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MODERN APPROACHES TO THE SURGICAL TREATMENT OF TUMORS OF THE FACIAL SKELETON

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Abstract

Tumors of the facial skeleton represent a heterogeneous group of benign and malignant neoplasms affecting the maxillofacial region. Due to the anatomical complexity of the facial bones and their proximity to vital neurovascular structures, surgical management remains highly challenging. The present study aims to evaluate modern surgical approaches in the treatment of facial skeletal tumors, focusing on oncological radicality, functional preservation, aesthetic outcomes, and postoperative quality of life. A clinical-analytical investigation was conducted involving patients who underwent surgical treatment for benign and malignant tumors of the facial skeleton. Contemporary techniques including computer-assisted planning, endoscopic approaches, microvascular reconstruction, and multidisciplinary management were assessed. The findings indicate that integration of advanced imaging, 3D modeling, minimally invasive techniques, and reconstructive microsurgery significantly improves oncological safety and functional outcomes. The study confirms that individualized surgical strategies based on tumor type, stage, and anatomical localization are essential for optimal results.

Keywords

facial skeleton tumors; maxillofacial surgery; oncologic surgery; microvascular reconstruction; computer-assisted surgery; endoscopic approach; craniofacial tumors; surgical oncology.

Introduction

Tumors of the facial skeleton constitute a complex group of pathological entities involving the maxilla, mandible, zygomatic bone, nasal bones, and orbital structures. These neoplasms may be benign (osteoma, ameloblastoma, fibrous dysplasia) or malignant (osteosarcoma, chondrosarcoma, squamous cell carcinoma with bone invasion). Due to the functional and aesthetic importance of the maxillofacial region, surgical treatment requires careful balance between oncologic radicality and preservation of facial symmetry, mastication, speech, and vision.

According to the World Health Organization classification of head and neck tumors, bone and cartilage tumors of the craniofacial region present specific biological behavior patterns that differ from those in long bones. Malignant tumors of the facial skeleton often demonstrate local aggressiveness and a tendency for early invasion of adjacent soft tissues and cranial structures. Early diagnosis and radical surgical excision remain the cornerstone of curative treatment.

Historically, surgical management involved wide resections with limited reconstructive options, often resulting in significant cosmetic and functional deficits. However, the development of craniofacial surgery, microvascular techniques, and computer-assisted planning has revolutionized the field. Advances in imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) enable precise assessment of tumor boundaries and invasion depth.

AMERICAN ACADEMIC PUBLISHER
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Modern surgical oncology increasingly incorporates multidisciplinary strategies, combining surgical resection with adjuvant radiotherapy or chemotherapy when indicated. The emergence of digital technologies, including virtual surgical planning (VSP) and 3D-printed patient-specific implants, has significantly enhanced reconstructive precision.

Despite technological progress, management of facial skeletal tumors remains challenging due to anatomical constraints, proximity to the brain and orbit, and the need for immediate functional reconstruction. Therefore, systematic evaluation of contemporary surgical approaches is essential to optimize treatment outcomes.

The objective of this study is to analyze modern surgical strategies in the treatment of tumors of the facial skeleton and assess their impact on oncological control, complication rates, and postoperative functional and aesthetic outcomes.

Materials and Methods

A prospective and retrospective clinical study was conducted at a tertiary maxillofacial surgical center between 2018 and 2024. The study included 86 patients diagnosed with tumors of the facial skeleton.

Study Population

Patients were divided into two main groups:

- Group I (Benign tumors) – 48 patients
- Group II (Malignant tumors) – 38 patients

Inclusion criteria:

- Histologically confirmed tumor of the facial skeleton
- Age above 18 years
- Indication for surgical treatment

Exclusion criteria:

- Distant metastases at diagnosis
- Severe comorbid conditions contraindicating surgery
- Recurrent tumors previously treated with radical surgery

Diagnostic Protocol

All patients underwent:

- Clinical examination
- CT and MRI imaging
- Histopathological biopsy
- Preoperative staging according to the Union for International Cancer Control TNM classification

Virtual surgical planning was performed in 42 cases using 3D reconstruction software. In selected patients, custom-made titanium implants or patient-specific cutting guides were produced using additive manufacturing technologies.

Surgical Techniques

Surgical approach selection was based on tumor type, size, and localization:

1. **Conventional open resection** with safety margins (1–2 cm for malignant tumors).
2. **Endoscopic-assisted approaches** for limited lesions of the maxilla and nasal cavity.
3. **Craniofacial resection** for tumors involving the anterior skull base.
4. **Microvascular free flap reconstruction**, including fibular free flap and radial forearm flap, for extensive mandibular or maxillary defects.

In malignant cases, neck dissection was performed when indicated.

Outcome Measures

Primary outcomes:

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- Completeness of tumor resection (R0 margins)
- Postoperative complication rate
- Local recurrence rate

Secondary outcomes:

- Functional restoration (speech, mastication, vision)
- Aesthetic evaluation (surgeon and patient assessment scales)
- Duration of hospitalization

Follow-up period ranged from 12 to 60 months.

Statistical Analysis. Quantitative data were expressed as mean ± standard deviation. Comparative analysis was performed using Student's t-test and chi-square test. Kaplan-Meier survival analysis was applied for malignant tumors. Statistical significance was defined as $p < 0.05$.

Results

Complete tumor resection (R0) was achieved in 92% of benign tumors and 84% of malignant tumors. Local recurrence occurred in 4% of benign cases and 18% of malignant cases during follow-up. Use of virtual surgical planning significantly improved margin accuracy ($p < 0.05$) and reduced operative time by approximately 20% in complex reconstructions. Microvascular free flap reconstruction demonstrated a success rate of 95%, with minimal flap failure (3 cases).

Postoperative complications included wound infection (8%), flap-related complications (5%), and transient facial nerve weakness (6%). The complication rate was lower in cases where computer-assisted planning was utilized. Functional outcomes showed satisfactory restoration of mastication in 81% of patients and acceptable speech intelligibility in 88%. Aesthetic outcomes were rated as good or excellent in 76% of cases following reconstructive surgery. Kaplan-Meier analysis revealed a 3-year disease-free survival rate of 72% for malignant tumors.

Discussion

The management of tumors of the facial skeleton requires integration of oncologic radicality and advanced reconstructive strategies. The high rate of R0 resections observed in this study confirms the importance of preoperative imaging and accurate surgical planning. Computer-assisted surgery and 3D modeling have significantly improved precision in osteotomies and implant placement. These technologies reduce intraoperative uncertainty and enhance reconstruction symmetry. Similar findings have been reported in recent maxillofacial oncology literature.

Microvascular free flap reconstruction remains the gold standard for large mandibular and maxillary defects. The fibular free flap offers excellent bone stock for dental rehabilitation and long-term functional recovery. High flap survival rates demonstrate the reliability of microsurgical techniques. Endoscopic approaches are increasingly used for selected tumors, reducing morbidity and improving cosmetic outcomes. However, they are limited to early-stage or anatomically accessible lesions.

Multidisciplinary collaboration among maxillofacial surgeons, neurosurgeons, oncologists, radiologists, and prosthodontists is essential for comprehensive treatment planning. Limitations of the study include moderate sample size and single-center design. Larger multicenter studies are required for further validation.

Conclusion

Modern surgical management of tumors of the facial skeleton has evolved significantly due to technological advancements and multidisciplinary integration. Computer-assisted planning, minimally invasive techniques, and microvascular reconstruction contribute to

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improved oncological safety, functional restoration, and aesthetic outcomes. Individualized surgical strategies based on tumor characteristics and anatomical localization are crucial for achieving optimal results. Continuous development of digital technologies and reconstructive methods will further enhance the quality of care for patients with craniofacial tumors.

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