Mandibular Osteoradionecrosis: Use of Sequential Fibula Free Flaps for a Remote Sequence of Complications

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ABSTRACT

Mandibular osteoradionecrosis is a serious complication of radiotherapy that often leads to severe facial deformity, intolerable pain, fracture, sequestration of devitalized bone and fistulas. The prophylaxis of this severe complication is a major goal in modern combined tumor therapy, but once the pathology is established, conservative treatment modalities are used in almost all patients in an effort to control progression. Radical surgery should only be instituted when conservative methods fail or when severe bone and soft-tissue necrosis prevails. Pathologic fractures and chronic fistulae are clear indicators for radical surgical management. This paper document a case report of severe bilateral mandibular osteoradionecrosis reconstructed with two sequential osteocutaneous fibular free flap. The authors discuss the different alternatives of treatment and the most important steps for a successful management of this challenge.

KEYWORDS: Radiotherapy, osteoradionecrosis, head and neck cancer

Although postoperative radiotherapy has proved effective in improving local control and survival in patients with head and neck cancers, and refinements in radiation techniques and increased attention to predisposing factors have decreased the incidence of osteoradionecrosis, the risk has not been totally eliminated and is one of the most serious and devastating complications of radiation therapy.^{1,2}

Osteoradionecrosis (ORN) has been described as a disease process with a common denominator of devitalization and devascularization of bone by irradiation. It is a complex metabolic and tissue homeostatic deficiency created by radiation induced tissue injury.

Traditionally, osteoradionecrosis of the mandible is defined as exposed irradiated bone that has failed to heal over a period of 3 months in the absence of a local tumor.³

Although ORN occurs typically in the first three years after radiotherapy, patients probably remain at indefinite risk.¹

The sequence suggested by Marx⁴ in 1983 is:

1. Radiation
2. Hypoxic-hypocellular hypovascular tissue
3. Tissue breakdown
4. A chronic nonhealing wound

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The common predisposing factors for osteoradionecrosis of the mandible include patient-related factors such as poor oral hygiene, periodontal disease, dental abscesses, extensive caries, the anatomical site of the tumor, increasing doses of radiotherapy, and dentoalveolar surgery during radiotherapy or in the early postoperative period.^{5,6} This last factor has been defined as responsible of over 50% of the cases of ORN.⁵

The prophylaxis of this severe complication is a major goal in modern combined tumor therapy, but once the pathology is established, conservative treatment modalities are used in almost all patients in an effort to control progression of an already established bone and soft-tissue damage; however, the ultimate need for radical resection after conservative treatment, including hyperbaric oxygen therapy, is as high as 70 to 83%.^{3,7-9}

The indication for more radical surgery is not clearly defined, but this kind of treatment should only be instituted when conservative methods fail or when severe bone and soft-tissue necrosis prevails. Pathologic fractures and chronic fistulae are clear indicators for radical surgical management.^{1,8}

Reconstruction of extensive, composite through-and-through defects of the mandible demands a careful appreciation of the three-dimensional relationship of the defects of the inner mucosal lining, mandible, its associated soft tissue, and outer skin cover to obtain a good, stable functional and aesthetic result.

CASE REPORT

A 70-year-old woman who presented with a swelling in right lateral tongue clinically T₂N₀M₀ with anatomopathologic diagnosis of squamous cells carcinoma (Fig. 1).

In her original hospital she underwent external cobalt-60 radiation therapy in both cervical fields, a total dose of 60 Gy in 30 fractions over a period of 6 weeks. The treatment was completed with brachytherapy (Iridium 196) 50 Gy totally. The pathology remitted com-

Figure 1 Primary lingual tumor in right lateral lingual border.

Figure 2 Radiographic appearance of osteoradionecrosis similar to that of secondary chronic osteomyelitis. The periosteal reaction is a typical radiographic sign, in addition to sequestrum formation and spontaneous fracture.

pletely and the patient was one year disease free, before consulting again to the specialist because of inflammation, pain, and fistula over the radiated right angle of the mandible.

Physical examination and Panorex view diagnosed osteoradionecrosis, so it was decided to transfer the patient to the department of oral and maxillofacial surgery from La Paz University Hospital.

First of all, a conservative management plan was established with curettage and 17 sessions of hyperbaric oxygen therapy. The unsuccessful outcome of this management resulted in the development of a pathologic fracture (Fig. 2). Considering the best choices of treatment, a hemimandibular reconstruction with a fibular free microvascular flap (Fig. 3) was performed. Limits of bone resection were determined on the radiological changes in addition to the intraoperative macroscopic appearance of the bone. The affected tissue was harvested with 0.5 to 1 cm bone margins including intraoral mucosa and the surrounding skin, all tissues in block. The size of the bone defect due to mandibulectomy was 8 cm. Despite optimal early follow-up and an asymptomatic period of 8 months, the patient sustained a contralateral fistula and an inflammatory episode. The panorex view corresponds to recurrent contralateral mandibular osteoradionecrosis (Fig. 4).

A second intervention is compelled due to persistent symptoms with noninvasive treatment. A second fibular free flap with skin perforator flap was harvested for hemimandibulectomy reconstruction (Fig. 5).

There has been successful long term follow-up with total resolution of the pathology at the present time (Fig. 6).

DISCUSSION

Mandibular osteoradionecrosis is a serious complication of radiotherapy that often leads to severe facial deformity,

Figure 3 (A) Radiographic control of right hemimandibulectomy reconstruction with microvascularized fibula free flap. (B) Coalescing, poorly demarcated radiolucencies in left mandible. Bone sequestrum in alveolar crest corresponding to bone necrosis.

intolerable pain, fracture, sequestration of devitalized bone and fistulas, and sepsis and infection.

In a retrospective study of 830 patients with head and neck carcinoma who developed osteoradionecrosis after radiotherapy or surgery in combination with radiotherapy, only 40% of patients with osteoradionecrosis could be healed completely by means of surgery and antibiotic medication.²

Most of the time, these complications are due to the difficult dental preventive management in the onco-

logic patient who is planning to undergo radiotherapy. The extreme difficulty in treatment to define the extent of necrosis and the bone limits and the extent of the devitalized soft tissues, which are the main cause of failure of the treatment.

The clinical findings of osteoradionecrosis are sometimes ambiguous. Also, the clinical differentiation between recurrent cancer and osteoradionecrosis may be difficult.¹⁰ The biopsy results do not always exclude recurrent cancers in these patients; sometimes, the final diagnosis can be made only after the sequestrectomy. A chronic unhealed wound, despite diligent treatment, should arouse suspicion of a recurrent cancer. In a series of Hao et al,¹¹ 11% of the patients with a clinical suspicion of osteoradionecrosis were found to have cancer recurrence after the pathologic examination of final sequestrectomy specimens. For this reason, surgical treatment of the osteoradionecrosis of the mandible must be as radical as the tumor surgery.

Susceptibility of the mandible as a primary site of osteoradionecrosis after the treatment of head and neck malignancies by radiation therapy is attributed to its anatomical properties. It is a compact bone and has a

Figure 4 Panoramic radiography following the second fibula flap.

Figure 5 Intraoperative view with the microvascular fibula free flap and skin island.

Figure 6 Clinical view of the patients after bilateral mandibular reconstruction with double microvascularized fibula free flap.

higher mineral content that may lead to a higher absorbed dose.¹² The ramus and condylar portions are relatively resistant to the development of radiation-induced ischemia, whereas the mandibular body, symphysis, and parasymphyseal regions supplied mainly by the inferior alveolar artery are at greater risk.⁵ This is the case of the patient described. Thorough debridement of all necrotic tissue is a prerequisite to successful surgical treatment of osteoradionecrosis of the mandible. The limits of bony resection were determined preoperatively according to the radiologic changes; however, the final decision was made intraoperatively.

Primary closure should be attempted in all cases, and for this purpose composite pedicled or free flaps including bone and soft tissue are recommended.^{3,6,12-14} An additional benefit when this type of reconstruction is planned is the possibility to extend the ablative surgery and ensure that what remains is only healthy bone and soft tissue.¹⁵

The most common free flaps used are composite tissues, which include fibula, scapula, iliac crest, or radius bone. All of them could be useful for reconstruction of mandibular osteoradionecrosis; however, the fibula osteoseptocutaneous flap provides additional advantages for this type of reconstruction.^{3,6,16-18} One advantage is critical: the bone length that can be harvested is enough to reconstruct virtually any mandible regardless the size of the defect. Thus, a more radical radionecrotic bone resection can be done if necessary. In addition, an extensive reliable skin island can be included together with the bone for reconstruction of associated oral mucosa or skin defects simultaneously.

In the present case, it is possible that the devitalized bone reached the left mandible at the very beginning. Maybe, the symptoms of the left teeth were the manifestation of incipient ORN, which only got worse after the dental removal. However, there was no clinical suspicion for recommending more extensive mandibulectomy in this patient at the time of the first operation.

Only the second complication developed, which compelled the sequential bilateral reconstruction with double fibula free flap. It is important not confuse this situation with the other one in which, a very extensive bone and soft tissue defect, makes the use of two simultaneous microvascular flaps indispensable.^{19,20}

CONCLUSION

Although osteoradionecrosis is more frequent in the area surrounding the tumor, where the dose of radiotherapy is increased, the damage to small vessels in a bone with a terminal blood supply can create remote complications in adjacent mandibular areas. A fibula osteoseptocutaneous free flap is a good option for reconstruction the mandible after radical treatment of osteoradionecrotic lesions.

There is the possibility of harvesting a double microvascular free flap, either simultaneously or in a sequential way.

REFERENCES

1. Jereczek-Fossa BA, Orecchia R. Radiotherapy-induced mandibular bone complications. *Cancer Treat Rev* 2002;28(1):65-74
2. Reuther T, Schuster T, Mende U, Kübler A. Osteoradionecrosis of the jaws as a side effect of radiotherapy of head and neck tumour patients—a report of a thirty year retrospective review. *Int J Oral Maxillofac Surg* 2003;32(3):289-295
3. Santamaria E, Wei FC, Chen HC. Fibula osteoseptocutaneous flap for reconstruction of osteoradionecrosis of the mandible. *Plast Reconstr Surg* 1998;101(4):921-929
4. Marx RE. Osteoradionecrosis: a new concept of its pathophysiology. *J Oral Maxillofac Surg* 1983;41(5):283-288
5. Balogh JM, Sutherland SE. Osteoradionecrosis of the mandible: a review. *J Otolaryngol* 1989;18(5):245-250
6. Curi MM, Dib LL. Osteoradionecrosis of the jaws: a retrospective study of the background factors and treatment in 104 cases. *J Oral Maxillofac Surg* 1997;55(6):540-544, discussion 545-546
7. Wood GA, Liggins SJ. Does hyperbaric oxygen have a role in the management of osteoradionecrosis?. *Br J Oral Maxillofac Surg* 1996;34:424-427
8. Notani K, Yamazaki Y, Kitada H, et al. Management of mandibular osteoradionecrosis corresponding to the severity of osteoradionecrosis and the method of radiotherapy. *Head Neck* 2003;25(3):181-186
9. Maier A, Gaggl A, Klemen H, et al. Review of severe osteoradionecrosis treated by surgery alone or surgery with postoperative hyperbaric oxygenation. *Br J Oral Maxillofac Surg* 2000;38(3):173-176
10. Celik N, Wei FC, Chen HC, et al. Osteoradionecrosis of the mandible after oromandibular cancer surgery. *Plast Reconstr Surg* 2002;109(6):1875-1881
11. Hao SP, Chen HC, Wei FC, Chen CY, Yeh AR, Su JL. Systematic management of osteoradionecrosis in the head and neck. *Laryngoscope* 1999;109(8):1324-1327, discussion 1327-1328
12. Baker DG. The radiobiological basis for tissue reactions in the oral cavity following therapeutic x-irradiation. A review. *Arch Otolaryngol* 1982;108(1):21-24
13. Sanger JR, Matloub HS, Yousif NJ, Larson DL. Management of osteoradionecrosis of the mandible. *Clin Plast Surg* 1993;20(3):517-530
14. Coffin F. The incidence and management of osteoradionecrosis of the jaws following head and neck radiotherapy. *Br J Radiol* 1983;56(671):851-857
15. Kildal M, Wei FC, Chang YM, Huang WC, Chang KJ. Reconstruction of bilateral extensive composite mandibular defects after osteoradionecrosis with two fibular osteoseptocutaneous free flaps. *Plast Reconstr Surg* 2001;108(4):963-967
16. Hidalgo DA. Aesthetic improvements in free-flap mandible reconstruction. *Plast Reconstr Surg* 1991;88(4):574-585, discussion 586-587
17. Wei FC, Santamaria E, Chang YM, Chen HC. Mandibular reconstruction with fibular osteoseptocutaneous free flap and simultaneous placement of osseointegrated dental implants. *J Craniofac Surg* 1997;8(6):512-521

18. Schusterman MA, Reece GP, Miller MJ, Harris S. The osteocutaneous free fibula flap: is the skin paddle reliable? *Plast Reconstr Surg* 1992;90(5):787-793, discussion 794-798
19. Wei FC, Celik N, Chen HC, Cheng MH, Huang WC. Combined anterolateral thigh flap and vascularized fibula osteoseptocutaneous flap in reconstruction of extensive composite mandibular defects. *Plast Reconstr Surg* 2002;109(1):45-52
20. Wei FC, Demirkan F, Chen HC, Chen IH. Double free flaps in reconstruction of extensive composite mandibular defects in head and neck cancer. *Plast Reconstr Surg* 1999;103(1):39-47