



## External validation of the MR imaging scoring system for the management of adnexal masses



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### ABSTRACT

**Objective:** To investigate the prognostic value of ADNEX Magnetic Resonance Imaging Scoring in the preoperative management of adnexal masses.

**Study design:** We performed a retrospective study on patients who underwent surgery for an adnexal mass, with prior exploration by Magnetic Resonance Imaging (MRI), at the Gynecology Department of the Poissy Teaching Hospital between May 2012 and August 2014. MRI data were retrospectively read by radiologists, without knowledge of the histology, and classified according to the criteria of the ADNEX MR score. The radiological presumption of benign or malignant mass was compared with the final histological diagnosis. We calculated the sensitivity, specificity, positive and negative likelihood ratios and ROC curve of the ADNEX MR score with their 95% confidence intervals (95%CI).

**Results:** One-hundred-and-forty-eight patients were included in the study of which 24 had malignant or borderline ovarian tumors. The proportion of malignant or borderline ovarian tumors in each class of the ADNEX MR score in our study was: ADNEX I: 0% (95%CI, 0–8); ADNEX II: 1.7% (95%CI, 0.04–8.9); ADNEX III: 7.7% (95%CI, 0.2–36); ADNEX IV: 57.1% (95%CI, 34.2–78.8) and ADNEX V: 100% (95%CI, 69.2–100). Thus, for an ADNEX MR score greater than or equal to 4, the sensitivity was 91.7% (95%CI, 73–99) and the specificity 92.7% (95%CI, 86.7–96.6) for the diagnosis of a malignant or borderline ovarian tumor. The area under the ROC curve was 0.92 (95% CI, 0.86–0.98).

**Conclusions:** MRI, coupled with the use of the ADNEX MR scoring system, can accurately classify adnexal masses into low-risk (ADNEX MR score <4) or high-risk (ADNEX MR score ≥4) group, thereby allowing for appropriate preoperative counseling and planning for surgery.

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### Introduction

The prevalence of presumably benign ovarian tumors is estimated to be between 14% and 18% in menopausal women and around 7% in women of childbearing age. Approximately 2% of adnexal masses are malignant or borderline tumors [1].

The preoperative characterization of adnexal masses for the optimization of treatment and appropriate patient referral to specialized surgery units can be difficult. In France, although there are currently recommendations for the management of benign

tumors, the frequency of potentially harmful interventions and incomplete staging, in the case of borderline or malignant tumors, remains high [2].

The diagnostic process for seemingly benign ovarian tumors as summarized in The French Recommendations for Clinical Practice in 2013 include 2D, Doppler ultrasound scan of the pelvis as the first line examination for all patients presenting with a pelvic mass [1]. Most adnexal masses can be classified using the nomenclature of the International Ovarian Tumor Analysis (IOTA) group [3,4]. MRI is indicated as a second-line investigation for masses that cannot be characterized by ultrasound and those of greater than 7 cm [1,5].

Despite the availability of algorithms which take into account clinical findings, including CA125 levels and signs of malignancy by ultrasound, the preoperative characterization of adnexal masses

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**Table 1**  
ADNEX scoring system by Thomassin et al.

Score ADNEX	Criteria
ADNEX 1: no mass	No mass
ADNEX 2: benign mass	Purely cystic mass Purely endometriotic mass Purely fatty mass
ADNEX 3: probably benign mass	Absence of wall enhancement Absence of solid tissue Curve type 1 within solid tissue
ADNEX 4: indeterminate MR mass	Curve type 2 within solid tissue
ADNEX 5: probably malignant mass	Peritoneal implants Curve type 3 within solid tissue

**Table 2**  
Comparison between ADNEX MR scoring and tumor characteristic.

ADNEX scoring	Benign tumor on histology	Malignant tumor or borderline on histology	Total
ADNEX I	44	0	44 (29.73%)
ADNEX II	59	1	60 (40.54%)
ADNEX III	12	1	13 (8.78%)
ADNEX IV	9	12	21 (14.19%)
ADNEX V	0	10	10 (6.76%)
Total	124 (83.78%)	24 (16.22%)	148

remains difficult, especially if the lesions are complex [6,7]. In this case, MRI is more precise than ultrasound, with an overall accuracy of 88–93% for the diagnosis of malignancy (vs 80% to 83% for ultrasound [8]). This also holds true for borderline tumors [9,10]. The inclusion of perfusion- and diffusion-weighted sequences during the MRI improves the diagnostic precision of MRI [11,12]. Thus, the technique is powerful, but interpretation is still left to the radiologists' judgment, and there is, as yet, no validated system of MRI-based classification for the characterization of adnexal images. Consequently, a five-class scoring system has been developed, the ADNEX MR score (Table 1), inspired by the ACR score in breast screening imaging [13] and based on enhancement curves. The ADNEX MR Score permits the classification of adnexal masses as a function of their risk of malignancy [14]. ADNEX 1 score refers to patients without ovarian mass detected; ADNEX 2 to benign masses; ADNEX 3 to masses that are probably benign; ADNEX 4 to indeterminate MR masses and ADNEX 5 to probably malignant masses (Table 1).

**Table 3**  
Comparison between tumor histology and ADNEX MR Scoring.

Histology type N	ADNEX I 44	ADNEX II 60	ADNEX III 13	ADNEX IV 21	ADNEX V 10	Total
Benign tumor n (%)	44 (34.5)	59 (47.6)	12 (9.7)	9 (7.3)	0	124 (83.8)
No tumor	43	0	1	0	0	44 (29.7)
Benign Brenner tumor	1	0	0	0	0	1 (0.7)
Functional cyst	0	5	0	0	0	5 (3.4)
Fibrothecoma	0	0	2	1	0	3 (2)
Benign germ cell tumor	0	14	1	0	0	15 (10.1)
Endometrioma	0	31	0	0	0	31 (20.9)
Serous cystadenoma	0	4	4	2	0	10 (6.8)
Mucinous cystadenoma	0	2	3	2	0	7 (4.7)
Cystadenofibroma	0	0	1	1	0	2 (1.4)
Other (tuboovarian abscess, uterine fibroma)	0	3	0	3	0	6 (4.1)
Malignant tumor n (%)	0	1 (4.7)	1 (4.7)	12 (50)	10 (41.7)	24 (16.2)
Borderline	0	0	1	2	1	4 (2.7)
Endométrioïd adenocarcinoma	0	0	0	3	1	4 (2.7)
Papillary serous adenocarcinoma	0	1	0	2	3	6 (4.1)
Mucinous adenocarcinoma	0	0	0	0	1	1 (0.7)
Clear cell adenocarcinoma	0	0	0	0	1	1 (0.7)
Invasive carcinoma	0	0	0	3	2	5 (3.5)
Carcinosarcoma	0	0	0	0	1	1 (0.7)
Non Hodgkin lymphoma	0	0	0	1	0	1 (0.7)
Metastasis	0	0	0	1	0	1 (0.7)

The principal objective of our study was to validate the ADNEX MR scoring system on an independent set of patients.

## Materials and methods

We performed a single site retrospective study between May 1, 2012 and August 31, 2014. We included all patients undergoing surgery for a pelvic gynecological pathology at Poissy-Saint Germain Hospital.

Pathological examination findings for the fallopian tubes and ovaries were available and all patients underwent a preoperative imaging assessment, including pelvic MRI, of at least the ovaries and the fallopian tube.

The score enhancement curves correspond to variations in signal increase in the solid tissues analyzed by dynamic contrast MRI, compared to the myometrial signal used as a reference. Indeed, the myometrium is highly vascularized and the perfusion sequences reflect the level of neo-angiogenesis [12,15] such that these curves provide information about the tendency to malignancy of the solid tissues (Fig. 1). The type 1 curves show progressive enhancement without a peak. The type 2 curves show moderate enhancement with a peak followed by a plateau. The type 3 curves show intense enhancement earlier than those for the myometrium.

The Comité d'Ethique de la Recherche en Gynécologie et Obstétrique (CEROG) approved this study, with the visa n°2015-0104.

## MRI

The MRI findings were re-read by two senior radiologists, with a specialty in pelvic imaging, who had no knowledge of the histology results (PL & OL). They classified the adnexal masses according to the ADNEX MR score (Table 1) [14]. Patients presenting bilateral masses were classified according to the more serious of the two.

## Statistical analysis

The predicted benign or malignant character of the adnexal masses determined by MRI was compared to the definitive histological diagnosis. Borderline ovarian tumors were classified as malignant. An ADNEX MR score equal to or greater than 4 was considered to be suspect or malignant. We calculated the

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