Multimodality Imaging of a Rare Case of Retroperitoneal Fetus in Fetu: A Radiologic Diagnostic Challenge

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Rafikah Rauf: Concepts, Design, Manuscript editing, and Manuscript review.
Eny Sanre: Definition of intellectual content, Data acquisition, and Manuscript review.
Stella Clarissa: Manuscript editing and Manuscript review.

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Yes.

ETHICAL STATEMENT
Ethical approval was not required for this radiological case report, as it describes an individual patient observation and does not involve experimental procedures. Written informed consent was obtained from the patient's legal guardian for publication of this case report and accompanying radiological images.

ABSTRACT

Introduction: Fetus in fetu is a rare congenital anomaly characterized by the presence of a malformed parasitic twin within its host, most commonly in the retroperitoneal space. Differentiation from mature teratomas is essential due to differences in malignant potential and management strategies.

Case report: We report a 4-month-old male who presented with progressive abdominal distension, jaundice, and pale stools. Imaging studies revealed a large retroperitoneal mass with fetiform features. Imaging showed a retroperitoneal mass with organized skeletal structures compressing the biliary system. Surgical removal revealed a sac-like mass containing limbs and vertebral elements. Histopathology confirmed fetus in fetu without malignancy.

Conclusion: Fetus in fetu should be considered in the differential diagnosis of complex retroperitoneal masses in infants. Multimodal imaging, especially the combination of ultrasonography, computed tomography, and magnetic resonance imaging, is invaluable for diagnosis, surgical planning, and distinguishing fetus in fetu from neoplastic entities.

CASE REPORT

BACKGROUND

This case highlights the radiological presentation of the rare occurrence of fetus in fetu (FIF) in a 4-month-old boy who has an atypical initial manifestation of the disease, which is jaundice. This case also provides new insights into multimodal radiological evaluation, including ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI), and one of the first cases to report magnetic resonance cholangiopancreatography (MRCP) findings of FIF.

CASE REPORT

A 4-month-old boy presented to our hospital with an enlarging abdomen since birth. The complaint was accompanied by generalized jaundice and pale stools for 1 month before presentation. There was no history of vomiting, decreased body weight, chemotherapy, radiotherapy, or surgery. The family had no history of birth defects or genetic metabolic diseases. The maternal antenatal history did not reveal any significant findings. The patient was delivered at term per vaginam with a birth weight of 3600 grams and body length of 47 centimeters.

On physical examination, the patient was compos mentis, weighed 5 kilograms, and had an abdominal circumference of 47.8 centimeters. The abdomen was enlarged with a palpable mass on the umbilical region, measuring approximately 9 cm x 9.5 cm x 4 cm with irregular margins, smooth contour, solid consistency, and fixed to the tissue underneath. The mass moved with respiration. (Figure 1) There were no abnormalities at digital rectal examination.

Laboratory evaluations delineated the following haemato-pathological findings: thrombocytosis of 640 x 103/µL, abnormal liver function tests-increased total bilirubin of 5.1 mg/dL, indirect bilirubin of 4.54 mg/dL, aspartate transaminase (AST) of 141 U/L, alanine transaminase (ALT) of 118 U/L, alkaline phosphatase of 651 U/L, and gamma-glutamyl transpeptidase (GGT) of 1099 U/L. There was also a hypoalbuminemia of 2.9 gr/dL. Elevated inflammatory markers were also found: quantitative C-reactive protein (CRP) of 13.3 mg/L and procalcitonin of 0.33 ng/mL. An important tumor marker, the alpha fetoprotein (AFP), was increased by 30.94 ng/mL. However, the beta human chorionic gonadotropin level was within normal limits.

Imaging Findings

Abdominal US showed a large mass in the abdominal cavity, mixed echo, with predominant anechoic structure and solid components resembling the spine, lower limb, including the femur and foot structures inside. The mass has an irregular margin, with size extending beyond the scan area, displacing the right kidney posteriorly and the liver cranially. It also constricts the common bile duct, causing dilatation of the gallbladder (Figure 2).

Abdominal contrast-enhanced CT scan showed a large intra-abdominal, retroperitoneal mass, with heterogeneous density predominantly hypodense, measuring about 13.18 x 10.77 x 12.53 cm. It contained solid densities resembling a fetus-like structure with vertebral, pelvic, femur, and cystic components inside, measuring about 7.35 x 8.44 x 9.43 cm, that displaced the liver cranially, right kidney posteriorly, intestinal loops left-anteroposteriorly, and pancreas left-laterally. It also constricted the common bile duct, causing dilatation of the gallbladder and common hepatic duct (Figure 3). Note the bony structures on the 3D reformat (Figure 4).

Gadolinium-enhanced abdominal MRI showed a mixed-signal intensity with predominantly high signal on T1 Fast Spoiled Gradient Recalled Fat Suppression (FSPGR FS) and T2 Single Shot Fast Spin Echo (SSFSE), non-contrast enhancing, shine-through on Diffusion Weighted Imaging/ Apparent Diffusion Coefficient (DWI/ADC). MRCP illustrated gallbladder, common bile duct, and common hepatic duct dilatation (Figure 5). To the best of our knowledge, this case represents one of the limited numbers of reported instances in which magnetic resonance imaging has been utilized as part of the comprehensive diagnostic assessment for FIF and one of the first cases to report the evaluation of MRCP in FIF.

Management

Marginal resection of the mass with general anesthesia, showing a retroperitoneal tumor encased within a fluid-filled membrane resembling an amniotic sac with hand, fingers, buttocks, feet, and toes components along with muscles, bones, cartilage, and intestinal tissues measuring about 18 x 17 x 7 centimeters (Figure 6).

Histopathology evaluation showed a cyst-walled structure with multi-layered squamous epithelial lining, containing lamellated keratinous mass. There were also spindle cell fibrous connective tissue, fat and cartilage tissue, hair follicles, and acini glands. The specimen did not contain malignant cells (Figure 7).

Follow-up

On follow-up 2 weeks after the surgery, the patient had no significant complaints and was recovering well.

DISCUSSION

Etiology and Demographics

FIF arises as a result of aberrant embryonic development. Most cases present as an abdominal mass diagnosed in patients younger than 18 months old [1]. It is a rare entity with an estimated incidence of 1 in 500,000 live births, with a 2:1 male predominance. The mass is described as “fetal-like” or “fetiform,” which resembles normal fetal anatomy [2,3]. Most occur in the abdomen, with approximately 72.2% located within the retroperitoneal cavity. Less commonly, reports found that they can also be present in the intraperitoneal cavity (5.8%), intrathoracic (4.7%), head-and-neck region (4.1%), sacrococcygeal/gluteal/perianal region (4.1%), intracranial (3.7%), and the gonads (3.7%) [2]. There are two primary hypotheses proposed for the origin of FIF, which are the “teratoma theory” and the “identical twin theory”. The “teratoma theory” suggests that FIF represents a highly differentiated form of teratoma, whereas the “identical twin theory” suggests that FIF results from aberrations during the twinning process. Under normal conditions, monozygotic twins develop symmetrically; however, in FIF, one twin ceases to grow properly and becomes enclosed within the body of its host twin during embryogenesis [4]. In most cases, a parasitic twin is located retroperitoneal, anencephalic, and usually has a vertebral column and budding limbs [1,3]. Although about 9% of cases of FIF have no vertebral column, particularly when the lesion is intracranial [5].

Clinical and Imaging Findings

The patient presented with progressive abdominal distension since birth, accompanied by clinical signs of jaundice. Physical examination revealed a palpable mass in the umbilical region. Laboratory investigations demonstrated reactive thrombocytosis and elevated liver function parameters, including AST, ALT, total and indirect bilirubin, alkaline phosphatase, and GGT levels. This finding was the result of the obstructive effect on the biliary system of the intra-abdominal mass. Additionally,

inflammatory markers such as CRP and procalcitonin were elevated, suggesting an underlying inflammatory process. There were elevated levels of AFP in this patient; however, there was no clear association of the tumor marker with the diagnosis of FIF. The elevated or normal serum levels of tumor markers do not rule in or out the diagnosis of FIF [2].

Radiological imaging is essential for the preoperative, noninvasive diagnosis of FIF. Radiograph demonstrates a soft-tissue density lesion with fetal bony structures in abnormal locations, which serves as an initial clue in diagnosis [3]. Ultrasonography illustrates the solid-cystic characteristics of the mass. In this case report, the abdominal ultrasonography showed solid components with heterogeneous echogenicity and areas suggestive of organized tissue within a cystic mass, along with calcifications resembling the spine, lower limb, including the femur and foot structures inside. This finding raised suspicion for a diagnosis of FIF. Subsequent contrast-enhanced CT provided critical diagnostic information. The intra-abdominal, retroperitoneal mass demonstrated heterogeneous density with well-formed axial skeleton elements, including vertebral bodies, pelvis, and the femur, along with appendicular skeleton elements, including the femur. The 3D reformatted image illustrates the bony structures more precisely.

To our knowledge, this case is among the few reported in the literature that includes MRI evaluation as part of the diagnostic workup for FIF. Gadolinium-enhanced MRI further delineated the heterogeneous signal intensity of the mass, with T2 shine-through characteristics observed on DWI/ADC sequences in the non-solid components. MRI also confirmed the encapsulated nature of the mass, with no evidence of invasion into adjacent retroperitoneal structures. MRI also allowed for superior tissue characterization and helped rule out malignancy, which is crucial in preoperative planning. MRCP of the patient revealed dilatation of the gallbladder, common bile duct, and common hepatic duct, secondary to external compression by the mass.

This case emphasizes the critical role of multimodal imaging in establishing a precise diagnosis and facilitating surgical planning through comprehensive anatomical delineation. Contrast-enhanced CT is the primary imaging modality of choice, as it provides critical information regarding the precise location of the lesion, presence of fetiform structures, vertebral segmentation, potential malignant transformation, vascular supply, and its relationship to adjacent anatomical structures, essential for preoperative planning [6]. The intra-abdominal FIF is usually contained in a complete sac without any major vascular connections to the host [5]. In the present case, an abdominal contrast-enhanced CT was performed to accurately delineate the anatomical composition and precise location of the mass.

Treatment and Prognosis

Surgical excision remains the gold standard for the management of FIF, with complete removal of the sac strongly recommended. Retention of any portion of the mass, including its membranous covering, may predispose the host to local recurrence. Furthermore, meticulous gross examination and comprehensive tissue sampling of the resected specimen, followed by thorough microscopic evaluation, are essential to exclude the presence of immature or malignant components. The postoperative prognosis of FIF is generally excellent; however, follow-up every 6 months or annually for a minimum of 2-3 years after surgery is recommended [4].

Differential Diagnosis

The presence of an axial skeleton component in the mass is a key imaging criterion that distinguishes FIF from a mature teratoma, the principal differential diagnosis [5]. Mature retroperitoneal teratoma comprises 53.3% of all pediatric retroperitoneal teratoma. It is mostly diagnosed in patients younger than 1 year old [7]. FIF and mature teratoma have all germ layer components; however, a key distinction must be made between FIF and highly differentiated or mature teratomas, because retroperitoneal teratomas carry a malignancy risk of up to 10% [1]. While teratomas can contain organized structures, they are true neoplasms derived from pluripotent embryonic cells and may exhibit malignant potential. In contrast, FIF represents a parasitic twin enclosed within its host [2]. The “Willis criteria” delineate the distinction between the two entities based on the development of the axial skeleton, particularly the vertebral axis, with other organs and limbs that demonstrate development past the primitive streak, therefore exhibit true organogenesis [3].

Plain radiography of mature teratoma demonstrates soft tissue masses with calcified elements. In most cases, ultrasonography shows cystic components with calcifications and vascularity on Doppler [8]. CT and MRI show a mass with cystic components, fat, and areas of calcifications [7]. Complete resection of the tumor in mature teratoma is the treatment of choice, with an excellent prognosis. Close monitoring of alpha-fetoprotein levels is recommended because of the risk of malignant recurrence, as the occurrence of a subsequent teratoma has been reported [1] (Table 2).

CONCLUSION

This case report underscores the pivotal role of a multimodality radiologic approach in the accurate diagnosis and effective preoperative assessment of fetus in fetu. The integration of ultrasonography, contrast-enhanced CT, and MRI provided comprehensive anatomical and tissue characterization, enabling precise differentiation from other retroperitoneal masses such as teratomas. Such an approach is crucial not only in identifying hallmark features like vertebral segmentation and fetiform structures but also in evaluating mass effect on adjacent organs, guiding surgical planning, and ruling out malignancy. Heightened clinical and radiologic awareness of FIF is essential to ensure timely diagnosis and optimal management of this rare congenital anomaly.

TEACHING POINT

Fetus in fetu is a rare congenital entity that typically manifests as a retroperitoneal mass containing organized axial and appendicular skeletal structures. Recognition of its characteristic fetiform configuration on multimodal imaging—particularly US, CT and MRI—is essential to distinguish it from teratoma and to guide appropriate surgical management.

QUESTIONS

Question 1: What is the typical location of fetus in fetu?

1. Intracranial
2. Gonads
3. Retroperitoneal (applies)
4. Intrathoracic
5. Sacrococcygeal

Explanation:

1. Intracranial [Approximately 3.7% of fetus in fetu cases are located intracranial.]
2. Gonads [Approximately 3.7% of fetus in fetu cases are located in the gonads.]
3. Retroperitoneal [Most fetus in fetu cases (72.2%) are within the retroperitoneal cavity.]
4. Intrathoracic [Approximately 4.7% of fetus in fetu cases are located intrathoracic.]
5. Sacrococcygeal [Approximately 4.1% of fetus in fetu cases are located in the sacrococcygeal/gluteal/perianal region.]

Question 2: What is the typical age at presentation for fetus in fetu?

1. Neonatal period or early infancy (applies)
2. School-age children
3. Adolescence
4. Middle adulthood
5. Elderly

Explanation:

1. Neonatal period or early infancy [Most reported fetus in fetu cases presented before 18 months of age.]
2. School-age children [A few reports showed fetus in fetu presentation in school-age children, but most of the cases are reported within 18 months of age.]
3. Adolescence [A few reports showed fetus in fetu presentation in adolescence, but most of the cases are reported within 18 months of age.]
4. Middle adulthood [A few reports showed fetus in fetu presentation in middle adulthood, but most of the cases are reported within 18 months of age.]
5. Elderly [No known report showed fetus in fetu presentation in the elderly population.]

Question 3: What is the gold standard management of fetus in fetu?

1. Chemotherapy and/or radiotherapy
2. Percutaneous aspiration
3. Total mass surgical excision with histopathological evaluation (applies)
4. Watchful waiting
5. Corticosteroid therapy

Explanation: 1. Chemotherapy and radiotherapy [Most fetus in fetu cases are benign, therefore they generally do not require chemotherapy and/or radiotherapy.]

2. Percutaneous aspiration [Percutaneous aspiration is not the gold standard for the management of fetus in fetu because it does not exclude immature or malignant components of the mass.]
3. Total mass surgical excision with histopathological evaluation [Surgical excision remains the gold standard for the management of fetus in fetu, with complete removal of the sac to avoid local recurrence.]
4. Watchful waiting [Watchful waiting is not recommended because it does not exclude immature or malignant components of the mass.]
5. Corticosteroid therapy [Corticosteroid therapy is not the gold standard for the management of fetus in fetu because it does not exclude immature or malignant components of the mass.]

Question 4: What is the most widely accepted embryological theory about the origin of fetus in fetu?

1. It represents a regressed form of mature teratoma
2. It results from the inclusion of a diamniotic twin within its sibling during early embryogenesis (applies)
3. It arises from the metaplastic transformation of mesenchymal tissue
4. It develops due to the abnormal persistence of the primitive streak
5. It results from the parthenogenetic activation of a germ cell

Explanation:

1. It represents a regressed form of mature teratoma [The "teratoma theory" suggests that FIF represents a highly differentiated form of teratoma.]
2. It results from the inclusion of a diamniotic twin within its sibling during early embryogenesis [The "identical twin theory' suggests that in FIF, one twin ceases to grow properly and becomes enclosed within the body of its host twin during embryogenesis.]
3. It arises from the metaplastic transformation of mesenchymal tissue [FIF development involves embryonic inclusion, not tissue-level metaplasia.]
4. It develops due to the abnormal persistence of the primitive streak [In FIF, the primitive streak stage is surpassed, and axial differentiation occurs, forming an organized fetal form.]
5. It results from the parthenogenetic activation of a germ cell [FIF does not result from germ cell abnormalities or parthenogenesis.]

Question 5: According to the Willis criterion, what key

feature must be present to define a lesion as fetus in fetu?

1. Evidence of germ-layer differentiation
2. Presence of sebaceous material and hair
3. Encapsulation within an amniotic membrane
4. Presence of malignant transformation within the mass
5. A well-developed vertebral axis with organogenesis arranged around it (applies)

Explanation:

1. Evidence of germ-layer differentiation [FIF may show tissues derived from all three germ layers, but this feature alone is not sufficient to diagnose FIF, as FIF emphasizes structural organization.]

2. Presence of sebaceous material and hair [These are typical of mature cystic teratomas, although FIF can occasionally contain hair or sebaceous material; their presence is not diagnostic.]

3. Encapsulation within an amniotic membrane [Encapsulation or membrane-like covering that contains fluid resembling amniotic fluid is supportive but not diagnostic of FIF.]

4. Presence of malignant transformation within the mass [FIF has neoplastic potential; however, malignancy is not the diagnostic criterion for FIF.]

5. A well-developed vertebral axis with organogenesis arranged around it [The Willis criterion defines the diagnostic standard for FIF with a lesion containing axial skeleton indicating bilateral symmetry, and organized development/ organogenesis with structures such as limbs, gut, or primitive organs arranged around the axis.]

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FIGURES

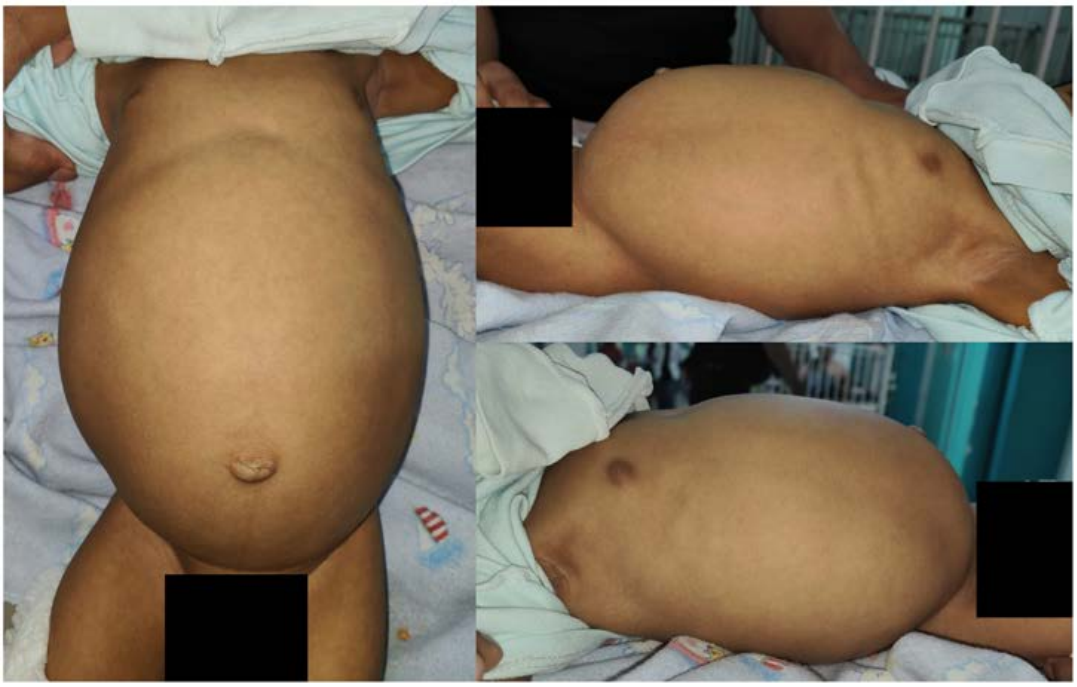

Figure 1: The abdomen was enlarged with a palpable mass on the umbilical region with irregular margins, smooth contour, solid consistency, and fixed to the tissue underneath.

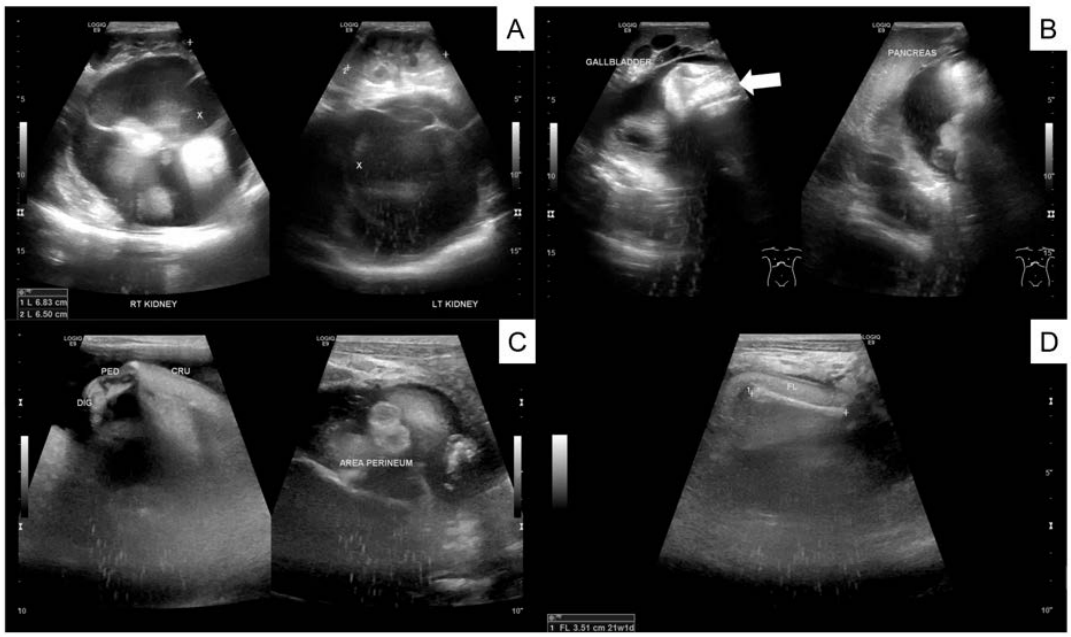

Figure 2: Abdominal ultrasonography of a 4-month-old male with fetus in fetu showed (A) a large mass in the abdominal cavity, mixed echo, with predominant anechoic structure and solid components. (B) Spine structure (arrow) along with (C) lower limb, foot, and toes' structure was seen inside the mass. (D) The femur bone was seen with an estimated length resembling a 21-week-old fetus.

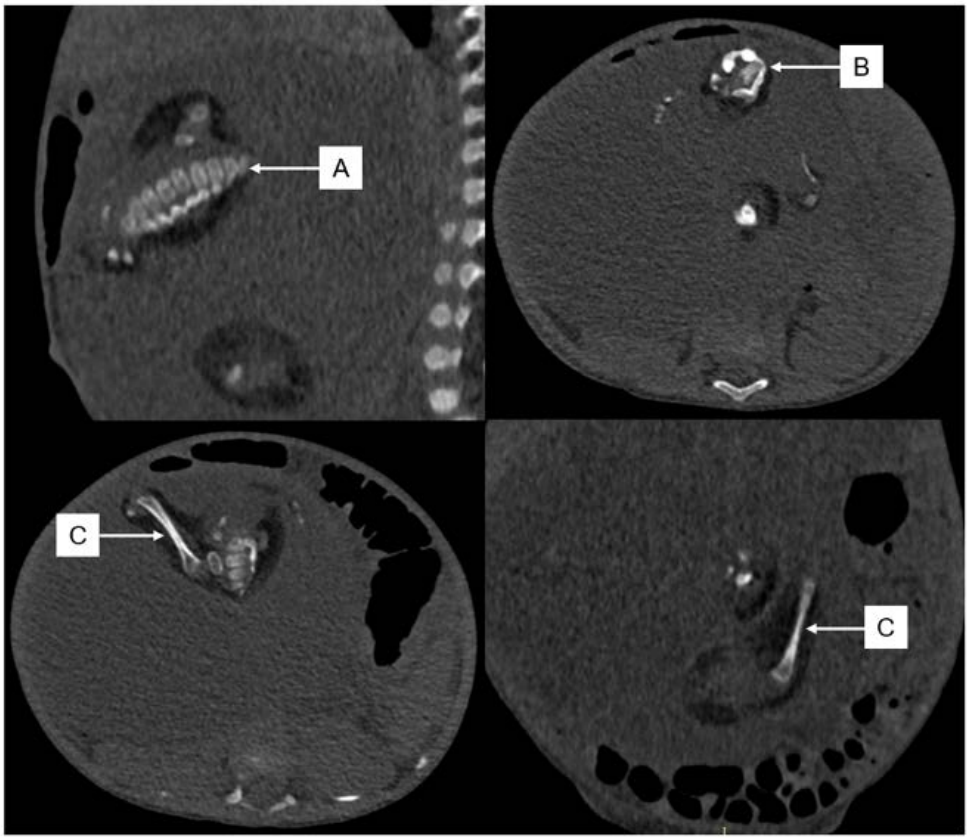

Figure 3: Abdominal contrast-enhanced computed tomography scan, axial, sagittal, and coronal views of a 4-month-old male with fetus in fetu showed a large intra-abdominal, retroperitoneal mass, with heterogeneous density predominantly hypodense measuring about 13.18 x 10.77 x 12.53 cm. It contained solid densities resembling a fetus-like structure measuring about 7.35 x 8.44 x 9.43 cm with spine (A), pelvis (B), femur (C), and cystic components inside.

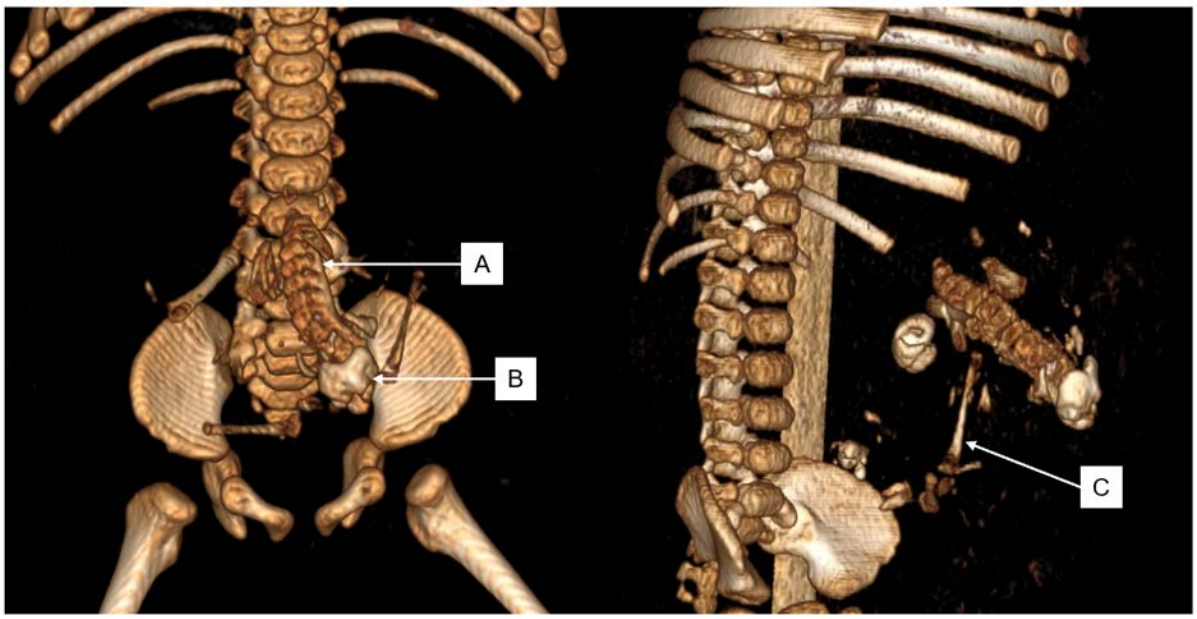

Figure 4: The 3D reformatted abdominal computed tomography scan of a 4-month-old male with fetus in fetu illustrates the bony structures of the mass that resemble the spine (A), pelvis (B), and femur (C).

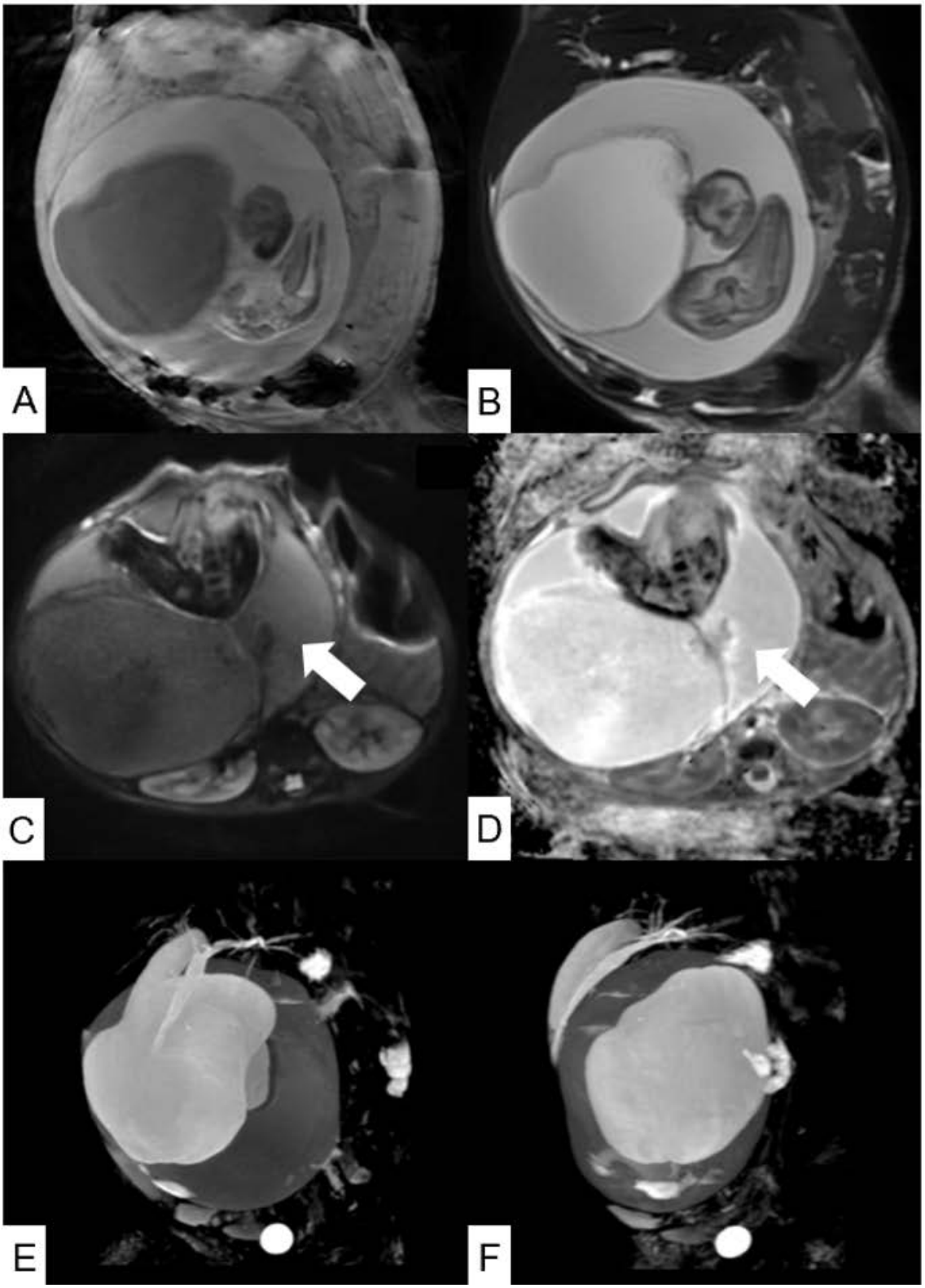

Figure 5: Gadolinium-enhanced abdominal magnetic resonance imaging of a 4-month-old male with fetus in fetu showed (A) T1 FSPGR FS and (B) T2 SSFSE FB sequence coronal view showed a mixed-signal intensity with predominantly high signal and non-contrast enhancing. (C) DWI and (D) ADC sequences showed shine-through properties of the non-solid component of the mass (arrow). (E) and (F) Magnetic resonance cholangiopancreatography of the patient illustrated gallbladder, common bile duct, and common hepatic duct dilatation.

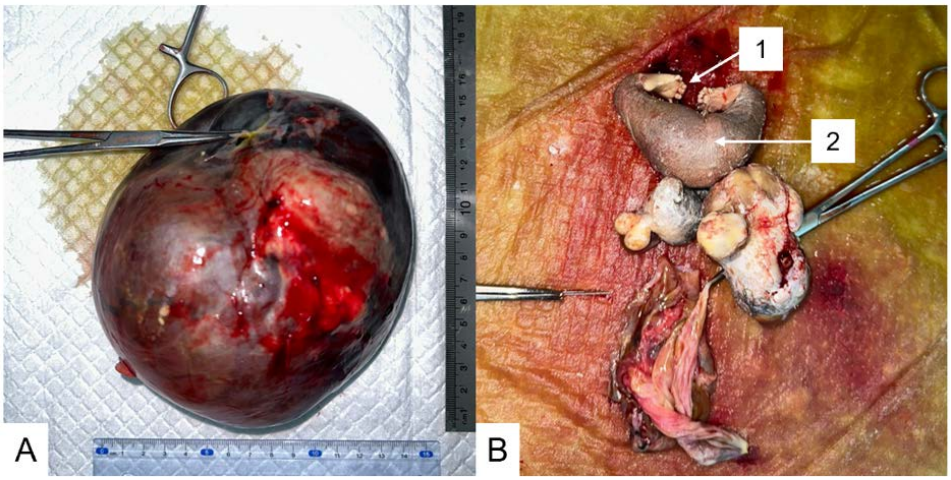

Figure 6: (A) The gross specimen of the mass. It was encased within a fluid-filled membrane resembling an amniotic sac. (B) Upon incision, there were feet and toes structures (1), buttocks (2) components along with hand and its fingers, muscles, bones, cartilage, and intestinal tissues (not annotated).

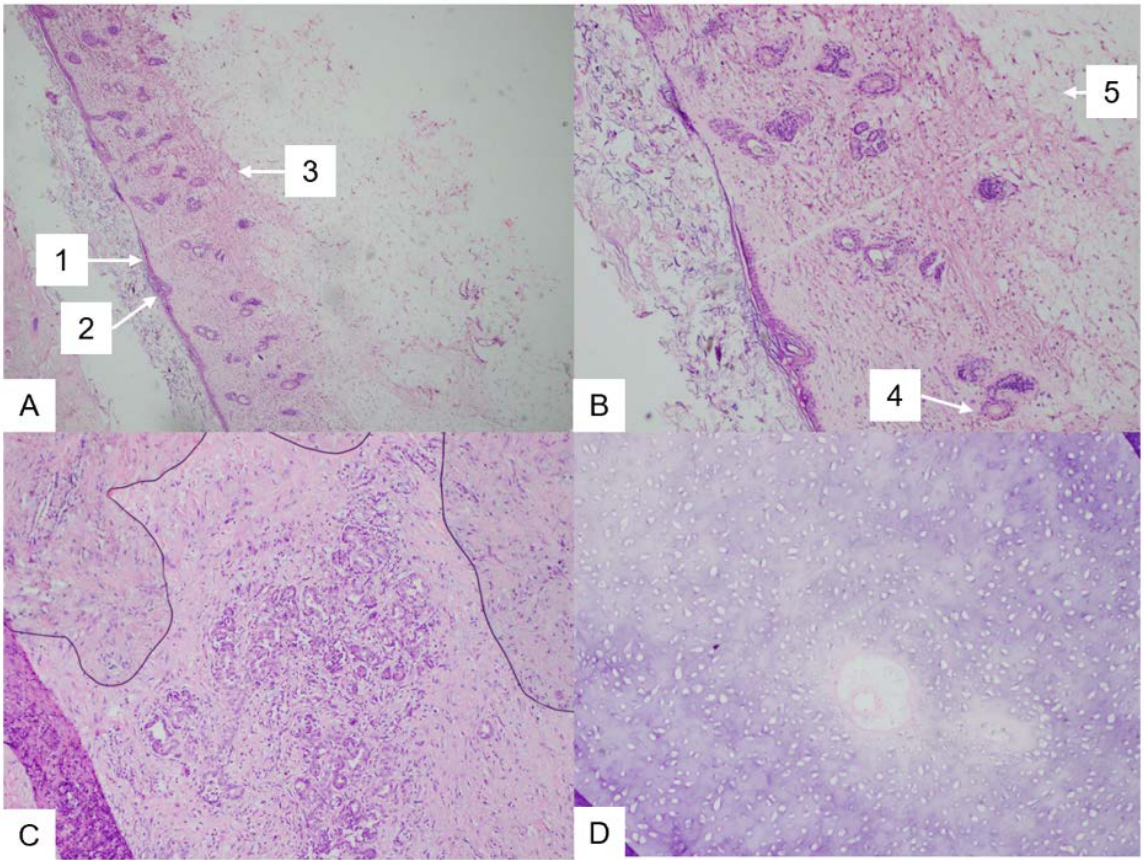

Figure 7: Histopathology evaluation of the mass. (A) The specimen showed cyst wall components that were partly lined with layered squamous epithelium (1), which contained a lamellated keratinous mass (2). Underneath it, there was connective tissue (3). (B) It also contained hair follicles (4) and fat tissue (5). (C) Cartilage tissue and (D) gland acini with hemorrhage foci were also seen.

Table 1: Summary of fetus in fetu characteristics.

	Fetus in fetu
Etiology	Unknown, but there are 2 primary hypotheses proposed: · The "teratoma theory" suggests that FIF represents a highly differentiated form of teratoma · The "identical twin theory" suggests that FIF results from aberrations during the twinning process
Incidence	1 in 500,000 live births
Gender ratio	2:1 male predominance
Age predilection	Most cases present during the first year of life
Risk factors	Unknown
Treatment	Surgical excision with complete removal of the sac is strongly recommended
Prognosis	Generally excellent; follow-up every 6 months or annually for a minimum of 2-3 years after surgery is recommended
Findings on imaging	· Ultrasonography: solid components with heterogeneous echogenicity and areas suggestive of axial and appendicular skeleton elements · Computed tomography: intraabdominal, retroperitoneal mass demonstrated heterogeneous density with well-formed axial and appendicular skeleton elements · MRI: heterogeneous signal intensity of the mass, with T2 shine-through characteristics observed on DWI/ADC sequences in the non-solid components · MRCP: dilatation of the biliary structures secondary to external compression by the mass

Table 2: Summary of fetus in fetu differential diagnosis.

	Fetus in fetu	**Mature teratoma**
Etiology	Unknown, but there are 2 primary hypotheses proposed: · The "teratoma theory" suggests that FIF represents a highly differentiated form of teratoma · The "identical twin theory" suggests that FIF results from aberrations during the twinning process	A true neoplasm derived from pluripotent embryonic cells
Incidence	1 in 500,000 live births	53.3% of all pediatric retroperitoneal teratoma
Gender ratio	2:1 male predominance	Unknown
Age predilection	Younger than 18 months old	Younger than 1 year old
Risk factors	Unknown	Unknown
Treatment	Surgical excision with complete removal of the sac is strongly recommended	Complete resection of the tumor
Prognosis	Generally excellent; follow-up every 6 months or annually for a minimum of 2-3 years after surgery is recommended	Excellent prognosis with close monitoring of alpha-fetoprotein levels
Findings on imaging	· Plain radiography: soft-tissue mass with fetal bony structures in abnormal locations · Ultrasonography: solid components with heterogeneous echogenicity and areas suggestive of axial and appendicular skeleton elements · Computed tomography: a heterogeneous mass with well-formed axial and appendicular skeleton elements · MRI: heterogeneous signal intensity of the mass · MRCP: dilatation of the biliary structures secondary to external compression by the mass	· Plain radiography: soft tissue masses with calcified elements · Ultrasonography: cystic components with calcifications and vascularity on Doppler · Computed tomography and MRI: a mass with cystic components, fat, and areas of calcifications

KEYWORDS

fetus in fetu; retroperitoneal; congenital; pediatric; radiology

ABBREVIATIONS

FIF = Fetus In Fetu
US = Ultra Sonography
CT = Computed Tomography
MRI = Magnetic Resonance Imaging
MRCP = Magnetic Resonance Cholangio Pancreatography
AST = A-Spartate Transaminase
ALT = A-Lanine Transaminase
GGT = Gamma-Glutamyl Transpeptidase
CRP = C-Reactive Protein
AFP = Alpha Feto Protein
FSPGR FS = Fast Spoiled Gradient Recalled Fat Suppression
SSFSE = Single Shot Fast Spin Echo
DWI = Diffusion Weighted Imaging
ADC = Apparent Diffusion Coefficient

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