Custom Facial Reconstruction for Osteosarcoma of the Jaw

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Osteosarcoma accounts for most primary bone cancers in children and young adults. High-grade lesions are typically managed with a combination of chemotherapy and wide-margin surgical excision. Although this malignancy typically affects the metaphyseal region of long bones, it also can be seen in the axial skeleton. Of axial locations, tumors in the head and neck can be particularly troubling to treat. Segmental bone loss after resection of malignant mandibular tumors continues to present important challenges to the reconstructive surgeon. Recent advancements in 3-dimensional modeling have facilitated custom templates for patient-specific reconstructions. This report describes the case of a young woman with osteosarcoma of the mandible undergoing customized template composite facial reconstruction using a vascularized osteoseptocutaneous fibula flap.

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Osteosarcoma is the most common primary bone malignancy affecting children and young adults. The term *osteosarcoma* refers to a group of bone tumors in which malignant cells of mesenchymal origin produce osteoid.[1,2] It is relatively uncommon, accounting for fewer than 1% of new cancer cases every year. However, it is aggressive in nature, with at least 30% of all cases ending in death, even when treatment is initiated promptly.[3] These tumors typically affect the metaphyseal region of long bones, whereas involvement of the mandible and skull is relatively rare, accounting for fewer than 8% of all cases.[4-6] Osteosarcoma of the jaw and skull typically occurs in an older population of patients, with a median age at diagnosis of 36 years.[7-9] These tumors tend to follow a more indolent course because they are often lower grade and tend to have a lower rate of metastasis.[10,11]

Of the different osteosarcoma subtypes, osteoblastic osteosarcoma accounts for most conventional osteosarcomas (as many as 50% of cases).[12,13] Chondroblastic osteosarcoma is a less common subtype in which the disease process produces a cartilaginous matrix and osteoid trabeculae.[14] This subtype is overrepresented in osteosarcomas of the mandible, where it accounts for nearly 50% of tumors.[15,16] These tumors are typically managed with a combination of chemotherapy and wide surgical excision.[17-20] Segmental bone loss after resection of malignant mandibular tumors continues to present an important challenge to the reconstructive surgeon. Because of their proximity to vital structures, ideal resection margins are often morbid and the potential for impairment related to speaking, swallowing, and breathing is very high.[17,18] Nevertheless, the goal of achieving clear surgical margins is of paramount importance, so "en bloc" resection with subsequent facial reconstruction is the ideal course of treatment.

Reconstruction with microvascular free flaps using native fibular bone and overlying skin has become a mainstay of reconstructive management for these lesions. A study by Foster et al[21] found that vascularized free flaps have better outcomes than nonvascularized free grafts, including higher rates of bony union and higher rates of success with subsequent dental implantation. Similarly, using the fibula as a donor site has proved to be the most versatile option owing to its

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segmental blood supply, excellent malleability, and relatively lower rates of long-term morbidity.[22,23] Overall, free flaps have greatly decreased cosmetic deformity and have improved functional results after resection of osteosarcomas of the skull and jaw. Recently, advancements in 3-dimensional modeling have facilitated custom templates for patient-specific reconstructions. These computer-based modeling systems have improved intraoperative graft shaping and improved esthetic and functional outcomes.[24,25]

This report describes the case of a young woman with osteosarcoma of the mandible undergoing customized template composite facial reconstruction using a vascularized osteoseptocutaneous fibula flap.

Report of Case

A 25-year-old woman presented for a second opinion regarding treatment of a mandibular chondroblastic osteosarcoma. She first noticed a painful bump in her anterior mandible 8 months before presentation and was concerned about a potential developing odontogenic infection. She subsequently developed localized soft tissue edema that extended to the buccal cortex of the mandible and decided at this time to present to her dentist. Initially, she was judged to have a dental abscess and was prescribed multiple rounds of antibiotics, but this proved unsuccessful at relieving her symptoms. A biopsy examination was performed, which confirmed a diagnosis of high-grade osteosarcoma, chondroblastic subtype. Other than a history of childhood febrile seizures and fibrocystic breast disease, her medical history was unremarkable.

Physical examination showed an obvious anterior mandibular soft tissue mass with displacement of the lower lip anatomy. Intraoral examination showed cortical expansion of the buccal and lingual cortex of the anterior mandible extending from the left lower lateral incisor to right lower lateral incisor. Neurologic examination showed loss of cranial nerve V3 function on the left and paresthesia of cranial nerve V3 on the right. Occlusion was stable and the patient had good dental hygiene. Magnetic resonance imaging (Fig 1) showed an enhancing mass in the alveolar process of the mandible consistent with a history of sarcoma. There was an abnormal high T2 signal in the right body of the mandible, with mild abnormal enhancement suggestive of disease extension consistent with osteosarcoma.

Given the clinical and radiographic information, the patient was staged and brought up for multidisciplinary board discussion, and surgery was decided as the first step in her multimodal treatment. Before surgery, a virtual surgical planning session was conducted with Medical Modeling (Golden, CO) surgical software to create customized surgical templates for tumor extirpation and vascularized fibular osteotomies and to create a stereolithographic model of the mandible to pre-form a Stryker CMF (Portage, MI) 2.4-mm surgical titanium reconstruction plate. The primary goal of the surgery was to achieve a wide-margin excision, preferably with a margin wider than 1 cm around the tumor. This was taken into account when running the software and creating the template. The patient was taken to the operating room; the tumor was noted intraorally, and the osteotomy cuts were estimated to course posteriorly through the existing teeth on the left side and through the first premolar on the right side. The second premolar was removed using the conventional dental elevator and forceps technique. Then, the templates were manually held in place and the osteotomy cuts through the mandible were performed using an oscillating saw. Intraoperatively, the authors noted that the custom templates provided were designed to have fixation screws that would have violated the tumor, necessitating manual maintenance of the templates in place during osteotomy. Once this was completed, the genioglossus musculature was carefully cut, making sure there was a healthy cuff of tissue around the lingual portion of the tumor. This enabled tumor removal (Fig 2). Cranial nerve XII was identified and preserved, as was the vermillion border of the lip. Numerous margins were sent for histopathology by frozen section. These included the skin all the way down to the periosteum and the marrow of the bone. All margins were negative.

In total, the patient had surgical resection of the anterior aspect of her mandible from the mid-parasymphysis to the mid-parasymphysis bilaterally and resection of the soft tissue of the floor of the mouth and skin of the soft tissue involving the chin. The marginal mandibular branches of the facial nerve were sacrificed bilaterally in the region of the anterior mandible to achieve complete resection of the soft tissue component of the tumor. Accordingly, a free fibular flap from the left lower extremity was planned. A skin island was designed posterior to the peroneal tendons based on the septum between the posterior and lateral compartments. The anterior and posterior compartment muscles were dissected off the bone, leaving a good muscle cuff not compromising the septum. The soft tissue defect was calculated as approximately 8×12 cm. After the bone was isolated, distal and proximal osteotomies were performed to dissect the pedicle from its proximal origin. As mentioned earlier, a computer-generated mandibular osteotomy template had been used for resection of the osteosarcoma. A Stryker CMF 2.4-mm reconstruction plate was adapted and contoured to a preexisting stereolithographic model of the patient's anterior mandible, spanning the site of the mandibular defect (Fig 3A). After completion of the dissection of