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CASE REPORT

A CUSTOMIZED 3D-PRINTED TITANIUM IMPLANT FOR ANTERIOR MANDIBULAR RECONSTRUCTION: A CASE REPORT

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Abstract

The advent of patient-specific implants (PSIs) in oral and maxillofacial surgery marks a significant milestone in the field, promising enhanced precision, functionality, and aesthetic outcomes of the patient. PSIs are custom-designed to match an individual patient's anatomy, offering a tailored approach to complex surgical procedures. This case report looks at how custom-designed implants made with cutting-edge 3D printing technologies changed the life of a patient with a large ameloblastoma of the follicular and plexiform type in anterior mandibular region. We made the implants to fit the patient's specific anatomy and physiological needs. We used a 3D computed tomography scan to identify and diagnose this abnormal growth, and obtained DICOM detailed imaging and then performed a successful intraorally surgical procedure for simultaneous resection and rebuilding, utilizing a custom-made 3D-printed implant for the patient. This case report exemplifies how patient-specific implants when tailored to a patient's unique anatomy, can significantly enhance the quality of care in oral and maxillofacial surgery, offering substantial benefits in both complex tumor resection and reconstruction.

Keywords: patient specific implant (PSI), 3D CT, periosteal pouch technique, mandibular reconstruction, ameloblastoma, 3D Printing

INTRODUCTION

Ameloblastoma is the most common noncancerous tumor in the maxillofacial region, accounting for approximately 1% of all cysts and tumors in that area.[6] Typically, this tumor is painless and exhibits modest but aggressive growth in a localized region. It stimulates the growth of the cortical bone or causes the lingual or buccal cortical plate to rupture, enabling it to penetrate the soft tissues permanently.[1] The ages of 20 to 40 have the highest incidence rate of this condition, but it can occur in any age group, with an equal predilection for both men and women (1:1). On a standard OPG, these tumors may appear as solitary or multiple well-defined radiolucent areas, exhibiting a distinct pattern resembling a honeycomb, soap bubble, or tennis racket. Compared to other kinds of tumors, ameloblastoma is more likely to demonstrate the proliferation of buccal and lingual cortical plates.[2]Although a conventional OPG is sufficient for moderate lesions in the mandibular area, CT and MRI are required for extensive lesions to accurately evaluate the extent of the lesion. Enucleation, curettage, or resection are the surgical treatments that surgeons select for ameloblastoma, contingent upon the tumor's size, location, and form. The risk of recurrence ranges from 17.7% for en-bloc resection to 34.7% for conservative treatment. To avoid recurrence, we prioritized performing segmental resections with a healthy bone safety margin.

Case Report

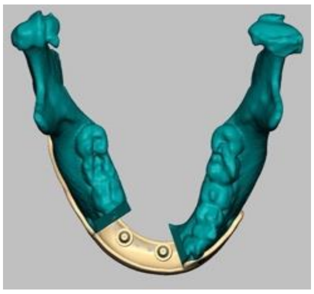
A 28-year-old female patient presented with a primary concern of swelling in lower front tooth area during the last two years that has progressively grown in size to its current dimensions without causing any symptoms. A visual examination from outside the mouth revealed widespread swelling in the chin area, measuring about 5 cm by 6 cm and spreading upwards from the lower lip to the lower edge of the jawbone. The skin covering the front part of the lower jaw showed no abnormal swelling. There is a single, clearly marked swelling in the lower jaw that stretches from tooth 44 to tooth 32. The swelling crosses the midline, leading to the loss of the mouth's normal contour. The mucosa covering the area was unremarkable, displaying a typical coloration, smooth texture, and glossy appearance. We observed Grade I movement in teeth 41, 42, and 44 and concluded that they were nonvital. Upon palpation, the swelling exhibited a firm consistency and was devoid of tenderness. The clinical examination results and the historical information led to a tentative diagnosis of ameloblastoma. The buccal and lingual cortical plates were growing on a CT scan, and thick septae separated several regions of radiolucency between teeth 44 and 32. A panoramic radiograph revealed an extensive and well-defined multilocular radiolucency in the jaw, spanning from tooth 44 to tooth 32. There is no root resorption, an enlarged periodontal ligament space, and a diminished lamina dura. CT imaging revealed a well-defined, multi-chambered growth with damaging alterations and weakening of the outer layer. The lesion underwent an incisional biopsy, and the histological investigation revealed the presence of lengthy interconnected cables. Columnar or cuboidal ameloblast-like cells surrounded the larger sheets of these cords, while loosely organized epithelial cells covered them. Several discrete tumor islands compose the supporting stroma. The islands consist of a layer of cuboidal or columnar cells, with nuclei that are often polarized and located along the margins. The core regions of follicles exhibited stellate reticulum-like cells. Histopathological examination indicated the presence of both follicular and plexiform ameloblastomas. We performed a complete intraoral marginal resection, a surgical procedure that involved the removal of a section of the mandible from tooth 45 to tooth 33. During the procedure, we preserved the periosteum by forming a pouch along the defect location for bone formation in the future. We then used CT and 3D printing to create a patient-specific titanium implant to reconstruct the anterior mandible. We placed the PSI in the periosteal pouch in a strategic location to facilitate new bone growth in the future. We rectified the PSI using screws, ensuring a seamless postoperative period. Six months after the surgical procedure, we proceeded to affix the crowns to the PSI. We successfully rehabilitated the patient's appearance and ability to do tasks. We observed no problems or recurrences during the patient's five-year follow-up.

Pre-operative pictures

Figure 1. Preoperative frontal view

Figure 2. Preoperative intraoral view
Figure 3. Preoperative mandibular occlusal view

Patients specific implant design pictures



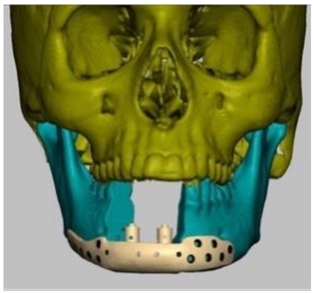
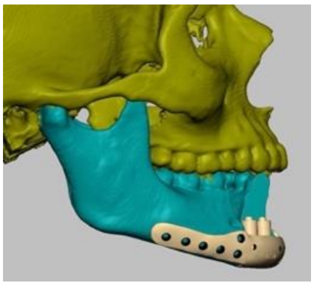


Figure 4. Mandibular occlusal view (virtual planning)
Figure 5. Frontal view (virtual planning)



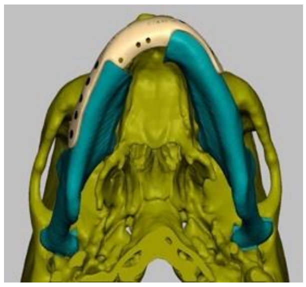


Figure 6. Lateral view (virtual planning)
Figure 7. Worm's view (virtual planning

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Intra operative pictures


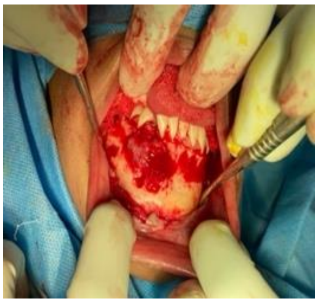

Figure 8. Intraoperative - anterior mandible
Figure 9. Full thickness mucoperiosteal flap elevation


Figure 10. Exposure of lesion
Figure 11 resection of lesion

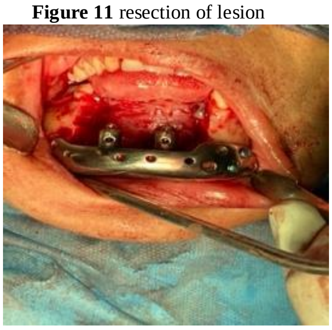

Figure 12. Placement and fixation of psi

Post-operative photos

Figure 13. Preoperative frontal view

Figure 14. Postoperative lateral view


Figure 15. Postoperative intraoral view
Figure 16. Fabricated prosthesis

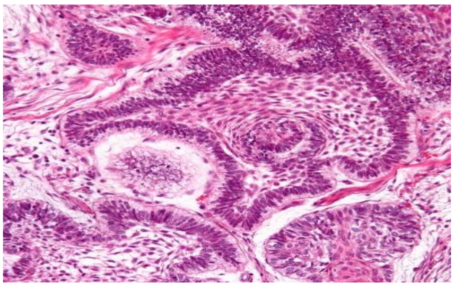

Figure 17. Histopathological picture

Follow up pictures

Figure 18. Preoperative opg

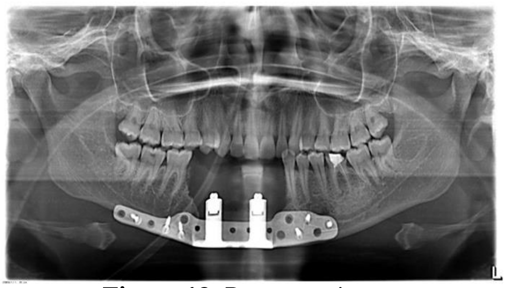

Figure 19. Postoperative opg

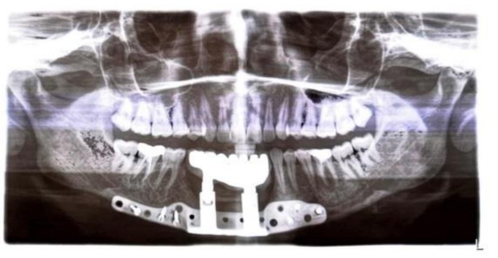

Figure 20 postoperative opg – six years follow up

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Discussion

Ameloblastoma is a non-cancerous tumor that originates from the outer layer of tooth cells. The tumor has the ability to cause significant damage by eroding bone and spreading to other tissues. This growth can lead to facial asymmetry, tooth movement, jaw misalignment, and disease-induced fractures. Upon examination, the patient exhibited a substantial and rigid mass in the lower mandibular anterior region. This mass resulted in asymmetrical facial characteristics, teeth that are not firmly attached, and the expansion of both the outer and inner layers of the jawbone. [3]Ameloblastoma originates from the cellular components of epithelial tissue and dental structures at various stages of development. Although the exact origin of ameloblastoma is still uncertain, studies have shown a connection between this condition and abnormal gene regulation throughout the process of tooth formation. Ameloblastomas occur with similar frequency in both genders.[8] About 70% of ameloblastomas are found in the molar ramus region of the jaw. Another 10–15% are found near an undeveloped tooth, and the last 10% are in the mandibular anterior region.[4] The current case had an ameloblastoma in the anterior mandibular region, but no unerupted teeth were visible. We classify ameloblastomas as either extraosseous or intraosseous. Benign tumors, known as peripheral ameloblastomas, slowly develop and connect to the gums or the inner surface of the teeth without affecting the underlying bone.[7] They can either be flat or have projecting stems. We classify six types of jaw ameloblastomas: unicystic, desmoplastic, mixed cystic, and solid forms. The coexistence of cystic and solid forms has a heightened degree of aggressiveness and is susceptible to recurrence. The histopathological variants include the follicular and plexiform types, followed by the acanthomatous and granular cell types. Desmoplastic, basal cell, clear cell, keratoameloblastoma, and papiliferous ameloblastoma are less common variants.[5] We describe ameloblastoma as a painless, gradually developing, solid tumor, and in our specific case, it was similarly painless and exhibited firm swelling. The onset of symptoms occurred around two years after the patient's first presentation. Additional clinical symptoms of the disease include pain or numbness in the affected region. On x-rays, ameloblastoma appears as a radiolucent lesion with a single- or multiple-lens appearance.[9] It may cause the cortical plate to grow, or it may not. Conservative treatment options include enucleation and curettage, marginalization, or radical surgery, which may involve excision with or without continuity defects. We suggest doing a marginal resection that extends about 1.5–2 cm beyond the radiological limit affecting the mandible. This ensures the complete removal of all microcysts and daughter cysts. In this case, upon histological investigation, the material exhibited a follicular and plexiform form, leading to a clearing margin of 1.5 cm. Rebuilding significant mandibular lesions may involve various techniques, including microvascular surgery. The free fibula flap has become a gold standard for mandibular reconstruction due to its unique anatomical and functional characteristics and fibula provides a long segment of bone that can be used to reconstruct extensive mandibular defects, whether resulting from trauma, infection, tumor resection, or congenital anomalies. Its length and strength allow for reconstruction of nearly the entire mandible if needed.[10-13] We performed a segmental resection to treat the tumor, which was extensive in the mandible, and reconstructed it with a patient-specific implant, maintaining the patient's aesthetic appearance without requiring a donor site.

Conclusion

The surgical treatment technique seems to have the most impact on the likelihood of a recurrence of the disease. Typically, professionals advise a yearly check-up for at least a decade. Multiple writers have suggested implementing an annual follow-up for five years. We have monitored the patient for five years and have seen no recurrence. The utilization of patient-specific implants (PSIs) in the treatment of mandible tumors represents a transformative advancement in oral and maxillofacial surgery. By leveraging cutting-edge 3D printing technology and meticulous preoperative planning, PSIs offer unparalleled customization, ensuring a precise fit and optimal functional and aesthetic outcome. Clinical evidence shows that PSIs greatly improve the reconstruction of mandibular defects. This means that patients recover faster and with less pain after surgery, and their oral functions and facial symmetry are restored more effectively than with traditional methods.

DECLARATIONS

Conflicts of interest and financial disclosures

No conflicts of interest

Ethical approval Consent to participate

The study was approved by the Hospital Ethical Committee

Consent to participate

A written informed consent was obtained from the individual for the publication process.

Data availability

The data is available upon the considerable request to the corresponding author

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