Management of pediatric maxillofacial tumors: A retrospective analysis and long-term follow-up outcomes

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Abstract: The aim of this study was to carry out a retrospective analysis of maxillofacial tumors in children and to present the long-term follow-up results including rehabilitation during mixed and permanent dentition till complete facial growth to insert implants and final fixed restoration. Our study was performed with a retrospective analysis of 40 patients under the age of 15 years with maxillofacial tumor treated in our clinics. In addition, treatment modalities and long-term follow-up results of these patients were evaluated. According to our results, it was established that maxillofacial tumors were mostly observed in the 11-15 age group, 22 cases, (55%), followed by 13 patients (32.5%) were among 6-10 age group and lastly 5 patients (12.5%) were among 0- 5 years age group. The mandible was most frequently affected 21 patients (52.5%), followed by the maxilla 12 patients (30%). The location and frequency of the remaining 7 patients (17.5%) were distributed over salivary glands, oral mucosa, and submandibular area. The odontogenic tumors comprised 16 cases (40%), while 23 cases (57.5%) were benign non-odontogenic, and the malignant non-odontogenic occupied one case (2.5%). Surgical modalities vary from excision, curettage, en bloc excision or radical resection was tailored for adequate treatment of these tumors. Rehabilitation included removable and fixed partial dentures and finally implants and fixed restoration.
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Key word: Pediatric, tumor, maxillofacial, implant, rehabilitation.

1. Introduction

A tumor is defined, in brief, as an abnormal growth of tissue, and tumoral formations are classified under two main headings, benign and malignant. [1-3]

A number of retrospective studies have been done on tumors of the maxillofacial region. [4,5] While pediatric tumors are far from uncommon, few studies on these have included retrospective analysis, demographic distribution, histopathologic spectrum, treatment and follow-up outcomes. [6,7]

The head and neck region is the primary tumor site for approximately 10% of all pediatric malignancies [8].A multi-disciplinary approach is required for best long-term outcomes in children with head and neck sarcomas. Advances in multimodal therapy including chemotherapy, surgical resection and/or radiation therapy have improved the survival rates for pediatric cancer in general, including chemotherapy, surgical resection and/or radiation therapy [9].

Maxillofacial region bone resection causes extensive defects in bone, oral mucosa, muscles and teeth. Reconstruction of the maxillofacial region has been a challenge owing to the complexity of function and esthetics. The reconstruction of mandibular continuity defects following tumor resection with free bone flaps is considered to be a treatment option. However, when a mandibular discontinuity defect is reconstructed with a free bone flap, the width of the bony portion allows for the predictable placement of implants [10] .

Implants inserted into pediatric patients do not follow the regular growth process of the craniofacial skeleton, so their use is usually restricted to patients with completed craniofacial growth ([11-13].

The aim of the present study was to investigate the distribution of pediatric odontogenic and non-odontogenic tumors of the maxillofacial region according to age, sex, biological behavior, histopathologic spectrum, and location, as well as to evaluate treatment modalities and long-term follow-up outcomes including rehabilitation, when needed, during mixed and permanent dentition till complete facial growth to insert implants and final fixed restoration.

2. Material and Methods:

The present study was carried out on 40 patients who attended our clinics who were 15 years old or younger at the first visit, had healthy medical files, were radiographically and clinically diagnosed with odontogenic or non-odontogenic tumors, and were given appropriate treatment.

Ninety cases of pyogenic and peripheral giant-cell granuloma determined in our survey of medical records were excluded since they fell under the classification of reactive hyperplasia; only neoplastic formations were evaluated.

Tumoral formations were grouped under three main headings: odontogenic, benign non-odontogenic, and malignant non-odontogenic. Distributions according to age and sex, as well as histopathologic spectrum and location, were determined. In addition, distribution according to location was investigated for the subgroups of odontogenic and non-odontogenic tumors (epithelial, mesenchymal and mixed, fibrous lesions, vascular neoplasms, and neurological tumors). Finally, the treatment modalities and long-term follow-up outcomes were assessed. Rehabilitation included removable and fixed partial dentures and finally implants were inserted when facial growth was complete at age 16 years for girls and 17 years for boys .When osseointegration was good ,temporary and then final restorations were constructed. Long-term follow-up outcomes were assessed for another two years.

3. Results

Forty children attending our clinics at ages ranging from 0 to 15 years with tumoral masses located in the maxillofacial region were included. Age distribution was as follows: 5 patients (12.5%) were 0-5 years old, 13 patients (32.5%) were 6-10 years old, and 22 patients (55%) were 11-15 years old .There was no noteworthy discrepancy in sex distribution, with the numbers of female and male patients being similar (18 girls, 22 boys).

Of the 40 tumoral masses, 16 cases (40%) were odontogenic, 23 cases (57.5%) were benign non-odontogenic, and one case (2.5%) was malignant non-odontogenic (Table I).

With regard to distribution according to tumoral mass location, the mandible was most frequently affected 21 patients (52.5%), followed by the maxilla 12 patients (30%), while oral mucosa, tongue, submandibular area and salivary glands constitute 7 patients (17.5%). (Table II)

The location and frequency of the 16 odontogenic tumors indicated that the most frequent tumor type was mixed 8 patients (20%), followed by mesenchymal 5 patients (12.5%) then epithelial constitute 3 patients (7.5%). (Table III)

Our assessment of non-odontogenic tumors based on biological behavior, histopathologic spectrum and location showed that slightly more than half of the tumors in this group 13 patients out of 23(56.5%) were of mesenchymal origin, and that the majority of these were giant-cell lesions (7 cases). The malignant non-odontogenic tumor in this study was determined to be osteogenic sarcoma one patient (2.5%). (Table IV).

Table I. Distribution of Tumors According to Age, Sex, Biologic Behavior and Tissue Origin

Age	Female	Male	Total	%	Tumor	Number	%
0-5	2	3	5	12.5	**Odontogenic**	16	40
6-10	6	7	13	32.5	**Benign non-odontogenic**	23	57.5
11-15	10	12	22	55	**Malignant non-odontogenic**	1	2.5
Total	18	22	40	100	**Total**	40	100

Table II. Distribution of Tumors According to Location

Location	Number	%
Mandible	21	52.5
Maxilla	12	30
Oral mucosa	2	5
Tongue	1	2.5
Salivary gland	1	2.5
Mandible + Maxilla	3	7.5
Total	40	100

Table III. Distribution of Odontogenic Tumors According to Location

	Tumor		Location		
			Mandible	**Maxilla**	**Total**
Epithelial	2 5%	Ameloblastoma	2	-	2
Mesenchymal	6 15%	Odontogenic myxoma	1	2	3
		Cementifying fibroma	2	2	3
Mixed	8 20%	Odontoma	3	2	5
		Ameloblastic Fibroma	3	-	3
Total	16 40%		11	5	16

Table IV. Distribution of Non-Odontogenic Tumors according to Biological Behavior and Location.

Tumor Location									
		Benign	Mandible	Maxilla	Oral mucosa	Tongue	Salivary glands	Submandibular area	Total
Epithelial	3 7.5%	Verruca Vulgaris	-	-	2	1	-	-	3
Mesenchymal	13 32.5%	Pl Adenoma	-	1	-	-	1	-	2
		Fibroma	-	-	1	-	-	-	1
		CGCG	3	3	-	-	-	-	6
		GCT	1	-	-	-	-	-	1
		Osteoma	1	1	-	-	-	-	2
Fibro-Osseous	4 10%	Oss.Fibroma	2	-	-	-	-	-	2
		FD	1	1	-	-	-	-	2
		Cherubim	-	-	-	-	-	1	1
Vascular	2 5%	Hemangioma	1	-	-	-	-	-	1
		Lymphangioma	-	-	-	1	-	-	1
Neurologic	1. 2.5%	Neuro-ectodermal tumor of infancy	-	1	-	-	-	-	1
Malignant									
Mesenchymal	1 2.5%	Osteogenic sarcoma	1	-	-	-	-	-	1
	60%	Total	10	7	3	2	1	1	24

Pl Adenoma: Pleomorphic adenoma **CGCG**: Central giant-cell granuloma. **GCT** : Giant-cell tumor.

Surgical techniques and Follow-up Outcomes

The majority of the 40 children with tumoral masses were treated with surgical excision, en bloc excision, and curettage. Some patients, however, received radical resection and primary reconstruction by reconstruction plate specific to criteria such as the clinical behavior and extent of the lesion. In one of the 7 patients with giant-cell lesions, involvement of the entire left mandible was observed, and after hemimandibulectomy, the mandible was reconstructed with iliac bone graft, costochondral graft, and reconstruction plate; there was no recurrence on four year follow-up. In the remaining six patients, giant-cell lesions exhibited aggressive behavior causing destruction to the cortical bone, and were large enough to cause facial deformities; these patients were treated with surgical curettage and en bloc excision. After six months a removable partial denture was constructed and follow-up period extended to four years. Finally implants were inserted when facial growth was complete at age 16 years for girls and 17 years for boys .When osseo-integration was completed ,temporary and then final restorations were constructed. Long-term follow-up outcomes were assessed for another two years.

Follow-up periods till the end of the study exhibited no recurrence in any of these patients with giant-cell lesions. (Case 1 fig: A,B,C,D ,E,F,G and H)

Despite being categorized as benign tumors, ameloblastomas have a high rate of recurrence, and there is a risk of malignant transformation. One of the two patients with ameloblastoma underwent radical resection (right hemi-mandibulectomy with primary reconstruction by reconstruction plate) approximately five years ago, and thus far has not experienced recurrence. The other patient was ten years old and had been treated by en bloc resection and there was no recurrence during the postoperative follow- up and examinations.

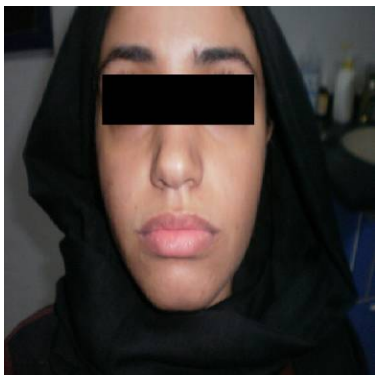
After six months a removable partial denture was constructed and follow-up period extended to four years revealed total filling of the defect by self bone regeneration.

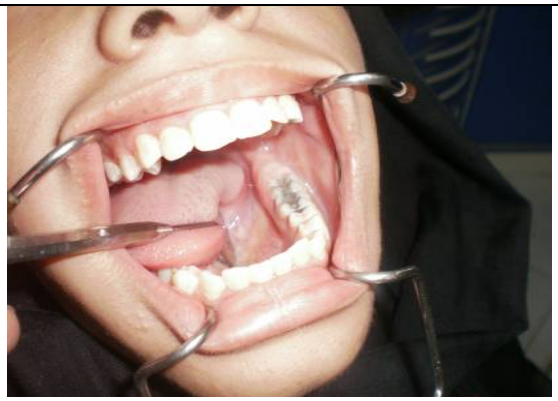
Finally two implants were inserted when facial growth was complete at age 17 years .When osseointegration was completed, temporary and then final restorations were constructed. Long-term follow-up outcomes were assessed for another two years. (Case 2 fig: A,B,C,D ,E,F,G,H and I)

Ameloblastic fibroma, a tumor of odontogenic origin, was determined in three patients (Table III). Two of these lesions were observed to cause moderate destruction, affecting almost the body and angle areas of the mandible. En bloc excision and curettage were performed. There was no recurrence during a mean follow- up period of five years with new bone formation in the region; the mandibular bone was reshaped in both patients. The third one was suffering from massive right mandibular swelling up to the right condyle. Radical resection and primary reconstruction by plating was done.

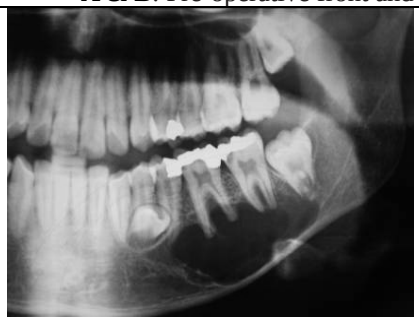
The six-month-old patient with a neuroectodermal tumor underwent tumor excision, and recurrence was not observed during four years of follow-up. This patient's follow-up and supervision are still in progress.

Case 1:

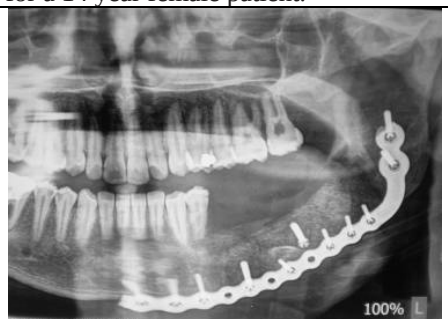




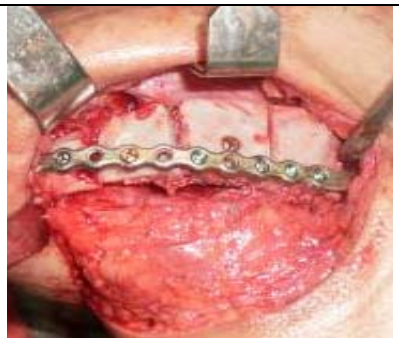
A & B: Pre-operative front and intra-oral photograph for a 14 year female patient.



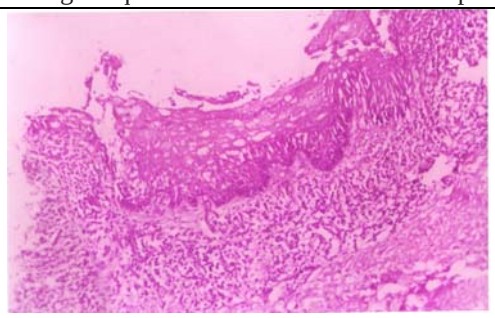
C. Preoperative Panoramic photo-radiograph showing a huge left mandibular lesion.



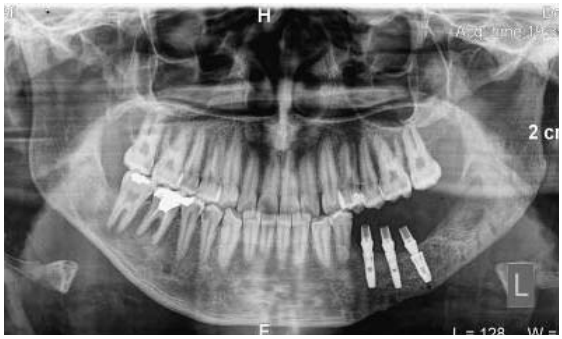
D: Immediate postoperative Panoramic photograph showing adequate contour of reconstruction plate



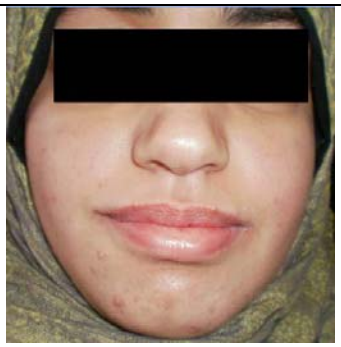
E. Intra-operative photograph showing immediate reconstruction with iliac crest bone graft



F. Microscopic examination showing central giant cell lesion

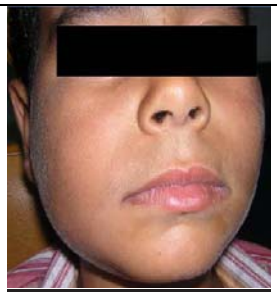


G. 6 months postoperative panoramic photoradiograph showing osseointegration of the three implants with temporary acrylic bridge

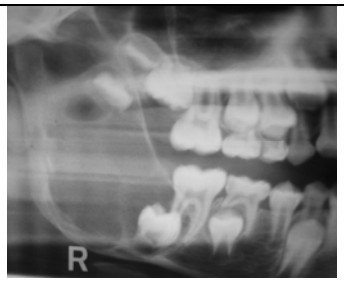


H. Postoperative photograph showing proper facial symmetry

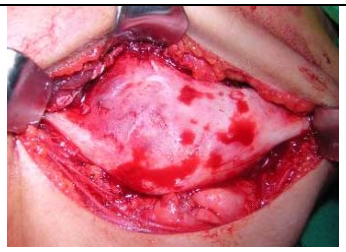
Case 2



A. Preoperative photograph showing right mandibular swelling

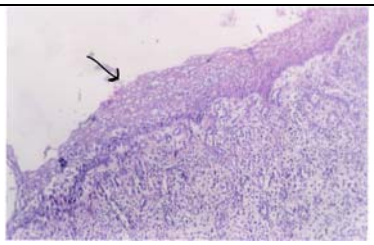


B. Preoperative Panoramic photo-radiograph showing huge right mandibular cystic lesion.

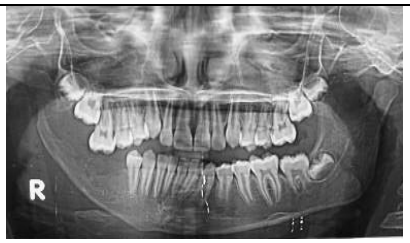


C. Intra-operative photograph showing bucco-lingual bulge and extension of the lesion.

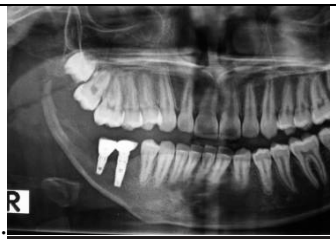
D. Immediate postoperative Panoramic photograph showing adequate contour of reconstruction plate



E. Microscopic examination showing Ameloblastoma

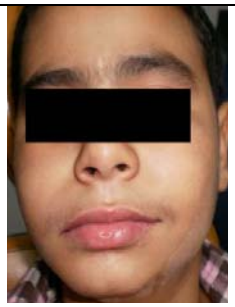


F. Four years postoperative panoramic photoradiograph showing total bone regeneration after removal of the reconstruction plate



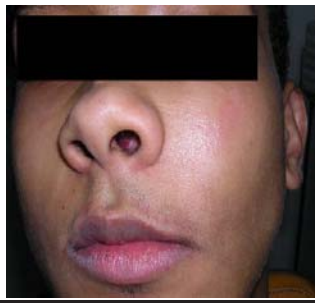
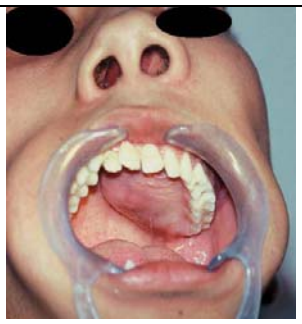
G. 6 months postoperative panoramic photoradiograph showing osseointegration of the two implants

H .Postoperative photograph showing intra-oral view.

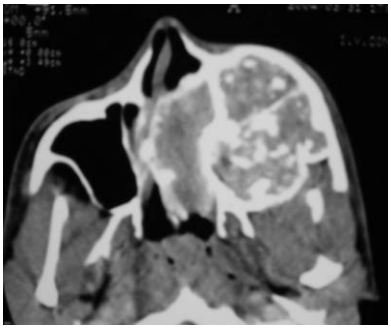
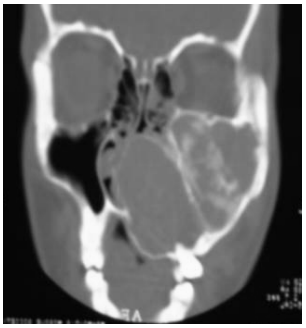


I. Postoperative photograph showing proper facial symmetry.

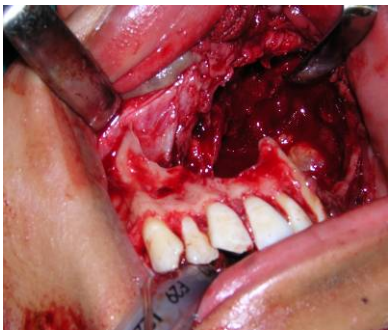
Case 3

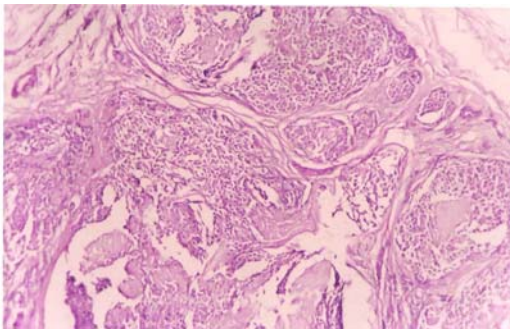
A & B: Pre-operative front and intra-oral photograph showing left maxillary swelling.

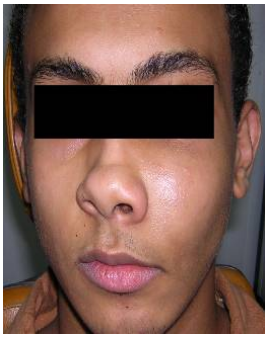
C. (axial) & **D**: (coronal) CT showing massive left maxillary swelling encroaching on left maxillary sinus and nasal septum.



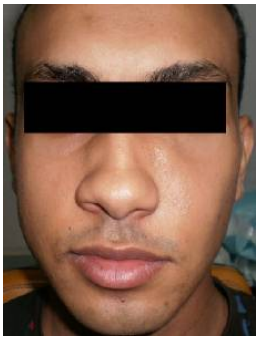
E: Intra-operative photograph showing en bloc excision of the lesion.



F. Microscopic examination showing Facial fibrous dysplasia



G. Postoperative photograph showing improved facial contour.



H. Postoperative photograph showing normal facial contour at 17 years old

One of the two patients with fibrous dysplasia was eleven years old.He was complaining of a huge left maxillary swelling encroaching on the sinus and causing deviation of the nasal septum with severe facial deformity, underwent en bloc excision of the lesion and osteoblastic contouring. He suffered no recurrence during 6 year follow-up. (Case 3 fig. A, B, C, D, E ,F ,G and H).

A seven years old patient with cherubism, a fibrous lesion characterized by extensive involvement of the jaw and facial bones, had been under our supervision for approximately five years, and remission is expected during puberty.

Appropriate chemotherapy or radiotherapy was recommended in the oncology centers for the patient with osteogenic sarcoma, a malignant non-odontogenic tumor. While remission after chemotherapy was observed, he underwent surgery (radical resection and simultaneous reconstruction with micro-vascular fibula transfer) in our clinic approximately three years ago, and is currently in a good health.

In general, a high primary stability for implants placed into the non –vascularized iliac crest bone graft was achieved. Implants placed were shown to integrate normally. The implants were functionally loaded and resulted in a high patient satisfaction.

4. Discussion

The majority of tumors of the mouth and jaw in children are benign. [14, 15] Tanaka et al. [14] reported that only 3% of their cases were malignant in nature. In another study, benign tumors composed 93% of cases [15].

The present study, in parallel with the above-mentioned studies, showed a significant proportion (97.5%) of cases to be benign, with only one out of 40 (2.5%) being malignant. The reason for this ratio being less may be related to the smaller number of malignant tumors cases who applied to our clinics. In contrast Arotiba [6] had conducted a study of orofacial tumors in Nigerian children and claimed that malignancy rates were 40% or more. Most of these malignant tumors were Burkitt's lymphoma (22.4%) while Asamoa et al [5] .had found a higher rate of Burkitt's lymphoma (44.8%) in Northern Nigeria. This tumor is a prevalent neoplasm in children, and is endemic in Africa which accounts for the high incidence rate of these malignant tumors in their studies.

Tanaka et al. [14] reported that pediatric tumors occur most frequently in the 6-11-years age group (43.8%), followed by the 12-15-years age group (31.4%). In a 102 patient series, they reported that 28 of 33 odontogenic tumors were in the 6-11 years age group, attributing this to the fact that crown formation of the permanent teeth is usually completed at 4-5 years of age.

A number of other researchers have reported higher incidences of tumor in the 11-15 years age groups. [6,16, 17] The incidences for girls and for boys are reported to be approximately equal. In the present study, we are in agreement with the literature, where maxillofacial tumors occurred most frequently at 11-15 years of age (55%), while the rates for girls and boys were almost similar.

In various studies on tumors, the mandible is reported to be the most frequently affected area. [14, 15, 18] In the present study we have got similar results 21 patients (52.5%) of cases had mandibular involvement.

The great majority of pediatric jaw tumors are non-odontogenic. Choung and Kaban [7] reported one ameloblastoma and odontomas of small diameter, as opposed to 47 non-odontogenic tumors. In a 46-patient series assessing benign jaw tumors, Dehner [2] found only four odontogenic tumors. In our series, benign non- odontogenic tumors accounted for 23 patients (57.5%) of tumoral formations a considerable proportion.

Of all odontogenic tumors, ameloblastomas are the most controversial in terms of treatment. [19, 20] Treatments range from surgical curettage to en bloc excision or resection. In planning treatment for pediatric tumors, we stress the importance of the growth development of the jaw, and of esthetics and functional concerns in later periods of life. [21, 22] In line with this view, with a single exception, we advocated radical resection in the treatment of all ameloblastomas. Although, it has been reported that pediatric ameloblastomas are generally unicystic and do not extend beyond the cystic wall of the tumor cell [21, 23], we have met cases of recurrence of unicystic ameloblastoma after thorough curettage within five years follow-up.

In the present study the single exception at which we advocate en bloc excision is the presence of at least 1.5-2 cm of uninvolved bone all around the lesion. In our demonstrating case of right mandibular ameloblastoma (Case 2) we have observed total filling of the defect by self bone regeneration after four years follow-up without affecting the normal facial growth of the child which confirms that radical resection does not interfere with growth of maxillofacial skeleton. This is in agreement with Kaban et al. [24] where they got similar comparable results.

Of benign non-odontogenic tumors in our series, tumors of mesenchymal origin were the most common (13 cases). This is in agreement with the literature data. [6, 7, 25]

Of tumors mesenchymal in origin, giant-cell

lesions had the highest incidence (7 cases). Choung and Kaban [7] reported that in their series, giant-cell lesions were the most common tumors of mesenchymal origin. Clear histopathological distinction is not possible between central giant-cell granuloma and giant- cell bone tumor; both are giant-cell lesions. The histopathological criteria to be considered in the diagnosis of real giant-cell tumors have been described, but the distinction between these two lesions cannot be made by histopathological findings alone. [4, 23] Therefore, in the diagnosis of cases we reported as giant-cell bone tumor and central giant-cell granuloma, in addition to histopathologic evaluation, intraoperative evaluation and the tumor's macroscopic appearance were important diagnostic criteria. The fact that the preliminary diagnosis we made based on our surgical experience were confirmed histopathologically suggests to us that, in giant- cell tumors, a specimen's macroscopic appearance is more hemorrhagic, fragile, and liver-tissue-like in appearance than in central giant-cell granulomas. And that in central giant-cell granulomas, a tumoral tissue of solid, fibrous structure is dominant in the periphery of the surgical specimen; hence the curettage and enucleation of central giant-cell granulomas are easier. As a result of this observation, the following factors were determined to be criteria that must be considered in intraoperative evaluation and in the tumor's macroscopic appearance: the fragility, color, and consistency of the tumor tissue; whether or not it is hemorrhagic; and the ease of curettage and enucleating. Furthermore, the literature indicates that giant-cell lesions of the jaw may exhibit a variety of behaviors, and that central giant-cell granulomas may have as much changeability as aggressive lesions or malignant giant-cell tumors. [3, 7, 26] In giant-cell bone tumors in particular, recurrence is more expected due to aggressive clinical characteristics, and treatment consists of a range of surgical methods, from surgical curettage to hemimandibulectomy and reconstruction with bone graft. [7] There was no recurrence in any of our seven patients with giant-cell lesions. One of these patients was treated with hemimandibulectomy, and the others with en bloc excision and curettage. This is in accordance with Erol and Ozer [1] where they reported a central giant-cell granuloma in a six-year-old patient had caused widespread bone destruction in the corpus and ramus and after surgical curettage there was no recurrence during long-term follow-up.

Another pathology, that is histopathologically indistinguishable from giant-cell lesions is cherubism [7, 19, 25] a hereditary disease exhibiting autosomal dominant transfer. It generally begins before the age of five, and spontaneous regression is expected after puberty. Choung and Kaban [7] followed up two cherubic patients, ages two and four, within 38 and 41 months respectively, and determined minimal change. Our patient who attended our clinics at age seven and was diagnosed with cherubism had been followed up for approximately five years, and regression in puberty is expected.

Rehabilitation by removable and fixed partial dentures after surgery made our patients satisfied as functioning, esthetic and speech had improved markedly. Implants were inserted when facial growth was completed .All implants showed success till the end of the study. These findings are in agreement with many authors. [27-29]

In summary and conclusion benign mesenchymal tumors are the most common jaw tumors in the pediatric patient group. They all appear histologically benign and not metastasize. However, giant cell lesions and myxomas, as well as fibro-osseus lesions may exhibit a locally aggressive growth pattern with a high recurrence rate. Treatment must therefore be planned with particular attention to the biologic behavior of the tumor and not the name. Tumors that exhibit a rapid growth pattern, pain, paresthesia, displacement of adjacent teeth, and root resorption should be treated with en bloc excision regardless of the histological diagnosis. Less biologically aggressive lesions may be treated by enucleation or curettage and should be followed by dental rehabilitation. Implants can be inserted safely and successfully, but in the proper time, in either augmented or reconstructed bone .

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