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ORIGINAL ARTICLE

Role of multidetector computed tomography in assessment of fibro-osseous lesions of the craniofacial complex

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KEYWORDS

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Abstract *Aim:* To assess the role of multidetector CT in assessment of fibro-osseous lesions of the craniofacial complex.
Materials and methods: This study included 25 patients. Their age ranged from 15 to 64 years with a mean age of 37.56 ± 15.17 years. All the studied individuals were chosen selectively regarding complaint (those with known fibro-osseous lesions, facial disfigurement, and facial swelling) regardless of age and gender and examined using MDCT in detection of the lesion, and assessment of the extensions.
Results: In the present study, the cranio-facial fibrous dysplasia represented almost half of the presented cases (48%) followed by osteomas (36%) then ossifying fibroma (12%) and brown tumor (4%). 13 out of 25 cases in this study were pathologically proven to be fibro-osseous lesions and surgically operated. The final diagnosis was made by consensus of imaging, clinical findings and pathological features.
Conclusions: Multi-detector row CT images, including reformations, better delineate craniofacial complex anatomy than do single-detector row CT images. Using multi-slice CT scanning in the craniofacial complex becomes possible to depict the complete path of complex structures.

1. Introduction

Fibro-osseous lesions (FOLs) of the craniofacial complex are represented by a variety of disease processes that are characterized by pathologic ossifications and calcifications in association with a hypercellular fibroblastic marrow element and share microscopic features (1). Whereas some are diagnosable histologically, most require a combined assessment of clinical, microscopic and radiologic features.

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In turn, some fibro-osseous lesions (FOLs) of the craniofacial complex are unique to that location whereas others are encountered in bones from other regions (2).

FOLs can involve paranasal sinuses, skull base, and maxillofacial region. Fibrous dysplasia, ossifying fibroma, and osteoma are three distinct entities that lie along a continuum from the least to the most bony content. They have similar appearance and makeup; however, their clinical implication varies (3).

Fibrous dysplasia is a benign dysplastic process of altered osteogenesis that may occur within a single bone (monostotic) or multiple bones (polyostotic) (1). When polyostotic fibro-osseous lesions typical for fibrous dysplasia are associated with other anomalies and endocrinopathy, this variant form constitutes the McCune-Albright syndrome (MAS). McCune-Albright syndrome (MAS) consists of at least 2 of the following 3 features: (1) polyostotic fibrous dysplasia (PFD), (2) café-au-lait skin pigmentation, and (3) autonomous endocrine hyperfunction (e.g., gonadotropin-independent precocious puberty). Other endocrine syndromes may be present, including hyperthyroidism, acromegaly, and Cushing syndrome (4).

Monostotic fibrous dysplasia of the craniofacial complex is often confused with other FOL, typically ossifying fibroma and diffuse sclerosing osteomyelitis of the mandible, diseases that manifest unique clinicoradiologic features (1).

Depending on the type and location of FD, the signs and symptoms vary and include facial deformity and asymmetry, vision changes, hearing impairment, nasal congestion and/or obstruction, pain, paresthesia, and malocclusion (5).

Improvement in CT imaging and software allows for accurate surgical simulation and intraoperative navigational tools may guide the surgeon throughout the contouring. Advanced CT software is useful for superimposition of pre- and post-operative images. These can then be compared to follow-up CT scans to determine the stability of the result or the presence of regrowth (5).

Malignant transformation of FD has been reported in less than 1% of cases of FD (6). Typically the malignancy is a sarcomatous lesion, most often osteosarcoma but fibrosarcoma, chondrosarcoma, and malignant fibrohistiocytoma have also been reported (7).

Fibrous dysplasia may also be associated with soft tissue myxomas, the Mazabraud syndrome is a rare syndrome comprising of fibrous dysplasia: usually polyostotic, multiple soft tissue (intramuscular) myxomas: typically in large muscle groups. It is most frequently seen in women (~70%) and usually present in middle age (mean age 46; range 17–82). There is an increased risk of osseous malignant transformation (8).

Radiologically the affected bones are usually expanded with an intact cortex and lose the normal cortico-medullary differentiation, being replaced classically by a homogeneous ground glass appearance, although mixed lucencies and sclerosis are also common (9).

1.2. Ossifying Fibromas

These are neoplasms in the true sense, exhibiting progressive proliferative capabilities with bony expansion and, importantly, well defined margins radiologically. Specific subtypes include psammomatoid variant of ossifying fibroma, trabecular variant of ossifying fibroma, gigantiform cementoma, and cemento-ossifying fibroma (1).

- **Trabecular Juvenile Ossifying Fibroma (TrJOF)**: The maxilla and the mandible are the dominant sites of incidence of TrJOF. Origin in extragnathic locations is extremely rare. Clinically, TrJOF is often characterized by a progressive and sometimes rapid expansion of the affected area; pain is a rare symptom (10).
- Radiographically, JTOF is an expansive lesion and may be fairly well demarcated, with cortical thinning and perforation. Depending on the amount of calcified tissue produced, the lesion will show varying degrees of radiolucency or radiodensity. Ground-glass as well as a multilocular honeycomb appearance has been described (11).
- Unlike TrJOF, psammomatoid juvenile ossifying fibroma (PsJOF) is a lesion that affects predominantly the extragnathic craniofacial bones, particularly centered on the periorbital, frontal, and ethmoid bones (12).
- PsJOF is clinically manifested as bone expansion that may involve the orbital or the nasal bones and sinuses. Orbital extension of sinonasal tumors may result in proptosis, and visual complaints including blindness, nasal obstruction, ptosis, papilledema, and disturbances in ocular mobility (1).
- *Radiographic examination of JPOF* shows a round, well-defined, sometimes corticated osteolytic lesion with a cystic appearance. Sclerotic changes are evident in the lesion which may show a ground-glass appearance. The lesions appear less dense than normal bone (11).

1.3. Osteoma

An osteoma is a benign osteogenic tumor characterized by compact or cancellous bone proliferation. It may be classified as peripheral, central, or extraskeletal. A peripheral osteoma arises from the periosteum, a central osteoma from the endosteum, and an extraskeletal osteoma in the soft tissue (13).

Osteomas are found mainly in the craniofacial bones. A peripheral osteoma (PO) occurs most frequently in the paranasal sinuses. The frontal-ethmoidal sinus is the most frequent site in the paranasal sinuses. Other locations include the orbital wall, temporal bone, pterygoid processes, and external ear canal (14).

Patients with osteomas should be evaluated for Gardner's syndrome (GS). This syndrome is an autosomal dominant disease characterized by gastrointestinal polyps, multiple osteomas, skin and soft tissue tumors, and multiple impacted or supernumerary teeth (15).

The imaging appearance reflects the underlying pathology, with ivory osteomas appearing as very dense radiodense lesions, similar to normal cortex, whereas mature osteomas may demonstrate central marrow (16).

Lesions that may resemble fibro-osseous lesions (FOLs) include a number of neoplastic, nonneoplastic, and metabolic disease processes that may manifest with clinical, radiographic, and histopathologic features that closely resemble those seen in fibro-osseous lesions (FOLs). It should be differentiated from paget, cherubism, osteosarcoma, cementoblastoma, proliferative periostitis, central giant cell granuloma, and hyperparathyroidism (1).

The purpose of the present study was to assess the role of multidetector CT in assessment of fibro-osseous lesions of the craniofacial complex.

2. Materials and methods

This study was conducted on 25 patients using MDCT in detection of the lesion, and assessment of the extensions. It was a combination of prospective (16 cases) and retrospective (9 cases) and was designed for cases of fibro-osseous lesions of cranio-facial complex. Their age ranged from 15–64 years with a mean age of 37.56 ± 15.17 years. 13 out of 25 cases were pathologically proven to be fibro-osseous lesions and surgically operated. Only patients with expansile bony lesions were included. Those who have been proven to be soft tissue or metastatic were excluded.

It has to be highlighted that 12 out of 25 cases underwent pre and post-contrast studies using optiray 350 (ioversol) as the contrast *adult dosage* usually: 50–150 mL IV max 150 mL or 100–250 mL IV of 240 mg/mL and *children dosage* (less than 18 years) 1.25 mL/kg (range 1–1.5 mL/kg); total administered dose should not exceed 5 mL/kg up to a volume of 250 mL and it has to be mentioned that it is not for intrathecal use (may cause death, convulsions, cerebral hemorrhage, coma, paralysis, and ARF), contrast induced nephropathy and allergy to iodinated contrast. Current policy suggests a creatinine of less than or equal to 1.5 mg/dl and no evidence of acute kidney injury for IV contrast administration.

All the studied individuals were chosen selectively regarding complaint (those with known fibro-osseous lesions, facial disfigurement and facial swelling) regardless of age and gender.

They were referred for radiological assessment of the extensions as physicians from other specialties were invited to be involved in the management including dentist, maxillofacial and head & neck surgeons.

The final diagnosis was made by consensus of imaging, clinical findings and pathological features.

All medical ethics approved by the faculty of medicine Alexandria University were considered.

All examinations were performed on a multislice CT (MSCT) scanner (emotion 6, Siemens, Germany), six row unit or General Electric Light Speed CT scanner (emotion 4, USA), four row unit.

Axial volumetric acquisition was taken and completed with reformations of coronal and sagittal images. Axial sections were made parallel to the infraorbital-meatal line from upper border of frontal sinus down to the end of the mandible. MDCT technique generally consists of thin-collimation (0.6 mm) scanning performed with a 0.3 mm overlap, an advanced table 1.3 mm/rotation, and a voltage of 120 kV with an intensity of 200 mA.

Axial images were reconstructed at 0.6 mm thickness and with a reconstruction increment of 0.3 mm resulting in more than 200 2D images to reduce stair-step artifacts using a high resolution bone algorithm.

All cases were examined in all the three orthogonal views namely: dead axial, dead sagittal and coronal view perpendicular to the hard palate and scanned for any variations in their normal anatomy.

The images were used in 3D reconstruction volume rendering with General Electric Light Speed CT scanner advantage 4.2 workstation where it was taken in multiple angles with bone and soft tissue windows for further clarification and planning for surgical interference.

2.1. Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using number and percent. Comparison between different groups regarding categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher's Exact test or Monte Carlo correction. Significant test results are quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level.

3. Results

The present work included 25 patients with fibro-osseous lesions of the craniofacial complex. They were 10 males and 15 females. Their ages ranged between 15 and 64 years with a mean age of 37.56 ± 15.17 years as shown in Table 1.

In the present study, the cranio-facial fibrous dysplasia represented almost half of the presented cases (12 patients) (48%), followed by osteomas (9 patients) (36%), then ossifying fibroma (3 patients) (12%) and brown tumor (1patient) (4%).

3.1. Fibrous dysplasia (12 patients) (Figs. 1 and 2)

In this study two thirds of patients (8 patients) (66.6%) with fibrous dysplasia were diagnosed *among females* and half of the patients (6 patients) were in *their 5th decade*. *The majority (8 patients) were complaining of headache (66.6%)* while only two patients presented by facial deformity (16.6%) and 4 patients (33.3%) presented by facial swelling.

The maxillary bone and sinuses mainly ethmoid, sphenoid, and maxillary are most frequently affected (4 patients each)(33.3%), followed by equal distribution for the mandibule, temporal bones and orbit (2 patients each) (16.6%). The skull base, zygoma and occipital condyle are less frequently affected (only one patient each) (8.3%) in the present study as shown in Table 2.

The number of patients was equal for both single bone involvement (monostotic 50%) and multiple bone involvement (polyostotic 50%). In this study the fibrous dysplasia was unilateral and specifically affecting the right side in most of the cases (11 patients).

Four patients with *maxillary involvement* (33.3%) showed buccolingual expansions with cortical thinning and three of

Table 1 Distribution of patients with fibro-osseous lesions according to age and sex.

Age	Males (%)		Females (%)		Total	
	n	%	*n*	%	*n*	%
10– < 20	2	8	2	8	4	16
20– < 30	2	8	3	12	5	20
30– < 40	2	8	1	4	3	12
40– < 50	2	8	7	28	9	36
50– < 60	0	0	1	4	1	4
60– < 70	2	8	1	4	3	12
Total	10	40	15	60	25	100

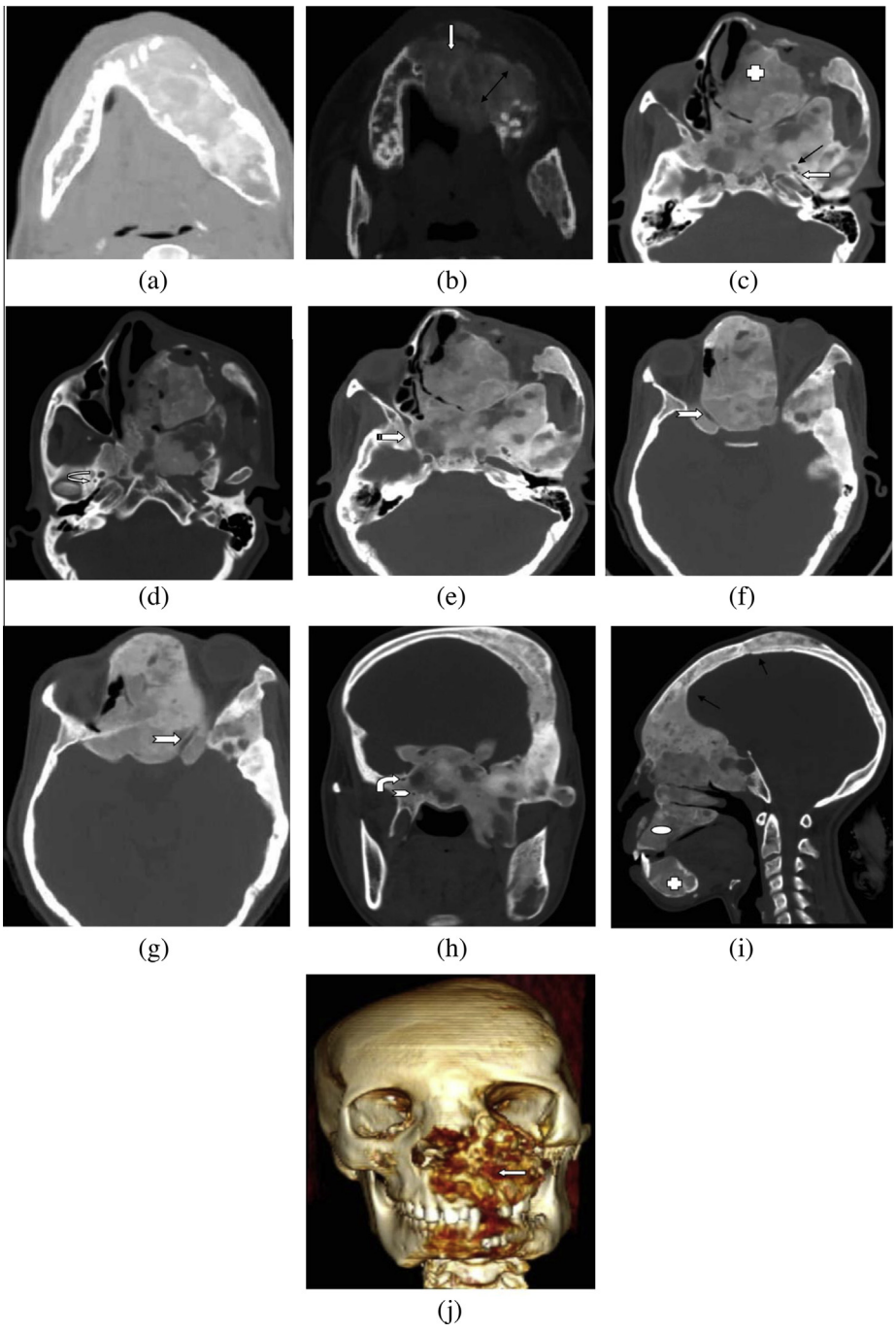

Fig. 1 19 years old female patient complained of left sided painless cheek swelling pathologically was proven to be fibrous dysplasia. (a) Axial section shows diffuse expansile mixed lytic and sclerotic ground glass density lesion involving the mandible notably the left side with implication of its alveolar margin and displacement of overlying teeth. (b) Axial section shows the lesion involving the maxillary bone notably the left side with implication of alveolar margin and buccolingual expansion (double arrow heads) with displacement of overlying teeth and implication of the incisive foramen (white arrow) crossing to the right side. (c) Axial section shows the involvement of sphenoid bones along with the nasal vault (cross figure) and fronto-parietal regions bilaterally (more left sided) with implication of the orbital bony frame works and skull base of the anterior and middle cranial fossa. The lesion mainly involved the diploic spaces with no cortical interruption noted. Totally encasement of the still patent skull base foramina is seen, namely foramen ovale (black arrow) on both sides, foramen spinosum (white arrow) on left side. (d) Axial section shows free foramen spinosum in right side (curved right arrow) bilaterally. (e) Axial section shows encasement of the still preserved superior (striped right arrow) orbital fissures. (f and g) Axial sections show encasement of the still preserved optic canals in both sides (notched right arrows in figure f and g). (h) Coronal section shows encasement of the still preserved foramen rotundum (bent arrow) and vidian canals (arrow head). (i) Sagittal section shows involvement of maxillary (oval figure), mandibular (cross figure), nasal vault, fronto-parietal bone (black arrows) and sphenoid bones (j) 3D volume rendering shows distorted facial osseous structures with the previously described expansile lesion of the maxillary, mandibular, nasal and orbital bony walls as well as fronto-parietal bones mainly left side.

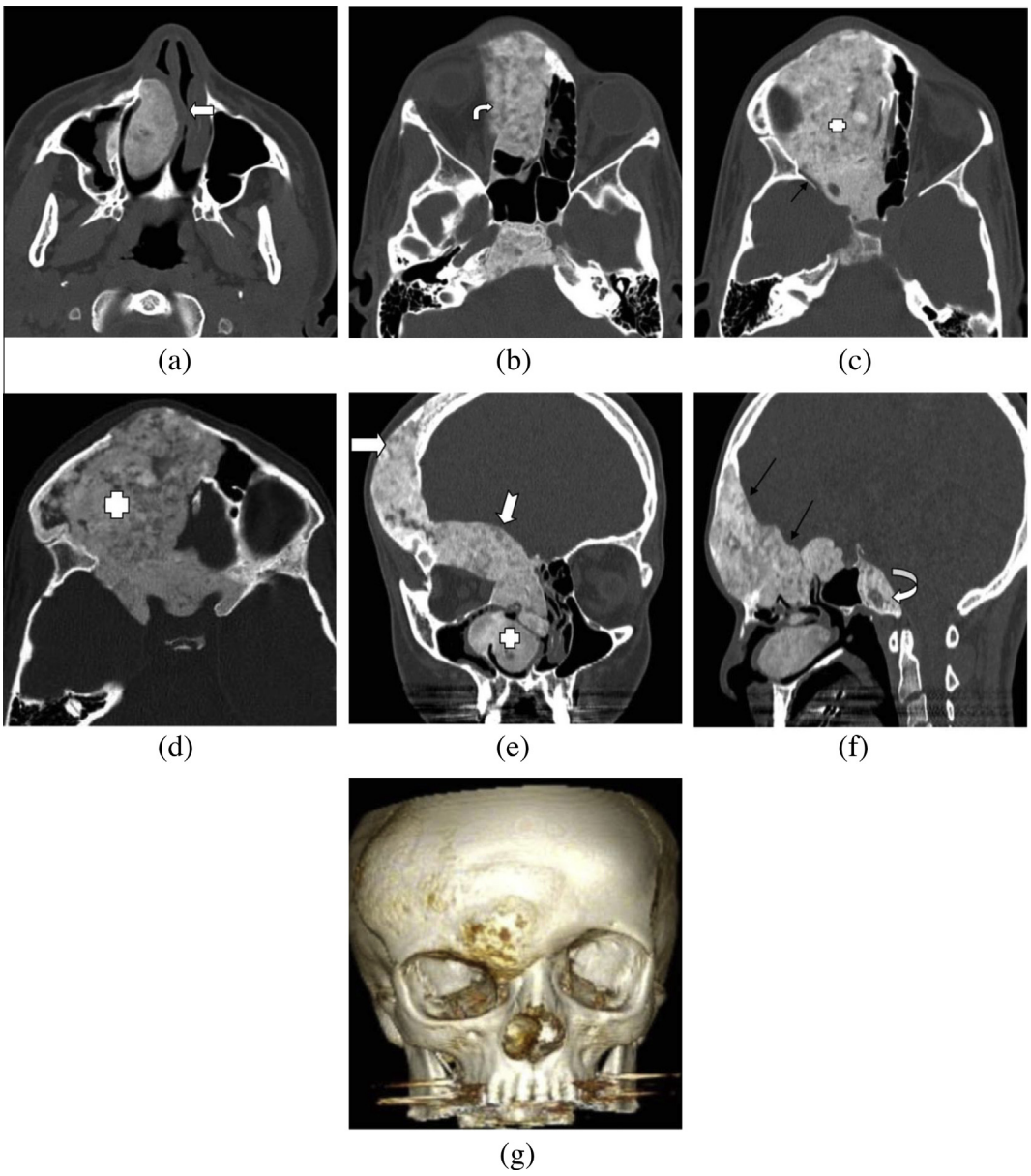

Fig. 2 22 year old female patient complained of headache, paranasal discharge and forehead swelling. (a) Axial CT section shows diffuse expansile mixed lyitc and sclerotic osseous lesion involving the right nasal cavity with deviation of nasal septum to left side (white arrow). (b) Axial section shows complete obliteration of the right ethmoidal air cells (bent arrow). (c), and (d) Axial sections show complete obliteration right frontal bone (cross figure). Distorted outlines of the right orbital bony frame work with optic canal implication are noted (black arrow). (e) Coronal section shows the lesion involving the right inferior turbinate (cross figure), lateral wall of the right nasal cavity with involvement of right orbital floor (notched left arrow) and parietal bone (white arrow). (f) Sagittal section shows involvement of the right fronto-ethmoidal (black arrows) regions as well as the right side of the anterior cranial fossa. Clival involvement is seen as well (curved left arrow). (g) 3D volume rendering image shows the previously described lesion with right orbital and nasal disfigurement. ... *features suggestive of fibrous dysplasia.*

them (25%) showed involvement of maxillary antrum in the form of obliteration.

Only two patients showed *involvement of lower border of mandible* (16.66%) with involvement of alveolar margin in both cases. Both patients showed displacement of overlying teeth (16.66%). Another two patients showed extracoanal extension (16.66%), one of them showed involvement of optic nerve (8.33%), and another one showed compression of medial rectus muscle (8.33%).

Patients with sinuses involvement (33.33%) showed obliterated sinuses and none of the patients showed small or hypoplastic sinuses. Skull base affection was seen in 4 patients, one of them only presented isolated skull base fibrous dysplasia whereas the other 3 showed skull base affection beside other bony involvement (maxillary, mandibular, petrous, etc.). The foramen ovale and foramen rotandum encasement are seen in three patients with less frequent involvement of the other skull base foramina as shown in Table 3.

Table 2 Distribution of the patients with fibro-osseous lesions according to the site of implication.

Site	Fibrous dysplasia		Ossifying fibroma		Osteoma		*p*
	No	%	No	%	No	%	
Maxilla	4	33.33					0.149
Mandible	2	16.66			1	11	1.000
Sinuses	4	33.33	2	66.67			0.031*
Frontal					4	44	0.027*
Ethmoidal					2	22	0.607
Skull base	1	8.33					1.000
Temporal bone	2	16.66					0.607
Occipital condyle	1	8.33					1.000
Zygoma	1	8.33					1.000
orbit	2	16.66	1	33.33			0.216
High parietal					1	11	0.502
External auditory canal					1	11	0.502
Anterior cranial fossa			1	33.33			0.129

p: *p* value for Monte Carlo test.
* Statistically significant at $p \leqslant 0.05$.

Typical ground glass density was seen in all of the patients with the majority (7 patients) showing *sclerotic pattern, homogenous matrix* (58.33%) and the rest (5 patients) shows *mixed lytic and sclerotic pattern, heterogenous matrix* (41.6%). *Ill defined margins* were seen in the majority (8 patients) (66.6%) whereas the rest (4 out of 12 patients) showed well defined margins (35%), *Thin cortex* was seen in the majority (7 patients) (58.3%), with fewer percentage (4 patients) (25%) showing intact cortex while only one patient showed absent cortex (8.3%) and no one showed thick cortex as shown in Table 4.

Only two out of 12 patients were associated with soft tissue swelling (18%).

3.2. Ossifying fibroma (3 patients) (Fig. 3)

Ossifying fibroma was found *more in males* with the *majority in the age range 10- < 20*. Majority of patients (two patients) (66.66%) complained of headache, nasal discharge, nasal obstruction and hyposomia with only one patient (33%) complained of proptosis and another one complained of limitations in ocular mobility.

In this study *two out of three patients showed bilateral involvement (66.66%)* and only one patient showed right sided ossifying fibroma. *Sinuses and nasal cavity* were mostly affected (two patients) whereas orbital and anterior cranial fossa involvement was seen in lesser percentage (one patient each) as shown in Table 2. *Sinus involvement* was seen in the form of obliteration and retained secretions (66.66%). *Orbital involvement* was seen in the form of proptosis in one patient (33%)and displacement of right medial rectus in another one.

Majority of patients (two out of three) (66.66%) showed mixed lucent and sclerotic density, thin cortex whereas only one patient showed cystic density and intact cortex. All of the patients showed heterogenous matrix, and well defined margins as shown in Table 4.

3.3. Brown Tumor (Fig. 4)

During our study one case with renal failure presented facial swelling, headache and nasal and discharge pathologically was proven to be brown tumor. It affected mainly the left sided nasal cavity, left ethmoidal air cells and left maxillary antrum which was obliterated and showed retained secretions. It was mainly unilateral and left sided and showed mixed lytic and sclerotic pattern and heterogenous matrix, with well defined margins and thin cortex. The mass acquired extraconal location indenting the left inferior and medial rectus extra-ocular muscles.

3.4. Osteoma (9 patients) (Figs. 5 and 6)

Headache was the main complaint seen in the majority of patients presented with osteoma (8 patients) (88.88%),

Table 3 Distribution of the patients with fibrous dysplasia according to involvement of skull base structures ($n = 4$ patients).

Skull base affection		Number of the patients	% Out of patients with fibrous dysplasia
Skull foramina	Lacerum	1	8.33
	Ovale	3	25
	Rotundum	3	25
	Superior orbital fissure	2	16.66
	Inferior orbital fissure	1	8.33
	Optic nerve canal	2	16.66
	Vidian canal	1	8.33
	Carotid canal	1	8.33

Table 4 Distribution of the patients with fibro-osseous lesions according to the radiological features.

Radiological Features		Fibrous dysplasia		Ossifying fibroma		Osteoma		*p*
		No	%	No	%	No	%	
Density	Cystic	0	0	1	33.3%			0.129
	Sclerotic	(Ground glass)7	58.33	0	0%	(Dense) 9	100	0.002*
	Mixed lytic and sclerotic	(Ground glass) 5	41.66	2	66.67%	0	0	0.030*
	Lytic	0	0	0	0%	0	0	-
Matrix	Homogenous	7	58.3	0	0%	9	100	0.004*
	Heterogenous	5	41.6	3	100%	0	0	0.003*
Margins	Well defined	4	25	3	100%	9	100%	0.002*
	Ill defined	8	66.6	0	0%	0	0%	0.003*
Cortex	Thin	7	58.3	2	66.67	0	0%	0.007*
	Absent	1	8.3	0	0%	0	0%	1.000
	Intact	4	25	1	33.3	0	0%	0.126
	Thick	0	0	0	0%	0	0%	–

p: *p* value for Monte Carlo test.
* Statistically significant at $p \leqslant 0.05$.

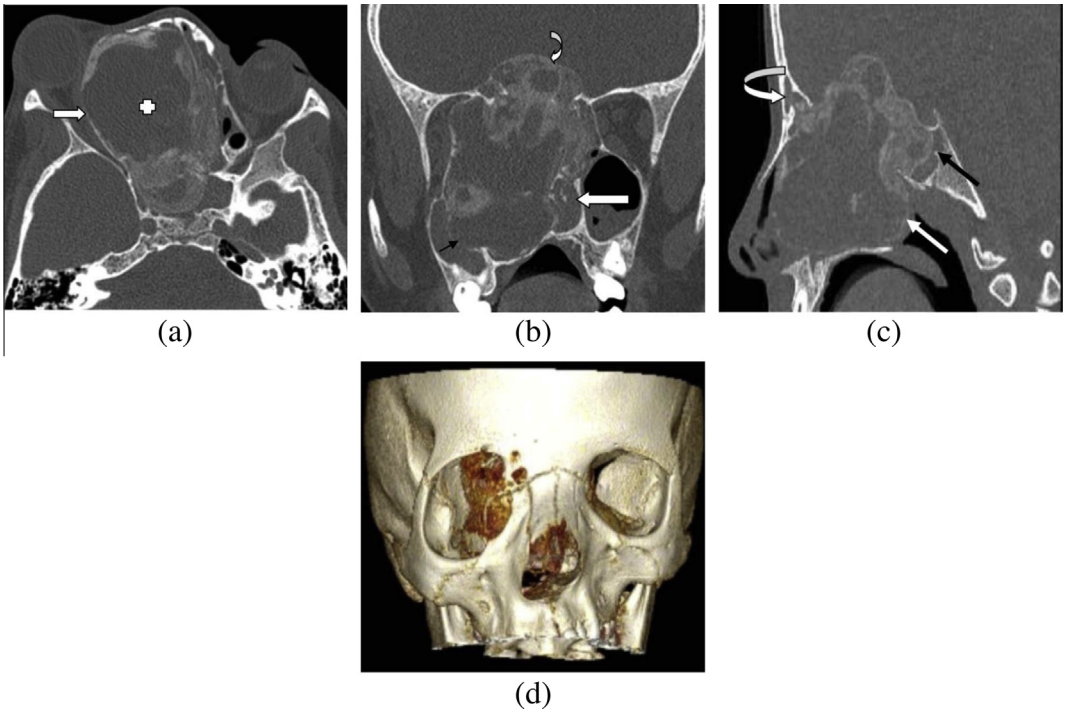

Fig. 3 15 year male patient complained of proptosis and headache pathologically was proven to be ossifying fibroma. (a) Axial section shows a large sino-nasal complex soft tissue fibro-osseous lesion epicentered upon the ethmoidal air cells (notably right sided) (cross figure) displaying faint ossific densities and hypodense areas. *Laterally*, it is violating the medial wall of the right orbit with extraconal component and consequent proptosis (white arrow). (b) Coronal section shows superior extension where, it violates the ethmoidal roof with consequent intracranial extension within the anterior cranial fossa (curved white arrow). *Inferiorly*, it is extending within the right nasal cavity with remodeling of its lateral wall and consequent projection within the right maxillary sinus (black arrow). *Medially*, it is encroaching upon the left nasal cavity with retained secretions (left white arrow). (c) Sagittal section shows *Posterior* extension where it projects within the sphenoid sinuses (black arrow). Limited extension through right posterior choana is seen (white arrow). *Anteriorly*, it is protruding into the frontal sinuses (curved white arrow). Consequent opacification of the previously mentioned sinuses with retained secretions is seen (d) 3D VR shows the extension of tumor.

mass/swelling was seen in only two patients out of nine (22%), and only one patient presented recurrent otitis media (11%).

The frontal sinus (44%) was found to be the most affected portions of the cranio-facial complex with less frequency regarding the other facial regions as shown in Table 2. All the diagnosed patients had *unilateral lesion* with five patients (55%) having right sided lesions in comparison to four (44%) patients with left sided lesions.

Regarding the degree of sinus involvement, two patients showed osteomas (22%), completely occupying the whole sinus whereas only one patient showed retained secretions (11%) and the rest of sinuses was free.

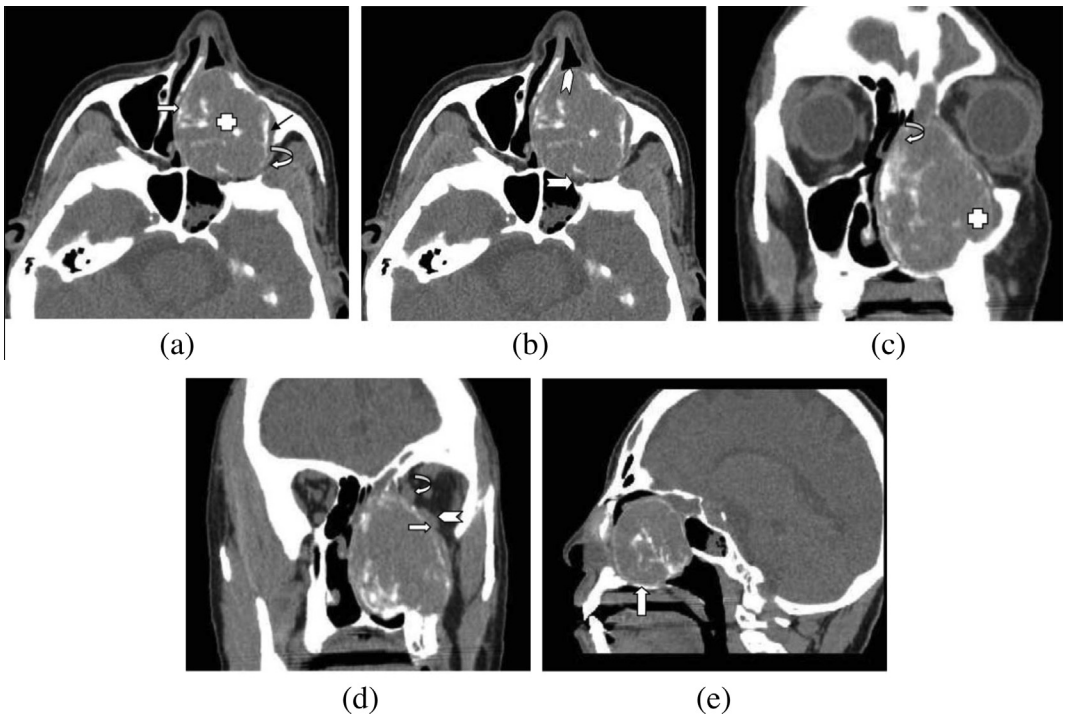

Fig. 4 A 45 year old female patient with known renal failure, she developed hyperparathyroidism, multiple facial brown tumors pathologically was proven to be brown tumor. (a) Axial section shows that sizable expanding space occupying lesion (cross figure) is noted epicentered at the left nasal cavity, with destruction of the left nasal turbinates. Destruction of the posterolateral wall of the left maxiallary antrum (curved white arrow) is also noted with further mild lateral extension into left masticator space. Laterally it occupies most of the cavity of the left maxillary antrum that otherwise showed obstructive effect and retained secretions (black arrow in figure a). *Medially* it occupied the left nasal cavity pushing the thinned out nasal septum (white arrow) to the right side. (b) Axial section shows the lesion extensions *Posteriorly* the lesion invades the left pterygo-palatine fossa (notched white arrow) reaching the base of the left pterygoid plates. *Anteriorly* the lesion extends toward the left anterior nasal aperture (arrowhead). (c) Coronal section shows the lesion epicentered upon left ethmoidal air cells (curved arrow) and left maxillary antrum (cross figure). (d) Coronal section shows *superior* extension where the lesion encroaches upon the left orbit with thinning out and very rarefied left inferior orbital wall (white arrow). The mass acquires extra-conal location indenting the left inferior (arrowhead) and medial (arrowhead in figure) rectus extra-ocular muscle. Consequent proptosis of the left eye globe is seen. (e) Sagittal section shows *inferior* extension where the lesion reaches the left sided hard palate (white arrow) that is also thinned out as well as the left alveolar process of the maxilla.

Sessile lesions were seen in the majority of the patients (8 patients) (88.88%) whereas only one patient (11%) showed pedunculated lesion. All of the patients with osteoma showed dense sclerotic homogenous matrix and well defined margins and none showed lytic, heterogenous matrix or ill defined margins as shown in Table 4.

In this study there was a statistical significant difference between the three diseases as *regards sinuses involvement* (p value = 0.031) particularly frontal sinus (p value = 0.027), *density* both sclerotic (p value = 0.002), and mixed lytic and sclerotic (p value = 0.03), *matrix* both homogenous (p value = 0.004), and heterogenous (p value = 0.003), *margins* both well defined (p value = 0.002) and ill defined (p value = 0.003), and thin *cortex* (p value = 0.007).

4. Discussion

Fibro-osseous lesions (FOLs) of the maxillofacial bones comprise a diverse group of pathologic conditions that includes developmental lesions, reactive or dysplastic diseases, and neoplasms (17).

Fibrous dysplasia (FD) is a non neoplastic developmental hamartomatous disease of the bone. It represents approximately 2.5% of all bone lesions and in total about 7% of all benign bone tumors. The disease has three different subtypes (monostotic, polyostotic, and Mc Cune Albright Syndrome) (3).

This study coincides with Sontakke et al. (18) who reported that the craniofacial type of fibrous dysplasia is found to be as common as fibrous dysplasia of the jaw and was more commonly seen in younger age (11, 19, and 22 years) as shown in our study. The unilateral nature of fibrous dysplasia was noted in most of cases (91.6%) only one patient was bilateral (8.3%) (18).

Bertoni et al. (19) suggested that the ill-defined margins of the lesion helped to differentiate it from other fibro-osseous lesions. In this study, the margins were ill-defined in eight patients out of twelve (66.6%) except in the region where they extended to the cortex of bone.

This study agreed with MacDonald et al. (20) who reported that ground glass appearance was the most common radiographic appearance of internal structure of fibrous dysplasia which substantiated the diagnosis of fibrous dysplasia. In this study about 7 patients out of twelve (58.3%) showed sclerotic

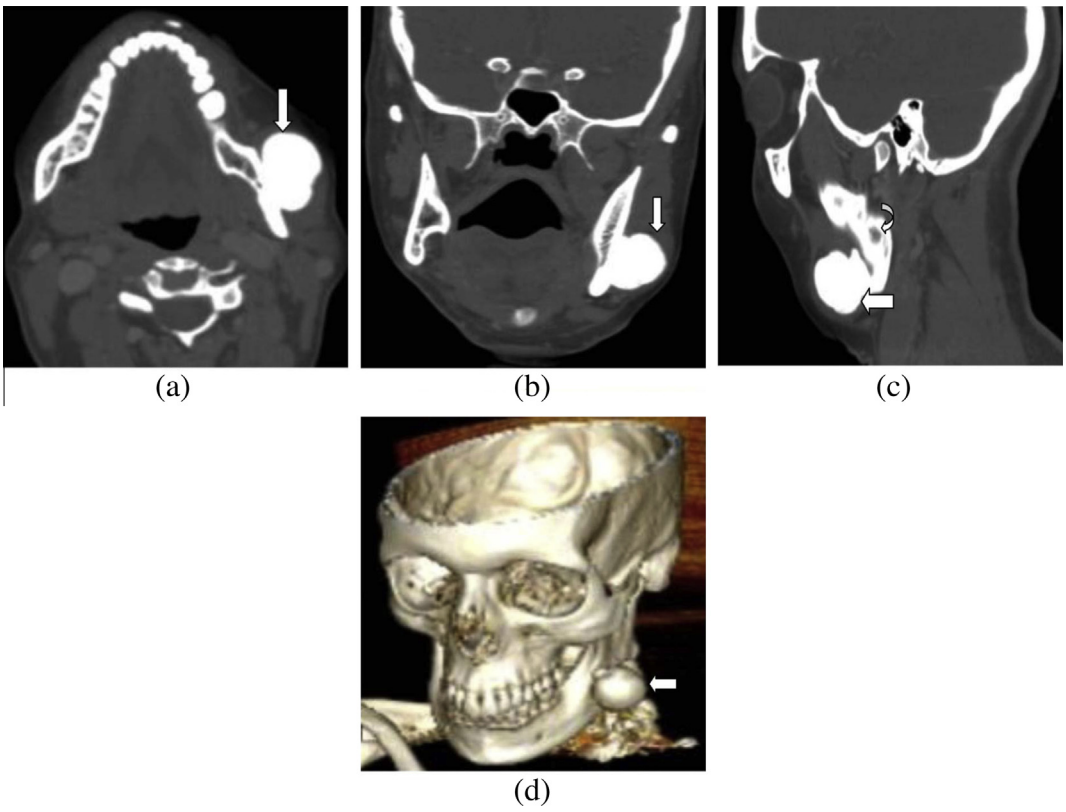

Fig. 5 33 year old female patient complained of left sided mandibular swelling (a) axial (b) coronal and (c) sagittal CT cut, (d) 3D VR image shows an ovoid mass lesion (white arrow) arising exophytically from the left angle of the mandible. The mass shows homogenous dense osseous attenuation (1500 HU) and associated with sclerosis of the marrow spaces of the mandibular angle (curved arrow). It grows in and expands the caudal part of the masseter (masticator space) with no intra-muscular extensions. . .. *features suggestive of mandibular osteoma.*

matrix and 5 patients (41.6%) showed mixed lytic and sclerotic which supports the study at the National Institute of Health (NIH) (21) which demonstrated that the typical characteristics of FD on CT and the natural radiographic progression may vary from a ''ground-glass'' to a mixed radio-dense/radiolucent lesion as the patient ages. In pre-pubertal patients with polyostotic fibrous dysplasia, the lesions most often appear as homogenous, radio-dense lesions on CT. As these patients enter the second decade of life, the FD lesions progress to a mixed appearance, which stabilizes in adulthood but does not resume a homogenous appearance (21).

Fibrous dysplasia showed bucco-lingual expansion in all four patients with maxillary involvement (33.3%) causing thinning of the cortical plate. The lesion displaced the inferior alveolar canal in all four directions (buccal, lingual, superior, and inferior) in the four patients with maxillary involvement (33%) which coincides with Sontakke et al. (18).

The lesion involving maxilla showed expansion on the external surface and on internal surface into maxillary sinus. The expansion of maxilla reduced the size of maxillary sinus cavity although the shape seemed unaltered. This unique finding could help in differentiating fibrous dysplasia from other tumors such as ossifying fibroma (22).

This study coincides with DeKlotz et al. (23) who reported that the sinuses may be affected by FD, with the most frequent site being the sphenoid sinus, followed by the ethmoid and maxillary sinuses (24). This is not surprising, as the anterior cranial base is often affected in patients with craniofacial polyostotic fibrous dysplasia (PFD) (24).

The features of fibrous dysplasia such as the margins, internal structure, and effect on surrounding structure were well characterized on CT images. The margins of lesion, ground glass appearance, and displacement of maxillary sinus were characteristic and consistent with the findings of fibrous dysplasia. Although no single radiographic feature is pathognomonic of fibrous dysplasia, all the features are suggestive of fibrous dysplasia (18).

CT accurately establishes the diagnosis and extent of bone involvement. Involvement of optic canals, orbital fissures, frontonasal ducts and ostiomeatal complex can be best evaluated by CT scanning. CT characteristics of fibrous dysplasia include expansion of the involved bone with heterogenous pattern of CT densities associated with scattered or confluent islands of bone formation. CT attenuation levels have been reported to range from 34 to 513 HU similar to our study depending on the fibrous tissue and bone content (25).

A different approach to morphological features in FOLs has been used where the newly developed technique of computer generated three-dimensional (3D) reconstruction to evaluate the shape and quantity of osteoid tissue within the lesions was applied (26).

Surgical contouring by a maxillofacial or craniofacial surgeon is indicated if the patient is bothered by facial

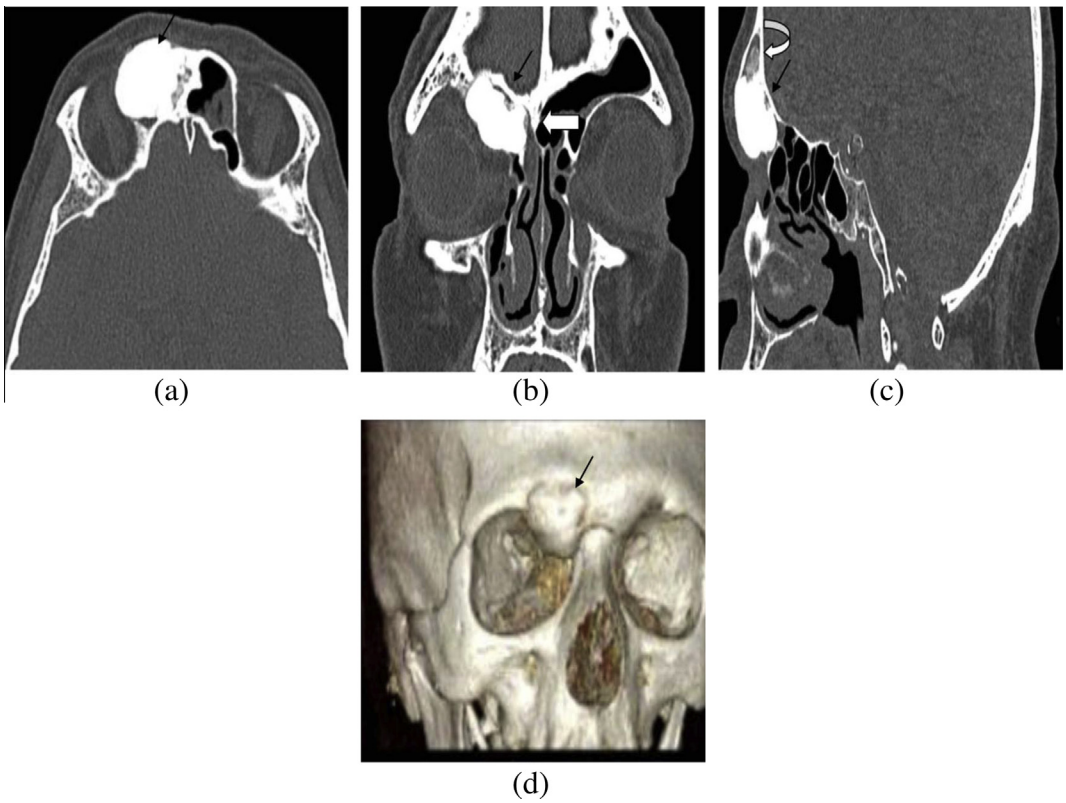

Fig. 6 64 year old male patient complained of sinusitis. (a) Axial section shows expansile osseous lesion protruding within the right frontal sinus (black arrows). It shows homogenous dense sclerotic matrix. (b) Coronal section shows lesion with encroachment upon frontal outflow tract (white arrow). (c) sagittal section shows retained secretions within frontal sinus (curved arrow). (d) 3D volume rendering shows osseous structure protruding from frontal sinus … *features suggestive of frontal osteoma.*

disfigurement. While complete resection may be possible in monostotic lesions, it is unlikely to be possible in PFD, and the surgeon must weigh the reconstruction options that will provide the patient with the best outcome as well as preserve the function of adjacent nerves and structures (5).

Regular follow-up with the surgeon is necessary to determine that there is no recurrence and further deformity (5).

4.1. Ossifying fibromas

The *conventional ossifying fibroma* usually presents as a solitary, slow growing, monostotic tumor in the third and the fourth decades of life in contrary. It shows female predilection and the male to female ratio is around 1:5 (27) whereas in our study the three cases were males and they were of young age 15 y and 32 y Although found predominantly in the mandible (75%), it can also arise in the skull base and PNS as shown in our three cases.

Orbital extension of sinonasal tumors may result in proptosis as shown in one of our cases (33%) and visual complaints including blindness, nasal obstruction (66.6%), ptosis, papilledema, and disturbances in ocular mobility (33%). This study coincides with Carvalho B et al. (11) who reported that radiographic examination of juvenile psammomatoid ossifying fibroma (JPOF) shows a round, well-defined as shown in our three cases, sometimes corticated osteolytic lesion with a cystic appearance as shown in one of our cases (33%) whereas (66%) showed mixed lytic and sclerotic.

Interestingly, Vikram and Udayashankar (28) have suggested that all the fibro-osseous lesions relating to ossifying fibroma and its subtypes should be referred to as ossifying fibroma only since they claim that there is no difference in behavior between the subtypes and the histological designations are only academic.

The fibrous dysplasia and ossifying fibroma cannot be distinguished by microscopy due to histological overlap. There are many features like the absence of cementicles, lamellar trabeculae and osteoblasts to distinguish them. The differentiation between the 2 entities is of great importance because of their divergent clinical behavior. Fibrous dysplasia is often polyostotic whereas ossifying fibroma is usually monostotic. Fibrous dysplasia is usually a self-limiting disease and therefore a complete resection is unnecessary and in most instances impossible. Radiographically ossifying fibromas are classically described as circumscribed unilocular lesions with a surrounding rim of eggshell thin bone giving a *'punched out'* appearance. Irregular thickening and thinning of the edges of this eggshell have been described as *'moth-eaten'* appearance. In contrast, fibrous dysplasia has a *'ground glass'* appearance with indistinct borders that blend imperceptibly into the adjacent bone without bone destruction (29).

4.2. Brown tumor

The most characteristic jaw lesion associated with hyperparathyroidism is a brown tumor, so named because its gross

appearance is characterized by a red-brown color (30). Unlike renal osteodystrophy, brown tumors may be seen in patients with either primary or secondary hyperparathyrodism (30). The clinical, radiographic, and microscopic appearances of a brown tumor are indistinguishable from those of a Central giant cell granuloma (CGCG). Spontaneous resolution of a brown tumor may occur after treatment of the underlying source of the lesion. Patient presenting with renal failure similar to the case in this study with fibro-osseous radiological features raise the possibility of brown tumor. It is mainly diagnosed by combination of radiological, pathological and clinical features (31).

Osteoma is a benign tumor composed of mature compact bone or cancellous bone. This tumor is essentially restricted to the craniofacial skeleton and rarely, if ever, is diagnosed in other bones (31). Kutluhan et al. (32) stated that the mandible and paranasal sinuses are the most commonly affected sites in the maxillofacial region which coincides with our study. Clinically, this neoplasm may be silent for years without any symptoms and diagnosed only when it becomes large enough as in two of our cases (mandibular and frontal osteoma) or observed coincidentally during radiological investigations (13) as shown in 7 patients out of 9 (77.7%) of our cases. Osteoma of the jaws may arise on the surface of the bone, as a polypoid or sessile mass (periosteal osteoma), or it may be located in the medullary bone (endosteal osteoma) (30)

Osteoma is the most common benign tumor of the paranasal sinus. Its incidence is between 0.014% and 0.43%. In this study there were 6 patients out of 9 (66%) diagnosed as paranasal osteomas. Sayan et al. (33) and Longo et al. (34) reported that the most frequently affected paranasal sinus of osteoma was the frontal similar to our study as shown in 4 patients out of 9 (44%), followed by the maxillary, ethmoidal, and sphenoidal sinuses where in our study the ethmoid was the second most common sinus followed by frontal (11%). Osteomas arising in the paranasal sinuses may cause symptoms such as sinusitis, headache as shown in 8 patients out of 9 (88%) in our study, or ophthalmologic manifestations (31), however in this study, the frontal sinus osteomas were found incidentally except one which causes frontal swelling (11%). Regarding sinus involvement this study shows that only two patients show obliterated sinuses (22%) and one patient (11%) shows retained secretions.

Osteomas, usually asymptomatic, often remain undetected unless incidentally found on a routine radiographic survey or until they cause facial asymmetry or functional impairment (35).

Radiographically, the presence of an oval, radiopaque, well-circumscribed mass as shown in all our cases attached by a broad base or pedicle to the affected cortical bone as shown in one of our cases (11%) is a hallmark of peripheral osteomas (32). Whereas the rest (8 patients out of 9) was sessile (88.8%) and all patients (100%) showed dense sclerotic matrix whereas no patient (0%) showed lytic matrix.

Important limitations of the present study must be acknowledged. 9 Cases in this study were retrospective correlation of radiological data limited by the data available in inpatient records. The fibro-osseous lesions were managed by multiple surgeons with differing biases on the diagnostic and management strategy for fibro-osseous lesions. Though the positive predictive value for osteoma and Fibrous dysplasia was high, neither reached statistical significance. Inclusion of a greater number of patients would provide the adequate statistical power to better understand the predictive value of preoperative CT imaging for fibro-osseous lesions.

5. Conclusion

Multi-detector row CT images, including reformations, better delineate craniofacial complex anatomy than do single-detector row CT images. Using multi-slice CT scanning in the craniofacial complex becomes possible to depict the complete path of complex structures A multi-detector row CT image is confirmed to be valuable in the diagnosis and in guiding the surgical interventions by allowing pre-operative delineation of craniofacial complex anatomy. The proximity of various components is best appreciated when the area is viewed in axial and coronal sections and different reconstructive methods using submillimetric thickness.

Conflict of interest

None.

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