Insights Into Fasciitis Ossificans: A Rare Condition Reviewed Across Decades of Literature

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ABSTRACT

Fasciitis ossificans (FO) often presents as a soft tissue tumor with a wide differential diagnosis due to the similarity in clinical and radiological features with other conditions. Therefore, microscopic examination and immunohistochemistry are essential for accurate diagnosis. FO is a benign, rapidly growing soft tissue tumor that occurs in various subcutaneous tissues. FO is considered a subtype of nodular fasciitis, sharing similar clinical behavior and histopathological features, often leading to restricted joint mobility. The pathogenesis of FO is typically an inflammatory response following trauma, infection, or biopsy procedure at the site of the tumor. Radiologically, FO is characterized by heterotopic ossifications and diffuse soft tissue swelling. The primary treatment is surgical excision. Literature reported no recurrence and excellent postoperative outcomes. This review article provides an overview of the published literature to formulate a comprehensive understanding of FO. Furthermore, to evaluate the common presenting symptoms, radiological characteristics, management and recurrence rate.

Keywords: Fasciitis ossificans, Myositis ossificans, soft tissue mass, tumour.

INTRODUCTION

Fasciitis ossificans (FO) is a benign, rapidly growing soft tissue tumor[1]. Its terminology varies based on location, including proliferative fasciitis, cranial fasciitis, intravascular fasciitis, proliferative myositis, myositis ossificans (MO), fibro-osseous pseudotumor of the digits, ischemic fasciitis, and postoperative/posttraumatic spindle cell nodule[2]. These variants are benign pseudo-sarcomatous proliferative lesions[3]. FO primarily affects axial regions and extremities, with rare occurrences in intravascular and dermal locations[1,4]. It is an uncommon tumor, with an estimated incidence of fewer than one case per 10 million people, predominantly affecting young and middle-aged adults[1,5]. FO is a type of nodular fasciitis, sharing similar clinical and histopathological characteristics, often leading to joint mobility restriction[6]. It typically arises from an inflammatory reaction triggered by trauma, infection, or biopsy[1,7] and is associated with USP6 translocations, a deubiquitinating enzyme regulating cellular functions[8]. Histologically, it is characterized by spindle-shaped fibroblasts or myofibroblasts with eosinophilic cytoplasm, lacking pleomorphism[9,10].

Some reports classify MO as a rare connective tissue disorder with distinct radiological features depending on location. The hallmark finding is heterotopic ossification with diffuse soft tissue swelling. MRI is valuable for differentiating it from conditions like infantile fibromatosis, cranial fasciitis, and rhabdomyosarcoma[7]. Morphologically, MO progresses through distinct stages. Initially, it presents with pain, tenderness, and rapid swelling, often mimicking soft tissue sarcoma. Over time, ossification occurs, forming solid bony structures that may restrict joint movement[11].

The management of FO is surgical excision[4]. A case report described a young female with multiple bony swellings across her trunk, diagnosed as MO. Complete surgical excision was not feasible, so she was managed with physiotherapy and analgesics. However, her condition progressively worsened, and she eventually lost to follow-up[12]. Another case involved inoperable MO with carotid space extension, initially suspected as fibrodysplasia ossificans progressiva. The patient's condition worsened, leading to treatment failure[13]. Most cases in the literature show excellent postoperative results, with no reported recurrence indicating good prognosis[1,14-30].

METHODOLOGY

Search Strategy: A comprehensive literature search was conducted through PubMed, Google Scholar, Scopus, and Web of Science

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to identify relevant studies published between 1938 and 2024. The search strategy included case reports, literature reviews, and systematic reviews on fasciitis ossificans. Keywords and Medical Subject Headings (MeSH) terms such as "fasciitis ossificans," "nodular fasciitis," "myositis ossificans," "soft tissue ossification," and "benign soft tissue tumor" were used to maximize the retrieval of relevant studies.

Study Selection and Inclusion Criteria: Studies were included if they were published in English and provided histopathological confirmation of fasciitis ossificans. Only case reports, literature reviews, and systematic reviews from 1938 to 2024 that documented clinical, radiological, and pathological findings were considered. Articles were excluded if they fell outside this timeframe, were not in English, were published as preprints, or presented only preliminary or unconfirmed results.

Titles and abstracts of retrieved articles were independently screened by two reviewers for relevance. Full-text articles of eligible studies were then obtained and further evaluated. Any discrepancies in study selection were resolved through discussion with a third reviewer to ensure objectivity and consistency.

Data Extraction and Synthesis: A structured approach was used to extract key information, including study characteristics, patient demographics, clinical presentations, radiological and pathological findings, treatment modalities, follow-up duration, and recurrence rates. Quantitative data were presented in tables, while qualitative findings were analyzed narratively.

RESULTS

The results (Table 1) provide a comparative analysis of demographic and clinical characteristics of Fasciitis Ossificans (FO) based on anatomic location (limb vs. head and trunk) (Figure 1). Gender distribution shows no significant differences in both locations (limb: 52% male, 48% female; head and trunk: 42% male, 58% female; $p>0.05$), suggesting that gender is not a determining factor in the anatomic site of FO. However, age emerges as a significant variable, with most cases occurring in patients ≤40 years (limb: 63%; head and trunk: 77%; $p<0.05$). This trend is particularly pronounced in the head and trunk region, indicating that younger individuals are more susceptible to FO, possibly due to higher tissue reactivity or trauma exposure. Pain is a nearly universal symptom, reported in 85% of limb cases and 97% of head and trunk cases ($p<0.001$), underscoring its clinical significance as a hallmark feature of FO. These findings highlight the importance of considering FO in younger patients presenting with localized pain, particularly in the head, trunk, or limbs, while also emphasizing the need for further research into age-related susceptibility and underlying mechanisms (Figure 2).

Table 1. Demographic and Clinical Characteristics of Fasciitis Ossificans by Anatomic Location

Variables	**Anatomic Location**	
	Limb (n=27)	**Head and trunk (n=31)**
Gender	n (%)	n (%)
Male (n=37)	14 (52)	13 (42)
Female (n=31)	13 (48)	18 (58)
95% C.I	(-0.229, 0.304)	(-0.407, 0.084)
P-value	0.785	0.198
Age		
>=40 Years (n=41)	17 (63)	24 (77)
>40 Years (n=17)	10 (37)	7 (23)
95% C.I	(0.002, 0.517)	(0.340, 0.756)
P-value	0.049	<0.001
Pain Status		
Pain (n=53)	23 (85)	30 (97)
Painless (n=5)	4 (15)	1 (3)
95% C.I	(0.514, 0.893)	(0.848, 1)
P-value	<0.001	<0.001

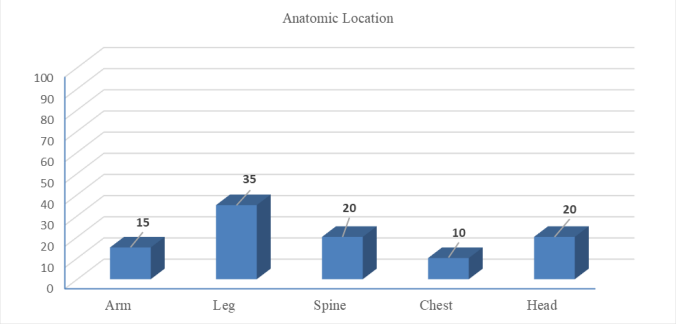

Figure 1. Anatomic Location

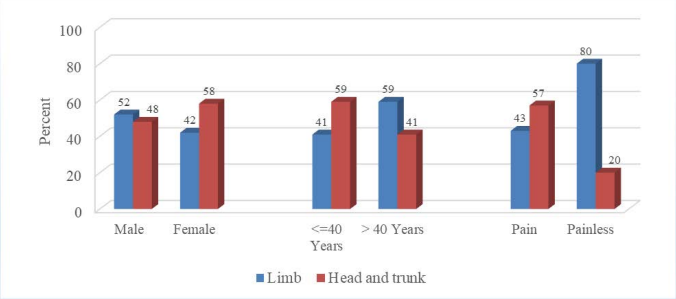

Figure 2. Gender, Age and Pain

FO primarily affects young adults, with the highest incidence observed in individuals aged 21-30 years. Most cases (70%) present with pain, although a significant portion (30%) remains painless, potentially leading to delayed diagnosis. Recurrence is relatively uncommon, as 70% of cases showed no recurrence following treatment, while 30% experienced recurrence, suggesting the importance of complete surgical excision and long-term follow-up (Figure 3). Anatomically, the leg is the most affected site, followed by the head, and spine, then arm and chest. These findings highlight the necessity of early recognition, accurate diagnosis, and appropriate treatment strategies to improve patient outcome and prevent recurrence (Tables 1, 2, and 3).

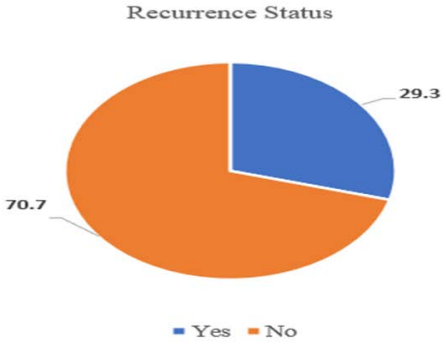

Figure 3. Recurrence Status

Table 2. Clinical features of the reported cases diagnosed with fasciitis ossificans

Reference	Age/Gender	Clinical Presentation	Location	Treatment	Recurrence
Kowalczyk et al. 2019 (1)	30 years/female	Painful knee with limited joint mobility. History of trauma within six weeks	Left knee	Arthroscopic medial retinacular repair with excision of the lesion	No recurrence
Satter et al. 2015 (2)	51 years/female	Slowly growing Painless nodule of 2-year duration	Ulnar aspect of the right fifth finger	Surgical excision	No recurrence
Klapsinou et al. 2012 (3)	51 years/female	Palpable lesion 7.5 cm in diameter	Latissimus dorsi muscle at right scapula	Surgical excision	No recurrence
	47 years/female	Palpable lesion	Right inguinal region	Surgical excision	No recurrence
	32 years/male	Palpable lesion	Left axillary region	Regressed spontaneously	No recurrence
	29 years/female	Palpable lesion	Rear thigh above the popliteal fossa	Surgical excision	No recurrence
Sápi et al. 2021 (5)	52 years/male	Painful lesion	Left thigh	Surgical excision	Recurrence
	40 years/male	Painful lesion	Right little finger	Surgical excision	No recurrence
	28 years/female	Painful lesion	Face	Surgical excision	No recurrence
	44 years/male	Painful lesion	Left arm	Surgical excision	No recurrence
	9 years/male	Painful lesion	Chest	Surgical excision	Recurrence
	52 years/male	Painful lesion	Left knee	Surgical excision	No recurrence
	21 years/female	Painful lesion	Forehead	Surgical excision	No recurrence
	5 years/male	Painful lesion	Right gluteal region	Surgical excision	Recurrence
	42 years/female	Painful lesion	Left shoulder blade	Surgical excision	No recurrence
	42 years/female	Painful lesion	Forehead	Surgical excision	No recurrence
	17 years/female	Painful lesion	Neck	Surgical excision	No recurrence
	21 years/male	Painful lesion	Right shoulder	Surgical excision	No recurrence
	6 years/male	Painful lesion	Right supraclavicular region	Surgical excision	Recurrence
	12 years/male	Painful lesion	Face	Surgical excision	No recurrence
	25 years/male	Painful lesion	Left forearm	Surgical excision	No recurrence
	40 years/female	Painful lesion	Right forearm	Surgical excision	No recurrence
	33 years/male	Painful lesion	Right forearm	Surgical excision	Recurrence
Schiff et al. 2013 (6)	41 years/female	Painful lesion	Left periauricular region	Surgical excision	No recurrence
Lin et al. 2016 (7)	1 year/female	Periorbital and scalp swelling, for one week post upper respiratory tract infection, that resolved following antibiotic course	Skull	Surgical excision	Recurrence
Papke et al. 2021 (8)	72 years/ female	Left lower extremity pain for 3 months	Left tibia	Surgical excision	Recurrence
Koplin et al. 2010 (10)	40 years/male	Painful lesion	Forearm	Surgical excision and radiotherapy	No recurrence
	5 years/male	Painful lesion	Base of skull	Not specified	Recurrence
	45 years/male	Painful lesion	Forearm	Surgical excision	No recurrence
	27 years/male	Painful lesion	Forearm	Surgical excision	No recurrence
Dhamangaonkar et al. 2013 (12)	16 years/female	Multiple bony swellings, multiple deformities resulting in loss of normal range of movement	All over the body	Physiotherapy and NSAIDs	Recurrence
Hullfish et al. 2022 (13)	22 years/female	Dyspnea and rapidly growing neck mass for 1 week	Right neck mass	Debulking of the mass.	Recurrence
Hammoutene et al. 2021 (14)	32 years/male	Firm, painless, well-limited, and mobile nodule, appeared 2 years ago, and increased in size for 4 months.	Right mandible	Surgical excision	No recurrence

Sato et al. 2007 (15)	77 years/female	Incidental painless nodule of the breast, without history of trauma, no nipple discharge, no distinctive past history	lower outer quadrant of the left breast	Excisional biopsy	No recurrence
Kim et al. 2007 (16)	23 years/female	2-month history of a rapidly growing, palpable mass with pain associated with movement	Volar surface of the palm of left hand	Surgical excision	No recurrence
Tarantino et al. 2001 (17)	12 years/female	Mass for approximately 1 year duration	Occipital	Surgical excision	No recurrence
Rozen et al. 2007 (18)	33 years/male	Known case of embryonal carcinoma of testis, treated 7 years ago, no evidence of recurrence.	Right axilla	Indomethacin, 150 mg daily, and high-dose opioid analgesia. Referral for specialist pain management.	No recurrence
Heifetz et al. 1992 (19)	7 months/ female	Right leg pain and inability to flex or extend the right knee that began following a vague history	Posterior distal femoral epiphysis of right leg	Posterior arthrotomy with excision of a well-demarcated intracapsular osteocartilaginous mass	No recurrence
Eida et al. 2021 (20)	11 years/female	Painless hard mass	Left mandible	Local excision	No recurrence
Galanis et al. 2017 (21)	18 years/male	Intensifying muscle soreness and a progressively growing palpable mass	Anterior distal third of the right humeral shaft	Total excision of the mass through anterior approach	No recurrence
Pohlodek et al. 2018 (22)	31 years/female	Growing lump	Upper, inner quadrant of her right breast near the infraclavicular region	Breast surgery	No recurrence
Grebić et al. 2017 (23)	48 years/female	Single, large, oval mass. Slightly tender, hard, not well-circumscribed, poorly mobile	Volar side of the right distal forearm	Surgical excision	No recurrence
Sasa et al. 2021 (24)	15 years/male	Not specified	Between the deltoid and small circular muscles	Surgical excision	No recurrence
Nowaczyk et al. 2013 (25)	20 years/female	severe pain of the adductors	Anteromedial surface of the right thigh	Surgical excision	No recurrence
Li et al. 2016 (26)	48 years/female	Upper left abdominal pain for few days	Left rectus abdominis muscle	Excisional Biopsy	No recurrence
Su et al. 2014 (27)	63 years/female	Painful mass for 1 day	Upper inner quadrant of the left breast	Simple excision	No recurrence
Jawadi et al. 2018 (28)	27 years/female	Progressively growing mass, with ulcerated overlying skin and no signs of infection	Left ring finger	Surgical excision	No recurrence
Hashmi et al. 2014 (29)	34 years/male	Small dermal nodule	Dorsal aspect of middle finger	Surgical excision	No recurrence
Thangavelu et al. 2011 (30)	36 years/female	Painful limitation of jaw opening. Palpation of the left coronoid process elicited mild pain.	Left jaw	Surgical excision	No recurrence
Innocenzi et al. 1997 (32)	22 years/female	Painless, rapidly growing, bright red, rounded nodule on the nose for 5 months	Tip of nose	Nodule was completely excised	Recurrence
Gupta et al. 2020 (33)	65 years/female	Painless lesion	Around right wrist	Surgical excision	Recurrence
Khanna et al. 2018 (34)	27 years/male	Swelling measured 12 cm × 10 cm for 2 and ½ years. With normal skin and nodular surface.	Right axilla, extending to the lateral border of the right scapula	Wide Local Excision	Recurrence

Bormann et al. 2024 (35)	23 years/female	2 months of painful palpable slowly growing mass at the junction of left vulvar crease and proximal thigh	Left upper thigh	Surgical Excision	No recurrence
Hashemi et al. 2011 (36)	2 years/male	Palpable masses in the frontal and lower cervical paraspinal and left periscapular muscles	Not specified	NSAIDs	Recurrence
Barwad et al. 2011 (37)	14 years/male	Painful hard mass, restricted range of motion around hip joint	Upper right thigh	Not specified	Recurrence
Alhabbab et al. 2022 (42)	19 months/male	Rapidly growing hard painless swelling started four months ago.	Right side of the submandibular region	Not specified	Recurrence
Al-Nemer et al. 2015 (43)	47 years/male	Progressive swelling, 10 days prior to a blunt trauma. Firm, well-circumscribed, painless mass in supraclavicular region	Right side of the neck	Surgical excision	No recurrence
Dogan et al. 2000 (48)	57 years/male	Pain in lower extremity.	Left lower extremity (femoral region)	Left femoropopliteal by-pass, and excision of 5 × 3 × 2.5 cm mass from left groin.	Recurrence

Table 3. Radiological and Pathological features of the reported cases diagnosed with fasciitis ossificans

Reference	Radiological Findings	Pathological Findings
Kowalczyk et al. 2019 (1)	MRI: with contrast left knee joint was performed. A rupture of the medial patellar retinaculum with excessive lateral pressure syndrome was described. MRI also showed contrast-responsive tissue infiltration, sized 36 mm × 16 mm × 30 mm, localized in the medial patellar retinaculum. A post-traumatic inflammatory lesion of the medial patellar retinaculum of the left knee was suggested.	A weak inflammatory infiltration with scattered lymphocytes was seen. There were areas with atypical cells and osteoid production. Immunohistochemistry: These fields resembled structures of an osteosarcoma. Mitotic figures were scarce (mitotic index of 1 per 20 high power fields). Foci of necrosis and giant cells were absent. Positive for smooth muscle actin (SMA), MyoD1 and neuron-specific enolase (NSE). Negative for cytokeratins, desmin, S-100 protein, CD57, CD246, and Ki-67 proliferation index.
Satter et al. 2015 (2)	NA	Microscopic appearance: picture resembling ganglion cells Immunohistochemistry: positive for factor XIIIa, and CD68. Negative for smooth muscle actin (SMA), S100, cytokeratin, Epithelial Membrane Antigen (EMA), or desmin
Klapsinou et al. 2012 (3)	Case 1: MRI suggested traumatic related hematoma. Case 2 and 3: MRI inconclusive Case 4: encapsulated lesion indicative of a rather benign condition	Case 1-3: proliferative myositis Case 4: myositis ossificans
Schiff et al. 2013 (6)	CT scan of the facial bones without contrast, several radiopaque entities attached to and extending medially and superiorly to the left coronoid process within the insertion of the temporalis muscle.	NA
Lin et al. 2016 (7)	Skull radiograph; showed diffuse soft tissue thickening. Contrast enhanced MRI: showed diffuse circumferential enlargement of the subgalea space	Microscopic appearance: showed primitive and relatively monotonous spindle cells arranged in a haphazard pattern and infiltrating the muscular tissue and fibrous fascia. Immunohistochemistry: was positive for SMA
Papke et al. 2021 (8)	Ankle radiograph: ill-defined, oval, lytic lesion with cortical destruction involving the distal tibial diaphysis. CT: lytic, destructive intramedullary lesion of soft tissue attenuation in the distal tibial diaphysis with cortical destruction laterally	Histopathological examination revealed a high possibility of giant cell tumor of bone with extensive secondary aneurysmal bone cyst-type changes
Dhamangaonkar et al. 2013 (12)	Radiograph: widespread myositis ossificans lesions at the cervical spine, shoulder girdles, elbows, and hips	

Hullfish et al. 2022 (13)	CT: right sternocleidomastoid muscle hematoma extending into carotid space, with leftward deviation of trachea. MRI: hyperintense and enhancing mass measuring extensive oedema	Microscopic appearance: spindled fibroblasts and myofibroblasts with no high-grade features, consistent with nodular fasciitis
Hammoutene et al. 2021 (14)	CT scan: well limited soft tissues lesion, right next the mandibular. This lesion has a partially ossified matrix, without implantation base nor scalloping of the mandibular bone.	Microscopic appearance: Circumscribed nodular lesion composed of newly formed differentiated spongious bone with osteogenic activity
Sato et al. 2007 (15)	NA	Microscopic appearance: 2 mitotic figures per 10 high-power fields, but no atypical forms were observed. Immunohistochemistry: positive for vimentin and a-smooth muscle actin but negative for pancytokeratin (AE1/AE3), desmin, S-100 protein, or c-kit, suggesting myofibroblast char- acters. Ki-67 labeling index was 41% in the peripheral spindle cell area.
Kim et al. 2007 (16)	MRI: discrete ovoid mass. This mass surrounded the 3rd flexor digitorum tendon with marked thickening of the synovial sheath and adjacent palmar subcutaneous tissue with infiltration of flexor tendon sheath of the hand.	Microscopic appearance: fibroblastic cells with no skeletal muscle and abnormal mitotic figures in the lesion. Within areas of fibroblastic proliferation, there was immature woven bone consisting of osteoid with calcification and chondroid differentiation.
Tarantino et al. 2001 (17)	CT scan: calcified tissue involved the soft tissues of the posterior portion of the neck on the left side, as far as the C-2 vertebral body; there was no pathological uptake of contrast medium. MRI: confirmed the presence of a well-defined non-homogeneous mass like subcutaneous fat. Angiography: extracranial roundish, pathological circulation fed by muscular branches of the left vertebral artery and the occipital branch of the left external carotid artery.	Pseudo malignant osseous tumour of the soft tissue
Rozen et al. 2007 (18)	CT scan and MRI: mass in the right axilla, intimately related to the axillary neurovascular bundle, consistent with a sarcoma. Calcification was noted. A full body thallium study: thallium uptake consistent with a ‘malignant soft tissue tumour’.	Microscopic appearance: mixed osteocytes and fibroblasts with osteoid formation. There were no malignant features
Heifetz et al. 1992 (19)	Plain X-ray of the right knee, three-phase bone scan of the hips, and spinal MRI were normal. 11 weeks later, a repeat plain X-ray of the right knee: ossified or calcified nodule in the region of the posterior distal femoral epiphysis. 2 weeks later a right knee arthrogram: mass attached to the posterior aspect of the right lateral meniscus, dysplasia epiphysealis hemimelica.	Microscopic appearance: dense, fibrous connective tissue that contained a core of mature lamellar bone that resembled osteoma.
Eida et al. 2022 (20)	X-ray: rounded radiolucent lesion with irregular border CT scan: exophytic juxtacortical mass eroding the cortical bone of the left mandible. MRI: well-defined mass with homogeneous low signal intensity On FDG-PET/CT of left mandibular mass: relatively high 18F-FDG uptake at 1 hour after injection with a maximum standardized uptake value (SUVmax) of 3.7	Microscopic appearance: Thick fibrous tissue attached to the bone surface, regarded as the periosteum. The inner portion of the mass was mainly composed of fascicles of spindle cells with bland nuclei. The tumor cell fascicles showed a curved, interlacing, and storiform pattern. The tumor contained focal myxoid matrices, slit-like vascular lumens, sparse osteoclast-like giant cells, and extravasated erythrocytes. Immunohistochemistry: positive for α-SMA, HHF35 and vimentin, and negative for S100 protein, desmin, CD34 and CD68. MIB-1 (Ki-67) labeling index was 7.2%.
Galanis et al. 2017 (21)	X-ray: well-defined mass with mineralized periphery and radiolucent centre at the distal third of the right humeral shaft.	Microscopic appearance: spindle cell lesion with moderate cellularity. There was mild mitotic activity without atypical mitoses. The stroma contained abundant collagen fibers, with focal myxoid and hyaline changes. Focal lymphocytic infiltration and mild hemorrhage were also observed. Immunohistochemistry: positive for vimentin and a-smooth muscle actin and negative for desmin, caldesmon, S-100 protein, b-catenin, CD34, CD117/c-kit, ALK-1, or CD57.

Pohlodek et al. 2018 (22)	Breast ultrasonography: oval-shaped, tumour of unclear aetiology with a pathological pattern of blood flow, as seen on Power-Doppler imaging. Chest CT scan: mass with ossification signs on the upper chest wall that appeared to be continuous with the right pectoralis major muscle.	Microscopic appearance: Nodular proliferation of spindle cells with characteristics centripetal zonation of ossification and giant osteoclasts like cells Immunohistochemistry: positive for anti-vimentin and anti-alpha smooth muscle actin (SMA) antibodies, and negative for anti-cytokeratins, anti-EMA, anti-desmin antibodies, and diffuse steroid receptors (estrogen and progesterone receptor).
Grebić et al. 2017 (23)	MRI: poorly defined, serpiginous, spindle-like and expansive mass within the flexor superficial muscles of the forearm. The mass in the superficial flexor compartment was showing heterogeneous signal intensity.	Microscopic appearance: Bone and osteoid formations with many osteoblasts and fibrous tissue with rich vascularization in the periphery of the mass
Sasa et al. 2021 (24)	MRI: 2 cm lesion between the deltoid and small circular muscles. The lesion seemed to be located within the muscle, just below the subcutaneous adipose tissue and adjacent to the periosteum of the left humerus.	Microscopic appearance: spindle-shaped cells and inflammatory cells within the collagenous background. Small vessels were prominent. Immunohistochemistry: positive for SMA, and negative for desmin, CD34, and β-catenin
Nowaczyk et al. 2013 (25)	Ultrasonography: oval and hypoechoic, area of inflammatory infiltration suggestive of an abscess.	Microscopic appearance: mesenchymal cells without features of atypia as well as granulocytes and lymphocytes
Li et al. 2016 (26)	abdominal CT: revealed a hyper-vascular tumour in left rectus abdominis muscle	Microscopic appearance: zonal proliferation of fibroblasts in random intersecting fascicles and extravasation of erythrocytes in the myxoid stroma, merging with the woven bone trabeculae lined by osteocytes and osteoblasts at the periphery
Su et al. 2014 (27)	Mammography: well-circumscribed, discrete nodule with bone density located in the patient's left breast.	Microscopic appearance: clearly demarcated nodule composed of mature lamellar bone trabeculae with osteoblastic rimming, bland spindle cell stroma, and some foci of entrapped normal breast parenchyma
Jawadi et al. 2018 (28)	X Ray of the hand: soft tissue swelling with no evidence of bone involvement. Assessment of neurovascular structures showed partial abutment of the radial sided bundle together with complete encirclement of the ulnar sided neurovascular bundle. The surrounding bone was free of any masses and associated mass effect.	Microscopic appearance: fasciitis like features, myofibroblast proliferation and scattered foci of osteoid formation. Immunohistochemistry: positive for Alpha-Smooth Muscle Actin (ASMA 1A4) and no evidence of malignancy
Hashimi et al. 2014 (29)	NA	Microscopic appearance: biphasic fibro-osseous lesion present in the dermis, composed of stromal and osseous components. Immunohistochemistry: negative for cytokeratin, and positive for ASMA, CD 34 and S100 stains
Thangavelu et al. 2011 (30)	CT scans: irregular ossified mass attached to the medial aspect of left ramus of the mandible extending medially to the medial and lateral pterygoid plates	Microscopic appearance: bone tissue with numerous lacunae filled with osteocytes. The periphery shows fibrous connective tissue with numerous spindle fibrocytes, and mature collagen fibers arranged in moderately thick bundles. Few blood vessels are also seen.
Innocenzi et al. 1997 (32)	Head and chest X-Rays, isotopic bone CT, and MRI showed no continuity between the neoplasm and the underlying cartilaginous and osseus structures.	Microscopic appearance: Spindle-shaped myofibroblast cells, trabeculae of woven bone rimmed by plump osteoblasts within a myxoid stroma. Immunohistochemistry: positive for vimentin and alpha-smooth-muscle actin. Negative for S-100, desmin, lysozyme, alpha-l-antichymotrypsin, alpha-1-antit- rypsin, HMB-45, EMA, KP1 and cytokeratins.
Gupta et al. 2020 (33)	X-Ray of the right wrist: ossification around dorsal aspect of distal end of the ulna in the areas of the extensor tendons	

Khanna et al. 2018 (34)	Chest x-ray: normal and showed no osteolytic lesions of the right ribs or scapula. MRI: irregular mass in the right axilla in the muscular-subcutaneous plane measuring 10.8 × 8.8 × 12 cm. This mass was attached to the lateral border of scapula and displaced the subscapularis anteriorly. The infraspinatus, teres minor and teres major muscles were displaced posteriorly. Multiple scattered areas of haemorrhage were noted within. The neurovascular bundle was seen displaced cranially. The lesion abutted the median, radial, ulnar nerves, and axillary vessels in a few sections. The lesion abutted the serratus anterior on the medial aspect. Magnetic Resonance Angiogram: feeders from the branches of right subclavian and axillary arteries and venous drainage into the right subclavian vein	Ultrasound guided biopsy: benign spindle cell neoplasm possibly of fibrous origin with moderate to abundant collagen and no evidence of cytological atypia/increased mitosis or necrosis. Microscopic appearance: Well circumscribed, encapsulated spindle cell lesion. The cells were arranged in irregular bundles and fascicles along with a small amount of mature collagen. Cells appeared to be plump, immature myofibroblasts and fibroblasts. Periphery of the lesion showed muscle giant cells, mitosis 2/10HPF. There was no evidence of necrosis. Immunohistochemistry: positive for Vimentin, Smooth Muscle Actin(SMA) and negative for S100 and CD34. Ki67 labelling index was less than 1%.
Bormann et al. 2024 (35)	Left upper thigh Ultrasonography: hypoechoic mass measuring 3.5 x 3x 2.4 cm. MRI: soft tissue mass measuring 4.8 x 2.7 x 4 cm extending into the left gracilise muscle	Microscopic appearance: haphazardly arranged spindle to stellate cells arranged in a myxoid matrix with mucin pools. FISH analysis revealed the presence of a UPS6 rearrangement.
Hashemi et al. 2011 (36)	X-Rays of the feet: bilateral hallux valgus congenital malformation. Thoracic CT-scan: soft tissue masses Foot and Neck X-Rays one year later: initiation of ossification in soft tissue masses VR and 3D reconstructed CT of thoracic bones: ossification in the paravertebral and periscapular region and the right arm	Microscopic appearance: fibro proliferative connective tissue with large islets of compact basophilic chondrocytes and lacunar cells surrounded by bone specula and activated osteoblasts
Barward et al. 2011 (37)	CT scan: heterogeneous mass in the upper part of quadriceps measuring 6.3 5.5 3.5 cm with peripheral areas of calcification. The adjacent iliac bone showed irregularity of the surface in relation to the mass. However, no bony attachment was identified.	FNAC biopsy: Microscopic appearance: low cellularity and consist of scattered multinucleated giant cells, osteoblasts, proliferating fibro- blasts and myofibroblasts embedded at places in pink stroma. The fibroblasts were spindle cells arranged both in cluster as well as singly scattered, with round to oval nuclei, blunt edges, homogenous bland chromatin, and elongated cytoplasm.
Manish et al. 2022 (38)	X-Rays of the elbow and wrist: ossification around the elbow and dorsal to the carpals and metacarpals in the location of the extensor tendon sheaths suggestive of traumatic myositis ossificans. There also was a suspicion of an epiphyseal injury to the lower end of the ulna.	NA
Whyte et al. 2012 (39)	X-Rays of the right foot: shortened first metatarsal shaft with hallux valgus. The great toe proximal phalanx is widened and misshapen with associated deformity of the first metatarsophalangeal and interphalangeal joints. X-Rays of the left hand: normal alignment and joint spaces without the bony deformities sometimes associated with FOP. Specifically, there is no shortening of the first metacarpal or small finger middle phalanx, nor is there clinodactyly.	Microscopic appearance: superficial tissue consisting of fascial or deep subcutaneous connective tissue, including fat but not skeletal muscle
Schmitz et al. 2019 (40)	Ultrasonography: hypodense nodule measuring 1.9 cm within the breast. MRI: tumour measuring 3.3 cm with wide contact to the ribs. Imaging did not allow discrimination between tumorous infiltration of the chest wall and peritumoral reaction imitating rib infiltration.	NA

Al-Hayder et al. 2019 (41)	CT scan: well-defined nodular lesion in the soft tissue without bone destruction, measuring 16 × 12 mm at the left medial canthus (corner of the eye)	Microscopic appearance: Subcutaneous tumor in close relation with sparse skeletal muscle. It consisted of a cellular proliferation of myofibroblast spindle cells with a tissue-culture like growth pattern. The background was myxoid with extravasated red blood cells and few lymphocytes. The cells had small distinct nucleoli without significant atypia. Scattered mitoses were observed, but there were no atypical forms. Immunohistochemistry: Immunohistochemistry: positive for smooth muscle actin while negative for S-100, CD 34, desmin, epithelial membrane antigen, and cytokeratin AE1/AE3 staining. The histopathological findings diagnosed nodular fasciitis
Alhabbab et al. 2022 (42)	Facial bone CT scan with IV contrast was obtained revealing submandibular ill-defined soft tissue mass at the right mandibular body and angle, extending to areas of unerupted teeth number 84 and 85, measuring 3.6 × 3 × 2.7 cm	Microscopic appearance: variably cellular areas of short irregular bundles and fascicles of fibroblasts and myofibroblasts associated with dense reticulin mesh work in a fibrous and myxoid stroma. scattered foci of microhemorrhage. Foci and fragments of reactive and metaplastic bone formation were found within the lesion. Scattered normal mitotic figures and lymphocytes were also seen with no evidence of malignancy, consistent with ossifying fasciitis. Immunohistochemistry: positive with Smooth muscle actin (SMA), and vitamin, where reacted negative to: S–100P, B catenin, and desmin protein
Al-Nemer et al. 2015 (43)	Chest X-ray showed no abnormality	Microscopic appearance: fat necrosis and benign spindle cell proliferation, intermingled with mononuclear inflammatory cells and a few multinucleated giant cells. At the periphery, a mixture of fibroblasts and osteoid bordered by mitotically active osteoblasts devoid of atypia was seen
Zhu et al. 2012 (44)	Mammography: circumscribed mass having globus contour with prominent popcorn calcification at the 12 o′clock position of right breast Ultrasonography: superficial hyperechoic heterogenous mass with irregular acoustic interface and angulated margins. The angulated margin indicated possible extension of mass into the adipose tissue. Doppler examination was unremarkable.	Microscopic appearance: Biopsy specimens suggested mesenchymoma, with large amounts of bone-like tissue and a small amount of fat, fiber and myxoid stroma.
Deliverska et al. 2013 (45)	CT: impressive extensive calcifications of the masseter muscle attached to the adjacent bone by a broad, calcified stalk.	NA
Boulnemour et al. 2018 (46)	Mammography: round dystrophic calcification measuring 1.6 cm, but no suspicious calcification, mass, or architectural distortion. Ultrasound: dystrophic calcification at the 1 o'clock position, 5 cm from the nipple, with associated marked posterior shadowing.	Microscopic appearance: proliferating spindle cells with fascicles of woven and trabecular bone and a small focus of cartilage. Immunohistochemistry: negative for p63, keratin AE1/AE3 and CK5, excluding malignant breast cancer subtypes.
Daroca et al. 1982 (47)	Aortogram using diaLrizoaLe meglumine and diatrizoate sodium (Renografin 76) was performed using a left groin approach; severe, bilateral, occlusive disease of the superficial femoral arteries, with occlusion proximal to the hiatus in the adductor magnus muscle. An area of partial occlusion was also present in the proximal left common iliac artery.	Microscopic appearance: well circumscribed but unencapsulated. Plump, fibroblast-like cells were arranged in short, interlacing fascicles. The fibroblasts were spindle shaped or stellate, and had delicate, stippled chromatin with one to two small nucleoli. In areas, the proliferating fibroblasts were separated by a clear, granular, or mucoid basophilic matrix.

Dogan et al. 2000 (48)	NA	Microscopic appearance: reactional lymph node and an irregularly shaped lesion extended into the perinodal fat tissue which is composed of proliferating fibroblasts with occasional mitotic activity. Within this fibroblastic proliferation, immature woven bone composed of osteoid with calcification and chondroid differentiation were seen.
Khan et al. 2022 (49)	NA	Microscopic appearance: well- circumscribed lesion composed of interlacing bundles of plump, spindle-shaped fibroblast like cells with a feather-like appearance arranged in the form of short and long fascicles in a fibrous and myxoid stroma. Variable amount of dense collagen fibers was noted. Scattered chronic inflammatory cells were found. Immunohistochemistry: were suggestive of benign myofibroblast proliferation with granulation tissue, consistent with NF.
Bosaily et al. 2019 (50)	X-Rays: both thick cortical and lacy trabecular bone irregularly distributed through the skeletal muscle fragments (12 cm, 7 cm, and 5.5 cm).	Microscopic appearance: trabecular bone (circle) with bone marrow (square) wrap around bundles of skeletal muscle (triangle) as is typical of myositis ossificans
Paulson et al. 2020 (51)	NA	Microscopic appearance: Lesions infiltrating skeletal muscle and bone and composed of plump myofibroblast proliferations Extravasated red blood cells, microcytic changes, osteoclastic-like multinucleated cells, keloidal collagen, metaplastic bone, and ectatic vessels were variably present.
Tan et al. 2010 (52)	NA	Microscopic appearance: acanthotic and hyperkeratotic epidermis with an area of ulceration. In the dermis, bony trabeculae, rimmed by bland-appearing osteoblasts, were observed lying within a fibrovascular stroma. Stromal blood vessels were prominent and variably dilated. In areas, the bony trabeculae were of varying maturity and the background fibrous stroma was moderately cellular

Consensus and Differences Across Decades of Reviewing the Myositis Ossificans Literature

Over the decades, a meticulous examination of the literature on myositis ossificans (MO) reveals several consensus points and notable differences in clinical presentation, management, and outcomes. This synthesis provides a comprehensive understanding of the condition's evolution in diagnosis and treatment (Table 2).

Consensus Observed

Clinical Presentation and Evolution: Across multiple cases, MO commonly presents as localized swelling or a mass, often painless, with gradual progression over weeks to months. While a history of trauma is frequently associated[1,31], other cases are entirely incidental findings, particularly in asymptomatic patients[3,5]. The literature consistently emphasizes the benign nature of the condition, with limited systemic effects.

Diagnostic and Treatment Approaches: The gold standard for treatment remains complete surgical excision of the lesion, often preceded by careful imaging studies to assess its extent and exclude malignant conditions[2,17]. Post-surgical outcomes are overwhelmingly positive, with the majority of studies reporting no recurrence following successful removal[12,20]. Conservative management with NSAIDs or physiotherapy is occasionally employed in non-surgical cases or during early stages[14,22].

Low Recurrence Rates: The reviewed literature highlights an overall low recurrence rate post-treatment, with multiple studies documenting no recurrence during follow-ups extending up to five years, reinforcing the long-term effectiveness of surgical excision[5,32].

Differences Observed

Age and Gender Distribution: MO displays a bimodal age distribution, affecting both paediatrics and adult populations[4,5,12,33]. While the condition does not appear to have a strong gender predisposition, certain anatomical locations, such as the breast, exhibit female predominance[5,32].

Location Variability: MO demonstrates significant diversity in anatomic localization, ranging from common extremity sites like the thighs and knees to more atypical locations such as the jaw, scalp, and breast[5,15,17,20,34,35]. This variability emphasizes the need for a broad differential diagnosis when evaluating soft tissue masses.

Diverse Clinical Spectrum: The clinical presentation of MO ranges widely, from painful, rapidly growing lesions to asymptomatic and slow-growing masses[3,25,36]. This heterogeneity underscores the challenge in distinguishing MO from more sinister conditions like sarcomas or metastatic disease, particularly in atypical cases.

Follow-Up and Recurrence Documentation: While most studies report low recurrence rates, follow-up durations vary significantly, with many cases lacking long-term outcome data[10,27]. Additionally, the quality of follow-up varies, ranging from routine clinical assessments to comprehensive imaging studies[2,37].

Prospective Research Directions: This extensive review of the literature on MO reflects decades of evolving understanding, marked by clear consensus in diagnostic and treatment strategies, alongside persistent variability in clinical presentations and anatomic sites.

The insights gained underscore the importance of individualized management approaches, particularly for atypical cases. Future research should focus on improving long-term follow-up protocols and exploring the pathophysiology behind MO's clinical variability to enhance diagnostic accuracy and therapeutic outcomes.

Case Presentation

A 38-year-old, previously healthy female presented to the surgical clinic with a painful lump in the left inguinal and upper thigh regions, which had been present for one year and had recently begun to increase in size. There was no history of direct trauma to the groin, although the patient reports history of vigorous daily exercise.

On physical examination, a soft tissue mass was noted in the left groin, extending to the upper thigh. The mass was firm to hard in consistency, approximately 4x6 cm in size, with limited mobility and no overlying skin changes.

An ultrasound examination over the lateral aspect of the left inguinal region revealed an ill-defined, non-compressible, hypervascular subcutaneous lesion measuring 3.5 x 1.5 cm. The lesion appeared heterogeneous, predominantly hypoechoic, and non-encapsulated, with significant surrounding inflammatory changes. It was located entirely within the subcutaneous tissue, with the underlying rectus femoris fat plane preserved

Further imaging with MRI showed a well-defined, spiculated lesion measuring 4 x 1.6 x 3.5 cm, isointense to muscles on the T1-weighted axial sequence (Figure 4). On the T2-weighted axial sequence, the lesion demonstrated a mild hyperintense signal (Figure 5) in the subcutaneous tissue of the left anterior upper thigh. The lesion was in contact with the fascia of the tensor fascia lata and positioned lateral to the sartorius muscle. No restricted signal was observed in the diffusion-weighted images, but there was intense enhancement following the injection of gadolinium (see arrow in T1WFS axial pre-contrast and arrow in T2WFS axial post-contrast images).

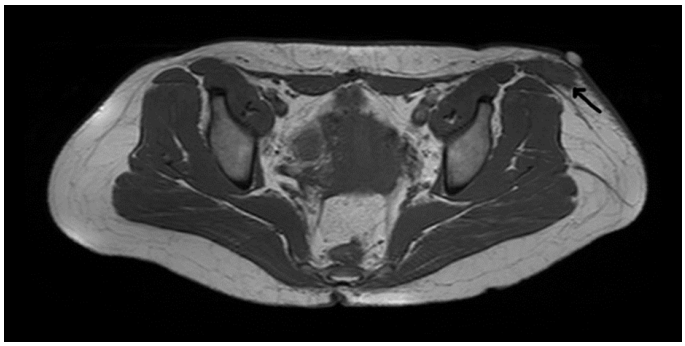

Figure 4. T1W axial sequence

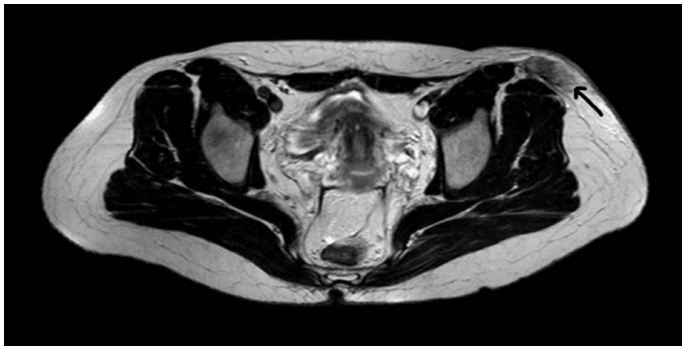

Figure 5. T2W axial sequence

Given the lesion's superficial location in the thigh and its contact with the fascia, the differential diagnosis included nodular fasciitis. However, it was challenging to distinguish it from other benign fibrous soft tissue lesions like fibromatosis, desmoid tumor, or from soft tissue sarcomas like fibrosarcoma and undifferentiated pleomorphic sarcoma (malignant fibrous histiocytoma).

The patient underwent complete surgical excision of the left groin soft tissue mass under general anesthesia, and a sample was sent for histopathology. Grossly, the specimen measured 41 x 25 x 16 mm. The cut surface was nodular, relatively well-demarcated, firm, and grayish white in appearance, with areas of peripheral gritty microcalcifications. The mass exhibited a variegated appearance, with regions blending into the surrounding fibrofatty connective tissue.

Microscopically, the lesion consisted of a spindle cell myofibroblastic proliferation with alternating areas of hypercellularity and vague intralesional zonation. While the inner zone is quite cellular and formed by mixed intersecting short fascicles or haphazardly laid down myofibroblasts, the intermediate zone is more fibrocollagenous and include wisps of osteoblastic activities and variable fibro-osseous bony deposition (Figure 6). The lesion was notably vascular and included random areas of myxoid and edematous changes, extravasation of red blood cells, scattered chronic inflammatory cells, and osteoclast-like multinucleated giant cells (Figures 7 and 8). No significant cytonuclear atypia was observed, and mitotic figures were rather infrequent.

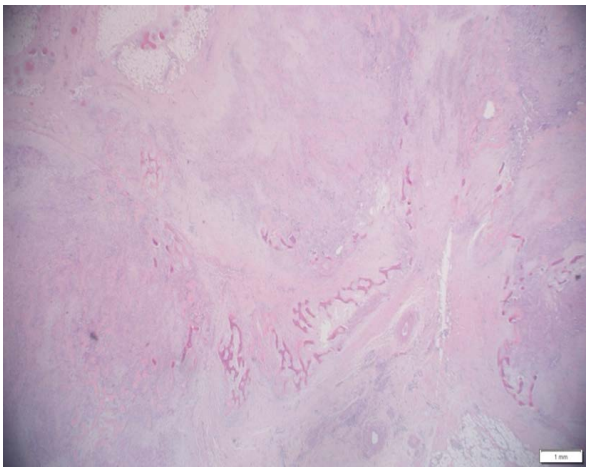

Figure 6. A clear lesional nodularity with apparent zonational differentiation; the outer zone displayed a fully mineralized bony trabecula. (H&E Stain -LPF).

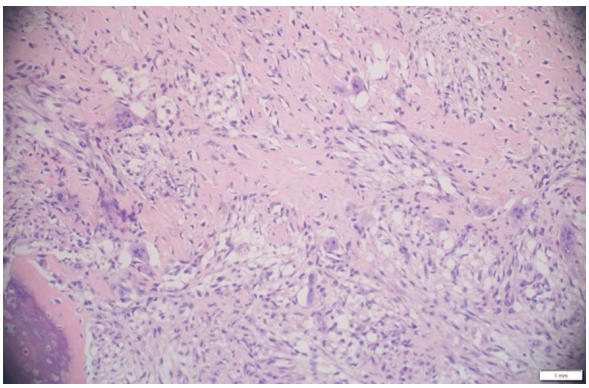

Figure 7. Spindle cell proliferation with random areas of myxoid and oedematous changes, scattered chronic inflammatory cells and osteoclast-like multinucleated giant cells (H&E Stain - MPF).

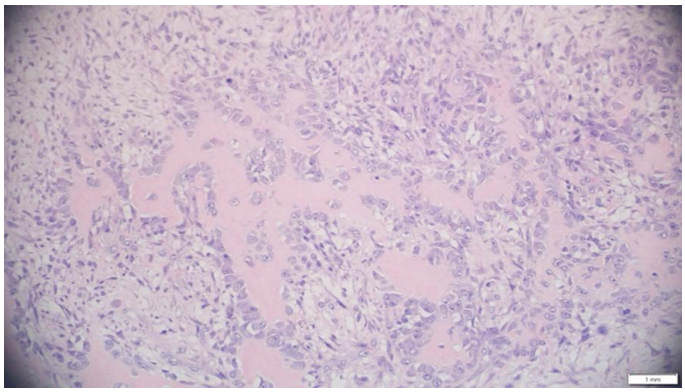

Figure 8. Intersecting short fascicles or haphazardly lay down myofibroblasts, the intermediate zone is more fibrocollagenous and include wisps of osteoblastic activities and variable fibro-osseous bony deposition (H&E Stain - HPF).

Given the clinical presentation and histopathological findings, the diagnosis of a mature stage of FO (lesion older than three weeks) was made. A two-year postoperative follow-up revealed no recurrence.

DISCUSSION

FO is a rare type of nodular fasciitis, characterized as a benign and rapidly growing soft tissue tumour that develops within fascial tissue and exhibits heterotopic ossification. It is predominantly observed in males during their second and third decades of life[35]. This condition develops following soft tissue trauma in 10-15% of cases, but it can also occur spontaneously or after surgery without any predisposing factors. Clinically, patients present with a rapidly growing soft-tissue mass, often associated with pain, swelling, and tenderness, particularly in the upper extremities, as seen in previously reported cases[16,18,33,34,38,39] (Tables 1, 2, 3).

FO can present in various anatomical locations within the body, requiring several radiological methods to reach a diagnosis, including x-ray ultrasound, mammography, angiography, CT, and MRI[1,17-20] Ultrasound is typically used for the initial diagnosis of FO, while other imaging modalities help eliminate differential diagnoses and precisely localize the mass.

Upon reviewing the literature (Tables 1, 2, 3), most cases of FO present as well-defined hypoechoic masses[1,14-22], while some present as well-defined hyperechoic masses with a central hypoechoic area and inflammatory changes[25]. In our case, FO appeared as an ill-defined mass on ultrasound; however, macroscopic examination revealed a well-demarcated, firm greyish-white mass with significant inflammatory infiltration of a 2 cm area. MRI findings of FO are variable in the existing literature depending on the location of the mass and extent of spread. In our case, MRI was used as a secondary imaging method, showing an isointense lesion to muscles on the T1-weighted axial sequence (Figure 1) and a mild hyperintense signal in the subcutaneous tissue on the T2-weighted axial sequence (Figure 2). There was no restricted signal on diffusion-weighted imaging, with intense enhancement after the injection of gadolinium. These findings contradict earlier case studies[13,16,17] that reported FO as hyperintense masses on T2-weighted images[15,18,20] (Table 3).

Histologically, FO is characterized by dense, cellular spindle cell proliferation of myofibroblasts merging with osteoblasts rimming ill-defined trabeculae, which subsequently mature into lamellar bone at the periphery. This zoning phenomenon is a vital histological finding in diagnosing FO[40]. In our case, spindle cell myofibroblast proliferation with alternating areas of cellularity and vague intralesional zonation confirmed the diagnosis of FO. To the best of our knowledge, all the cases included in our literature review showed spindle cell components or myofibroblast proliferation under microscopic examination. Furthermore, our case showed no significant atypia, consistent with previously reported cases[14.15.25,34,41,42,43]. Calcification is common in FO, noted macroscopically, microscopically, and radiologically, as reported in previous studies[44,45,46,47,48].

Immunohistochemistry is an essential part of FO biopsy examination. Smooth Muscle Actin (SMA) is an immunohistochemical marker for smooth muscle cells, myoepithelial cells, and some malignancies[7]. Previous literature shows that SMA is usually positive in FO[32,34,41,49]. In our case, both SMA and vimentin were diffusely positive. Vimentin, another confirmatory tissue marker for FO, helps eliminate any uncertainty in clinical diagnosis[49]. FO typically presents with strong diffuse immunoreactivity to vimentin, supported by our case and existing literature[15,20-22]. Negative immunoreactivity to markers such as desmin and S100 protein is also crucial to rule out other soft tissue tumours. In our reported case of FO, desmin was negative, along with S100 protein, supporting the prevailing literature[15,20-22,24].

Once the diagnosis of FO has been established, surgical excision is the mainstay of treatment[14,32,34]. In our case, the patient underwent complete surgical excision under general anaesthesia, with no recurrence of the lesion observed during the two-year follow-up, thus supporting previous case studies[19-22]. This case reinforces the efficacy of surgical management in FO, highlighting its excellent prognosis and low recurrence rate. This case of FO in a 38-year-old female underscores the importance of considering FO in differential diagnoses for soft tissue masses, regardless of patient demographics. Comprehensive imaging and histopathological evaluation are crucial for accurate diagnosis. Surgical excision remains the most effective treatment, with excellent prognosis and low recurrence rates (Table 1).

In conclusion, FO usually presents as a soft tissue tumor with a vast number of differentials, which have similar findings in the clinical and radiological assessment. Therefore, it is essential to examine the lesion under microscopy and immunohistochemistry to reach the diagnosis of FO. Surgery excision is the superior method to manage FO, with extremely rare recurrence rate.

Limitations: This is a rare disease entity therefore it was challenging to find cases reported. In addition, a challenge that arose during literature review and data analysis is that not all variables discussed in our review were mentioned in the cases found in literature.

CONCLUSION

FO often presents as a soft tissue tumor with a wide differential diagnosis due to the similarity in clinical and radiological features with other conditions. Therefore, microscopic examination and immunohistochemistry are essential for accurate diagnosis. Surgical excision is the preferred treatment, with low recurrence rate.

Authorship Contribution: HA, SA, RY, and HE conceived and designed the study; LA, ZS, NAR, and NAS performed the research process and collected the data; HA, AE, HE performed the statistical analyses; HA, SN, SQ, LA, ZS, NAR, KA and NAS wrote the original draft of the manuscript; RMD, LA, ZS, NAR, and NAS prepared the figures and tables; HA, RY, AE, HE, and SQ edited and revised the manuscript; HA was the project manager; All authors approved the final version of the manuscript.

Potential Conflicts of Interest: None

Competing Interest: None

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