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Case Report

Multimodality imaging findings of infected endometriomas: "T1 signal reversal" as a potential diagnostic sign?☆,☆☆

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ABSTRACT

Endometrioma superinfection is a rare clinical entity that may cause diagnostic confusion and can be complicated by rupture, peritonitis, sepsis, and even death. Therefore, early diagnosis is crucial for appropriate patient management. Since clinical findings can be mild or nonspecific, radiological imaging is frequently used for diagnostic purposes. From a radiological perspective, it can be challenging to distinguish the presence of infection in an endometrioma. Complex cyst structure, wall thickening, increased peripheral vascularization, nondependent air bubbles, and surrounding inflammatory changes have been reported as potential US and CT findings suggestive of superinfection. On the other hand, there is a gap in the literature regarding MRI findings. To the best of our knowledge, this is the first case report in the literature to discuss MRI findings and temporal evolution of infected endometriomas.

In this case report, we aim to present a patient with bilateral infected endometriomas at different stages, and to discuss the multimodality imaging findings, focusing specifically on the MRI. We defined 2 new MRI findings that may indicate the presence of superinfection in the early period. The first one was the "T1 signal reversal" seen in bilateral endometriomas. The second one, "progressive disappearance of T2 shading," was observed only in the right-sided lesion. These nonenhancing signal changes accompanied by increased lesion sizes during MRI follow-up were thought to represent a transition from blood to pus, and the percutaneous drainage of the right-sided endometrioma microbiologically confirmed our suspicion. In conclusion, MRI can be helpful in the early diagnosis of infected endometrioma

Abbreviations: US, Ultrasound; CT, Computed tomography; MRI, Magnetic resonance imaging; T1W, T1-weighted; T2W, T2-weighted; CRP, C-reactive protein.

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due to its high soft tissue resolution. Percutaneous treatment may contribute to patient management as an alternative to surgical drainage.

Introduction

Endometriosis is a chronic and inflammatory gynecologic disease characterized by the extrauterine presence and growth of endometrial tissue. It is one of the leading causes of chronic pelvic pain and infertility, with a prevalence of approximately 10% in women of reproductive age [1–3]. The ovary is one of the most frequently affected organs in endometriosis (20%-40% of cases) [2]. Ovarian cystic endometriosis foci containing chronic cyclic bleeding products are called endometriomas [2].

Radiological evaluation is beneficial in both the diagnosis and follow-up of endometriomas. US and MRI are the 2 commonly used imaging modalities. Endometriomas are typically observed as hypoechoic lesions containing low-level fine echoes on US (the so-called "ground glass appearance"), and as T1 hyper- and T2 hypointense lesions on MRI. T2 hypointensity is mainly related to chronic blood products containing a high concentration of iron and protein, which has been described as the "T2 shading" phenomenon. However, T2 signal of endometriomas may be variable, and "T2 shading" may not always be seen [2,4,5]. Endometriomas are not expected to enhance on postcontrast images. Because of their intrinsic high T1 signal, dynamic subtraction images are essential in demonstrating enhancing intralesional foci, which may indicate malignant transformation. Although the presence of a solid enhancing component can suggest the development of malignancy (endometrioid or clear cell cancer), it is known that decidual hyperplasia may develop due to hormonal effects during pregnancy and may mimic malignancy [4,6]. Even though CT findings are nonspecific, endometrioma should be considered in the presence of adnexal cystic lesions with high attenuation [4]. Still, CT is frequently used in the emergency setting to exclude other pathologies that may present with pelvic pain.

Besides diagnostic radiology, interventional radiology can also contribute to the management of endometriomas. With current percutaneous treatment strategies, a significant regression can be achieved in patients' symptoms and the size of the endometriomas without adversely affecting the ovarian reserve [5].

Even though endometriomas cause chronic symptoms, they may rarely present with acute symptoms when complicated due to rupture or superinfection and can lead to diagnostic confusion [1]. This article aims to discuss the multimodality imaging findings and management of a patient diagnosed with bilateral infected endometriomas.

Case report

A 49-year-old G2P2 white female with known endometriosis was admitted to our hospital with complaints of dull pelvic pain, predominantly on the left side, and low-grade fever lasting for several days. Other vitals were normal. In the lab examination, urinalysis was normal. There was no leukocytosis, but a slight increase in the neutrophil percentage (73.5%, Normal range: 40%-70%])) was noted. She was hospitalized with a preliminary diagnosis of pelvic inflammatory disease, as her initial C-reactive protein (CRP) value was also high (64.7 mg/L, [Normal range: 0-5 mg/L]).

On transvaginal US, a lesion consistent with endometrioma was observed on the right adnexa, and a complex cystic lesion with thick walls and septa was seen on the left side. Due to the patient's clinical presentation, a pelvic MRI with intravenous contrast was performed with the suspicion of a tubo-ovarian abscess.

Compared to the patient's previous pelvic MRI 6 months ago, the current MRI revealed that the T1 hyperintense endometrioma in the left adnexal region had been replaced by a larger T1 hypointense and T2 hyperintense lesion in the interim period. After gadolinium-based contrast administration, peripheral and septal contrast enhancement without a solid mural component was observed in this lesion (Fig. 1).

In addition, a focal T1 hypointense area was noted in the medial part of the right-sided endometrioma. On T2-weighted (T2W) images, hyperintensities were seen in this area, while the rest of the endometrioma was T2 hypointense. Postcontrast images showed no contrast enhancement in this medial component (Fig. 2).

Considering the patient's clinical status, radiological findings were evaluated as compatible with the left tubo-ovarian abscess. On the other hand, signal changes on the right side were interpreted as radiological findings of unknown clinical significance at that time.

Based on the patient's preference, an initial conservative approach was adopted instead of surgical drainage. Blood cultures were taken, and combined "sulbactam/ampicillin + clindamycin + gentamicin" treatment was started per local guidelines. Tumor markers were also ordered to evaluate the presence of possible underlying malignancy. Other tumor markers were normal except for the mild elevation in CA-125 (87.1 U/mL, [Normal range: 0-35 U/mL]), possibly due to endometriosis [7]. Blood culture results were reported as negative.

At the end of the 3-day inpatient follow-up, the patient had febrile values, increased pelvic pain, and physical examination findings concerning for peritonitis. Additionally, a progressive increase in CRP (up to 299.5 mg/L), elevated erythrocyte sedimentation rate (95 mm/h), newly developed leukocytosis (12×10^3 /mm^3), and an increase in neutrophil percentage (up to 91.4%) were observed. A contrast-enhanced abdominal CT scan was performed to evaluate the left tubo-ovarian abscess and investigate other possible intraabdominal infection foci. Abdominal CT on day 3 showed extensive pelvic fat-stranding, peritoneal thickening, and diffuse intra-abdominal

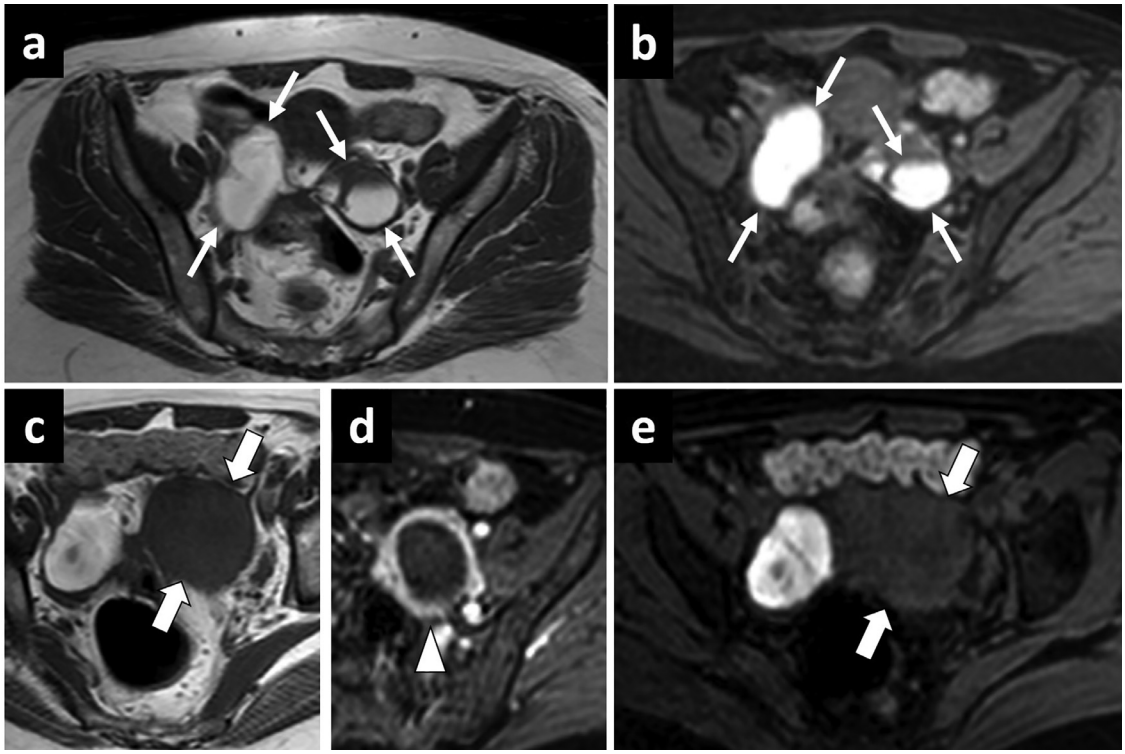

Fig. 1 – Left-sided tubo-ovarian abscess. (A and B) Axial plane T1W (A) and T1W fat-suppressed (B) baseline pelvic MR images 6 months before the patient's clinical presentation show «kissing ovaries» and bilateral T1 hyperintense endometriomas (small white arrows, A and B). (C–E) Axial plane T1W (C), T1W fat-suppressed postcontrast (D), and T1W precontrast (E) MR images at the time of clinical presentation demonstrate complete reversal of the previous T1 signal hyperintensity of the left adnexal lesion with a notable size increase (large white arrows, C and E). Note was also made of enhancing thick walls (arrowhead, D) and septation of this lesion (not shown). Imaging findings were found to be consistent with tubo-ovarian abscess secondary to infected endometrioma.

fluid, all of which emerged in the interim period, in addition to bilateral adnexal cystic lesions identified on admission MRI (Fig. 3).

Because of the clinical progression and radiological findings, initial antibiotherapy was switched to the "meropenem + vancomycin" combination with broader-spectrum coverage. In the following 6-day follow-up, a significant improvement was observed in the patient's clinical status. The leukocyte count returned to normal. Neutrophil percentage (72%) and CRP levels (46.75 mg/L) decreased significantly. On the 10th day of hospitalization, follow-up US revealed a considerable regression in the dimensions of the left tubo-ovarian abscess and the disappearance of intraabdominal free fluid. The same examination also showed a right adnexal cystic lesion consistent with endometrioma and mildly increased pelvic fat tissue echogenicity (Fig. 4).

While the patient was planned to be discharged soon, her clinical condition deteriorated abruptly on the 11th day. Marked suprapubic tenderness and high fever developed under broad-spectrum antibiotherapy. Blood cultures were taken, and a pelvic MRI was ordered again. On MRI, although the left-sided abscess had largely regressed, the size of the right-sided lesion had increased volumetrically by 50% in the interim. More strikingly, a progressive increase in the size of the T1 hypointense and T2 hyperintense non-enhancing component was observed in the medial portion of the right-sided endometrioma (Fig. 5). Additionally, extensive T2 hyperintensities throughout the pelvic fat planes, consistent with inflammation, were noted on fat-suppressed T2W images.

Due to the lack of clinical response to the conservative approach, the patient was referred to interventional radiology for percutaneous drainage. Since there was a satisfactory regression in the left-sided abscess in response to antibiotherapy, the procedure was planned for the right adnexal lesion. An 8F drainage catheter was placed with the Seldinger technique via transabdominal access, and approximately 70 mL of malodorous, hemopurulent content was evacuated successfully (Fig. 6). Microbiological examination of the aspiration sample revealed the presence of *carbapenemase-producing Escherichia coli* (Fig. 7). The control blood cultures were also negative. The patient's parenteral antibiotherapy was shaped according to the resistance profile of the microbiological agent, and conservative management was continued with gradual clinical improvement.

Discussion

Infected endometrioma is a rare entity, and current literature is limited to a small number of case reports [1,6,8,9–13]. Lower

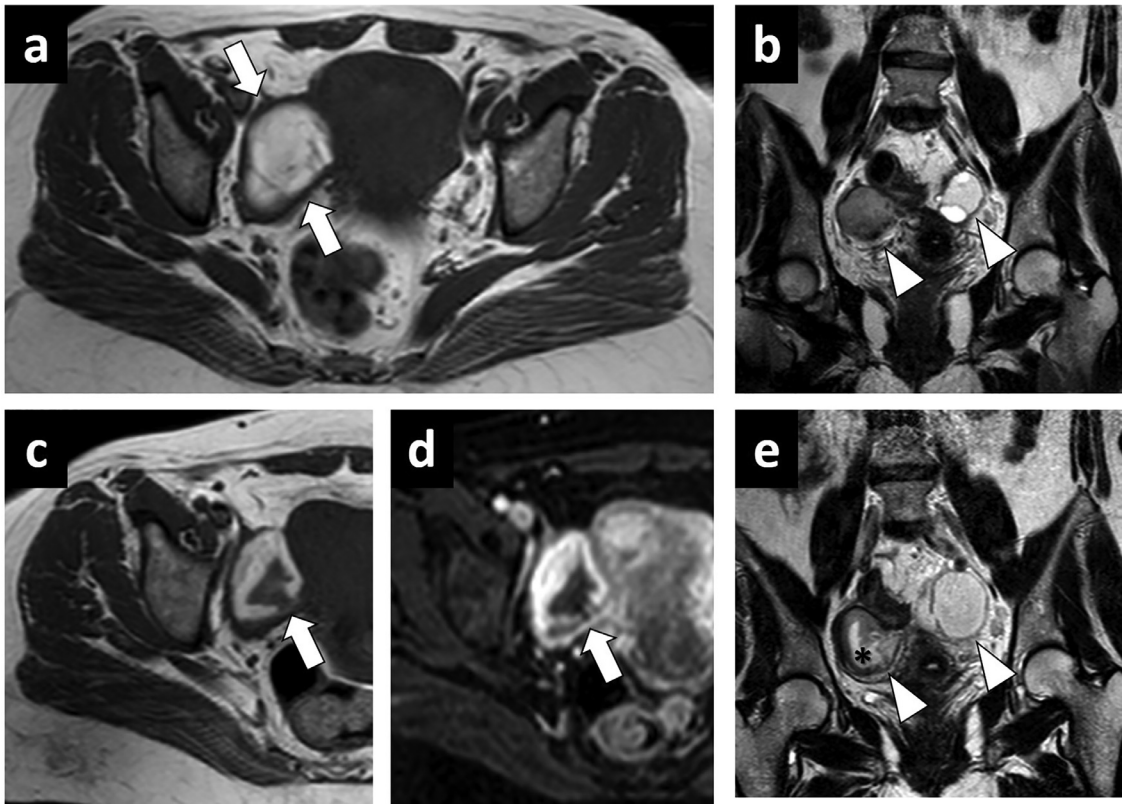

Fig. 2 – Early signal changes in the right-sided endometrioma. (A and B) Axial plane T1W (A) and coronal plane T2W (B) baseline pelvic MR images 6 months before the patient's clinical presentation show initial T1 signal characteristics of the right-sided endometrioma (arrows, A) and T2 signal characteristics of bilateral endometriomas (arrowheads, B). (C–E) Axial plane T1W (C), T1W fat-suppressed postcontrast (D), and coronal plane T2W (E) MR images at the time of clinical presentation demonstrate focal reversal of T1 signal hyperintensity in the medial part of the right-sided endometrioma with no apparent enhancement (arrows, C and D), and corresponding T2 hyperintensity in this area (black asterisk, E). Note was also made of the enlargement of bilateral adnexal lesions in the 6-month interim (arrowheads, E).

abdominal pain and fever are generally expected clinical findings. However, in some cases, the insidious onset of symptoms may cause patients to be admitted to the hospital late with signs of peritonitis in a preseptic state. Early detection of infection is vital, as it may be complicated by rupture and can be fatal [1,8].

It is well-known that the susceptibility to secondary infection increases in patients with endometrioma [12,14]. Decreased cytotoxic immune response in the endometrioma microenvironment, the thin and weak structure of endometrioma walls, and the fact that the chronic blood products in the endometrioma create a nutrient-rich proliferation environment for microorganisms are some of the possible explanations for this situation [12]. Direct inoculation after invasive pelvic procedures such as laparotomy, laparoscopy, endometrioma aspiration, and transcutaneous oocyte retrieval; ascending infection originating from the lower genital tract; local extension from adjacent intestinal loops; and hematogeneous/lymphatic spread of systemic infection are potential routes of transmission [1,10]. However, several cases of spontaneously infected endometrioma with unknown etiology have also been reported [1,12].

There is limited information in the literature on imaging findings of infected endometriomas. It has been stated that the sonographic findings of infected and noninfected endometriomas may be similar [4]. Although there is a tendency to associate the presence of infection with more complex US appearances, many of these findings, including fluid-fluid levels, septations, thickened walls, mural nodularity, and echogenic wall foci can also be observed in non-infected endometriomas [4]. While thick enhancing walls and perilesional fat stranding may favor the presence of infection on CT, patient management frequently needs to be guided by clinical suspicion due to the non-specific nature of these imaging findings. Additionally, while intralesional air bubbles strongly suggest superinfection in the absence of intervention history, the lack of intralesional air does not rule out superinfection, as it is not a sensitive finding [9].

Although MRI is a very efficient imaging modality in diagnosing endometriomas owing to its high soft tissue resolution, our extensive literature search showed lacking information on MRI findings of infective endometriomas. To the authors' knowledge, this is the first case report regarding MRI findings.

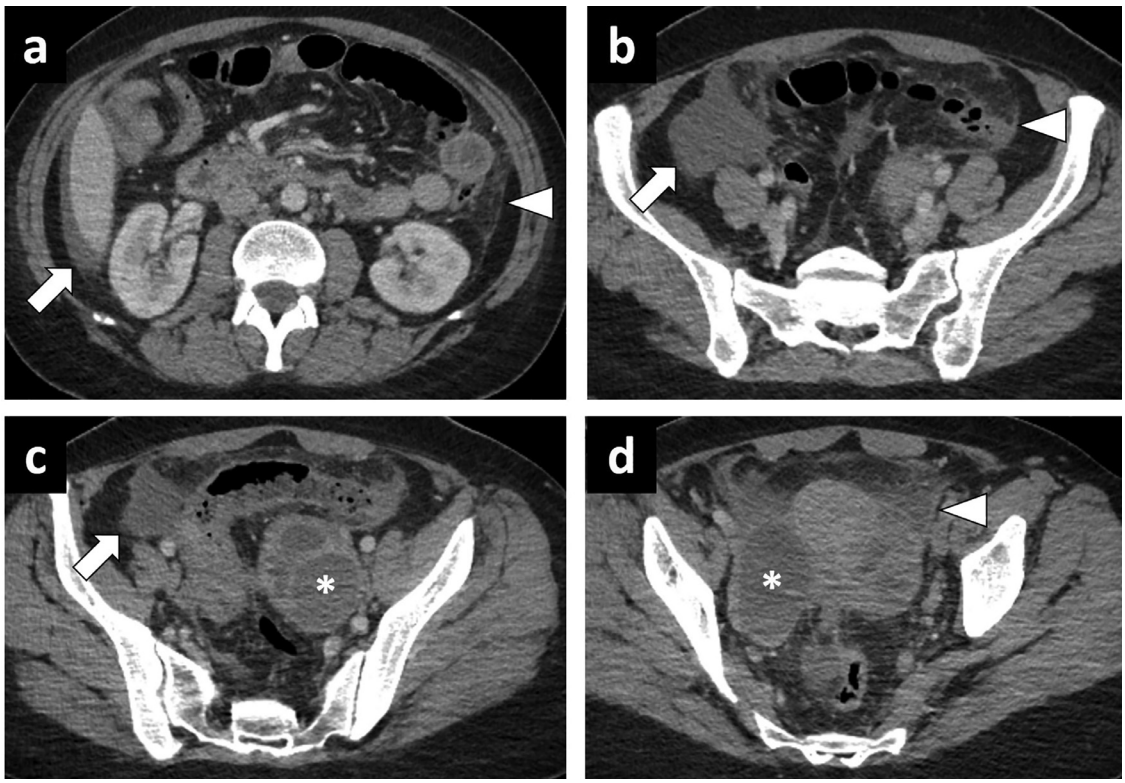

Fig. 3 – Clinical progression and development of peritonitis on day 3 (A–D) Consecutive axial postcontrast abdominal CT images from superior to inferior show intraabdominal free fluid (arrows, A, B, and C), peritoneal thickening (arrowheads, A, B, and D), extensive pelvic fat stranding (D), and bilateral cystic adnexal lesions with enhancing thick walls (asterisks, C and D).

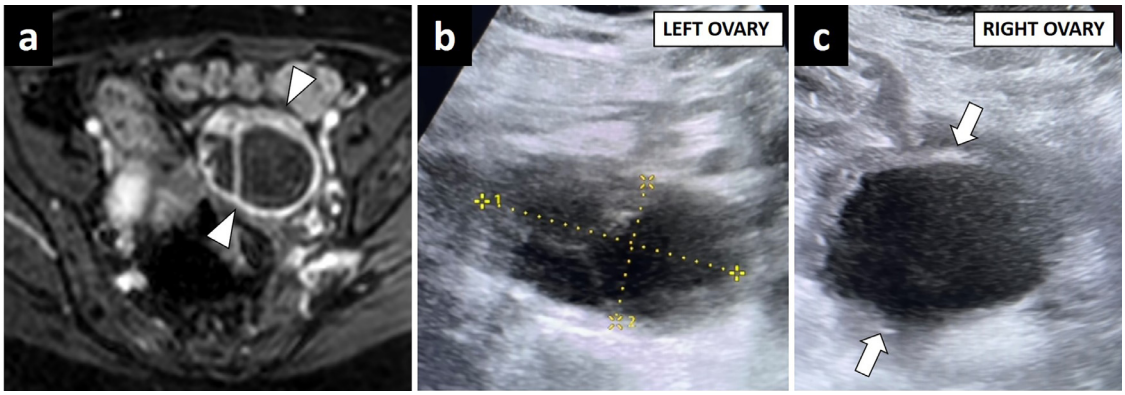

Fig. 4 – Follow-up US findings on day 10. (A) Axial plane T1W fat-suppressed postcontrast image at the time of admission demonstrates the initial size and appearance of the left-sided lesion with thick enhancing walls and septa (arrowheads, A). (B and C) Axial plane gray scale US images of the left and right ovary on day 10 show a considerable regression in the dimensions of the left tubo-ovarian abscess (B) and right-sided endometrioma with low-level fine internal echoes and thickened walls (arrows, C). Note was also made of slightly increased echogenicity of surrounding pelvic fat tissues.

The first notable finding in our case is the complete reversal of T1 signal hyperintensity of the left adnexal lesion, which showed an increase in size in the 6-month interim. The transformation of the left adnexal lesion corresponds to the formation of a tubo-ovarian abscess, representing the final stage of infection. No significant change was observed in the T2 signal intensity of this lesion, which had already displayed an intermediate/high signal on T2W imaging at baseline. The presence of infection in this lesion was confirmed based on regression with antibiotic therapy.

Second, and more importantly, we suggest that the "T1 signal reversal," focally observed in the right-sided endometri-

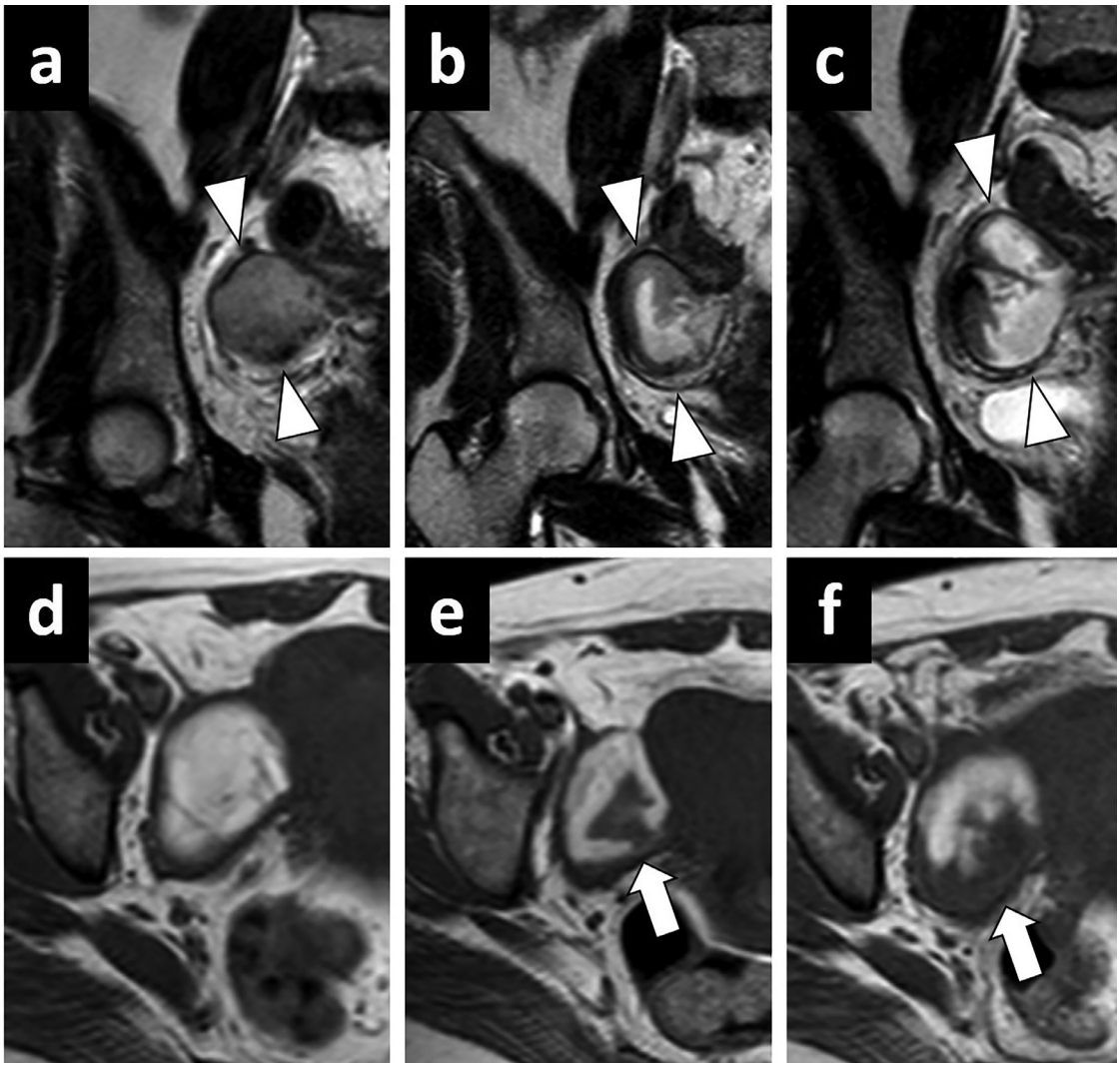

Fig. 5 – Temporal evolution of right-sided infected endometrioma. (A–C) Coronal plane T2W images of baseline MRI 6 months before the admission (A), MRI at the time of admission (B), and follow-up MRI on day 11 after admission (C) demonstrate progressive «disappearance of T2 shading» and a considerable increase in lesion size (arrowheads, A, B, and C). (D–F) Axial plane T1W images of baseline MRI 6 months before the admission (D), MRI at the time of admission (E), and follow-up MRI on day 11 after admission (F) demonstrate focal and progressive «T1 signal reversal» within the endometrioma (arrows, E and F).

oma and progressed in the follow-up MRI, could represent a gradual transition from chronic blood products to purulent content and demonstrates the early stage of infection. Furthermore, "T1 signal reversal" may help in early diagnosis considering the fact that this finding was first seen at the time of admission when the symptoms were mild, and peritonitis findings were not yet developed.

In addition, the "progressive disappearance of T2 shading" in the right-sided endometrioma is another finding that might reflect the course of the infection. Although this finding was previously described as a suspicious sign for malignant transformation (probably due to increased secretions in the malignant component), our case showed that it could also be seen in the presence of infection [3]. The superinfection of the right adnexal lesion was proven by microbiological evaluation of the aspiration sample obtained during the percutaneous treatment. Interestingly, US findings at the time of drainage were indistinguishable from the characteristic ground-glass endometrioma appearance, revealing the diagnostic superiority of MRI over US.

It has long been known in the literature that T1-weighted images are indispensable for endometrioma evaluation [6]. The vast majority of endometriomas (except fibrotic deep infiltrative endometriotic implants and those with acute bleeding) are T1 hyperintense [15,16]. However, some endometriomas might have a heterogeneous internal structure with T1 hypointense areas due to blood products of different stages [16,17]. In addition, malignant transformation and decidualization during pregnancy may present with intralesional T1 hypointense components, which necessitate the evaluation of

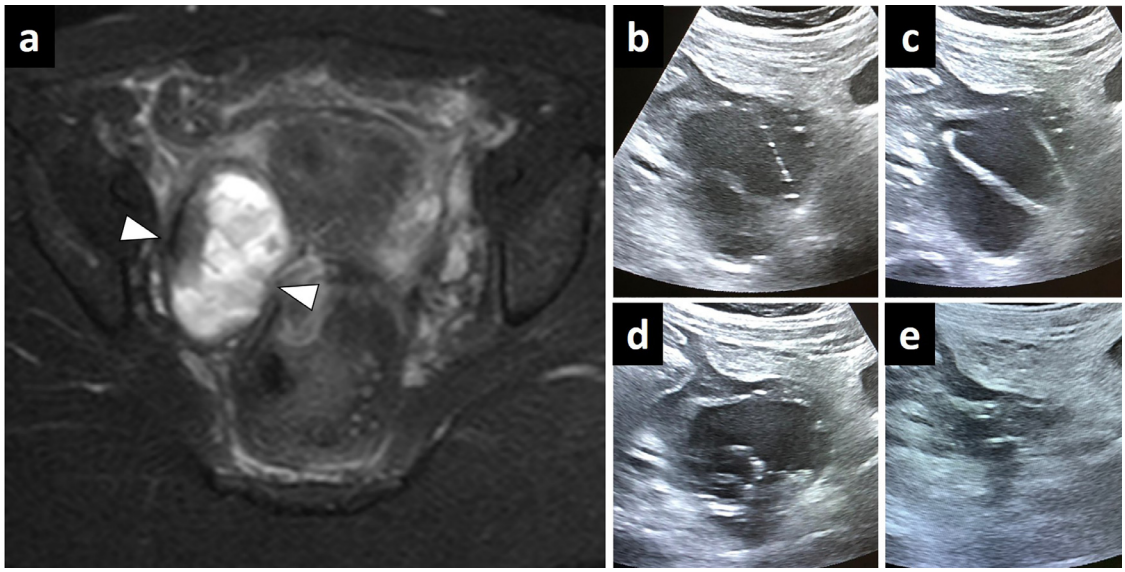

Fig. 6 – Extensive pelvic inflammation and percutaneous drainage. (A) Axial plane fat-suppressed T2W image of follow-up MRI on day 11 demonstrates almost complete «disappearance of T2 shading» in the right adnexal lesion (arrowheads, A) and extensive T2 hyperintensities throughout the pelvic fat planes, consistent with inflammation.
(B–E) Axial plane gray scale US images of the percutaneous drainage procedure. The lesion was punctured with an 18G hollow needle under US guidance (B). After obtaining the aspiration sample for microbiological examination, a guide wire was introduced through the needle (C). The 8F drainage catheter was advanced into the cavity over the guide wire (D). After catheter insertion, approximately 70 mL of hemopurulent content was evacuated, and almost complete resolution of the lesion was observed (E). The catheter was left in place to allow free drainage, and the initial aspiration sample was sent for microbiological examination.

dynamic postcontrast images with subtraction [6]. The presence of contrast enhancement in these T1 hypointense components can distinguish malignant transformation and decidualization from purulent content or acute hemorrhage. To further differentiate causes of intralesional nonenhancing T1 hypointensity, the patient's clinical status and temporal variation of imaging findings may be helpful. While acute hemorrhage tends to evolve and retract over time, the possibility of infection should be considered in the presence of progression.

In our case, a limited MRI protocol was used, and auxiliary diagnostic sequences for endometriomas, such as diffusion-weighted imaging (DWI) and susceptibility-weighted imaging (SWI), could not be obtained [6,17]. Therefore, it is a question mark how the conversion of blood to pus will be reflected in these sequences and how they can be used in the differential diagnosis. For example, to speculate, in the presence of intralesional nonenhancing T1 hypointensity, increased susceptibility on SWI could theoretically aid in the above-mentioned differential diagnosis of acute hemorrhage versus pus. On the other hand, it is doubtful to what extent DWI can contribute, as both endometrioma (blood products) and pus can restrict diffusion [6]. Yet, no supporting case examples exist in the literature for these statements. Therefore, imaging findings of infected endometriomas in these sequences are among the issues that need to be clarified in the future.

Due to their rarity, there has yet to be a consensus on how to manage infected endometriomas. Although the combination of early surgical drainage (laparoscopic/open cystectomy or oophorectomy) and intravenous antibiotics has been recommended in the early literature, widespread peritoneal inflammation, underlying endometriosis foci, and peritoneal adhesions may make the surgical approach challenging [1,13,18].

Two case reports on successful percutaneous drainage of infected endometriomas have been published in the last 5 years [10,11]. In these cases, as in our case, the main goal was not to treat the endometrioma but to eliminate the source of infection. Although long-term follow-up results regarding recurrence and reinfection rates are needed, early results of this minimally-invasive procedure, a reasonable alternative to surgery, are promising.

Last but not least, the hyperviscosity of noninfected endometriomas often prevents effective drainage, technically necessitating irrigation with repetitive sterile saline injections and aspirations during the percutaneous procedure. However, in our case, we were able to evacuate all the infected endometrioma contents easily with one-time aspiration. We believe this situation is due to the liquefaction of the viscous content, reflecting the blood-to-pus conversion. In this way, reduced viscosity, correlated with T2 signal increase, can facilitate drainage and increase the procedural success rate.

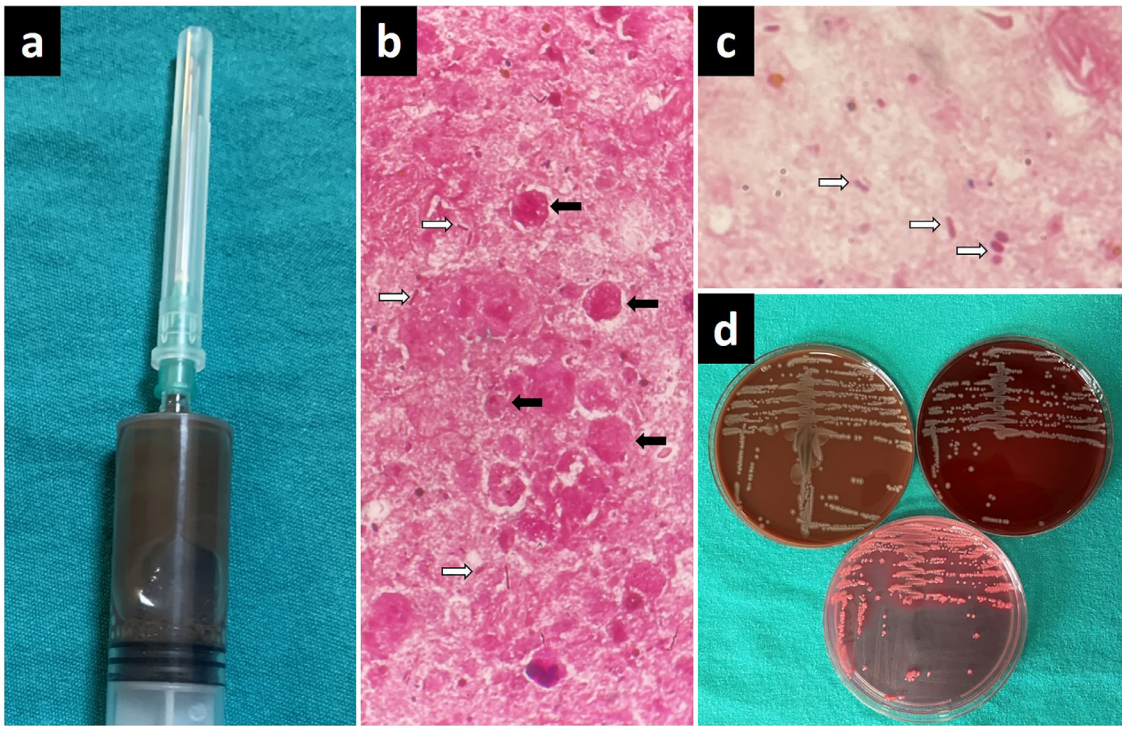

Fig. 7 – Findings of microbiological examination. (A) Photograph of foul-smelling aspiration sample with a brownish cloudy color. B) Photomicrograph of direct microscopic examination (x1000 magnification) shows multiple scattered gram-negative bacilli (white arrows, B) and extensively degraded blood cells (black arrows, B). (C) Photomicrograph of direct microscopic examination (x1000 magnification) from a less cellular area better demonstrates the presence of gram-negative bacilli (white arrows, C). (D) Photograph of culture plates (After 24 hours of aerobic incubation at 37°C). Chocolate agar (left upper) and 5% Sheep Blood agar (right upper) show abundant non-hemolytic bacterial colonies. MacConkey agar (lower) demonstrates pink colonies surrounded by a dark pink area of precipitated bile salts, a characteristic finding for *Escherichia coli*. Further tests confirmed the presence of *carbapenemase-producing E coli*.

Conclusion

Infected endometriomas can be resistant even to broad-spectrum antibiotics and can be fatal. Although some US and CT findings have been described in the literature, it is difficult to distinguish between infected and noninfected endometriomas radiologically. On the other hand, to the best of our knowledge, no MRI findings for infected endometriomas have been identified so far. In this case report, we defined 2 potential MRI findings, and demonstrated temporal evolution of infected endometriomas. The fact that these MRI findings preceded clinical deterioration in our case may show the potential role of MRI in early diagnosis. Thus, it might be wise to consider the possibility of superinfection in the presence of these identified findings and to prompt clinical correlation. It should also be remembered that percutaneous drainage can be an important alternative to surgery in these cases requiring early intervention. To conclude, with the growing literature and increasing number of cases, the effectiveness of diagnostic and interventional radiology will likely increase in managing infected endometriomas.

Patient consent

The authors declare that a written and signed informed consent for publication was obtained from the patient.

Authors' contributions

O.O., I.D., and C.E. searched the literature and wrote the manuscript. O.O., E.A., and G.A. designed radiology figures. K.Y.E., and C.A.A. provided clinical follow-up information and edited the text. I.T.O. provided microbiological information and prepared microbiology figures. All of the authors read and approved the final manuscript.

Availability of data and material

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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