RESEARCH

Fibrous dysplasia—a 13-year retrospective radiographic analysis in a south Indian population

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Objective: The aim of this study was to examine the clinical and radiographic presentation of fibrous dysplasia through a 13-year retrospective study in patients who reported to the outpatient unit of Government Dental College, Trivandrum.

Methods: The clinical file records and radiographs of the patients who reported to the outpatient clinic in the Department of Oral Medicine and Radiology were retrospectively reviewed for histopathologically diagnosed fibrous dysplasia. A detailed analysis of the clinical and radiographic features of the 24 cases retrieved was carried out.

Results: The male-to-female ratio of incidence was approximately 1:1. Most of the patients were in the second or third decade of life. Almost all the patients presented with a complaint of swelling on the side of the face. The mandible was more frequently involved than the maxilla. The most common radiographic pattern observed was the “ground-glass” appearance. Most of the patients exhibited expansion of the involved bone and loss of lamina dura of associated teeth.

Conclusion: The awareness of protean features of fibrous dysplasia evident through this study is essential in the accurate diagnosis and proper treatment planning of such lesions.

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Introduction

Fibrous dysplasia is a perplexing disease of bone, of unknown aetiology, uncertain pathogenesis and diverse histology.^{1,2} It is often described as a hamartomatous malformation characterized by idiopathic arrest in the normal maturation of bone in the woven bone stage, interspersed with abnormal proliferation of fibrous connective tissue containing varying amounts of osteoid and osseous structures of presumably metaplastic nature.³ The term fibrous dysplasia was first used by Lichtenstein in 1938.⁴ Post-zygotic mutation in the guanine nucleotide-binding protein, α -stimulating activity polypeptide 1 (GNAS 1) gene is the recently proposed aetiology for fibrous dysplasia. It has been suggested that clinical severity of the lesion depends on the time of appearance of the mutation.^{5,6} There are two primary categories of the disease: monostotic fibrous dysplasia

that involves only one bone and polyostotic fibrous dysplasia, which involves several bones. A monostotic form does not progress into a polyostotic form of the disease.⁷ Jaffe–Lichtenstein syndrome is a variant of polyostotic fibrous dysplasia with café-au-lait pigmentation of the skin. A more severe form of the polyostotic form of fibrous dysplasia accompanied by endocrine disturbances of varying types in addition to skin pigmentation is called the McCune–Albright syndrome. Another category identified as the craniofacial type of fibrous dysplasia is confined to the face and jaws involving two or more bones.⁸

Fibrous dysplasia creates radiographic patterns that are virtually indistinguishable from other lesions affecting the bones, such as Paget’s disease and cemento-osseous fibroma. Difficulty is often experienced when the lesion is detected on radiographs with negligible clinical evidence. Awareness is required regarding the myriad of radiographic appearances on account of its local effects on the jaw, and also because of the possibility of extensive lesions of this entity in the skeleton.

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In order to obtain a better appreciation of the clinical presentation and the intriguing radiographic features of fibrous dysplasia, all the cases of this disease which came to the outpatient department of Government Dental College, Trivandrum, during the period of 1996–2010 were analysed retrospectively.

Materials and methods

The clinical record library of the Department of Oral Medicine and Maxillofacial Radiology, Government Dental College, Trivandrum, a tertiary referral centre, was retrospectively reviewed and all the histopathologically diagnosed cases of fibrous dysplasia documented from November 1996 until February 2010 were analysed. This period selected is coincident with the tenure of the current head of department and the file

records she instituted. The Institutional Ethical Committee approval was not required as this was a retrospective study based on file records of patients who gave informed consent prior to documentation and treatment.

Patients were not included in this series if adequate histories and relevant radiographic data could not be obtained. The features were entered into a *pro forma*, highlighting the radiological features. Conventional plain film radiographs such as panoramic radiographs and intraoral radiographs were available for all cases supplemented with other skull views. Intraoral periapical radiographs were considered for all cases at the suspected peripheries of the lesions in order to define the exact extent of the lesion. CT was generally performed when the borders of the lesions could not be discerned from plain radiographs, especially in the lesions affecting the anatomically complex maxilla.

Table 1 Summary of clinical and radiographic features of fibrous dysplasia affecting the mandible

Case no.	Age	Sex	Chief complaint with duration	Site of the lesion	Radiographic picture		
					Periphery	Internal structure	Effect on surrounding structure
1	28	Female	Swelling 4–5 years	42–34 region (crossing the midline)	Ill defined	Ground glass appearance	Displacement of 32, 31, 41, 42; loss of lamina dura of 33, 32, 31, 41, 42, 43.
2	20	Female	Swelling 3 months	35–38 region	Ill defined	Mixed radiolucent–radiopaque (indiscernible pattern)	Expansion of buccal cortex; inferior alveolar nerve canal displaced superiorly
3	55	Male	Swelling 18 years	42–48 region	Well defined	Sclerosis	Inferior alveolar nerve canal not discernible Loss of lamina dura on 43, 44, 45, 47 Loss of lamina dura on 44, 45, 46
4	12	Female	Swelling 6 months	43–48 region	Ill defined	Radiolucent	
5	35	Male	Swelling 6 years	33–37 region	Ill defined	Mixed radiolucent–radiopaque with cystic pattern	Inferior alveolar canal displaced superiorly Displaced 35 Loss of lamina dura 33–37
6	15	Female	Swelling 2 years	32 region to the left angle of the mandible	Well defined	Ground glass appearance	Expansion of lower cortex of the mandible giving a characteristic “thumb-print” appearance. Loss of lamina dura on 35, 36, 37
7	39	Male	Swelling 2 years	35–44 region (crossing the midline)	Well defined	Ground glass appearance	Expansion of the labial cortex; inferior displacement of inferior alveolar canal. Loss of lamina dura of all associated teeth
8	64	Female	Swelling and pain in left lower teeth 6 months	33 region to the left ramus of the mandible	Ill defined	Ground glass appearance	Expansion of the buccal and lingual cortical plates with characteristic “thumb-print” appearance Inferior alveolar canal not discernible Superior displacement of 36, 37, 38 Loss of lamina dura of 33–38
9	32	Female	Swelling 4 years	42–45 region	Ill defined	Mixed radiolucent–radiopaque (indiscernible pattern)	Expansion of buccal cortical plate Displacement of 43, 44. Loss of lamina dura on 43, 44, 45
10	24	Female	Swelling 6 years	46 region to the right angle of the mandible	Ill defined	Orange peel appearance	Expansion of bucco-lingual cortical plates Expansion of lower border of posterior body and angle of the mandible on the right side Inferior alveolar canal superiorly displaced Loss of lamina dura on 46, 47
11	32	Male	Swelling 5 years	48 region to posterior body of the mandible	Ill defined	Ground-glass appearance	Inferior alveolar canal displaced inferiorly Loss of lamina dura of distal root of 47

Table 2 Summary of clinical and radiographic features of cases affecting the maxilla

Case no.	Age	Sex	Chief complaint with duration	Site of the lesion	Radiographic picture		
					Periphery	Internal structure	Effect on surrounding structure
12	42	Female	Swelling since childhood	14–18 region	Ill defined	Ground glass appearance	Near total obliteration of right maxillary sinus Loss of lamina dura of 14
13	20	Female	Swelling 5–6 years, associated pain in 27 region 4 days	22–27 region	Ill defined	Ground glass appearance	Displacement of floor of the sinus Loss of lamina dura of 23–27
14	14	Male	Swelling 4 years	25–28 region	Ill defined	Orange peel appearance	Effacement of sinus walls; resorption of roots of 24, 25
15	9	Male	Swelling 6 months	Right ala to zygoma region 11–16 region	Ill defined	Ground glass appearance	Loss of lamina dura of 24, 25, 26 Expansion of buccal cortex in relation to involved teeth
16	10	Female	Swelling 6 months	25–27 region	Ill defined	Orange peel appearance	Lamina dura loss on 12–16 Loss of lamina dura of 26, 27
17	66	Male	Swelling since second decade	22–28 region	Ill defined	Ground-glass appearance	Sinus floor effaced Loss of lamina dura on 23–28 region
18	21	Female	Swelling 1 month	25,26 region	Ill defined	Orange peel appearance	Loss of lamina dura on 25, 26

The various study variables considered were age, sex, chief complaint and its duration, type of fibrous dysplasia and the site of the lesion in jaw bones. The various radiographic parameters studied were the periphery of the lesion; internal structure; presence of areas of cystic degeneration; effects on adjacent structures, including displacement of inferior alveolar canal; encroachment into paranasal sinuses; expansion of the lower border of the mandible; thinning or loss of cortex; loss of lamina dura; and root resorption. The accepted radiological criteria from literature and standard text books such as White and Pharaoh and Worth were considered.^{9,10} The definition of boundaries was according to the criteria set by Slootweg and Muller.¹¹ A lesion was considered to be well demarcated when its radio-density changed significantly within a distance of 1 mm when passing to the surrounding bone.

Results

Patient demographics

During the 13 year period of study, 24 cases were histopathologically diagnosed as fibrous dysplasia. Three cases which were identified as fibro-osseous lesions with doubtful histological pictures and inadequate radiographic data were not included in this study. The cases were in the age range of 9–66 years at presentation with an average age of 29.75 years. An increased prevalence of the disease was seen in the second and third decade of life. Male patients were more affected, with 13 cases, while females accounted for 11 cases; a male-to-female ratio of incidence being approximately 1.18:1. The chief complaint of 21 patients was an aesthetically disfiguring swelling of the face. The older age group of patients primarily presented with pain of

odontogenic origin of short duration associated with a barely detectable swelling. The mean age of the patients when prior awareness of the complaint was considered was calculated to be 19.2 years. 18 cases were classified as having monostotic lesions, 5 cases had craniofacial lesions and 1 case had a polyostotic presentation.

Figure 1 Axial CT scan of the skull in a case of craniofacial fibrous dysplasia. The involvement of the zygoma, the sinus and the anterior cranial fossa is seen

Table 3 Summary of jaw bone features in craniofacial and polyostotic lesions of fibrous dysplasia

Case no.	Age	Sex	Chief complaint with duration	Site of the lesion	Radiographic picture		
					Periphery	Internal structure	Effect on surrounding structures
19	13	Male	Swelling with protusion of left eyeball 6 months	Frontal bone, left maxillary sinus, left zygoma, roof of sphenoid	Ill defined	Sclerosis	Effacement of sinus walls
20	21	Male	Swelling with difficulty in mouth opening 6 months	Left squamous temporal bone, left zygoma	Ill defined	Mixed radiolucent–radiopaque indiscernible pattern	Expansion of the zygoma
21	54	Female	Pain and swelling 6 months	14–25 region (crossing the midline) Frontal, zygomatic & nasal bone, anterior, middle posterior cranial fossa	Ill defined	Ground-glass pattern of skull bones Sclerosis frontal bones Cystic changes in the maxilla	Displacement of 11 and 21 Loss of lamina dura of 14–25
22	21	Male	Swelling 10 years	47, 48 region extending to the ramus, involving the posterior end of hard palate right side	Ill defined	Ground glass appearance	Expansion of lower cortical plate of the mandible Inferior alveolar canal not discernible
23	35	Male	Swelling 6 years	15–18 region, zygoma, frontal bone, temporal bone, maxillary sinus	Ill defined	Ground glass appearance	Near total obliteration of the right maxillary sinus Expansion of buccal cortical plate of the right maxilla Loss of lamina dura of 16, 17, 18
24	32	Male	Swelling left leg 6 months, swelling face 15 years	23–28 region 44–48 region to the sigmoid notch, ribs, femur	Ill defined	Mixed radiolucent–radiopaque indiscernible pattern	Effacement of sinus walls Increased width of ramus and body Loss of lamina dura 24–27, 33–37

Anatomic location of lesions

Among the cases of fibrous dysplasia affecting facial bones, the mandible was reported as the most affected bone in 13 cases, of which 11 cases solely involved the mandible (Table 1). Maxillary involvement was seen in 12 of the cases, of which 7 cases involved the maxilla alone (Table 2). Four cases involving the zygoma and four involving the frontal and temporal bone were considered as the craniofacial form of fibrous dysplasia

(Figure 1, Table 3). In the single case of polyostotic fibrous dysplasia, apart from the jaws, the ethmoid, occipital bone, the femur and the ribs were also involved (Table 3). The unilateral presentation of fibrous dysplasia was apparent in 21 cases in the present study with an increased predilection for the left side (57.14%). With regard to the site of lesion in the jaw bones, maxillary and mandibular involvement noticed was 1.08:1. Among the cases involving the

Figure 2 Panoramic radiograph showing a mixed radiolucent–radiopaque appearance with an indiscernible pattern (arrow)

Figure 3 Intra oral periapical radiograph displaying an orange peel appearance. The inferior alveolar nerve canal (black arrows) has been displaced upwards markedly. Contrast has been enhanced to visualize the canal trajectory

maxilla, the premolar–molar area was affected in five cases; the canine–premolar–molar area in three cases; the entire maxilla was affected in three cases; and the canine–premolar area alone was affected in one case. Among the cases affecting the mandible, the body of the mandible was involved in 12 cases; the angle region was affected in 4 cases; and the ramus in 3 cases.

Radiographic analysis of the lesion

Of all the cases reviewed, 12 cases were investigated by CT. Only two cases, both of which involved the mandible, showed a well-defined corticated border. The others had ill-defined peripheries. On studying the internal structure of the lesion on plain films, a single

Figure 4 Panoramic radiograph displaying the characteristic sclerosis. The borders of the lesion are well defined. The inferior alveolar nerve canal is obscured because of the lesion

Figure 5 Coronal CT of case 21. Frontal bones show heterogeneous round sclerotic foci scattered in ground glass pattern

case depicted a purely radiolucent appearance. 19 cases showed a mixed radiolucent–radiopaque appearance, of which 4 cases showed a non-discernible pattern (Figure 2). The characteristic orange peel appearance (Figure 3) was noticed in 4 of the cases studied and a ground-glass appearance noticed in 11 cases. Sclerosis

Figure 6 Bone window axial CT scan of case 21 showing cystic changes in the lesion. The cystic changes appear to be confluent around the maxillary teeth

Figure 7 Part of a panoramic radiograph showing the “thumb print” pattern of the lesion in the mandible. Note that the inferior dental canal has been displaced inferiorly

was noticed in three cases of fibrous dysplasia studied (Figures 4 and 5). Cystic change of the lesion was noticed in two cases, one each involving the mandible and the maxilla (Figure 6). Among the lesions involving the maxillary sinus, displaced borders of the sinus were noticed in five cases. Near total obliteration of the left maxillary sinus was noticed in two cases. Of the cases involving the mandible, expansion of the lower border of the mandible was noticed in four cases and the characteristic “thumbprint pattern” in two cases (Figure 7). In case 21, the CT revealed varied internal structure of bones; frontal bones showing dense sclerotic foci scattered in a ground-glass pattern and cystic changes around the root of maxillary teeth. In the cases involving the mandible, the inferior

Figure 8 Panoramic radiograph displaying the characteristic inferior displacement of the inferior alveolar nerve trajectory

alveolar canal appeared to be superiorly displaced in three cases while it was inferiorly displaced in two cases (Figure 8). The canal was not traceable in three cases. On studying the teeth involved in the site of the lesion in these cases, root resorption was noticed in a single case involving the maxilla. Loss of lamina dura of the teeth was noticed characteristically in 20 cases.

Discussion

This clinical series demonstrates the analysis of the various presentations of fibrous dysplasia. There are variations in this study compared with the earlier reports and studies on fibrous dysplasia. The average age of presentation was 29.75 years. This was the age at which the cases presented to the clinic. When prior awareness of the patients was considered, the calculated mean age was found to be 19.2 years. Two patients over the age of 60 years presented with a massive swelling, indicating that such lesions may remain asymptomatic and may stop patients from seeking dental care until there is gross disfigurement or pain is experienced. In case 17, the patient gave a history of swelling of more than 40 years duration but refused treatment because the lesion was not increasing in size. This is in accordance with Eisenberg and Eisenbud, who stated that the majority of cases burn out in early adulthood when skeletal maturity has been reached.¹² A single male patient in the fourth decade of life presented with the polyostotic form consistent with the findings of Windolz,¹³ who revealed that the polyostotic form typically represented only about one-third of patients. In our study, males were more affected, disparate with the systematic review of cases of fibrous dysplasia by MacDonald-Jankowski,¹⁴ Yoon *et al*¹⁵ and Slootweg and Muller,¹¹ where a female predominance was noted. Unlike most studies on fibrous dysplasia, in our clinical series the mandible was more affected than the maxilla.^{11,14,15} A predilection for the left side was observed in this study; however, it may be expected that such a predilection may be just an earlier stage of manifestation of the disease condition in monostotic patients and may vary when the sample size is larger.^{14,16}

Craniofacial bones were involved in 25% of the cases, including the case showing a polyostotic presentation (Table 3). With regard to involvement of the bones of the craniofacial region, the mandible was the most involved bone followed by the maxilla, zygoma, frontal, temporal, sphenoid, ethmoid, parietal and occipital bones. Such a presentation is in contrast with the findings of Lustig and co-workers,⁷ who identified the ethmoid as the most commonly involved bone, followed by the sphenoid, frontal, maxilla, temporal, parietal and occipital bones.

This article highlights the various radiographic presentations of fibrous dysplasia in the jaw bones. To a certain extent, plain films help to define the lesion.

CT scans are required to demarcate lesions in the anatomically complex maxilla and the skull. Periapical radiographs however do help to determine the internal structure of fibrous dysplasia accurately as it is placed closest to the jaw. Only 2 of the 24 cases showed well-defined borders, both of which involved the mandible. The lesion may be sharply defined when a sclerotic rim is present or may be ill defined if it lacks perilesional sclerosis and may fade into the adjacent normal bone.¹⁷ Sherman and co-workers¹⁸ and Eversole *et al*¹⁹ reasoned that diffuse lesions are usually poorly defined and dysplastic in nature. The basic patterns described by Fries in 1957 are pagetoid (56%), a mixture of dense and radiolucent areas of fibrosis; sclerotic (23%), mass is homogeneously dense; and cystic (21%), a spherical or ovoid lucency surrounded by a dense boundary.²⁰ In this clinical series, the most common presentation was that of a mixed radiolucent–radiopaque type pattern of which the “ground-glass” appearance was most common. In the study by MacDonald-Jankowski and Li²¹ and in the systematic review by MacDonald-Jankowski,¹⁴ fibrous dysplasia most commonly presented radiographically as a poorly defined ovoid (fusiform) area of dysplastic bone exhibiting a ground-glass appearance. Cystic change was noted in two cases in patients who were in their fourth and fifth decades of life, thus justifying that radiolucent lesion resembling cysts occasionally occur in mature lesions of fibrous dysplasia.²² In fibrous dysplasia of the mandible, only four cases showed expansion of lower border of the mandible of which the characteristic “thumb-print” pattern was noticed in two cases (Figure 7). Petrikowski *et al*²³ suggested that the upward displacement of the inferior alveolar canal was a unique characteristic of fibrous dysplasia. In the present study, the inferior dental canal was superiorly

displaced in three cases, inferiorly displaced in two cases and remained non-traceable in four cases, thereby agreeing with the findings of MacDonald-Jankowski and Li.²¹

Fibrous dysplasia affecting the maxilla always involves the antrum, either by obliterating it or by gross displacement of its borders encroaching on the neighbouring bones, as in the cases depicted in our study.⁹ Loss of lamina dura was noted in 20 cases, which has been considered as a pathognomonic sign on fibrous dysplasia.²³

In conclusion, it may be emphasized that the radiographic study of these lesions, using both plain films and advanced methods like CT, contribute to the exact diagnosis and also aid in defining the accurate extent of the lesion. Aesthetic deformity or functional disturbances associated with the jaw lesions of fibrous dysplasia are the major indications for treatment. Awareness of the myriad of radiographic appearances of fibrous dysplasia is essential and will be beneficial in the accurate diagnosis and proper treatment planning, even without invasive diagnostic procedures.

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References

1. Daramola JO, Ajabe HA, Obisesan AA, Lagundoye SB, Oluwasanmi JO. Fibrous dysplasia of the jaws in Nigerians. *Oral Surg Oral Med Oral Pathol* 1976; **42**: 290–300.
2. Waldron CA. Fibro-osseous lesions of the jaws. *J Oral Maxillofac Surg* 1993; **51**: 828–835.
3. Mohammed-Araghi H, Haery C. Fibro-osseous lesions of craniofacial bones. Role of imaging. *Radio Clin North Amer* 1993; **31**: 121–134.
4. Lichtenstein L. Polyostotic fibrous dysplasia. *Arch Surg* 1938; **36**: 874–898.
5. Riminucci M, Saggio I, Robey PG, Bianco P. Fibrous dysplasia as a stem cell disease. *J Bone Min Res* 2006; **21**: 125–131.
6. Cohen MM Jr, Howell RE. Etiology of fibrous dysplasia and McCune-Albright syndrome. *Int J Maxillofac Surg* 1999; **28**: 366–371.
7. Lustig LR, Holliday MJ, McCarthy EF, Nager GT. Fibrous dysplasia involving the skull base and temporal bone. *Arch Otolaryngol Head Neck Surg* 2001; **127**: 1239–1247.
8. Davies ML, Yardley JH. Fibrous dysplasia of bone. *Amer J Med Sci* 1957; **234**: 590–606.
9. White SC, Pharoah M. *Oral radiology. Principles and interpretation*, 5th edn. St Louis: CV Mosby, 2004.
10. Worth HM. *Principles practice oral radiologic interpretation*. Chicago: Year Book Medical Publishers, 1963.
11. Slootweg PJ, Muller H. Differential diagnosis of fibro-osseous jaw lesions. A histological investigation on 30 cases. *J Cranio-maxillofac Surg* 1990; **18**: 210–214.
12. Eisenberg E, Eisenbud L. Benign fibro-osseous diseases: current concepts in historical perspective. *Oral Maxillofac Clin Nor Am* 1997; **9**: 551–562.
13. Windolz F. Cranial manifestations of fibrous dysplasia of bone. *Am J Roentgenol* 1947; **58**: 51–63.
14. MacDonald-Jankowski DS. Fibrous dysplasia in the jaws of a Hong-Kong population: radiographic presentation and systematic review. *Dentomaxillofac Radiol* 1999; **28**: 195–202.
15. Yoon JH, Kim J, Lee CK, Choi J. Clinical and histopathological study of fibro-osseous lesions of the jaws. *Yonsei Med J* 1989; **30**: 133–143.
16. Waldron CA, Giansati JS. Benign fibro-osseous lesions of the jaws: a clinical-radiologic-histologic review of sixtyfive cases. *Oral Surg Oral Med Oral Pathol* 1973; **35**: 190–201.
17. Bertoni F, Arias LF, Alberghini M, Bacchini P. Fibrous dysplasia with degenerative atypia a benign lesion potentially mistaken for sarcoma. *Arch Pathol Lab Med* 2004; **128**: 794–796.
18. Sherman RS, Glauser OJ. Radiological identification of fibrous dysplasia of the jaws. *Radiology* 1958; **71**: 553–558.
19. Eversole LR, Sabes WR, Rovin S. Fibrous dysplasia: a nosologic problem in the diagnosis of fibro-osseous lesions of the jaws. *J Oral Pathol* 1972; **1**: 189–220.

20. Megerian CA, Sofferman RA, McKenna JM, Eavey RD, Nadol JB. Fibrous dysplasia of the temporal bone: ten new cases demonstrating the spectrum of otologic sequelae. *American J Otol* 1995; **16**: 408–19.
21. MacDonald-Jankowski DS, Li TK. Fibrous dysplasia in a Hong Kong community: the clinical and radiological features and outcomes of treatment. *Dentomaxillofac Radiol* 2009; **38**: 63–72.
22. Langlais RP, Langland OE, Nortje CJ. *Diagnostic imaging of the jaws*. Baltimore: Williams & Wilkins, 1995, pp 583–588.
23. Petrikowski CG, Pharoah MJ, Lee L, Grace MG. Radiographic differentiation of osteogenic sarcoma, osteomyelitis and fibrous-dysplasia of the jaws. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1995; **80**: 744–750.