surgeries. This required extensive subperiosteal dissection of the proximal fibula to secure a longer pedicle, increasing its vulnerability to the dynamic stresses of the oral maxillofacial region and neck. Baserga et al.⁶ have postulated that mechanical stress could lead to proliferative stimulation, potentially altering the ossification propensity of the pedicle. While studies on contralateral pedicle anastomoses are lacking, we hypothesize that the increased length of the pedicle, achieved through subperiosteal dissection, might enhance its susceptibility to ossification due to the amplified range of mechanical stress.

Recent literature includes reports on modified FFF harvesting techniques to prevent heterotopic pedicle ossification. For instance, Tarsitano et al.¹³ proposed a technique that involves dissecting the periosteum free from the vascular pedicle after separating it from the excess proximal fibula bone, with no subsequent occurrences of ossification reported¹⁴. Similarly, Kim et al.¹⁵ described starting the subperiosteal dissection along the excess fibula before performing osteotomies, suggesting that this technique can reduce ischemia time and expedite pedicle dissection after harvest. Surgeons should prioritize techniques that ensure safe and expedient harvest of the flap, with management of ossified pedicles being driven by symptom presentation.

Pedicle ossification is often asymptomatic. However, if the patient develops symptoms such as progressive dysphagia, hard swelling, or pain during mastication or neck movement, further investigation is needed. For instance, a CT or positron emission tomography (PET)-CT scan can be used to evaluate changes over time and differentiate between tumor recurrence and pedicle ossification^{6,7}. If clinical symptoms occur, surgical resection of the ossified pedicle is recommended.

Wood et al.⁷ found that the average time to the onset of ossification was 12 months, although it can be shorter. In our case, the earliest imaging evidence of ossification appeared on a CT scan 1 month postoperatively, presenting as a linear bone-like structure with density between the cortical and marrow bone. The most recent CT scan at 2 years postoperative showed increased size and density of the mass, which had become clinically palpable. Since the patient had been lost to follow-up for more than 2 years, we could not determine if the ossification would continue to grow. Therefore, further follow-up is necessary for effective management of pedicle ossification.

This case report presents the first documented instance of pedicle ossification following FFF reconstruction for mandibular restoration post-radiation therapy in Korea. It underscores the complex interplay of surgical techniques, anatomical factors, and pharmacological influences in head and neck reconstructions.

Factors such as extensive periosteal dissection, local mechanical stress, and the use of pharmacological agents like dexamethasone may contribute to pedicle ossification. Differentiating between tumor recurrence and pedicle ossification through careful observation and clinical evaluation is crucial. When symptoms such as pain, swelling, or functional impairment arise, surgical resection of the ossified pedicle should be considered to alleviate symptoms and prevent misdiagnosis.

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Authors' Contributions

J.H.K. participated in data collection and writing the manuscript. M.G.K., S.M.K., U.H.K., S.H.P., and D.W.K. participated in data collection. J.H.K., J.H.L., and J.Y.P. participated in the study design. S.W.C. participated in the study design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

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Ethics Approval and Consent to Participate

Institutional Review Board approval was waived due to the retrospective case report (National Cancer Center, No. NCC2024-0295). Informed consent was not required for the case report.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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