MRI Radiological Patterns in Ovarian Tumours: A Pilot Study at LASUTH

Adegboyega[1*] OA, Olumodeji[4] AM, Rabiu[3] KA, Kuye-Kuku[3] TO, Oladimeji[2] IA.

[1]Department of Radiology, Lagos State University College of Medicine, Lagos State, Nigeria.
[2]Department of Radiology, Lagos State University Teaching Hospital, Lagos State, Nigeria.
[3]Department of Obstetrics and Gynaecology, Lagos State University College of Medicine, Lagos State, Nigeria.
[4]Department of Obstetrics and Gynaecology, Lagos State University Teaching Hospital, Lagos State, Nigeria.

Abstract

Objective: To evaluate the reliability of pre-operative Magnetic Resonance Imaging (MRI) in predicting operative and pathological outcomes of ovarian tumors in a Nigerian population (LASUTH).

Methods: A retrospective cross-sectional study was conducted at Lagos State University Teaching Hospital, Nigeria, between 2019 and 2024. The MRI, intraoperative, and histopathological results, from 87 patients with ovarian tumours were abstracted from the electronic archives of the Departments. Then, descriptive statistics and Pearson chi-square tests were used with significant levels expressed as $p \leq 0.05$.

Results: The mean age of the patients was 45.66 years, with the majority (70.1%) between 36-53 years. The most common MRI diagnosis was multiseptated cystic mass (34.5%), followed by adnexal multiloculated mass (19.5%). High correlations were seen between MRI and histopathology: mucinous cystadenoma with endometriotic cyst (100%), multilobulated solid/cystic mass with borderline serous cystadenoma (20.8%), ovarian cysts with simple benign cysts (80%), and multiseptated cystic masses with borderline serous cystadenoma (79.2%). Adnexal multiloculated masses were intraoperatively linked with bilateral adnexal masses (100%), bilateral mesenteric masses with ovarian mass with adhesions (54.2%), and multiseptated cystic masses with ovarian cystic mass with adhesions (92.3%). Distribution of age was 100% of multilobulated solid/cystic masses and mucinous cystadenomas in the 18-35 years age group, and 100% of adnexal multiloculated masses in the 54-72 years age group.

Conclusion: Pre-operative MRI predicts the intraoperative/pathological outcomes of ovarian tumors in this Nigerian population. This study encourages similar studies with a larger sample in the future for validation and widening generalizability.

Keywords: MRI Radiological patterns, Ovarian Tumours, Intraoperative, histopathological, LASUTH

Introduction

Ovarian tumours, malignant and benign, are a significant health issue due to late detection of the tumour and high case fatality.[1] Non-specific patient presenting features make it more difficult to diagnose in the early stage, with diagnoses being made at a point of advanced disease when prognosis is abysmal in Nigeria.[2,3]

Notably, Magnetic Resonance Imaging (MRI) has now come to the forefront in evaluating and managing ovarian tumours, especially in complex situations when the report by ultrasound is inconclusive.[4] MRI is recognised to possess the greater ability to differentiate between benign and malignant lesions, being highly sensitive and specific through the use of advanced imaging techniques in the form of T1-weighted, T2-weighted, and diffusion-weighted imaging.[1]

MRI radiological patterns in ovarian tumours are the various imaging characteristics demonstrated by different ovarian tumours as evaluated by Magnetic Resonance Imaging (MRI).[5] Ovarian tumours are typically classified into three main categories: benign, borderline, and malignant, each with its characteristic radiological features which assist in diagnosis and treatment. The significance of such radiological patterns is that they can impact clinical management, such as surgery and chemotherapy decisions, especially for those seeking to preserve fertility.[2,4]

The large variation between tumour types is critical for accurate diagnosis. Benign tumours such as cystadenomas exhibit well-defined, thin-walled morphology on MRI, whereas borderline tumours are challenging to differentiate from their malignant counterparts based on similar imaging features. Surface epithelial neoplasms and germ cell tumours are malignant and exhibit complex cystic and solid morphology typical of cancer, and hence advanced imaging techniques like Dynamic Contrast-Enhanced MRI (DCE-MRI) are needed to facilitate accurate characterization.[5]

There are also controversies with the grading of certain tumors, i.e., serous cystadenomas containing focal borderline components and thus challenging to definitively diagnose. Also, MRI, while a wonderful modality, cannot differentiate between borderline and malignant tumor based on imaging criteria alone, which underscores the need to incorporate radiological findings with histopathology as well as possible intra-operative findings to offer the most optimal treatment strategies.[6-8]

Recently, the technological advancement of MRI and the incorporation of predictive biomarkers such as radiomics and radiogenomics have been valuable to enhance diagnosis and tailor therapeutic strategies in cases of ovarian tumours. Such new technologies will develop early diagnosis and intervention, and could radically redefine clinical outcomes to treat ovarian cancer.[9,10]

The objective of this study was to determine the reliability of pre-operative MRI imaging in indicating the surgical and pathological outcomes of ovarian tumors based on their radiological patterns.

Methodology
Study design and setting

A retrospective cross-sectional study design was employed for this study. The MRI reports from 100 patients with Ovarian tumours between 2019 and 2024 were abstracted from the electronic records of the Departments of Obstetrics and Gynaecology, and the Department of Radiology of the Lagos State University Teaching Hospital.

However, a total of 13 reports were excluded from this study for failure to meet the inclusion criteria because of records were incomplete and those managed withoutconservative surgery

Inclusion criteria

- Were diagnosed with ovarian tumours (benign or malignant).
- Have had surgical intervention for these tumours.
- Complete clinical, radiological, surgical, and histopathological records are available.

Exclusion criteria

- Patients were managed conservatively without surgery.
- Incomplete records.

Data management

Data was collected on paper and uploaded into a Google Form for proper record-keeping and password protection. Data was analyzed using a statistical package for the social sciences version 22.

Ethical consideration

This study protocol followed international and institutional ethical guidelines. The protocol was approved by the Health Research and Ethics Committee of the Lagos State University Teaching Hospital (REF I.D:LREC/06/10/2805).

Data Analysis

The data collected was processed using Microsoft Excel 2016. This study utilized the Statistical Package for Social Science (SPSS) Inc., Chicago, IL, USA, version 27.0 for the analysis. Pearson chi-square was used to examine the relationship between age on the MRI findings, with the level of significance set at $p \leq 0.05$

Result

This study comprised 87 patients who underwent MRI for suspected Gynecological pathology with a mean age of 45.66 years. The majority of patients (70.1%) belonged to the 36-53 age group, followed by 16.1% belonging to the 18-35 age group and 13.8% belonging to the 54-72 age group. The median age was 49 years, and this was also the modal age (Table 1).

The incidence of various ovarian-related abnormalities as observed using MRI was as follows: the most common was multiseptated cystic mass observed in 34.5% (n=30), followed by Adnexal multiloculated mass observed in 19.5% (n=17). Bilateral mesenteric mass, Multilobulated solid/cystic mass, and Ovarian cysts were some less common anomalies diagnosed by MRI and were observed occurring in 16.1% (n=14), 14.9% (n=13), and 13.8% (n=12), respectively. Nevertheless, Mucinous cystadenoma was the least common finding, present in 1.1% of patients (Figure 1).

Additionally, the relationship between Ovarian pathologies detected by MRI and Patients' age exhibited some relevant data as presented in Table 3. All multilobulated solid/cystic masses (100%) and mucinous cystadenomas (100%) occurred exclusively in the youngest age group (18-35 years). In the contrary, all of the adnexal multiloculated masses (100%) occurred within the age group 54-72 years. The group of middle age (36-53 years) presented a mixed range of findings in which multiseptated cystic masses predominated (49.2%), followed by mesenteric masses bilaterals (23%), and ovarian cysts (19.7%).

		Frequency	Percent (%)	Cumulative Percent (%)
Valid	18-35	14	16.1	16.1
	36-53	61	70.1	86.2
	54-72	12	13.8	100.0
	Total	87	100.0	
	Mean	45.66		
	Median	49.00		
	Mode	49		

In addition, the current study investigates the correlation between Ovarian pathologies on MRI and histopathology in 87 patients. A high and significant correlation was observed between Table 3 showed that Mucinous cystadenoma and multilobulated solid/cystic masses (100%, $p < 0.05$); Ovarian cysts and simple benign cysts (80%, $p < 0.05$); Multiseptated cystic masses and borderline serous cystadenoma (79.2%, $p < 0.05$). However, Adnexal multiloculated masses were most frequently correlated with "no evidence of malignancy" (61.5%), while Bilateral mesenteric masses correlated significantly with high-grade ovarian stromal sarcoma (57.1%, $p<0.05$). Table 4 shows the correlation between MRI and intraoperative findings. Adnexal multiloculated mass correlated significantly with bilateral adnexal mass (100%, $p<0.05$) as an intraoperative finding. Likewise, Bilateral mesenteric mass on MRI correlated well with ovarian mass with adhesions intraoperatively (54.2%, $p<0.05$). Multiseptated cystic mass on MRI correlated equally well with ovarian cystic mass with adhesions intraoperatively (92.3%, $p<0.05$). This suggests that a multiseptated cystic mass on MRI may be an excellent indicator for the surgical presence of an ovarian cystic mass with adhesions. Mucinous cystadenoma on MRI and Multilobulated solid/cystic mass was found to be only related to intraoperative findings: cyst (100%) and multilobulated solid/cystic mass, respectively, intraoperatively, although not statistically significant (Table 4).

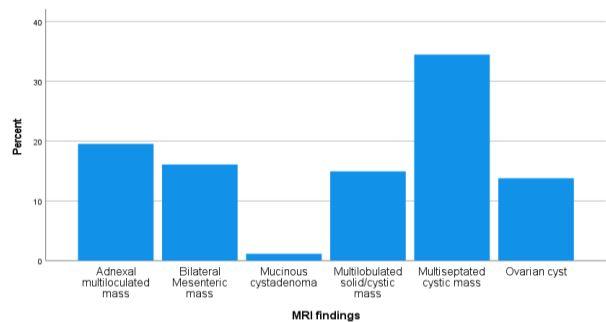**Table 1:** Descriptive Statistics on the Patients' Age

Figure 1: Descriptive Statistics of the MRI findings

Table 2: Relationship between MRI- revealed ovarian pathologies and Patients' Age

			Age 18-35	36-53	54-72	Total
MRI findings	Adnexal multiloculated mass	Count	0	5	12	17
		% within Age	0.0%	8.2%	100.0%	19.5%
	Bilateral Mesenteric mass	Count	0	14	0	14
		% within Age	0.0%	23.0%	0.0%	16.1%
	Mucinous cystadenoma	Count	1	0	0	1
		% within Age	7.1%	0.0%	0.0%	1.1%
	Multilobulated solid/cystic mass	Count	13	0	0	13
		% within Age	92.9%	0.0%	0.0%	14.9%
	Multiseptated cystic mass	Count	0	30	0	30
		% within Age	0.0%	49.2%	0.0%	34.5%
	Ovarian cyst	Count	0	12	0	12
		% within Age	0.0%	19.7%	0.0%	13.8%
Total		Count	14	61	12	87
		% within Age	100.0%	100.0%	100.0%	100.0%

Table 3. Relationship between MRI findings and Histopathological findings

			Histopathological findings Borderline serous cystadenoma	Endometriotic cyst	High-grade Ovarian Stromal Sarcoma	No evidence of Malignancy	Simple benign cyst	Total
MRI findings	Adnexal multiloculated mass	Count	0	0	1	16[a,c,e]	0	17
		Percent	0.0%	0.0%	4.8%	61.5%	0.0%	19.5%
	Bilateral Mesenteric mass	Count	0	0	12[a,d,e]	2	0	14
		Percent	0.0%	0.0%	57.1%	7.7%	0.0%	16.1%
	Mucinous cystadenoma	Count	0	1[a,c,d,e]	0	0	0	1
		Percent	0.0%	100.0%	0.0%	0.0%	0.0%	1.1%
	Multilobulated solid/cystic mass	Count	5	0	6[e]	2	0	13
		Percent (%)	20.8%	0.0%	28.6%	7.7%	0.0%	14.9%
	Multiseptated cystic mass	Count	19[c,d,e]	0	2	6	3	30
		Percent	79.2%	0.0%	9.5%	23.1%	20.0%	34.5%
	Ovarian cyst	Count	0	0	0	0	12[a,c,d]	12
		Percent	0.0%	0.0%	0.0%	0.0%	80.0%	13.8%
Total		Count	24	1	21	26	15	87
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The percent indicates the percent of the MRI findings within the Histopathological findings. Subscripts: 'a'; 'b'; 'c'; 'd'; 'e' denotes a subset of Histopathological findings categories whose column proportions differ significantly from Borderline serous cystadenoma; Endometriotic cyst; High-grade Ovarian Stromal Sarcoma; No evidence of Malignancy and Simple benign cyst, respectively at the .05 level.

Table 4. Relationship between MRI findings and Intraoperative findings

			Intraoperative findings						Total
			Ascitic Fluid with Cystic Mass	Bilateral Adnexal Mass	Bilateral Ovarian Mass	Cyst	Ovarian cystic mass with adhesions	Ovarian Mass with adhesions	
MRI findings	Adnexal multiloculated mass	Count	4	12 [a,f]	0	0	0	1	17
		Percent	17.4%	100.0%	0.0%	0.0%	0.0%	4.2%	19.5%
	Bilateral Mesenteric mass	Count	1	0	0	0	0	13 [a]	14
		Percent	4.3%	0.0%	0.0%	0.0%	0.0%	54.2%	16.1%
	Mucinous cystadenoma	Count	0	0	0	1	0	0	1
		Percent	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	1.1%
	Multilobulated solid/cystic mass	Count	0	0	13	0	0	0	13
		Percent	0.0%	0.0%	92.9%	0.0%	0.0%	0.0%	14.9%
	Multiseptated cystic mass	Count	16 [c]	0	1	0	12 [c,f]	1	30
		Percent	69.6%	0.0%	7.1%	0.0%	92.3%	4.2%	34.5%
	Ovarian cyst	Count	2	0	0	0	1	9 [a]	12
		Percent	8.7%	0.0%	0.0%	0.0%	7.7%	37.5%	13.8%
Total		Count	23	12	14	1	13	24	87
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The percent indicates the percent of the MRI findings within the intraoperative findings. Superscripts: 'a'; 'b'; 'c'; 'd'; 'e' denotes a subset of intraoperative findings categories whose column proportions differ significantly from Ascitic Fluid with Cystic Mass; Bilateral Adnexal Mass; Bilateral Ovarian Mass; Cyst; Ovarian cystic mass with adhesions and Ovarian Mass with adhesions, respectively at the .05 level.

Discussion

The mean patient age of 45.66 years with a peak age range of 36-53 years, providing an appropriate setting against which the MRI findings mentioned in suspected gynaecological pathology can be analyzed. This corresponds to the age range during the peri-menopausal stages of life when shifts in hormones and pathological processes occur more frequently.[11]

The frequency of multiseptated cystic masses in our series is noteworthy. Multiseptate cystic masses are commonly encountered with benign pathology, but may also be reflective of more sinister pathologies such as mucinous tumors or borderline ovarian tumors,[12] particularly in Africa where there may be limited access to early screening and diagnosis and late presentation with the gynaecological disease is common.[13] However, it contrasts with findings reported from the developed world where early diagnosis following routine screening typically results in the identification of smaller, less complex cystic lesions.[14]

Relatively high incidence of adnexal multiloculated masses can be attributed to hydrosalpinx, tubo-ovarian abscesses, or neoplastic processes and untreated pelvic inflammatory disease (PID).[15,16] Moreover, the low incidence of mucinous cystadenomas in our study suggests that Mucinous tumours are comparatively not a common clinical symptom in ovarian tumours, but their incidence can vary depending on geographical and ethnic considerations.[17,18]

The age-related distribution of MRI appearance may reflect natural differences in etiology, pathogenesis, and disease course in various age categories of gynecological illness. Zhang et al. observed an accompanying trend in one study and illustrated that young women were found with benign cystic masses more frequently.[19] In comparison, older women were more frequently associated with solid masses and malignancy. This is consistent with our findings, suggesting a possible change in age with the type of gynecological pathologies encountered.[20]

However, our findings are contrary to a study by Ajani et al. in Nigeria, where no correlation was found between age and the type of ovarian pathology.[21] This may be because of differences in study design, sample size, and the type of pathologies examined.

This study uncovered the variable correlation between Pre-operative MRI image and intraoperative findings such as the significance between adnexal multiloculated mass on MRI

and bilateral adnexal mass (100%, p<0.05) as an intraoperative finding, showed a high likelihood of having a bilateral adnexal mass intraoperatively when there is an adnexal multiloculated mass on pre-operative MRI. This finding agrees with Aswini et al. research that MRI had accurately predicted the occurrence of bilateral adnexal masses with accuracy, sensitivity, and specificity values of 95%, 98%, and 93%, respectively.[22]

Similarly, a bilateral mesenteric mass and multiseptated cystic mass shown by MRI revealed a significant correlation in intraoperative ovarian mass with adhesions and ovarian cystic mass with adhesion, respectively.

This indicated that bilateral mesenteric mass and multiseptated cystic mass are reliable predictors for intraoperative ovarian mass with adhesions and ovarian cystic mass with adhesion, respectively.[23,24]

Limitations
In general, these observations corroborate the mounting evidence indicating that MRI can contribute useful diagnostic information to surgical planning in gynaecological patients. The strong correlations seen between particular MRI findings and intraoperative observations confirm the role of MRI as an aid in guiding surgical decisions and enhancing patient outcomes.

Recommendations
The limitations such as limited funds from the patients to perform surgeries and improper recording of patients' information resulting in lost data. As such, there is a need for additional studies with larger samples and diverse patients to confirm these findings and test the generalizability of our results.

References
1. Sahu SA, and Shrivastava DA, Comprehensive Review of Screening Methods for Ovarian Masses: Towards Earlier Detection. Cureus. 2023; 15(11) :48534. doi: 10.7759/cureus. 48534.
2. Sanni D, Soyemi S, Popoola O, and Rabiu K, Morphological spectrum and epidemiological profile of ovarian tumours in black West African women at Lagos State University Teaching Hospital, Ikeja, Nigeria. Int J Forensic Med Invest. 2020; 8(6), 2067–2073. https://doi.org /10 .18203/2320- 6012.ijrms20202245
3. Ayogu M, Abdullahi H, andEze I. Incidence, characteristics, pattern, and management of ovarian cancer in Abuja, Nigeria. Int J Forensic Med. Invest.2020; 8(9), 3187–3193. https://doi.org/10. 18203/2320-6012.ijrms20203665
4. Saida T, Mori K, Hoshiai S, Sakai M, Urushibara A, Ishiguro T, Minami M, Satoh T, and Nakajima T. Diagnosing Ovarian Cancer on MRI: A Preliminary Study Comparing Deep Learning and Radiologist Assessments. Cancers. 2022;14(4):987. doi: 10.3390/ cancers 14040987.
5. Foti PV, Attinà G, Spadola S, Caltabiano R, Farina R, Palmucci S, Zarbo G, Zarbo R, D'Arrigo M, Milone P, and Ettorre GC. MRI imaging of ovarian masses: classification and differential diagnosis. Insights Imaging. 2016;7(1):21-41. doi: 10.1007/s13244-015-0455-4.
6. Shaaban AM, Rezvani M, Elsayes KM, Baskin H Jr, Mourad A, Foster BR, Jarboe EA, and Menias CO. Ovarian malignant germ cell tumors: cellular classification and clinical and imaging features. Radiographics. 2014; 34(3) :777-801. doi: 10.1148/rg.343130067.
7. Chung WJ, Chung HW, Shin MJ, Lee SH, Lee MH, Lee JS, Kim MJ, and Lee WK. MRI to differentiate benign from malignant soft-tissue tumours of the extremities: a simplified systematic imaging approach using depth, size and heterogeneity of signal intensity. Br J Radiol. 2012;85(1018):831-6. doi:10.1259/bjr/27487871.
8. Jalili A, and Afzali N. Diagnostic Value of MRI Compared to Histopathological Results in Differentiating Benign from Malignant Ovarian Masses. Maedica (Bucur). 2024;19(1):4-8. doi: 10.26574/maedica.2024.19.1.4.
9. Chaddad A, Tan G, Liang X, Hassan L, Rathore S, Desrosiers C, Katib Y, and Niazi T.Advancements in MRI-Based Radiomics and Artificial Intelligence for Prostate Cancer: A Comprehensive Review and Future Prospects. Cancers (Basel). 2023;15(15):3839.doi: 10.3390/cancers15153839.

10. Zeng S, Wang XL, andYang H. Radiomics and radiogenomics: extracting more information from medical images for the diagnosis and prognostic prediction of ovarian cancer. Mil. Med Res 2024; 11:77.doi: 10.1186/s40779-024-00580-1.

11. Ceylan B, and Özerdoğan N. Factors affecting age of onset of menopause and determination of quality of life in menopause. Turk J Obstet Gynecol.2015;12(1):43-49.doi:10.4274/tjod.79 836.

12. Wasnik AP, Menias CO, Platt JF, Lalchandani UR, Bedi DG, and Elsayes KM. Multimodality imaging of ovarian cystic lesions: Review with an imaging based algorithmic approach. World J Radiol. 2013; 5(3): 113-25. doi: 10.4329/ wjr. v5.i3.113.

13. Adamou N, and Umar U. Delayed Presentation of Patients with Gynaecological Malignancies in Kano, North-Western Nigeria. Open J. Obstet. 2015; 5:333-340. Doi: 10.4236/ojog. 2015.56048.

14. Elias KM, Guo J, and Bast RC. Early Detection of Ovarian Cancer. Hematol Oncol Clin North Am. 2018; 32(6): 903-914. doi: 10.1016/j.hoc. 2018.07.003.

15. Kelleher CM, and Goldstein AM.Adnexal masses in children and adolescents. Clin Obstet Gynecol. 2015; 58(1): 76-92.doi: 10.1097/GRF .0000000000000084.

16. Bennett JA, and Oliva E. Pathology of the adnexal mass. Clin Obstet Gynecol. 2015; 58(1): 3-27.doi:10.1097/GRF.0000000000 00082.

17. Prat J, D'Angelo E, and Espinosa I. Ovarian carcinomas: at least five different diseases with distinct histological features and molecular genetics. Hum Pathol 2018; 80: 11–27. doi:10.1016/j.humpath.2018. 06.018.

18. Zhang Y, Li C, Luo S, Su Y, Gang X, Chu P, Zhang J, Wu H, and Liu G. Retrospective Study of the Epidemiology, Pathology, and Therapeutic Management in Patients with Mucinous Ovarian Tumors. Technol Cancer Res Treat. 2020;19:1533033820946423.doi: 10.1177/1533033820946423.

19. Zhang B, Zhang L, and Meng G. Clinical analysis of 52 adolescent patients with ovarian masses ≥10 cm in diameter. J Int Med Res. 2021 ;49(8): 3000605211032781 .doi: 10.1177/03 000605211032781.

20. Buhari M, Ojo B,Ijaiya M,and Aboyeji A. Ovarian Cancers in Ilorin, Nigeria-a Review of Over 80 Cases. Nig. Q. J. Hosp. Med.. 2005; 15:10 (4)31-4. Doi: 10.4314/nqjhm. v15i3. 12772.

21. Ajani MA, Salami A, Awolude OA, and Oluwasola AO. Hormone-receptor expression status of epithelial ovarian cancer in Ibadan, South-western Nigeria. Pan Afr Med J. 2017;27:25-9. doi: 10.11604/pamj. 2017.27.259.11883.

22. Guerra A, Cunha TM, and Félix A. Magnetic resonance evaluation of adnexal masses. Acta Radiol. 2008; 49(6): 700-9. doi: 10.1080/0284 1850802064995.

23. Medeiros LR, Rosa MI, Silva BR, Reis ME, Simon CS, Dondossola ER, and da Cunha Filho JS.Accuracy of magnetic resonance in deeply infiltrating endometriosis: a systematic review and meta-analysis. Arch Gynecol Obstet. 2015;291(3):611-21. doi: 10.1007/s00404-014-3470-7.

24. Mitchell S, Gleeson J, Tiwari M, Bailey F, Gaughran J, Mehra G, Muallem MZ, andSayasneh A. Accuracy of ultrasound, magnetic resonance imaging and intraoperative frozen section in the diagnosis of ovarian tumours: data from a London tertiary centre. BJC Rep 2024; 2(1): 50. doi: 10.1038/ s44276-024-00068-4.