The MRI features of ovarian cystadenofibromas (CAFs)- an assessment of the morphological and enhancement patterns with histological correlation

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Purpose

- Ovarian cystadenofibromas (CAFs) are rare ovarian tumours derived of both epithelial and stromal components but are classified as epithelial tumours.
- Although a benign tumour, their imaging features may overlap with malignant tumours. They are typically multi-locular cystic masses with solid components which is a characteristic also seen in malignant pathologies.
- Differentiating CAFs from malignancy is crucial as it influences clinical and surgical treatment.
- Magnetic resonance imaging (MRI) is the technique of choice for characterising complex adnexal lesions, due to greater soft tissue contrast resolution.
- The purpose of our study was to determine and describe the imaging characteristics of histologically proven CAFs on MRI.
Methods and Materials

- Study approval was granted by the local clinical governance committee (071-11).
- A retrospective search was performed for all histologically confirmed CAFs, discussed at the gynae-oncology multidisciplinary team meeting between January 2007- June 2011.
- There was a total of 47 CAFs in 42 patients.
- The average ages of the patient was 57 years (range 21-79).
- There were bilateral CAFs in six patients.

MRI sequences

- MRI sequences were performed with a pelvic phased array coil.
- An anti-peristaltic agent was administered by intravenous injection unless contraindicated (20 mg hyoscine butylbromide, Buscopan).
- Axial T1-weighted spin-echo MR imaging from the renal hilum to the symphysis pubis.
- Axial T2-weighted fast spin-echo MR imaging of the pelvis or whole abdomen and pelvis if necessary to cover larger adnexal masses.
- Sagittal T2-weighted fast spin-echo imaging from one femoral head to the other.
- Unenhanced and enhanced fat-suppressed spoiled gradient-echo T1-weighted imaging was performed in the sagittal or axial plane.
- 42 CAFS and 38 patients had enhanced sequences which were obtained after intravenous injection of 10 ml of 0.2 mmol/kg of gadoterate meglumine (Dotarem; Guerbet, France).
- In 16 patients, dynamic contrast enhanced fat-suppressed spoiled gradient-echo T1-weighted MR imaging was performed. The total acquisition time for this sequence was 22-30 s. This sequence was performed before and immediately after controlled pump IV injection of 3 ml/s followed by a 30ml saline flush, and then repeated at 30, 60, 90 and 120 s into the examination.
- Where multiphase dynamic contrast enhanced sequences were available, a circular region of interest (ROI) (at least 3mm in diameter, avoiding partial voluming effect and spatial mis-registration) was drawn manually.
- If the solid component was less than 3mm in diameter, an ROI was not drawn as it was not deemed possible to obtain meaningful semi-quantitative data.
- The contrast wash in rate (WIR) was recorded using the Philip's Achieva standard breast package quantitative analysis software. In this software, WIR = SI_0 - SI_{max} /time, where SI_0 corresponds to signal intensity without contrast enhancement, SI_{max} corresponds to signal intensity at maximum enhancement and time corresponds to time between SI_0 and SI_{max}. 
• Each MRI was reviewed by consensus fashion by one of two radiologists (SL, YZT), and a gynaecological radiologist with > 10 years experience (AR). The recorded parameters were the size in three orthogonal planes, side of the lesion and content of the CAF.
• CAF morphology was classified as purely cystic, cystic-septate, cystic-solid, cystic-septate-solid, mostly solid or purely solid.
• Septae were defined as thin and linear tissue within a cyst, and for the purposes of our study were considered distinct from a solid component.
• The solid components' signal characteristic on T1 and T2-weighted sequences was recorded as low, intermediate, high or variable.
• The signal on T1 was compared to the outer myometrium respectively. The signal on T2 was compared to urine. The solid component's predominant morphology was recorded.
• The signal intensity of the cystic components was compared to urine on T1, T1 fat saturated, and T2-weighted sequences. Ancillary parameters including CA 125 values, ascites, peritoneal disease and nodal enlargement were also noted.
• The histological subtype of the CAFs was recorded.
Results

The average size of the CAFs: 73 mm craniocaudally, 65 mm in left to right dimensions, and 61 mm in anteroposterior dimensions.

- For each CAF, the longest of these dimensions was recorded and had an average of 80 mm.
- Forty seven percent were right sided and 53% were left sided lesions.
- None of the patients had visible peritoneal disease. The contralateral ovary was abnormal in 23 of 47 (49%) CAFs. Their pathology is listed in table 1.
- There were 36 benign serous CAFs, four benign mucinous CAFs, two benign seromucinous CAFs, two serous adenofibromas and three borderline serous CAFs.
- In one serous adenofibroma, there was a co-existent adenocarcinoma.

Septal pattern

- Thirty five of 47 (74%) CAFs had septae within them. Six of these were comprised of septi and a cystic component alone, whilst 28 contained solid components in addition to septi and a cystic component. The characteristics of the septae are recorded in Table 2.

Solid pattern

- A solid component was seen in 40 of 47 (85%) CAFs.
- The solid components were multiple in 27 of 40 (68%) CAFs, solitary in 12 of 40 (30%) CAFs, and diffuse wall thickening in 1 of 40 (2%) CAFs.
- The maximum solid component size measured an average of 21 mm (range 3-75 mm).
- The signal characteristics of the solid tissue is shown in Table 3. Of note, the solid material returned low T2-weighted signal in 30 of 40 (75%) CAFs.
- Of the 35 CAFs with solid components and enhanced sequences available for qualitative review, seven CAFs had no discernable enhancement. All seven CAFs were benign. The solid material enhanced less than myometrium in 22 CAFs, of which 20 were benign and two were borderline CAFs. In six CAFs, the solid material enhanced more than myometrium, of which five were benign and one was a borderline CAF.
- The most common solid tissue morphology was the nodular pattern in 16 of 40 (40%). The second most common morphology was papillary in 14 of 40 (35%). A "carpet like" layer of solid tissue was seen in 6 of 40 (15%), and both a nodular and papillary pattern were demonstrated in 4 of 40 (10%). (Figure 1-4)
- A carpet like pattern was present when sessile, small tiny nodules or tufts were seen along a septum or wall of the cyst.
Fig. 1: Figure 1: Sagittal T2-weighted sequence shows an multiloculated cystic adnexal mass. There is a solid, nodular component arising from the wall of an internal septum.

References: - London/UK
Fig. 2: Figure 2 Sagittal T2-weighted sequence demonstrates solid tissue within a cystic mass. The solid tissue demonstrates a papillary pattern with branching fronds of soft tissue. The solid tissue is also of very low T2 signal.

References: - London/UK
**Fig. 3**: Figure 3 Axial T2-weighted sequence demonstrating a multiloculated, cystic adnexal mass with solid components. There are both nodular (thick arrow) and papillary (thin arrow) solid components.

**References**: - London/UK
**Fig. 4:** Figure 4 Sagittal T2-weighted sequence. There is a large cystic adnexal mass extending from the pelvis superiorly into the upper abdomen. There is sessile soft tissue arising from the anterior wall of the mass. This has been described as a carpet-like pattern.

**References:** - London/UK
Dynamic contrast enhanced imaging

- Sixteen CAFs were available for semi-quantitative analysis of dynamic contrast enhanced sequences. Of these, five CAFs had solid tissue which was too small for an adequate ROI to be drawn and one patient had a purely cystic CAF.
- Nine patients therefore had solid tissue in which wash in rates could be measured (four of these patients had previously been reported in Bernadin et al)[1]. All patients had a wash in rate less than 5.8 l/s with an average of 3.2 L/s (standard deviation= 1.1).
**Fig. 5**: Figure 5 Dynamic contrast enhanced sequence. The subtraction image shows an area with the left CAF which enhances. An ROI was placed within this enhancing solid tissue. The solid component had a low wash in rate in keeping with benign solid tissue

**References**: - London/UK

Cystic components

- All CAF lesions demonstrated a cystic component
- Their findings are in Table 3

Borderline CAFs

- Three CAFs in two patients were borderline CAFs on histology and all contained solid components
- Two had multiple solid components, and one had a solitary solid component. The solid components in all borderline CAFs returned low T2-weighted signal
- All demonstrated enhancement on visual inspection with two enhancing less than myometrium and one enhancing more than myometrium.
- DCE was not available in these CAFs for semi-quantitative analysis
- All three borderline CAFs had an abnormal contralateral ovary. Two of the borderline CAFs occurred in the same patient (bilateral serous CAF). In the other patient with a borderline CAF the contralateral ovary contained a borderline serous tumour.

Co-existing adenocarcinoma and serous adenofibroma

- One CAF in our cohort was an adenocarcinoma arising on a background of a serous adenofibroma
- There were multiple solid components, measuring up to 4cm, and demonstrating mixed T2-weighted signal and high T1 signal
• The solid component enhanced more than the myometrium on the delayed enhanced sequence
• It had numerous septae which were greater than 3mm in thickness. The contralateral ovary also contained a CAF confirmed at histology, but was not included in our study as it was not clearly identified on MRI as detailed above.
Table 1: Pathology of contralateral ovary

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endometriotic cyst</td>
<td>1</td>
</tr>
<tr>
<td>Fibrous tumour (1 fibroma, 1 Brenner)</td>
<td>2</td>
</tr>
<tr>
<td>Borderline serous tumour</td>
<td>3</td>
</tr>
<tr>
<td>Cystadenoma</td>
<td>4</td>
</tr>
<tr>
<td>Polycystic ovary</td>
<td>1</td>
</tr>
<tr>
<td>CAF</td>
<td>11</td>
</tr>
<tr>
<td>Borderline mucinous adenocarcinoma</td>
<td>1</td>
</tr>
<tr>
<td>Benign cystadenoma</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table 1:** Table 1: Pathology of contralateral ovary

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Table 2: Septal characteristics

<table>
<thead>
<tr>
<th>Number of septae</th>
<th>% (number of CAFs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25% (12)</td>
</tr>
<tr>
<td>&lt;5</td>
<td>32% (15)</td>
</tr>
<tr>
<td>&gt;5</td>
<td>43% (20)</td>
</tr>
</tbody>
</table>

Distribution of septae
- Focal/cluster: 34% (16)
- Diffuse: 40% (19)

Septal thickness (mm)
- <3mm: 49% (23)
- >3mm: 26% (12)

Enhancement pattern
- None: 15% (7)
- Less than myometrium: 43% (20)
- More than myometrium: 9% (4)

Table 2: Table 2: Septal characteristics

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<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solid component</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>30 (75%)</td>
<td>30 (75%)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>5 (12%)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>high</td>
<td>1+ (3%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Multiple</strong>*</td>
<td>4 (10%)</td>
<td>7 (18%)</td>
</tr>
<tr>
<td><strong>Cystic component</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=46)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>10 (22%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>16 (35%)</td>
<td>0</td>
</tr>
<tr>
<td>high</td>
<td>1 (2%)</td>
<td>34 (74%)</td>
</tr>
<tr>
<td><strong>Multiple</strong>*</td>
<td>19 (41%)</td>
<td>11 (24%)</td>
</tr>
</tbody>
</table>

*The signal returned was a mixture of low, intermediate, or high signal separated by septations

+benign mucinous CAF

**Table 3**: Table 3: Solid and cystic component’s signal characteristics

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Conclusion

- Our study describes 47 CAFs in 42 patients
- This is the largest cohort of CAFs with MRI imaging
- Three small series have described MRI features of CAF. Cho et al described MRI features in 11 CAFs, and Jung et al described MRI features in 12 CAFs, Outwater et al described MRI features in 14 CAFs
- Our findings support previous findings that CAFs are multicystic masses with enhancing solid contents
- Low T2- weighted signal intensity solid component are also a prominent feature of CAFS and were demonstrated in 30 of our 40 CAFs which contained solid material
- Our cohort included 3 borderline CAFs and no imaging features were able to discern them from other benign CAFs
- We found the CAFs are often associated with an abnormal contralateral ovary
- The CAFs also demonstrated a slow wash in rate which has not been documented previously.
References


