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Case Report

Typical and atypical magnetic resonance imaging manifestation of ovarian mature cystic teratomas: A report of two cases ☆

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ABSTRACT

The mature teratoma, also known as a dermoid cyst, is the most common type of ovarian teratoma (OT). They constitute 95% of all teratomas and 69% of germ cell tumors, and their heterogeneity leads to various clinical manifestations with a wide range of imaging presentations. We presented 2 patients undergoing pelvic magnetic resonance imaging (MRI) showing a mature cystic teratoma and pathologic examination confirming typical and atypical findings.

Introduction

Ovarian teratomas (OTs) are common ovarian tumors that account for a significant portion of all adult ovarian tumors. Teratomas comprise mature or immature tissues that develop from the 3 pluripotent germ cell layers: ectoderm, mesoderm, and endoderm. OTs can occur at any age, though they are more common during the reproductive years – usually encountered in women in their 20s and 30s and the most common benign ovarian tumor in women under 45 [1,2]. As a result, they fall into mono-dermal teratomas, mature cystic teratomas (dermoid cysts), and immature teratomas. The most prevalent subtype of ovarian teratoma, also known as a dermoid cyst, accounts for more than 95% of all teratomas and 69% of germ cell tumors—patients with ovarian cystic teratoma present with a diverse range of radiological signs and symptoms [3,4]. An ovarian mature cystic teratoma with typical and atypical imaging features is the subject of our case studies.

Case description

Case 1

A 25-year-old mother of 1 child with regular periods was asymptomatic before attending her medical check-up. The anamnesis did not relate to any abdominal distention or

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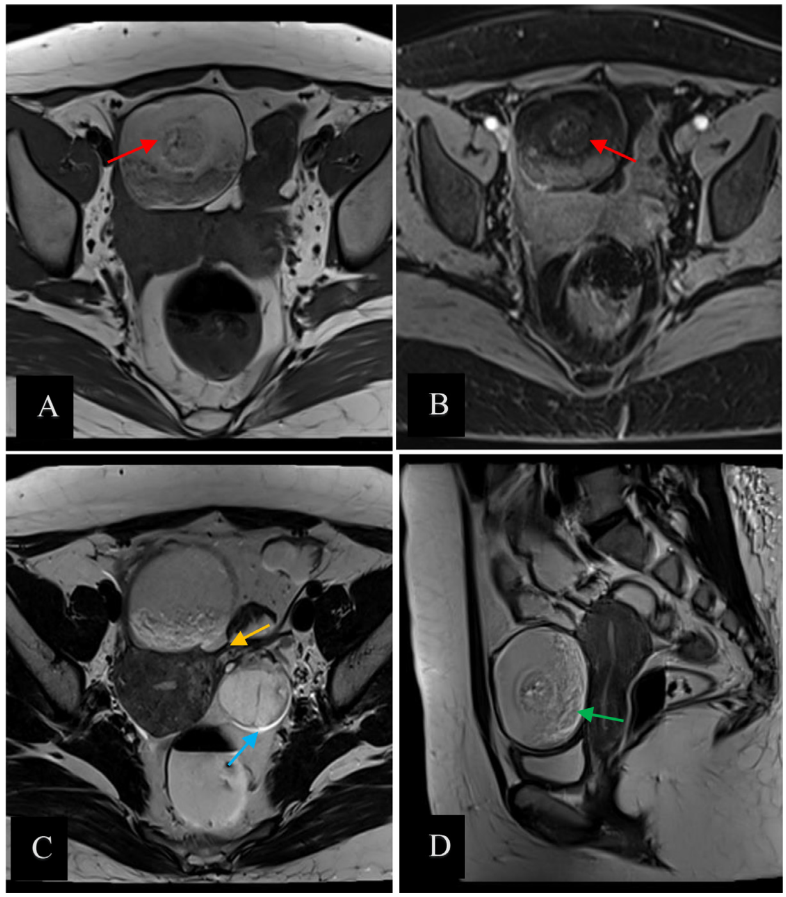

Fig. 1 – T1-weighted axial plane (A) and T1-Fat saturated (B) showed fat fluid levels with Rokitansky nodules inside (red arrow). T2- weighted axial plane (C) and sagittal plane (D) with a low signal intensity band (yellow arrow) on the posterior border of the cyst and a high-intensity band on the opposite side (blue arrow). Cheese-like material seen inside the tumor made an impression of hair tufts (green arrow).

abdominal pain. Tumor marker tests (beta-human chorionic gonadotropin – ß-hCG, alpha-fetoprotein, carcinoembryonic antigen – CEA) levels were normal, except for an elevation of the lactate dehydrogenase (LDH) of 387 U/L. An abdominal ultrasound discovered a pelvic mass with calcification.

A pelvic MRI revealed a complex cyst at the right adnexal tumor measuring approximately 5.0 × 5.94 × 6.7 cm. On T1-weighted images, the cystic teratoma's sebaceous component appeared hyperintense and lost signal upon fat saturation. An intracapsular rounded nodule or Rokitansky nodule and fat-fluid level were also seen (Fig. 1). Chemical shift artifact was seen in T2-weighted images as areas of very high signal intensity at fatty and nonfatty tissue interfaces, with a low-intensity band on the opposite side of the lesion. The uterus and left ovary were both normal (Fig. 2)

The right ovary obtained during the operation had a yellowish, soft, and spherical morphology. It was demonstrated that removed masses, keratinized tissues, hair, serous liquid, and non-neoplastic tissues could be examined pathologically (Fig. 3). The patient was discharged with no complications and planned a follow-up 6 months later.

Case 2

A 23-year-old female student, unmarried, presented herself to our center with abdominal distention for about 4 months which worsened in the last month. She had a regular period and moderate menstrual pain a day before the period. The vital sign was stable; however, the mass exceeded the umbilicus, with firm consistency, mobile, and painless on palpation. The biological markers (Lactate dehydrogenase, alfa-fetoprotein, and beta-HCG) were normal. No family history of similar illness or cancer history was recorded. Unilocular cystic mass measuring 9.8 × 16.2 × 21.9 cm occupied the right lower abdomen on pelvic MRI with contrast injection, showing hypo-intensity signal on T1 and hyper-intensity signal on T2 weighted images. There was no solid component or septation, and the border was smooth. The apparent diffusion coefficient and diffusion-weighted imaging sequence revealed T2-shining-through (Fig. 5) The hyperintensity signal seen on T1 and T2 weighted images indicated a number of small spherical structures floating in the cystic mass, known as the "floating ball" presentation. The saturated sequence showed drop

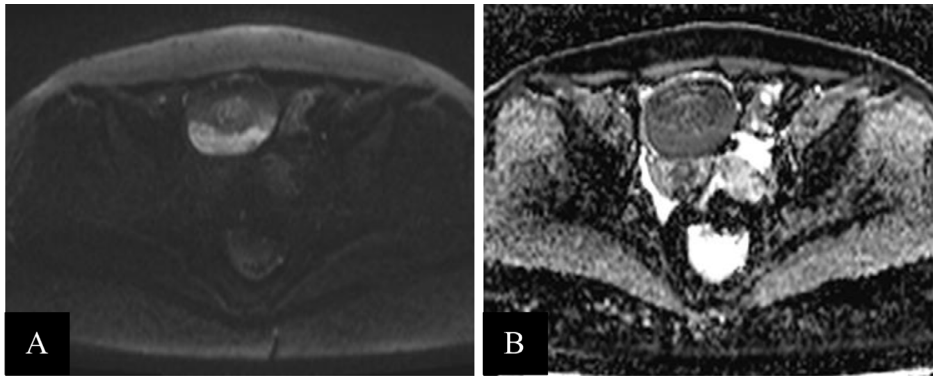

Fig. 2 – Diffusion-weighted image (A) and Apparent diffusion coefficient (B) Low apparent diffusion coefficient (ADC) values and high signal intensity in the right ovarian cystic lesion's posterior portion on the map point to diffusion restriction within the hair-containing sac.

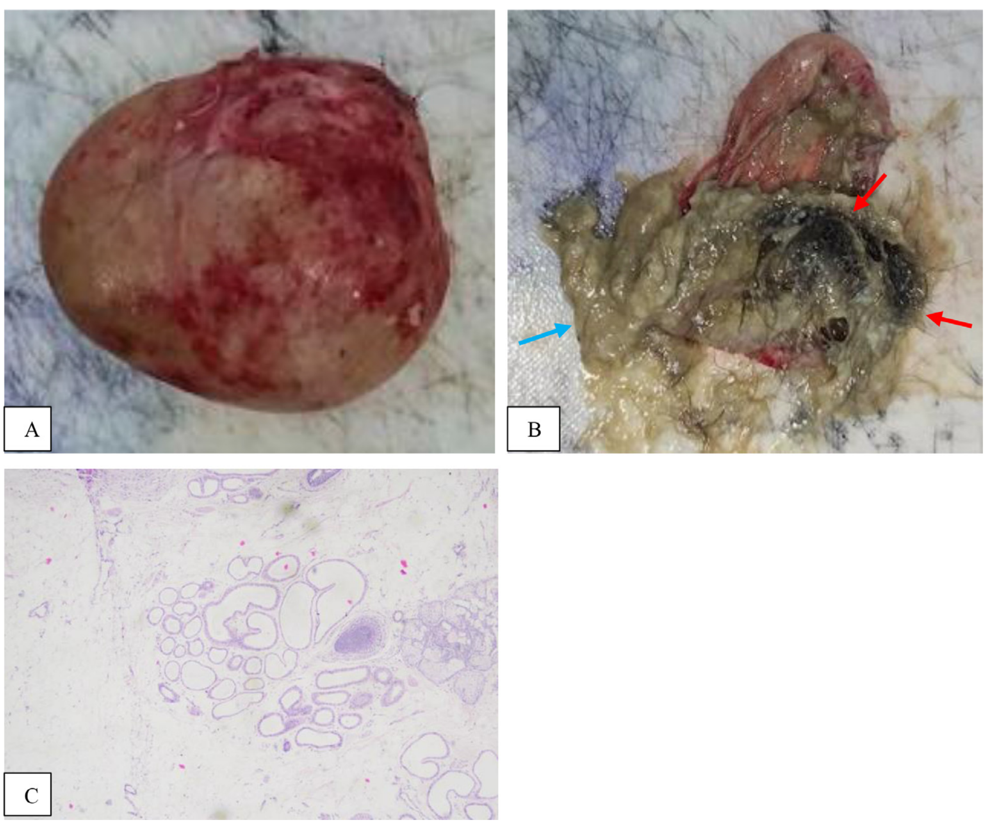

Fig. 3 – The yellowish pasty sebaceous material (blue row-heads) and hair (red arrowheads) found within the cyst cavity of the gross tumor (A) and the bisected tumor (B) account for the fat echogenicity and signal intensity observed on MR imaging. Pathology examination (C) shows sebaceous glands and hair follicles.

signal intensity demonstrating the fat component (Fig. 4), one of those rare presentations.

The patient underwent a laparoscopic procedure, and a right oophorectomy revealed a large cystic tumor. After the cyst decompression, the tumor was removed using an endoscopic retrieval bag. The contralateral ovarium was normal. Pathology examination confirmed the diagnosis of mature cystic teratoma of the right ovary (Fig. 6). The patient recovered well postoperatively and was discharged 2 days after. No medication was prescribed, and she was scheduled for a follow-up 6 months later.

Discussion

There are 4 types of ovarian tumors, including epithelial, germline, sex cord-stromal, and metastatic. Ovarian teratoma

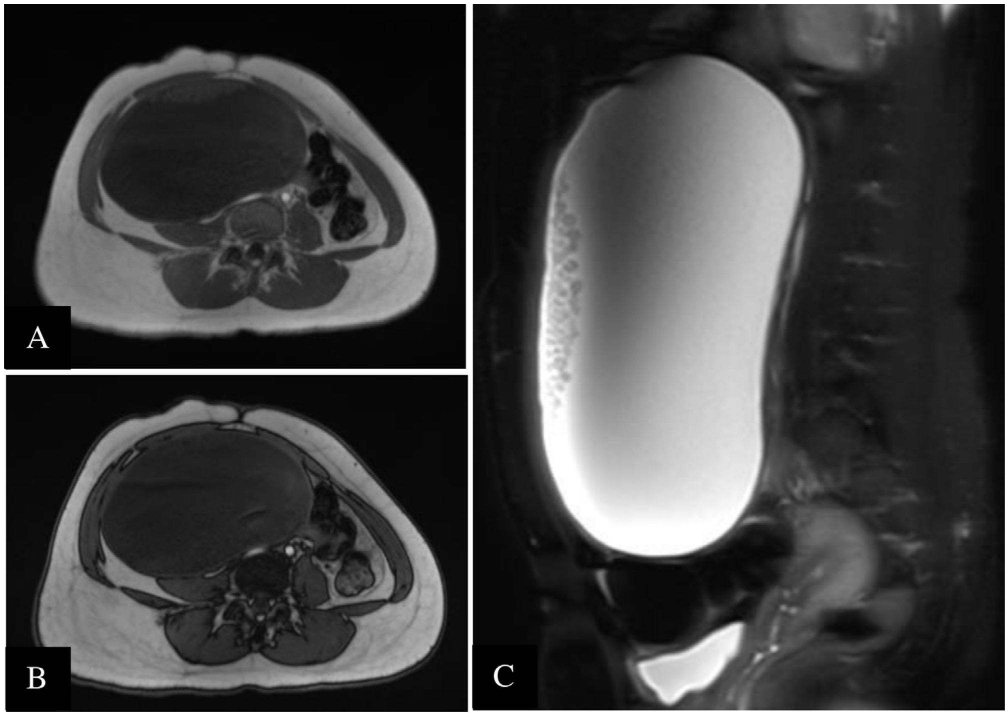

Fig. 4 – In-phase axial T1-weighted (a), out-of-phase axial T1-weighted (b), and T2-weighted sagittal (c) plane showed a huge cystic lesion with numerous floating spheric formations inside it that show slight hyperintensity in the in-phase T1-weighted with isointense in the out-of-phase T1-weighted.

(OT) is a common type of ovarian tumor that occurs among young women and accounts for 20% of all ovarian tumors in adults. Teratomas are made up of either mature or immature tissue and arise from 3 layers of pluripotent germ cells. Endoderm consists of gastrointestinal, bronchial epithelium, and thyroid tissue; ectoderm comprises skin derivatives and nerve tissue; mesoderm involves fat, bone, cartilage, and muscle. They are thus classified as mature cystic teratomas (dermoid cysts) and immature teratomas [2,4].

Unless a complication or paraneoplastic syndrome develops, the majority of teratomas are asymptomatic at the time of diagnosis and are frequently discovered coincidentally on imaging that was performed for another purpose. After all, the mass effect of the teratoma may result in pelvic pressure and pain should it grows to some extent. Patients with large tumors are more likely to develop ovarian torsion, which manifests as nausea, vomiting, pelvic pain, fever, and unusual bleeding. Furthermore, patients may also present with symptoms of peritonitis, such as abdominal pain, if their tumors ruptured. Torsion (6% of OTs), rupture (1%-4%), malignant transformation (1%-2%), infection (1%), and autoimmune hemolytic anemia (1%) are some of the complications, with a small percentage of patients exhibiting additional nonspecific symptoms [1–4].

Depending on the histologic component of ovarian germ cell tumors, various biological markers may be elevated, and they may aid in early diagnosis, treatment monitoring, and post-treatment monitoring. Serum alpha-fetoprotein (AFP), human chorionic gonadotropin (hCG), and lactate dehydrogenase (LDH) are paramount in germ-cell tumors. The serum levels of AFP are not elevated immature or mature cystic teratomas that have undergone a malignant transformation; nonetheless, they are found in 100% of women with yolk sac tumors, 61.9% of immature teratomas, and 11.8% of immature germinomas. Glycoprotein produced by the syncytiotrophoblast, called human chorionic gonadotropin, has been shown not to increase in mature cystic teratomas. Additionally, dysgerminoma typically brings about an increase in LDH. The larger the tumor, the higher the serum CA 19-9 levels, and they are elevated more often in teratomas. However, elevated CA 19-9 solely has been shown to have a low diagnostic value [5,6].

Mature cystic teratomas typically have a readily identifiable imaging manifestation, while less common OTs present a challenge for radiologists. Ultrasound (US), computed tomography (CT), and magnetic resonance imaging (MRI) are commonly used to detect and characterize the tumor (MR). The appearance of ultrasound is nonspecific and varies depending on bone, tooth, hair, and echogenic fat material; meanwhile, a cyst's fat can be easily seen on an MRI. However, it is necessary to be familiar with the unusual imaging characteristics of cystic teratoma [1,2,6].

For a diagnosis to be accurate, fatty, calcific, or osseous elements typically need to exist. Buy et al. reported that fat and tooth or calcification were present in 93% and 56% of cases, respectively. Moreover, Yamashita and team described fatty fluid in 66 of 78 mature cystic teratomas (85%). Similar to retroperitoneal fat, the sebaceous component of dermoid cysts exhibit substantially high signal intensity on T1-weighted MR images. Fat (lipid) has a relatively long T2 relaxation time in addition

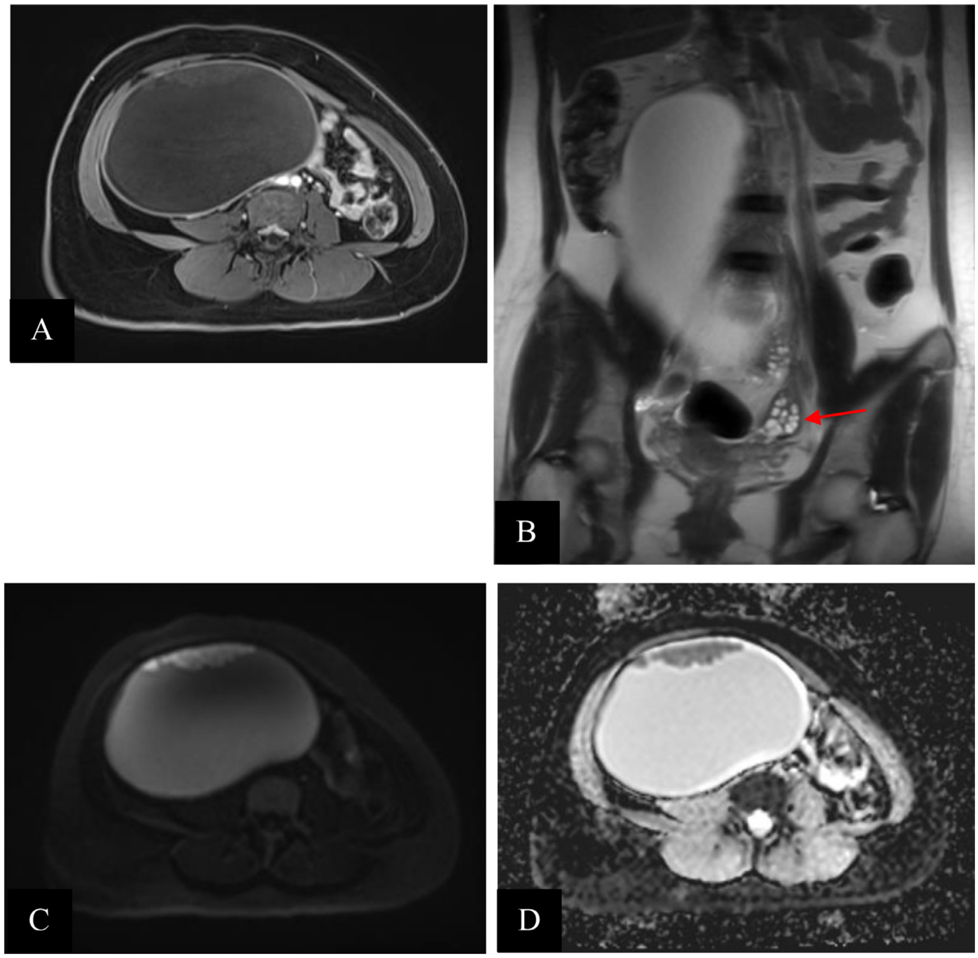

Fig. 5 – Axial T1 post contrast injection (A) coronal T2 (B) axial diffusion-weighted imaging (C) ADC sequence (D) plane showed a cystic lesion on right adnexa without enhancement after contrast media injection. The cystic lesion was slightly hyperintense on diffusion-weighted imaging (DWI) and ADC sequence; nevertheless, the floating ball inside the lesion showed restricted diffusion. The left ovarium was normal (red arrow).

to a short T1 relaxation time; consequently, it appears hyperintense on T1-weighted fast spin echo images and moderately intense to hyperintense on T2-weighted images. This combination of distinct signal intensities on T1- and T2-weighted images is not specific to fat and must be distinguished from MR imaging findings in intra-cystic hemorrhage and is mimicked by some hemorrhagic lesions, prominently endometriomas [2,7].

In gynecological MR imaging, fat suppression sequences are an essential addition to standard sequences – this fat saturation technique is used most frequently to differentiate between blood and fat. Chemical shift imaging, also known as Dixon's in/opposed phase methods, is the most sensitive method for detecting minor fat. Teratomas may exhibit the boundary artifact known as reversed chemical shift, which is perpendicular to the direction of the frequency-encoding gradient, and is able to distinguish fat from hemorrhage. T2-weighted images reveal foci or areas with a very high signal intensity at the interfaces of fatty and non-fatty tissue, as well as a low-intensity band on the tumor's opposite side. OTs can be identified by this unusual artifact, which can be found within or near the tumor. Similarly, the decreased signal in the out-of-phase images indicates the presence of microscopic fat. Moreover, it is common for mature teratomas to have 2 distinct fluid layers. A denser high attenuation fluid layer can be seen in the dependent portions of the tumor, while a less dense fatty fluid layer with lower attenuation can be recognized on top of the first layer. However, short T1 inversion recovery sequences (STIR) are not chemical shift-specific and cannot be used to differentiate fatty masses from hemorrhagic masses [1,3,7].

The most common typical finding projecting into the cystic lumen is the Rokitansky nodule, also known as a dermoid plug. A raised protuberance, known as the Rokitansky protuberance, usually projects into the cyst cavity – if bone and teeth are present, they tend to settle in this protuberance. Furthermore, the majority of the hair grows from this nodule and floats in the lumen with keratin and sebum, with the fat present more than 93% of the time. Most lipids are found in sebaceous liquid, whereas adipose tissue is less common. The size, number, relationship with the cyst wall, shape, and content of the Rokitansky nodule are all readily assessed using

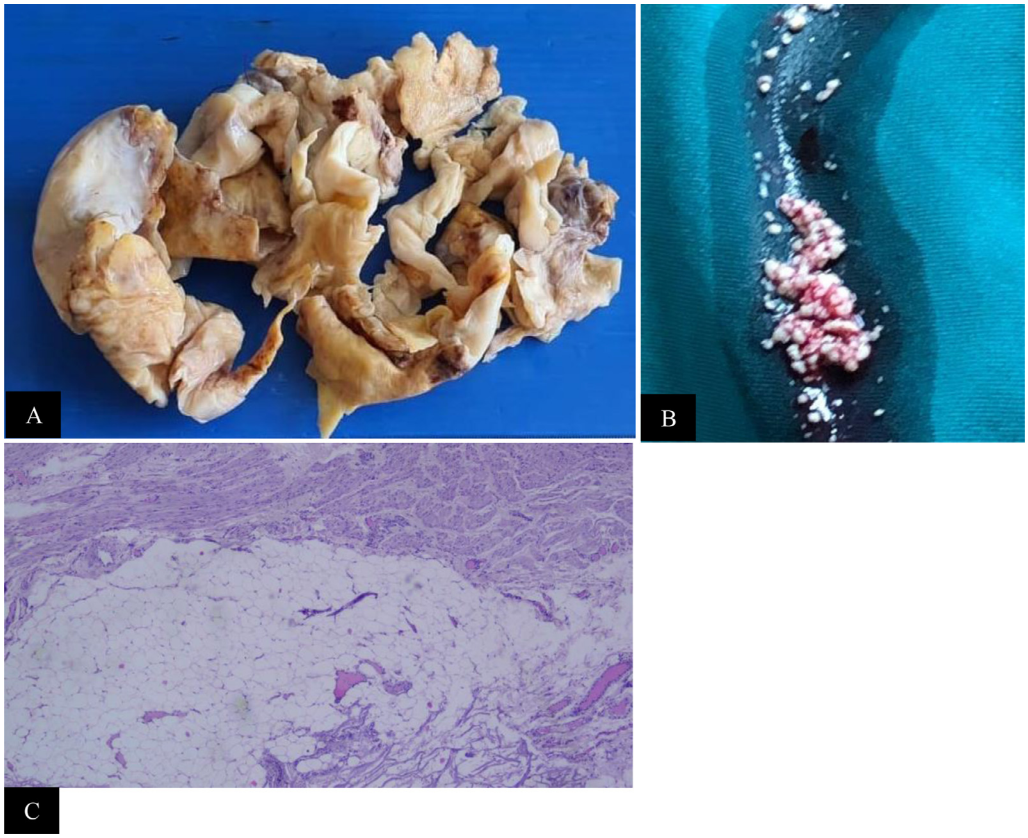

Fig. 6 – Surgical specimen (A and B) shows a sebaceous-filled cyst. Histopathology (C) confirmed teratoma and no apparent signs of malignancy.

MRI. Rokitansky nodules of benign maturing cystic teratomas exhibit varying enhancement patterns on dynamic contrast-enhanced MR imaging, often relating to the specific amount of solid tissue in the nodule. The Rokitansky nodule or another part of the tumor's wall may contain intra-tumoral fat. In menopausal patients, Rokitansky nodules may develop into malignant transformations, especially in large tumors (more than 9.9 cm) and serum squamous carcinoma antigen levels greater than 2 ng/mL [1,2,6].

On T1-weighted images, fat and fluid may show layering with a high signal intensity of the supernatant fatty layer. Even if the patient's position does not reveal complete layering at fat–fluid level, this demonstrates that the layered debris, which is primarily composed of matted hair, is gravity-dependent. This finding may be due to the slowing down of the layering process by the viscosity of the fatty liquid. Due to a chemical shift artifact, the hair is typically mixed with a white, cheese-like substance noticeable on MR images. On T2-weighted images, the intensity decreases as the amount of hair increases [2,3,7].

In some cases, atypical imaging manifestations can occur in mature cystic teratomas caused by tumor components that can be distinguished with a pure fatty component in the cyst, combination, and collision tumors without fat in the cystic cavity. On imaging studies, a small percentage of mature cystic teratomas have only a tiny amount of fat visible or none. Rarely, however, imaging studies show only fat and no other components. These mature cystic teratomas may resemble other uncommon tumors that contain lipids, such as benign pelvic lipoma or liposarcoma. With opposed-phase imaging, Yamashita et al. found such small foci of fat in 15% of cases. In addition, mature cystic teratomas occasionally contain intra-cystic, nondependent lipid material spheres [2,7].

The "floating ball" sign, defined by one or more small spherical structures floating in a cyst, is a rare pathognomonic feature of mature ovarian teratoma with a 25% incidence rate. It may also be referred to as the "poke-ball" sign representing a single ball floating in a fat-fluid interphase, or the "meat-ball" or "truffle" sign, pointing out numerous small floating globules, as was the case with our patient. Spherules, known as floating balls, contain varying amounts of keratin, fibrin, hemosiderin, sebaceous material, hair, and fat. According to the contents, these floating spherules take a gravity-dependent or -independent position in the cyst. Although their formation mechanism is still unknown, it is speculated that spherules are made by the aggregation of sebaceous material around a nidus made up of debris, squamous or hair shafts while moving in the cystic cavity. The mobility of the spheres is due to their low density relative to the other content of the cyst. The given spherical form is owing to the difference in physical and thermal properties of the material being deposited. The outer portion, formed by sebaceous material aggregation around the nidus, has the opposite signal intensity as the inner portion. Fat, either microscopic or

Table 1 – MR imaging of ovarian mature cystic teratoma.

	Typical feature	Atypical feature
Mature teratoma	• Intralesional fat • Fat-fluid level • Hair/tuft of hair • Rokitansky nodule/dermoid plug	• Minimal fat in the cyst wall or Rokitansky nodule • Floating intracystic spheres/ floating ball

macroscopic, may also be present in these spherules, which can be observed through phase-opposed phase imaging or fat suppression methods. It is possible to observe floating small fatty particles without a nidus, essential in diagnosing teratomas without a major fat component (Table 1) [3,6,8].

Histologically, mature tissues from various cell lines are found within the wall. Squamous epithelium usually covers the walls of the cyst, and hyalinized, compressed ovarian stroma often covers the outside of the cyst. Ectodermal components are virtually present in all mature cystic teratomas, and dermoid cysts occur when ectodermal tissues predominate. In the majority of cases, endodermal tissues (mucinous or ciliated epithelium) can also be seen, and mesodermal tissues are present in more than 90% of cases. A diagnosis of immature teratoma is warranted if any immature tissue is present, while mono-dermal teratoma is one in which the germ cell line of the teratoma is predominant or exclusive (endodermal or ectodermal). Mature teratoma is usually treated surgically: premenopausal women may opt for cystectomy, especially those who prefer to keep their fertility, whilst oophorectomy is the standard treatment for mature OTs in postmenopausal women, perimenopausal women with multiple teratomas in the same ovary and women with a large cystic teratoma that replaces most of the normal ovarian tissue. Although mature OTs are benign, there is a higher risk of complications in the more extensive tumors. As a result, the American College of Obstetricians and Gynecologists (ACOG) recommends continuous monitoring of the tumor's size with transvaginal pelvic ultrasound examinations every 6-12 months [1,3,6].

Conclusion

OTs are common ovarian tumors that are found in the majority of ovarian tumors. They are more often discovered during imaging procedures for another purpose in most patients without complications, such as rupture, torsion, malignant transformation, infection, and autoimmune hemolytic anemia or paraneoplastic syndromes; however, some cases of mature cystic teratomas present with atypical imaging manifestations. Old age, large mass, and high serum squamous carcinoma antigen level are thought to be associated with the malignant transformation of OTs and also pose challenges for radiologists. Mature cystic teratomas are usually treated surgically.

Patient consent

Informed consent obtained for publication of a case report. Written informed consent was obtained from the patient for the publication of this case report.

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