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# The many faces of fibrous dysplasia: a single-center experience

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## ABSTRACT

**Purpose:** To present a single-center experience on imaging features of fibrous dysplasia (FD).

**Materials and methods:** A 10-year database overview in our department identified 20 patients with FD, aged 13-74 years. X-rays were available in 11, Computed Tomography (CT) in 12 and Magnetic Resonance Imaging (MRI) in 8 patients. FD lesions were evaluated for their number, distribution and morphology, by two experienced musculoskeletal radiologists.

**Results:** Eleven (11) patients exhibited monostotic type of FD (M-FD), four (4) patients polyostotic type (P-FD) and five (5) patients craniofacial FD (CF-FD), accounting for totally 70 lesions, mostly asymptomatic. Two P-FD patients had a history of McCune-Albright Syndrome (MAS). Radiographic appearance of lesions varied from ground glass (n=61) to mixed lucent/sclerotic (n=4) or completely lucent (n=5) with or without septations, whereas most lesions (n=58) appeared expansile. The classic "rind sign" was present in seven (7) M-FD lesions and in only three (3) lesions of the

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P-FD type, while bone deformity was not uncommon, particularly in P-FD lesions. MR imaging findings were not specific for FD. Malignant change was seen in one P-FD patient whereas co-existent exostoses were present in another P-FD case. Fractures complicated three P-FD lesions.

**Conclusions:** FD is usually an incidental finding, demonstrating typical radiographic characteristics, meeting the "Do-not-touch-lesion" criteria. However, atypical findings, mimicking malignancy, are not uncommon. Detailed knowledge of the varied radiological features allows narrowing the differential diagnosis. Comorbidities are common in the P-FD type and should be excluded by workup.

KEY WORDS

Fibrous Dysplasia; Imaging; Do-not-touch lesion; Mc-Cune Albright syndrome.

## *Introduction*

Fibrous dysplasia (FD) is a rare non-heritable skeletal disorder, arising from sporadic mutation of the α-subunit of the Gs stimulatory protein, which leads to replacement of normal cancellous bone by abnormal fibro-osseous tissue and immature woven bone. It accounts for approximately 5% of benign bone tumors [1, 2].

The disease may affect a single bone in 70-80% of cases (monostotic type, M-FD) or multiple bones (polyostotic type, P-FD) in the remaining 20-30%. Craniofacial fibrous dysplasia (CF-FD) is a common variant, involving only the skull and facial bones, affecting about one half of the patients with P-FD and 10-25% of those with M-FD [3, 4, 5, 6].

FD may also appear as part of the rare Mc-Cune Albright (MAS) or Mazabraud syndromes. MAS manifests with multiple endocrine disorders, most commonly precocious puberty, followed by acromegaly, Cushing syndrome, hyperparathyroidism, hyperthyroidism, diabetes and café-au-lait spots on skin, whereas the extremely rare Mazabraud syndrome is characterized by coexistence of skeletal FD lesions with intramuscular myxomas [5, 7, 8, 9].

According to literature, the most common M-FD sites include the ribs, femur, tibia and humerus, whereas in P-FD the tibia, femur, pelvic bones and feet are commonly affected. The extent of the disease in P-FD may vary from two separate skeletal sites to involvement of approximately 75% of the skeleton [1, 5, 7, 8].

FD, particularly the monostotic type, is usually asymptomatic, detected as an incidental finding on X-rays, CT or MR imaging performed for other purposes [1, 4, 10].

The typical radiographic appearance of FD is a well-circumscribed lesion, usually of ground-glass matrix, associated with bony expansion and occasionally bowing deformities, "Shepherd's crook" being the most characteristic [4, 5, 10]. However, more atypical patterns such as radiolucent areas or chondroid calcifications may be seen and imitate osseous or cartilaginous malignancies.

CT is particularly useful for assessing complex anatomic areas such as the facial and pelvic bones, better defining the extent of the disease and delineating complications such as optic canal stenosis [8, 9, 11]. On MR imaging, FD presents rather nonspecific signal intensity patterns i.e. hypointensity on T1-weighted images (T1WI) and variable signal intensity on T2-weighted images (T2WI), depending upon the relative proportions of fibrous and osseous tissue within the lesion [8, 10, 12].

Since FD is not infrequently encountered as a radiologic differential diagnosis in everyday clinical practice, radiologists should be aware of the many and often misleading imaging faces of the disease in various imaging modalities, in order to avoid misinterpretation as more sinister pathology. Equally important is the early recognition of malignancy signs, as there is a rare (<1%) potential of malignant transformation, mainly in the polyostotic type [13, 14, 15]. To the best of our knowledge, most previous reports involve review papers or case reports, while series of cases are less frequently encountered.

The purpose of our study is to present the wide spec-

trum of typical and atypical imaging appearances and complications of FD seen in a series of patients having addressed to a single center over a ten-year period. Rare presentations of FD, such as malignant transformation, MAS and a first-described association with multiple exostoses, are included in this series.

## Materials and Methods

### Patients

A retrospective review of our Department's database from the last ten years identified 20 patients with FD, 11 males and 9 females, aged 13-74 years (mean age 40 years). The final diagnosis of FD had been posed on the basis of clinical, radiological and at least two years follow-up evaluations in all patients, whereas two patients additionally underwent biopsy.

Seven patients had addressed to the Tertiary Orthopedic Oncology Department of our Hospital, whereas in the remaining thirteen patients FD was incidentally discovered on X-ray, CT or MRI performed for other purposes. Radiographs were available in eleven (11) patients, CT in twelve (12) patients and MRI in eight (8) patients.

Due to its retrospective nature, our institutional ethics committee did not require approval for this study and patient informed consent was waived.

### Imaging Technique and Analysis

Radiographs were performed for evaluating lesions in the upper and lower extremities, obtained in two perpendicular planes and assessed for lesion number and distribution, opacity, internal matrix, margins and effect on surrounding cortex, as well as for the presence of associated periosteal reaction or any soft tissue component. The size of the lesions was defined as their largest diameter.

The majority of the CT examinations were conducted on a 64-slice multidetector CT scanner (Brilliance; Philips healthcare) with a slice thickness of 1 mm, using bone and soft tissue algorithm reconstruction. Five patients had turned to our Department seeking a second opinion consultation; these patients had undergone CT examinations on other scanners. CT was performed in complex anatomical areas, such as the skull, pelvis and ribs, as well as for assessment of the lesion matrix, i.e ground glass, lytic or mineralized, in three cases with long bone lesions.

MR imaging had been performed in the pelvis, skull and femoral bones on different MRI scanners. All MR studies included T1WI (Time to Repetition, TR: 400-800 ms, Time to echo, TE: 15-20 ms) in all eight patients, T2WI (TR: 2600-6800 ms, TE: 100-120 ms) in six of them, T2 Short-Tau-Inversion Recovery (STIR) images (TR: 4500-5600 ms, TE: 70-90 ms) in three of them, Fluid Attenuation Inversion Recovery (FLAIR) images (TR: 2000-8000 ms, TE: 140-160 ms) in one of them and contrast-enhanced T1WI in three patients. Axial, coronal and sagittal planes were obtained in all patients. MR images were evaluated for bone marrow changes, soft tissue extension, gadolinium-enhancement characteristics and possible involvement of surrounding tissues.

All images were reviewed in consensus by two musculoskeletal radiologists with 20 and 7 years of experience respectively.

## Statistical Analysis

The Excel application (Microsoft Office 2016) was employed for descriptive statistics and graphical representation of lesion distribution.

## Results

Patients were categorized in M-FD (11 patients/11 lesions), P-FD (4 patients/39 lesions) and CF-FD (5 patients/20 lesions), accounting for 70 lesions in total.

Thirteen patients were asymptomatic and FD lesions were discovered incidentally, during radiographic examination for trauma or other diseases. Two patients complained of pain at the site of involvement, one due to pathological fracture and the other one due to gradual enlargement of the lesion, as portrayed during follow-up; the latter needed to undergo biopsy in order to exclude malignancy. One patient with P-FD exhibited leg-length discrepancy owing to a femoral lesion involving the full extent of the bone. One patient with CF-FD displayed mild facial asymmetry, without significant neurovascular deficits, whereas another one presented with recurrent headaches and episodes of sinusitis. One of the P-FD patients and one with CF-FD had a known history of MAS, manifesting with precocious puberty, GH insufficiency and thyroid abnormalities in both patients, as well as diabetes in one of them, while pituitary adenoma was also present in one patient with CF-FD.

Patients' demographics and available imaging studies are demonstrated on **Table 1**. There was a slight

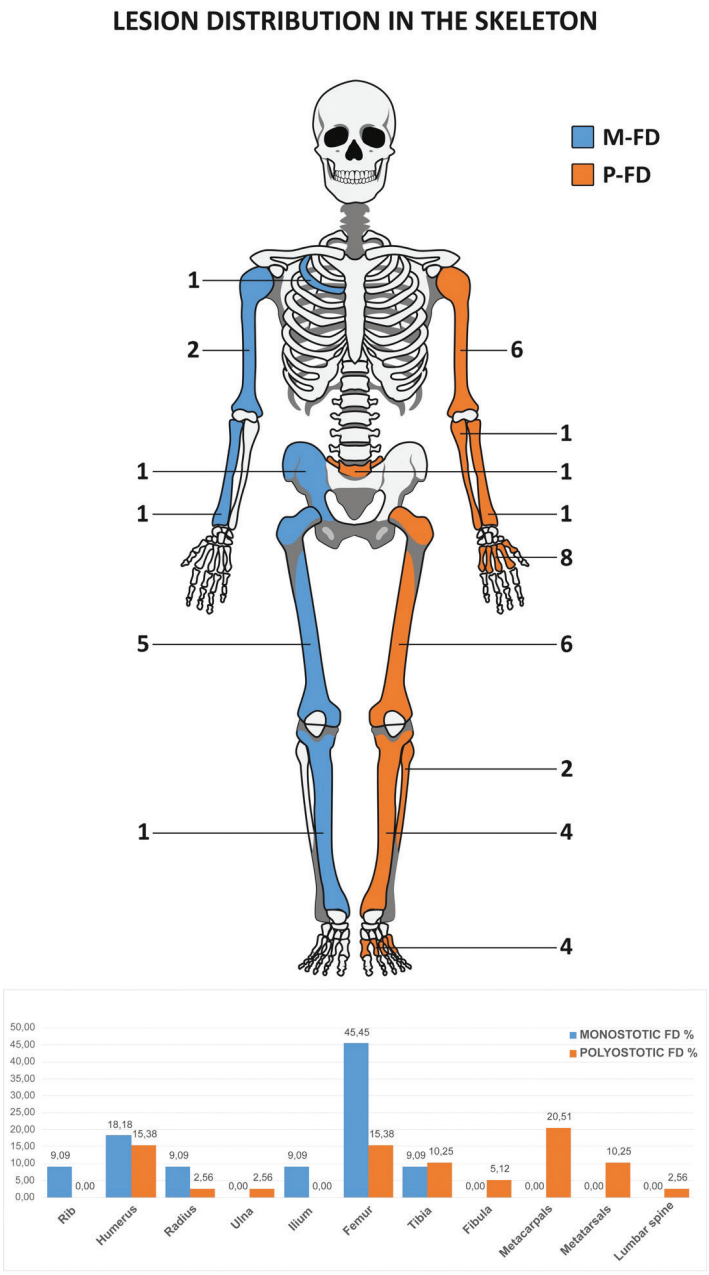


***Figure1.*** *Comparison of M-FD and P-FD lesion distribution: Graphic image demonstrates the distribution of M-FD and P-FD lesions throughout the skeleton, in terms of absolute numbers. Clustered column chart depicts the percentage of affected bone sites in both FD types.*

male predominance (male/female ratio: 1.2/1). Patients with M-FD were older than those with CF-FD and P-FD.

The most common morphologic characteristics of the 70 FD lesions encountered were ground glass appearance (n=61) and bony expansion (n=58).

*M-FD and P-FD types:*

**Figure 1** shows the distribution of M-FD and P-FD lesions in the skeleton in terms of absolute numbers and percentages at each bone site. The most frequently involved site in M-FD was the proximal femur (5 patients), followed by the humerus and less frequently the pelvic bones, the tibia, the radius and the ribs. P-FD involved multiple long bones (3 patients), small tubular bones (2 patients), craniofacial bones (1 patient) as well as the

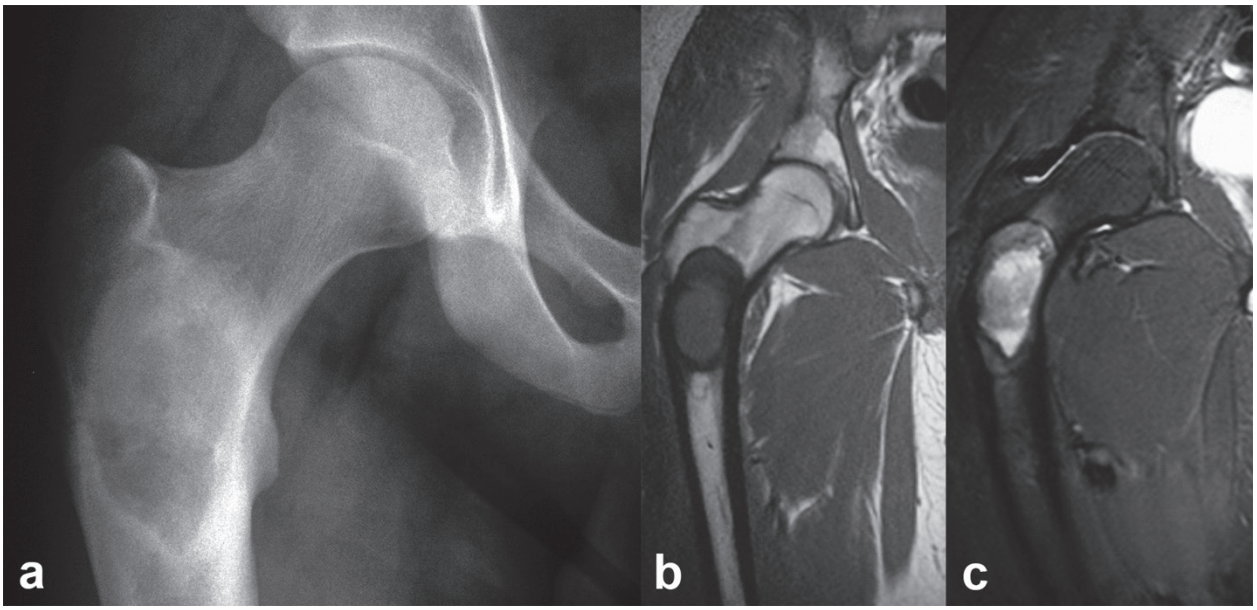


***Figure 2. M-FD:*** *Plain radiograph (a) demonstrates a well-defined lesion of ground-glass matrix at the proximal metadiaphysis of the right femur, presenting with the typical sclerotic rim ("rind sign"). The lesion exhibits low signal intensity (similar to muscle) on T1-W MR image (b) and heterogeneous, increased signal on the respective STIR image (c), with associated expansion of the medullary cavity and bowing deformity. No cortical destruction or periosteal elevation is present.*

spine (1 patient). One patient who was categorized as P-FD presented a monomelic pattern of involvement; that is two FD lesions in only one bone (proximal metaphysis and diaphysis of the right humerus).

Lesion size in M-FD type ranged from 1.0 cm to 11 cm in craniocaudal diameter (mean size 5.95 ± 2.52 cm), whereas in P-FD type measurable lesions varied from 2.0 to 25 cm (mean size 6.89 ± 5.35 cm).

Regarding the location in short axis, the vast majority of lesions were central (n=40) and only four (n=4) were eccentric. Concerning the location in long axis, most lesions affected the proximal metadiaphysis and only nine had their epicenter in the diaphysis. In one patient with P-FD, oblong lesions in nine of the affected bones, including the humerus, femur, tibias, metatarsal and metacarpal bones, occupied the whole length of the each individual bone.

**Table 2** presents the morphologic features of FD lesions in the affected bones. The most common findings in M-FD included bony expansion and ground glass appearance with or without septations. The rind sign, i.e. a layer of sclerotic reactive bone of various thickness surrounding the lesion, was most prominent in lesions located at the proximal femoral metadiaphysis (**Figure 2**). Interestingly, most P-FD lesions in the appendicular skeleton did not display the rind sign. Lucent components within a ground glass lesion were not infrequently seen (13/50 lesions), whereas three M-FD and two P-FD lesions appeared completely lucent (5/50). Three P-FD lesions as well as one M-FD lesion, demonstrated a mixed lucent-sclerotic pattern (4/50). Mineralized sclerotic areas were not usual, whereas chondroid-type calcifications were only seen in one P-FD patient. Osseous remodeling was common, particularly in P-FD with bone deformities, while the characteristic "Shepherd's crook" deformity was seen in one M-FD and one P-FD case. Less frequent findings observed in P-FD patients included fractures, seen in three lesion sites, one of which also exhibited signs of malignant change (subsequently confirmed by histology). Malignant transformation was shown as cortical destruction in a FD lesion with adjacent soft tissue ossification. Another patient with P-FD presented multiple exostoses near an FD lesion (**Figure 3**). FD lesions did not present periosteal reaction, except for the lesion with sarcomatous transformation.

Available MR imaging in six FD lesions of the long bones exhibited intermediate to low signal intensity on T1WI and heterogeneity/slight hyperintensity on T2WI and STIR images, compared to muscles, as depicted in

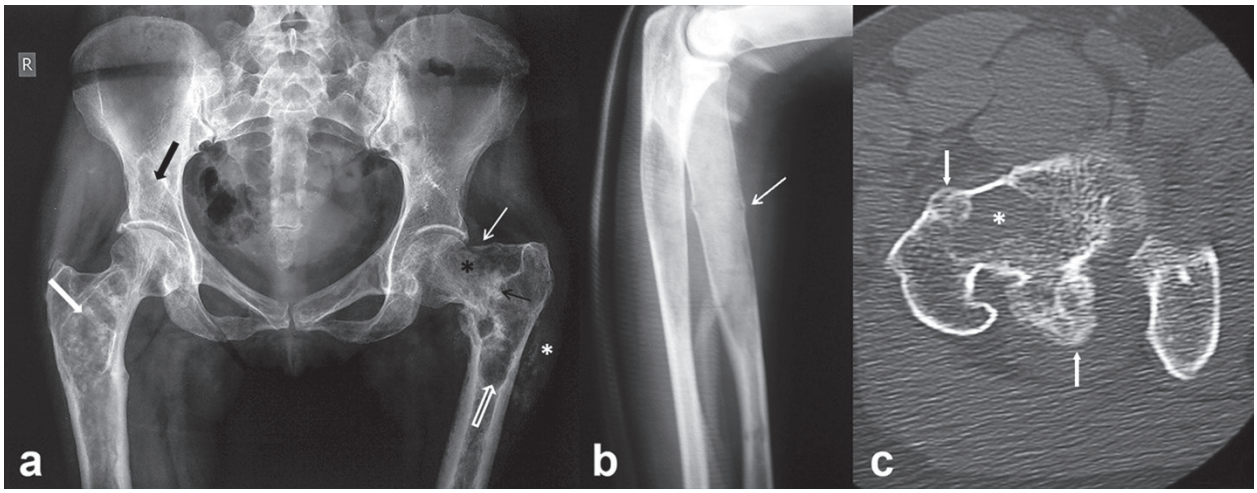


***Figure3. P-FD:***

***a.*** *54-year-old patient with multiple FD lesions of variable appearance in the axial and appendicular skeleton: Plain radiograph depicts a well-demarcated lesion of hazy opacity with a sclerotic rim and internal calcifications, accompanied by slight expansion of the right proximal femoral shaft (solid white arrow). A lesion with similar features is seen in the ipsilateral iliac bone (solid black arrow). A radiolucent lesion is present at the neck and proximal metaphysis of the left femur; the lesion has well defined margins peripherally (open white arrow) whereas a permeative pattern with cortical destruction is seen more centrally at the lateral aspect of the femoral neck (black asterisk), associated with a soft tissue mass with calcifications (thin white arrow); calcifications extend below the level of the greater trochanter (white asterisk). Notice the concomitant pathologic femoral neck fracture (thin black arrow). This was a site of malignant osteosarcomatous transformation, as proven by histology.*

***b.*** *Plain radiograph reveals well-demarcated, expansile, ground glass lesions of ipsilateral radius and ulna in a 13-year-old female patient with P-FD and MAS. Note the transverse diaphyseal fracture of the radius seen as a radiolucent fracture line between bony calluses (arrow), resembling a bird's beak.*

***c.*** *39-year old male with P-FD: Axial CT image shows a well-defined lytic lesion in the right femoral neck (asterisk), in association with multiple co-existing exostoses (arrows).*

**Figure 2.**

*CF-FD type:*

Regarding craniofacial involvement, five patients presented with lesions confined to the skull and facial skeleton and were categorized as CF-FD type, whereas in one P-FD case with multiple lesions craniofacial bones were also involved, as previously described. Multiple facial bones were affected in four CF-FD patients with most lesions crossing the sutures. Only one patient presented with the extremely rare isolated involvement of the clivus (**Figure 4**). Distribution of lesions in the craniofacial skeleton is depicted in **Table 3**.

The most frequently affected site in cases classified as CF-FD was the frontal bone, followed by the zygomatic, ethmoid bones and the clivus in three patients, temporal and sphenoid bones in two patients, as well as the mandible in one patient, adding up to 20 lesions in total**.** Bony expansion was seen in all cases of CF-FD and was more striking compared to the expansion of long bone lesions. Bilateral asymmetric involvement was seen in three patients, while two patients presented with unilateral lesions. Noteworthy, 13 out of 20 CF-FD lesions exhibited cortical thinning, although a smooth outer cortical contour was maintained in all cases. All craniofacial lesions showed the typical ground glass appearance on CT, while three of them also displayed sclerotic areas, yet no lucent component was seen in any lesion. Cortical thinning with mild remodeling of the inner diploic table of the occipital bone was observed in one patient (**Figure 4**). Additional findings on CT and MRI included invasion to the paranasal sinuses in two patients. MR imaging, available in two CF-FD patients, revealed T1WI and T2WI signal intensities similar to those described in long bone lesions, along with moder-

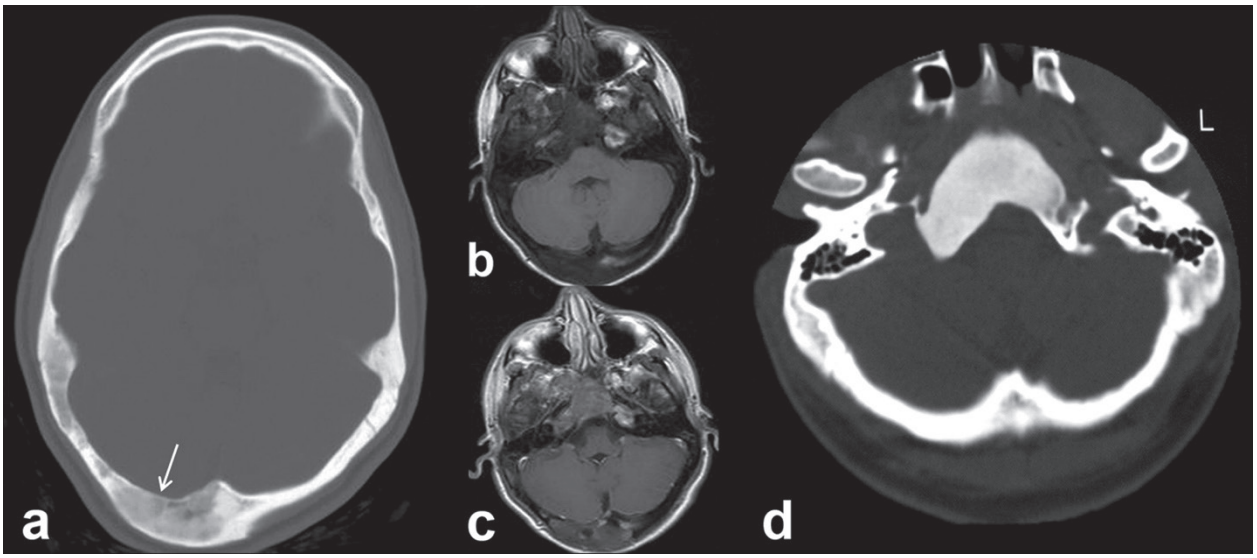


***Figure4. CF-FD:***
***a,b,c:*** *Skull involvement in the setting of P-FD associated with MAS in a 13-year-old female: Axial brain CT image (a) demonstrates expansile ground glass lesions of the right temporal and occipital bone with bone remodeling and focal areas of cortical thinning. Note the mild remodeling of the inner diploic table in the right occipital bone, adjacent to the cerebellum (arrow). On an axial T1W MR image, lesions located at the occipital bone, clivus and the apex of the right temporal bone are portrayed as isointense or slightly hypointense to muscle (b), showing moderate enhancement on the corresponding post-contrast T1W image (c).*
***d.*** *Axial brain CT image of a 17-year-old male shows a rare FD case presenting with an expansile ground glass lesion confined to the clivus.*

ate heterogeneous enhancement on contrast-enhanced T1WI.

## *Discussion*

In our study, the most common site of involvement in M-FD patients was the femur (45%) whereas in previous studies femoral involvement was common but in no more than 23% of the cases [1, 3, 5]. Although many review studies have been published on FD, there is a sparsity of clinical series reporting incidence and relative frequencies of FD imaging findings; the largest series by Kransdorf et al. from AFIP [1] and a more recent study by Kinnunen et al. [12], which was mainly based on case reports and small series, may have a selection bias for more uncommon cases. For example, only one patient with rib involvement has been encountered in our study (9% of total M-FD lesions), in contrast to Kransdorf et al. who refer the rib as a frequent M-FD site accounting for up to 28%. On the other hand, in the current series there was involvement of the femur, the humerus, the pelvis and small tubular bones in almost all P-FD patients, in alignment with Kransdorf et al. We came across with only one site of FD in the spine (2.5% of the P-FD cases) which is considered an uncommon site of P-FD. Rare cases of spinal FD more often involve multiple vertebral bodies, being mostly encountered in P-FD rather than M-FD [3, 4, 7, 16]. In our CF-FD cases, multiple skull and facial bones were affected, appearing to cross the sutures, conforming to previous reports [7, 8, 9]. Nonetheless, lesions confined to the clivus, as seen in one of our CF-FD patients, are extremely rare [9, 10].

FD is usually asymptomatic, appearing as an incidental finding on imaging studies, as occurred in most of our patients. Only few patients presented with clinical symptoms, the most common being rapidly escalating pain at the site of involvement either due to fracture or increase in lesion size and also in case of sarcomatous change. Two P-FD patients had a history of precocious puberty and thyroid abnormalities, setting the diagnosis of the rare MAS, which generally affects 2-3% of patients with FD [7, 9].

The typical radiographic appearance of FD is that of

**TABLE 1. FD patient data and available imaging examinations.**

| FD type | Number of Patients | Gender | | Mean Age (years) | Total Lesions | Number of available radiological examinations | | |
|---|---|---|---|---|---|---|---|---|
| | | M | F | | | X-RAY | CT | MRI |
| M-FD | 11 | 7 | 4 | 43 | 11 | 7 | 5 | 5 |
| P-FD | 4 | 1 | 3 | 39 | 39 | 4 | 2 | 1 |
| CF-FD | 5 | 3 | 2 | 33 | 20 | 0 | 5 | 2 |

*FD: Fibrous Dysplasia; M-FD: Monostotic FD; P-FD: Polyostotic FD; CF-FD: Craniofacial FD*
*M: Male; F: Female*
*CT: Computed Tomography; MRI: Magnetic Resonance Imaging*

**Table 2. Morphologic features disposition in M-FD and P-FD lesions.**

| Lesion Morphologic Characteristics | M-FD | | P-FD | |
|---|---|---|---|---|
| | Number of Lesions | Percentage % | Number of Lesions | Percentage % |
| Expansion | 7 | 63.64 | 32 | 82.05 |
| Rind Sign / Sclerotic Rim | 7 | 63.64 | 4 | 10.26 |
| Cortical thinning | 5 | 45.45 | 23 | 58.97 |
| Endosteal Scalloping | 3 | 27.27 | 14 | 35.90 |
| Ground Glass Component | 7 | 63.64 | 34 | 87.18 |
| Internal Calcifications | 0 | 0.00 | 1 | 2.56 |
| Septations | 3 | 27.27 | 2 | 5.13 |
| Bone Deformity | 4 | 36.36 | 10 | 25.64 |
| Bone Remodeling | 2 | 18.18 | 15 | 38.46 |
| Fracture | 0 | 0.00 | 3 | 7.69 |
| Signs of aggressiveness | 0 | 0.00 | 1 | 2.56 |

*M-FD: Monostotic Fibrous Dysplasia; P-FD: Polyostotic Fibrous Dysplasia*

a well-circumscribed, expansile, intramedullary lesion of ground glass matrix, occasionally displaying endosteal scalloping, surrounded by a layer of sclerotic reactive bone, the so called "rind sign", typically without the presence of soft tissue component or periosteal reaction. [1, 5]. Most of the FD lesions in this study, especially those of M-FD, comply with the above "typical" description. However, the "rind sign" was not present in all lesions, but was mostly observed in older patients with lesions located in the proximal femoral metaphy-

**Table 3. Distribution of lesions in the craniofacial skeleton.**

| Location | Number of Lesions | Percentage % |
|---|---|---|
| **Frontal bone** | **4** | **15.38** |
| Parietal bone | 1 | 3.84 |
| Temporal bone | 3 | 11.53 |
| Occipital bone | 1 | 3.84 |
| Sphenoid bone | 3 | 11.53 |
| Ethmoid bone | 3 | 11.53 |
| Zygoma | 6 | 23.07 |
| Mandible | 1 | 3.84 |
| Clivus | 4 | 15.38 |

sis/metadiaphysis, which undergoes greater mechanical forces, in contrast with younger patients and affected non weight-bearing sites, where lesion margins were mainly well-demarcated with no sclerotic rim.

The matrix of FD lesions ranged from the common ground glass appearance to completely lucent (more rarely), whereas a mixed pattern with ground glass matrix integrating lucent or sclerotic components was also frequent. This variability of FD lesions has also been well recognized in previous reports and has been attributed to the variable amounts of fibrous tissue, cystic elements or woven bone. X-rays and CT can better illustrate the ground glass appearance, with CT being the method of choice, whereas MR imaging was not specific in our cases as well in previously reported ones. Internal calcifications of the cartilaginous type within an FD lesion, also known as fibrocartilaginous dysplasia (FCD), were seen in one patient. FCD represents a rare form of FD that should be differentiated from enchondroma, chondrosarcoma or the extremely rare chondrosarcomatous transformation of FD [17]. An aneurysmal bone cyst (ABC) component has been occasionally described in FD lesions but we did not encounter any ABC in our cases [18].

A radiolucent FD lesion, lacking a sclerotic margin, located mostly in the appendicular skeleton, pelvis and spine can be difficult to differentiate from a lytic metastasis, especially in adults [19], whereas in children and young adults this appearance may resemble non-aggressive Ewing sarcoma (ES) or the lytic type of a low-grade central osteosarcoma (LGCOS) [20, 21, 22, 23]. Although ES and LGCOS usually appear as permeative lytic lesions with cortical destruction and a soft tissue component, low-grade tumors can occasionally exhibit a non-aggressive appearance, with mild cortical thinning, little or no periosteal reaction and even without the presence of soft tissue mass [21], while MRI findings may also be non-specific [21, 22, 23], thus biopsy should be considered [22, 23]. More advanced imaging techniques such as whole body MR or whole body CT imaging could be of help in the follow-up of P-FD patients in order to exclude malignant change.

FD lesions usually appear with the same imaging features in both monostotic and polyostotic forms. Nevertheless, larger lesions and greater overall severity of skeletal involvement, in addition to bowing deformities and remodeling of long bones, are more common in P-FD, as demonstrated in our series as well as in previous ones. "Shepherd's crook" deformity of the proximal femur, seen in two patients, is very characteristic for FD but may also be present in other metabolic disorders, such as Paget's disease of the bone and osteogenesis imperfecta [24].

Involvement of craniofacial bones presents with three common patterns according to Chen et al.: mixed pattern with lytic and sclerotic regions 55%, homogeneous sclerotic 34%, and predominantly cystic or lytic 11% [11]. Regardless of the dominant pattern, all CF-FD cases show at least some component of the typical ground-glass attenuation on CT, even when this is not evident on a plain film [8]. In our study, CF-FD was mostly of the mixed type with ground glass and sclerotic regions and mainly displayed asymmetrical involvement of the affected bones. Notwithstanding, CF-FD frequently requires differentiation from Paget's disease of the bone; Paget's disease has a later onset and a predilection for the skull vault, usually sparing the facial bones, displays a more symmetrical involvement and affects both diploic tables. Fibrous dysplasia is considered to spare the inner diploic table [24]; however, in one case we observed mild remodeling of the inner table in an occipital bone lesion.

As a rule, FD lesions seem to be stabilized after puberty [3, 10]. Nonetheless, progression of the disease was recognized during follow-up in one of our M-FD patients, aged 26 years.

To the best of our knowledge, coexistence of long bone FD lesions with multiple exostoses, as observed in one patient of this study, has not been formerly described. This patient was lost for long term follow-up, so we are not aware whether he has developed any complications.

During the clinical course of FD, the disease may complicate with fractures, as seen in two of our patients, which are due to structural weakness of the bone and may have a characteristic double beak appearance [4].

Malignant transformation is a rare complication of FD; Ruggieri P. et al. found malignant transformation in 28 among 1122 cases of FD, most common in P-FD cases at a rate of 6.7% versus 1.9% in M-FD [14, 25]. In our series only one lesion presented malignant change to osteosarcoma, in a patient with P-FD. Osteosarcoma is the commonest type of sarcoma complicating FD, followed by fibrosarcoma, chondrosarcoma and malignant fibrohistiocytoma [15, 25], whereas an association with prior irradiation has also been reported [4, 25]. Rapid onset of pain and local swelling are suspicious clinical findings. Radiographic findings indicative of malignant transformation include an ill-defined, mineralized, osteolytic lesion within or near areas of ''ground-glass'' opacity, associated with cortical destruction. MR images are of great value in illustrating sarcomatous change, demonstrating an enlarged, heterogeneous and predominantly hyperintense bone marrow lesion on T2WI, with heterogeneous gadolinium enhancement, commonly associated with cortical destruction and extraosseous soft tissue component [12].

**Limitations:** At first, due to the retrospective nature of the article, we did not have access to throughout clinical information and long term follow-up. Furthermore, our study has a limited number of patients, due to the rarity of FD and an even smaller number of MR examinations available. However, to the best of our knowledge, series of consecutive patients with FD attending a single center, as in this study, have been scarcely reported.

### *Conclusions*

According to the findings of the current study, FD can present not only as the typical homogeneous, ground-glass lesion but also as a lytic, sclerotic or mixed-density/heterogeneous lesion. FD lesions in patients with the P-FD type appeared more frequently aggressive, and were more commonly associated with complications such as fractures or malignant change. Although FD is usually a straightforward radiographic diagnosis, classified as a "Do-not-touch" lesion, it may rarely display more aggressive or non specific appearance, mimicking bone malignancies. Familiarity with the radiological variability of the disease is crucial for the diagnosis of FD and obviation of further unnecessary investigation. **R**

### *Conflict of interest*

All authors declare that they do not have any conflict of interest.

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### *Ethical approval*

The institutional review board of the hospital (UGHA) waived the requirement to obtain written informed consent due to the retrospective nature of the study.

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