CASE REPORT

Clear Cell Adenocarcinoma Arising from Clear Cell Adenofibroma of the Ovary: Value of DWI and DCE-MRI

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Clear cell adenofibroma (CCAF) is a rare surface epithelial-stromal tumor of the ovary and recently considered another precursor of clear cell adenocarcinoma (CCA) other than endometrioma. We report magnetic resonance (MR) findings of a borderline CCAF that contained a small CCA focus. The tumor manifested a characteristic “black sponge” appearance. The CCA focus showed high signal intensity on diffusion-weighted imaging (DWI) and early enhancement on dynamic contrast-enhanced (DCE) MR imaging (DCE-MRI), and the CCAF components showed low signal intensity on DWI and gradually increasing contrast enhancement on DCE-MRI.

Keywords: clear cell adenofibroma, clear cell adenocarcinoma, magnetic resonance imaging, MRI, ovary

Introduction

The highly chemoresistant nature of ovarian clear cell adenocarcinoma (CCA) results in a poorer prognosis than that of other malignant surface epithelial-stromal tumors of the ovary when the tumor is of high stage.1,2 Because patients with early stage CCA may have a similar or better prognosis than patients with high grade ovarian serous tumors, early detection by imaging is important.1,2 A high frequency of concurrent endometriosis is one characteristic of CCA, and endometrioma is considered a precursor of CCA.3 Benign and borderline clear cell tumors are rare; most are borderline clear cell adenofibromas (CCAF), which are recently considered another precursor of CCA.3 We report a case of an ovarian borderline CCAF that contained a small CCA focus, which was well visualized on magnetic resonance (MR) imaging including diffusion-weighted imaging (DWI) and dynamic contrast-enhanced MR imaging (DCE-MRI).

Case Report

A postmenopausal 55-year-old woman, gravida 2, para 2, was referred to our hospital because of genital bleeding. On admission, serum biochemistry revealed no abnormality or elevation of tumor markers (cancer antigen 125, Sialyl-Lewis X, carbohydrate antigen 72-4, and alpha-fetoprotein), but the level of estradiol (E2) was elevated (79 pg/mL). Transvaginal ultrasonography revealed a right adnexal solid and cystic mass 7 centimeters in diameter. Pelvic computed tomography (CT) demonstrated lobulation and low attenuation of the right adnexal mass, and heterogeneous enhancement after intravenous administration of iodinated contrast medium.

The patient underwent pelvic MR imaging at 3 tesla (Signa HDx 3T, GE Healthcare, Milwaukee, WI, USA). T2-weighted MR images demonstrated the tumor as a multilocular cystic mass with solid components of low intensity containing numerous tiny cysts of very high intensity, showing a black sponge-like appearance (Fig. 1A). DWI demonstrated small nodular areas of very high intensity within a mass of low intensity (Fig. 1B). The nodu-
lar area showed intense contrast enhancement on the early phase of DCE-MRI (3-dimensional fast spoiled gradient-recalled echo sequence with fat suppression) with intravenous administration of 0.1 mmol/kg of gadopentetate dimeglumine at 2 mL/s and intense prolonged contrast enhancement on postcontrast fat-saturated $T_1$-weighted image (Fig. 1C). Enhancement of DCE-MRI was considered to plateau after a rapid increase in the nodular area (Fig. 1D) but increased gradually in the other area of the tumor (Fig. 1E). These MR imaging findings suggested an ovarian cystadenofibroma (CAF) containing a malignant focus.

MR findings revealed an enlarged uterus with thickened endometrium of 8 mm such as that of a woman of reproductive age, and estrogen-producing activity of the ovarian tumor was suspected. $T_2$-weighted image demonstrated an endometriotic lesion as an adhesive fibrous area of tissue retraction of low intensity (Fig. 1F), and fat-saturated $T_1$-weighted image demonstrated hemorrhagic foci of high intensity between the right ovarian mass and the uterus.

The patient underwent bilateral salpingo-oophorectomy, simple hysterectomy, pelvic lymphadenectomy, and omentectomy. The surface of the right ovarian mass was lobulated and smooth, and endometriotic adhesions with the uterus were observed. The cut surface of the mass showed a multilocular cystic appearance with yellowish sponge-like fibrous components, and the area of very high intensity on DWI corresponded to a whitish, dense

![Fig. 1.](image-url)
nodular area (Fig. 2). Microscopic examination of the mass revealed tubular glands lined by a simple layer of hobnail cells within a fibrous stroma, and borderline CCAF was diagnosed (Fig. 3A). The whitish nodular area within the mass showed a complex tubulopapillary pattern, and tubular glands were crowded with hobnail cells with hyperchromatic, pleomorphic nuclei. This area was diagnosed as CCA (Fig. 3B) arising from borderline CCAF as a precursor via a multi-step carcinogenesis. The resected uterus was enlarged such as that of a woman of reproductive age, and an endometrial polyp was revealed. The patient’s elevated estradiol level was normalized after surgery.

**Discussion**

Ovarian adenofibroma (AF) and CAF are surface epithelial-stromal tumors characterized histologically by prominent fibrous stroma with epithelial elements in all subtypes-serous, mucinous, endometrioid, and clear cell. AF and CAF may appear as predominantly solid masses or as cystic masses with solid components. Black sponge-like appearance is a characteristic MR manifestation of ovarian AF and CAF and consists of tiny foci of high intensity within solid components of very low intensity on T2-weighted images; these foci reflect scattered small cystic glandular structures within dense fibrous stroma.

Several studies recently reported the usefulness of DWI in evaluating ovarian tumors. High intensity on DWI of solid components of malignant ovarian tumors reflects the hypercellularity of tumor cells and long T2 relaxation time of cancerous tissues, whereas low intensity may suggest benign ovarian lesions. Takeuchi and associates reported that none of 13 cases with ovarian AF/CAF revealed high signal intensity on DWI.

DCE-MRI is useful for characterizing solid or complex ovarian masses. The early enhancement pattern on DCE-MRI can help accurately distinguish among benign, borderline, and invasive ovarian tumors, correlating with the angiogenic status of the tumor. Tanaka and colleagues also

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**Fig. 2.** The cut surface of the resected specimen showed a multilocular cystic appearance with yellowish sponge-like fibrous components that contained a whitish, dense nodular portion (arrow).

**Fig. 3.** (A) Photomicrograph of the mass revealed tubular glands lined by a simple layer of hobnail cells bulging into the lumen within a fibrous stroma. (B) The nodular area showed a complex tubulopapillary pattern, and tubular glands were crowded with hobnail cells with hyperchromatic, pleomorphic nuclei.
suggested the utility of the enhancement pattern for distinguishing benign from malignant solid ovarian tumors, malignant tumors showing plateaued enhancement after rapid increase and benign tumors showing gradual increasing enhancement.\textsuperscript{12}

On T\textsubscript{2}-weighted images, manifestation of our patient’s tumor as a solid and cystic mass with black sponge-like appearance suggested CAF. The presence of an area of very high intensity on DWI that showed hypervascularity on DCE-MRI suggested a malignant focus caused by the step-wise carcinogenesis of ovarian CAF. It is suggested that the pathogenesis of CCA is related to endometrioma or CCAF and that both endometrioma and CCAF are precursors of CCA.\textsuperscript{3} Because CCAF may also contain endometriotic tissue histologically, noncystic endometriosis may induce a fibromatous stromal reaction that results in the formation of CCAF as a precursor.\textsuperscript{3} In our case, surgery revealed ovarian CCAF with a noncystic endometriotic lesion with fibrous adhesion, which suggested the step-wise carcinogenic pathway from noncystic endometriosis via CCAF to CCA.

We conclude that probable ovarian AF or CAF with black sponge-like appearance and adjacent noncystic endometriosis that appears as fibrous tissue of low intensity on T\textsubscript{2}-weighted imaging may suggest CCAF. A malignant focus caused by the CCAF-CCA carcinogenic pathway may exhibit very high intensity on DWI and hypervascularity on DCE-MRI, and these MR findings may aid early diagnosis of CCA. However, we report a single case; clear detection of CCA focus within CCAF may not always be possible on MR imaging.

References