Craniofacial Fibrous Dysplasia: Study of 23 Cases

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Abstract: Objectives: Despite recent advances in the understanding of the natural history and molecular abnormalities, many questions remain surrounding the progression and management of fibrous dysplasia. We aimed to describe the clinical, radiological findings and management in a consecutive series of patients diagnosed with fibrous dysplasia of the craniofacial bones. Patients and methods: A prospective and retrospective analysis of collected data for 23 patients with histopathologically confirmed fibrous dysplasia involving the skull and facial bones managed at the Maxillofacial and Neurosurgical department between February 2011-June 2012. The demographic data, clinical presentation, radiographic characteristics, and the management of these patients were reviewed. Result: Age of patients ranged from 7-55 years with higher predilection in female (16 patients, 70%). In the current study, the most common affected fascial bones were maxilla (7 patients), mandible (3 patients). As regarding the cranial bones, the frontal and temporal bones were affected in 5 patients. Sphenoidal bone was affected in 3 patients. Most of the patients presented by facial painless swelling of deformity (17 patients) while 6 patients presented by swelling and proptosis. Conservative surgical procedures (shaving) were performed in 15 cases while resection and reconstruction were performed in 8 cases. Reconstruction with mesh was used in 7 patients while reconstruct with bone graft was used in one patient. All patients were followed up for more than 6 months, by clinical examination, x ray and CT scanning. The frequency of follow up was tailored according disease aggressiveness, optic nerve involvement and type of intervention performed. Marked improvement in the aesthetic aspect in most cases. 3 of the patients who were treated by shaving required further creation, and one patient required 3 sittings to reach acceptable results. Conclusions: Each patient may present with variable symptoms and clinical findings, thus the care of these patients must be customized to their needs and sites of involvement.

Keywords: fibrous dysplasia, cranial bone, fascial bone.

Abbreviation: Fibrous Dysplasia FD

1. Introduction

Fibrous dysplasia is a benign dysplastic process of bone in which the normal bone matrix is replaced by fibroblastic proliferation. It may occur within a single bone (monostotic) or multiple bones (polyostotic).1,2,3 When polyostotic fibro-osseous lesions are associated with other anomalies andendocrinopathy, this variant form constitutes the McCune-Albright syndrome (MAS).4 Fibro-osseous dysplasias accounts for around 7% of all benign bone neoplasms.5 Craniofacial involvement occurring in all of the severe forms and about 30% of the monostotic forms. However, the distinction between monostotic and polyostotic forms can be very difficult because of the intimate connection of the individual craniofacial bones and the fact that the disease does not appear to be limited by the suture lines.7 Most craniofacial lesions are monostotic, yet when a diagnosis of fibrous dysplasia is rendered a skeletal imaging survey must be ordered to search out lesions in other bones. Physical examination must be performed to uncover accompaniments that support the diagnosis of McCune-Albright syndrome.8-11

Monostotic fibrous dysplasia of the craniofacial complex is often confused with other benign fibrous osseous lesion, typically ossifying fibroma and diffuse sclerosing osteomyelitis of the mandible, diseases that manifest unique clinic-radiologic features. Monostotic fibrous dysplasia occurs in the jaw, frontal, ethmoidal, temporal and calvarias bones.1,2,5 Any cranial or facial bone can be affected by fibrous dysplasia and the clinical associated features will depend upon the bone or bones affected. Signs and symptoms can include facial pain, headache, cranial asymmetry, facial deformity, tooth displacement, and visual or auditory impairment.12,13 Malignant change is rare, roughly 0.5% for the monostotic form and 4% for McCune–Albright syndrome.14 Osteosarcoma was the most common, followed by fibrosarcoma, and chondrosarcoma. Malignant transformations were found mostly in the third or fourth decade of life. It is important to note that 28% of these transformations were in patients who had had fibrous dysplasia lesions radiated.15
The clinical behavior and progression of FD vary, thereby making the management of this condition difficult with few established clinical guidelines. This paper provides a clinically-focused comprehensive description of craniofacial FD, its natural progression, the components of the diagnostic evaluation and the multi-disciplinary management.

Table (1) patient demography, site, clinical presentation, and treatment options in 23 patients with fibrous dysplasia

<table>
<thead>
<tr>
<th>Patient n</th>
<th>Sex</th>
<th>Age</th>
<th>Site</th>
<th>Clinical presentation</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>15 years</td>
<td>Rtzygoma</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>25 years</td>
<td>Rt maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>16 years</td>
<td>Lt mandible</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>4</td>
<td>Female</td>
<td>7 years</td>
<td>Lt maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>43 years</td>
<td>Rt temporal and fronto-orbital</td>
<td>Painless swelling proptosis</td>
<td>resection + reconstruct with mesh</td>
</tr>
<tr>
<td>6</td>
<td>Female</td>
<td>47 years</td>
<td>Rt temporal and fronto-orbital</td>
<td>Painless swelling proptosis</td>
<td>resection + reconstruct with mesh</td>
</tr>
<tr>
<td>7</td>
<td>Female</td>
<td>33 years</td>
<td>Ltzygoma</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>8</td>
<td>Female</td>
<td>20 years</td>
<td>Rtzygoma and maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>9</td>
<td>Female</td>
<td>30 years</td>
<td>Rtrfronto-orbital</td>
<td>Painless swelling proptosis</td>
<td>resection+ reconstruct with mesh</td>
</tr>
<tr>
<td>10</td>
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<td>19 years</td>
<td>Pan facial</td>
<td>Facial deformity</td>
<td>Shaving</td>
</tr>
<tr>
<td>11</td>
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<td>18 years</td>
<td>Rt maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
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<td>Lt mandible</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
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<td>Shaving</td>
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<td>Painless swelling</td>
<td>resection+ reconstruction by bone graft</td>
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<tr>
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<td>Male</td>
<td>7 years</td>
<td>Rt maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>16</td>
<td>Female</td>
<td>22 years</td>
<td>Rt sphenoidal ridge</td>
<td>Painless swelling proptosis</td>
<td>resection+ reconstruct with mesh</td>
</tr>
<tr>
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<td>Female</td>
<td>45 years</td>
<td>Lt maxilla</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>18</td>
<td>Female</td>
<td>43 years</td>
<td>Rt temporal and fronto-orbital</td>
<td>Painless swelling proptosis</td>
<td>resection + reconstruct with mesh</td>
</tr>
<tr>
<td>19</td>
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<td>Painless swelling</td>
<td>Shaving</td>
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<tr>
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<td>Male</td>
<td>22 years</td>
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<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
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<td>Female</td>
<td>15 years</td>
<td>Left zygoma</td>
<td>Painless swelling</td>
<td>Shaving</td>
</tr>
<tr>
<td>22</td>
<td>Female</td>
<td>55 years</td>
<td>Rt sphenoidal ridge</td>
<td>Painless swelling proptosis</td>
<td>resection + reconstruct with mesh</td>
</tr>
<tr>
<td>23</td>
<td>Female</td>
<td>35 years</td>
<td>Ltsphenoidal ridge</td>
<td>Painless swelling</td>
<td>Shaving resection + reconstruct with mesh</td>
</tr>
</tbody>
</table>

Patients and methods:
This study was performed at Assiut University hospital (Single Tertiary Hospital) with 23 patients of cranio-maxillofacial fibrous dysplasia managed at the Maxillofacial and Neurosurgical departments between February 2011-June 2012. All clinical records, investigations and treatment charts were reviewed and data regarding age, gender, anatomic site, clinical presentation, associated complications, radiographic evaluations including X-ray, computed tomography (CT) and magnetic resonance imaging (MRI) were obtained preoperatively and postoperatively when possible. The indication and sequence of these investigations is best tailored according to the individual situation. Treatment details were analyzed. In all patients, histopathological examination confirmed the diagnosis (table1). All patients were followed up by clinical examination, X-ray and CT scanning. The frequency of follow up was tailored according disease aggressiveness, optic nerve involvement and type of intervention performed but not less than 6 months.

3. Results:

Age and SEX
There were total 23 patients who sustained cranio-maxillofacial fibrous dysplasia. There were 7 males (30%) and 16 females (70%). Their range from 7 – 55 years. The majority of patients were in the second (6 cases) and third decades (6 cases) of life.
Case (1) Pre and post-operative image of patient has RT sphenoidal ridge FD and presented with proptosis
Anatomical site
In the current study, the most common affected bones were maxilla (7 patients), mandible (3 patients). As regarding the cranial bone, the frontal and temporal bones were affected in 5 patients where sphenoidal bone was affected in 3 patients.

Clinical presentation:
The site of cranial involvement in fibrous dysplasia determines the clinical manifestations. Most of them present as a painless, slowly enlarging bony mass. In the current study, most of the patients presented by facial painless swelling of deformity (17 patients) while 6 patients presented by swelling and proptosis.

Radiological findings
All patients submitted to skull X-ray with serial films to assess disease progress. In total, 23 patients underwent computed tomography (CT), 7 patients had three-dimensional computed tomography (3D-CT), and 10 patients underwent magnetic resonance imaging (MRI). For patients in our series, plain film X-rays were usually sufficient to diagnose most cases of fibrous dysplasia. Radiographic findings demonstrated the classic ground-glass appearance on standard X-ray films. CT findings of the 23 patients in this study also showed characteristics of fibrous dysplasia (pagetoid, cystic or radiolucent and sclerotic).

Histological finding
Histological confirmation of the disease was performed in all cases that underwent surgery. No case showed malignant changes over the period of observation.

Treatment, and follow up
Conservative surgical procedures (shaving) were performed in 15 cases while resection and reconstruction were performed in 8 cases. Reconstruction with mesh was used in 7 patients while reconstruct with bone graft was used in one patient. All patients were followed up for more than 6 months. Marked improvement in the aesthetic aspect in most cases. 3 of the patients that were treated by shaving required further operation, and one patient required 3 sittings to reach acceptable results. Patient treated by resection showed improvement of proptosis and saving of vision.

4. Discussion
Fibrous dysplasia is a developmental, benign anomaly of bone development occurring in single or multiple bones characterized by the replacement of normal bone by fibro-osseous tissue.
Fibrous dysplasia can be divided into subtypes; roughly 70% are monostotic, and roughly 30% are polyostotic. It is also found in McCune–Albright syndrome (an association of fibrous dysplasia), precocious puberty, endocrine abnormalities, and pigmented cutaneous lesions in female patients. There seems to be no transition from one form to the other. Fries found that the skull was involved in 72% with a polyostotic form, and in 28% with a monostotic form. The fronto-orbital region was affected in 20% of patients.

**Age and sex**

Craniofacial FD typically presents at around 10 years of age and then progresses throughout adolescence. The disease was initially thought to become inactive after childhood but subsequent reports have proved this to be untrue. In our study, age of patients range from 7 – 55 years. The majority of patients were in the second and third decades of life (6 cases for each). Gender prevalence of FD is equal however in our study there is higher predilection in female (16 patients, 70%).

**Anatomical site**

There is a predilection for membranous bones. In order of frequency, the maxilla, mandible, frontal, ethmoid, and sphenoidal bones are commonly involved whereas parietal, temporal and occipital bones are less commonly affected. In the current study, the most common affected bones were maxilla (7 patients), mandible (3 patients). As regarding the cranial bone, the frontal and temporal bones were affected in 5 patients where sphenoidal bone was affected in 3 patients.

**Clinical presentation**

The clinical presentation depends on the site, duration, extent and nature of the lesion. It ranges from a mild local swelling with little or no pain to a gross deformity with complications such as proptosis, visual disturbance and sensorineural hearing loss.

The ocular effects of craniofacial FD are of particular concern. It may cause globe displacement due to the involvement of the sphenoid and/or ethmoid bones. Loss of vision may occur secondary to involvement of the sphenoid bone that compresses the optic nerve. Hence, in cases of optic canal involvement, a complete ophthalmological assessment, including testing for visual acuity, visual field, color perception and visual evoked potential, is necessary. In the current study, most of the patients presented by facial painless swelling of deformity (17 patients) while 6 patients presented by swelling and proptosis.

**Radiographic features**

Radiographic features vary depending upon the stage of the disease, degree of ossification (the proportion of bone and fibrous tissue in the lesion). Early onset lesions are radiolucent and later progressively calcify, culminating in a “ground glass” or mottled mixed radiolucent/radiopaque pattern. Critical to the diagnosis is the fact that fibrous dysplasia fails to manifest any discrete margins; rather, the lesional bone subtly blends into the surrounding normal appearing bone.

The ability of CT to resolve detail of both soft tissue and dense bony structures makes it a very suitable imaging modality for the assessment of craniofacial fibrous dysplasia. Computed tomography (CT) is a better radiological tool, especially for assessing the extent of the tumor in cases of suspected optic canal involvement. FD has characteristic appearances on CT and consists of three varieties: ground-glass pattern (56%), homogeneously dense pattern (23%) and cystic variety (21%). Various studies have suggested the use of magnetic resonance imaging (MRI) as a diagnostic tool for FD.

Radionuclide scans, such as bone scintigraphy, have some role in the diagnosis/evaluation of FD. Radionuclide scan has high sensitivity but low specificity. Single photon emission computed tomography (SPECT) has been reported to be more sensitive in detecting the areas involved in cases of FD.

**Management**

The management of the condition has undoubtedly become a subject of challenging complexity. Opinions about treatment range from various surgical methods to medical treatment such as pamidronate given intravenously, but it is clear that a conservative approach may not be suitable in all cases of craniofacial fibrous dysplasia. Fibrous dysplastic lesions that are not symptomatic, that do not progress, and that do not cause deformities our functional impairment should simply be monitored.

Non-operative treatments have a role in the management of craniofacial FD. Some authors have reported their experience with the use of steroids, mainly in the treatment of visual symptoms from optic nerve compression. Another line of medical treatment is the bisphosphonates, for example pamidronate. This group of drugs inhibits osteoclastic activity. Most experiences have been in patients with polyostotic FD or McCune-Albright Syndrome; there is limited data on patients with craniofacial FD. Unfortunately there are no objective methods to assess or predict the outcome of medical treatment. Subjective criteria have been suggested, such as a decrease in inflammatory symptoms like pain and swelling. Serum alkaline phosphatase, a marker for bone turnover, is consistently reduced in patients treated with pamidronate, making it a good monitor of response to medical treatment. The use of urinary hydroxyproline as a marker has also been suggested.
although experience with it is more limited. Serial radiographs have been used to assess response but results are not consistent\textsuperscript{35}. Local bone mineral density has been found be more consistent than serial X-rays in the monitoring of response to treatment\textsuperscript{32}.

The difficulties in establishing the surgical indications result from the benign nature of the lesion and the unpredictable natural history. These lesions can behave in a reactive, dysplastic or neoplastic manner\textsuperscript{36}. There may be frequently sudden and irreversible symptoms that complicate the planning of surgical treatment beside the disease extent, especially with regard to involvement of the skull base\textsuperscript{37}.

A dilemma exists about the wisdom of early operative intervention. Resection may clear the disease but the impact of surgery on the maturing craniofacial skeleton must be considered\textsuperscript{38}. An incomplete extenteration of the lesion may result in up to a 25% local recurrence rate\textsuperscript{39}. However, a more radical clearance may compound the difficulties of reconstruction. While an extended resection may help prevent the rare occurrence of malignant transformation in residual dysplastic bone, the extent to which this approach is justified remains uncertain.

Surgical treatment of FD consists of either conservative shaving/contouring or radical excision with immediate reconstruction. The choice of surgical option depends on several factors: site of involvement, rate of growth, aesthetic disturbance, functional disruption, patient preference, general health of the patient, surgeon's experience and the availability of a multi-disciplinary team (neurosurgeon, ophthalmologist, otolaryngologist, orthodontist)\textsuperscript{40}.

**Surgical classification**

For lesions in zone 1, total excision of the dysplastic bone is recommended. For lesions in zones 2, 3 and 4, conservative excision or shaving has been proposed. In the current study, conservative surgical procedures (shaving) were performed in 15 cases while resection and reconstruction were performed in 8 cases.

In thinner bone, such as the orbital plate of the maxilla, ethmoid and frontal bones, the cortex expands more rapidly and to a greater degree than in thicker cortical bone\textsuperscript{41}. When the orbit is involved compression and subsequent distortion of the globe can cause errors in refraction, focusing, and accommodation,\textsuperscript{42} so immediate removal of the dysplastic process and decompression of the optic nerve canal is necessary. Visual loss in fibrous dysplasia is caused by the progressive compression of venous drainage of the optic nerve, which leads to reduced retinal perfusion\textsuperscript{43}. Operations also essential when the foramen magnum is affected to prevent life-threatening conditions.

It was previously considered prudent to wait for completion of skeletal growth as this might coincide with an arrest of further disease progression\textsuperscript{44}. However, the growth rate of normal residual tissue and perhaps, more importantly, dysplastic tissue appears unaffected by early surgical intervention\textsuperscript{45}. In some clinical situations, early surgery may prevent the onset of irreversible symptoms, such as loss of vision. The possibility of reactivation in later life exists however, especially in pregnancy\textsuperscript{46}. Some authors have advocated that sequential radiographic monitoring may be adequate in many cases, with limited surgery for symptomatic complications\textsuperscript{47}. Clearly these varied perspectives call for clinical judgment in any given case.

We found the classification proposed by Chen and Noordhof\textsuperscript{48} to be of practical value, in planning our surgical approach (Table 2).

| Zone 1 | Frontal, orbital, nasal, ethmoid, zygoma, upper maxilla, (facial involvement amenable to surgery). |
| Zone 2 | Parietal, part of occipital, temporal (lateral cranial base) (Hair covered cranium). |
| Zone 3 | Central cranial base, petrous, mastoid, pterygoid, sphenoid (difficult or dangerous). |
| Zone 4 | Maxillary alveolar bone, mandible (teeth bearing). |

Reconstruction after excision is important in the management of craniofacial FD. This is particularly true in cases of zone 1 involvement. The use of autologous tissues, namely grafts of calvarial bone and rib, is preferable. Split calvarial grafts are usually obtained from the frontal, temporal or parietal regions. As these bones have diploe between the inner and outer cortices they are easily split. The inner cortex is
used as the graft while the outer cortex is placed back to its original position. Rigid fixation is achieved with mini or microplates.

Ribgrafts are also frequently used in a split fashion. One reconstructive technique is the "chainlink fence" technique, useful for the reconstruction of large defects especially in the fronto-orbital region, particularly when calvarial bone graft is not available. Full-thickness rib grafts are useful for the reconstruction of the superior orbital rim as they are effective in re-establishing rim contour. We used it in one patient after excision of fronto-temporal FD.

Micro vascular free flap reconstruction has a role, especially for lesions involving the mandible where segmental excision is necessary. Orthognathic surgery may be necessary in some patients with zone 4 lesions, as these patients have been found to have higher rates of mal-occlusion. Orthognathic surgery helps to restore stable occlusion and good facial aesthetics. Results after orthognathic surgery have been maintained long-term, without cases of recurrence after surgery. This demonstrates that fibrodysplastic bone is capable of healing adequately using standard methods of fixation. Routine dental therapies, including orthodontic treatment, have been found not to exacerbate the disease. In our study, reconstruction with mesh was used in 7 patients while reconstruct with bone graft was used in one patient.

Malignant transformation of fibrous dysplasia occurs infrequently, with reported frequency ranged from 0.4 to 4%. None of our cases demonstrated malignant change over the period of observation.

Conclusion
FD, a disorder characterized by the replacement of bone with fibro-osseous tissue with immature woven bones. It results in skeletal distortion with cosmetic and functional problems. The extent and location of the disease must be carefully assessed in each patient, and treatment plan individualized accordingly.

Acknowledgements
The authors have received permission from the patients depicted in the manuscript to use their photographs for this purpose.

References


