Original Research Article

Role of multi-detector computed tomography in the detection and differentiation of adnexal mass lesions

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ABSTRACT

Background: The objective of this study was to evaluate the role of multi-detector computed tomography (MDCT) in the detection and differentiation of adnexal masses using post-operative histopathology findings as the gold standard.
Methods: One hundred and forty five cases that were referred with a primary diagnosis of adnexal masses on clinical or USG examination were evaluated by MDCT in the Department of Radiodiagnosis from January 2013 to December 2013. One hundred twelve cases subsequently underwent surgical exploration and histopathological examination, which was used as a control for the evaluation of MDCT findings, were included in this study.
Results: Majority (54.5%) of the patients were in the age group of 31-50 years. MDCT detected adnexal masses as malignant in 56 cases, while in other 56 cases it read adnexal masses as benign. Final histopathology revealed adnexal masses in 57 (51%) cases as malignant while in 55 (49%) cases as benign. There were three cases which on MDCT appeared as malignant were subsequently found to be benign in histopathology. Similarly there were four cases which on MDCT appeared as benign were subsequently proved to malignant in histopathology. The sensitivity, specificity, Positive predictive value and negative predictive value of MDCT for diagnosing a malignant adnexal mass was 93.0%, 94.5%, 94.6% and 92.8% respectively. MDCT findings more predictive of malignancy were solid or cystic-solid mass, necrosis in a solid lesion, cystic lesion with thick, irregular walls or septa, and/or with papillary projections. The presence of ascites, peritoneal metastases, and lymphadenopathy were also helpful to confirm malignancy.
Conclusions: MDCT is an excellent and accurate non-invasive modality in the detection and characterization of adnexal masses from benign and malignant.

Keywords: Adnexal mass, Benign, Computed tomography, Malignant, Sensitivity, Specificity

INTRODUCTION

Adnexal masses represent a spectrum of conditions from gynecologic and nongynecologic sources. They may be benign or malignant. Ovarian cancer is the leading cause of death from gynecologic malignancy. It is the fifth leading cause of cancer death in the United States among female population.[1,2] The risk of ovarian cancer increases steadily with age with the greatest risk occurring after menopause. There is a 1.42 percent lifetime risk of dying from ovarian cancer.[2]

When ovarian cancer does occur, it tends to do so in prepubescent girls and in post-menopausal women.

Although most masses in prepubescent girls are benign, 5 to 35 percent are malignant.[3-7] Small (less than 2 cm) functional cysts can develop in newborns, but these are related to maternal hormones and usually regress during the first months of life.[4,8] Ovarian cancer is rare in premenopausal women. Other etiologies, such as functional cysts, leiomyomata, and ectopic pregnancy, are more common and can cause significant morbidity. In pregnant women, the most common cause of an adnexal mass is a corpus luteum cyst. In nonpregnant patients, the most common etiologies are functional cysts and leiomyomata.[9] In postmenopausal women, 30 percent of adnexal masses are malignant.[10]

The goal of evaluation is to differentiate between benign and more serious conditions, such as ovarian cancer. While the diagnosis may be delayed because of unspecified symptoms, appropriate treatment plan will be achievable with deliberate staging of the tumor and will follow by a better outcome.[11] The presence of an adnexal mass is the leading indications for gynecologic surgery, but the characterization of clinically diagnosed ovarian masses is frequently not possible until surgery and histopathologic examination have been performed. In most institutions the type of surgery (laparotomy vs. laparoscopy) depends on the probability of malignancy, which is based mostly on imaging appearance.[12,13]

Putting together with a thorough observation, physical examination and characteristics of the mass will give valuable information about its nature.[14,15] Afterward, several invasive and non-invasive paraclinical evaluations can provide additional information.[16,17]

Computed tomography of abdomen and pelvic can depict the adnexal masses as well as probable local or regional invasions. Additionally, it can differentiate gastrointestinal tract, urinary tract and reproductive malignancy from each other using contrast materials. Multidetector computed tomography (MDCT) makes multiplanar evaluation of pelvic and abdominal structures available as well as two- or three-dimensional illustrations.[18] Further given details about the extension of the tumors particularly improves the treatment plan and outcome.

The 16-slice MDCT can provide high quality images of surrounding organs like diaphragm, paracolic gutters and intestine which defines patients who will benefit neo-adjuvant chemotherapy before debulking.[19] Although the diagnostic accuracy of spiral CT and its axial views for nature and extension of the adnexal masses are reported, local data regarding mass evaluation by MDCT are scarce.[20] For better evaluation of adnexal masses to differentiate between benign and more serious conditions, such as ovarian cancer this study was undertaken in the Department of Radio-diagnosis, Patna Medical College Hospital, Patna, with the objectives to evaluate the role of multi-detector computed tomography (MDCT) imaging in characterizing adnexal masses and to co-relate the diagnostic value of MDCT with post-operative histopathology findings in the detection and differentiation of adnexal masses.

METHODS

This was a prospective hospital based analytic-descriptive study conducted during the period from 1st January 2013 to 31st December 2013 in the department of Radio-diagnosis, Patna Medical College Hospital, Patna, India. All patients with clinically or ultrasonographically detected adnexal masses who were referred from Obstetrics and Gynaecology department for MDCT evaluation and subsequently underwent surgical exploration and histopathological examination were included for this study. One hundred and forty five cases that were referred with a primary diagnosis of adnexal masses on clinical or USG examination were evaluated by MDCT in the Department of Radio diagnosis. Excluded from the study were patient with adnexal mass who did not undergo surgical exploration and histopathological evaluation, adnexal masses <6cm with clear cyst in reproductive age women, non gynaecological origin of adnexal masses, Poly Cystic Ovarian Syndrome ectopic pregnancy and critically ill patients. Institutional ethical committee approval was obtained. A written informed consent was obtained from all the participants.

MDCT protocol

At first patients' brief history and physical examination findings any were noted down from patients' case sheet before MDCT imaging and recorded on a predesigned and pre-tested proforma.

All MDCT were performed on GE Bright Speed 16 Slice CT scan machine in the department of Radiodiagnosis, Patna Medical College Hospital. Image scanning parameters were as follows: rotation time 1 second, table speed 15.4 mm/rotation, reconstruction interval 0.6 mm at Kernel H20, 120 kV/260 mAs, and acquisition time 9s.

MDCT images were obtained from the abdomen and pelvic, covering the area from the diaphragm to the symphysis pubis (craniocaudal). All scans were done with a standard protocol using the triple phase. Precontrast scan of the upper abdomen; arterial phase using the automatic.

Bolus tracking system

Portal phase yielded with a delay of 60 s after the arterial one. The contrast medium (iohexol) was administered at a dose of 1.5 mL per kg, with a variable flow rate of 3-4 mL per second through the antecubital vein of the right arm.

To facilitate the differentiation of calcified peritoneal implants from bowel loops, 500 ml of water was

administrated 30 min prior to the examination. Although it may be difficult to recognize small peritoneal implants and distinguishing them from bowel loops, a careful evaluation of multiplanar reformatted (MPR) images usually enables this differentiation. All patients were fixed during MDCT examination to prevent motion artifacts.

MDCT images were initially interpreted at work station and later on reviewed by an experienced consultant radiologist. MDCT findings used to diagnose malignancy were: diameter greater than 4 cm, presence of masses bilaterally, cystic-solid mass, necrosis in a solid lesion, cystic lesion with thick, irregular walls or septa and/or with papillary projections. Presence of ascites, peritoneal metastases and lymphadenopathy were used to confirm malignancy.

Histopathological co-relation

An experienced pathologist examined all the resected specimens with no knowledge of the MDCT findings. The histopathological findings were considered as a control for the evaluation of MDCT findings in adnexal mass.

Statistical analysis

The collected data were thoroughly checked, then entered in an Excel spreadsheet (Microsoft, Redmond, WA, USA) for analysis. The method consisted of transcription, preliminary data inspection, and interpretation. Data were analyzed using GraphPad Instat version 3 (GraphPad Software, La Jolla, CA, USA). Results are presented as number and percentages. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for MDCT were calculated in comparison with histopathological findings.

RESULTS

One hundred and forty five cases that were referred with a primary diagnosis of adnexal masses on clinical or USG examination were evaluated by multidetector computed tomography (MDCT) of which 112 (77.2%) patients met the inclusion criteria and were considered for final analysis.

Table 1: Age distribution of cases.

Age (Years)	Number (n)	Percentage (%)
<21	8	7.1
21-30	14	12.5
31-40	28	25.0
41-50	33	29.5
51-60	20	17.9
>61	9	8.0
Total	**112**	**100.0**

Among the patients majority (54.5%) were in the age group of 31-50 years (Table1). Most common presentation were pain abdomen and/pelvic pain (76%) followed by mass abdomen and/distension of abdomen (59%). Many patients presented with multiple complaints. Fifteen percent patients' were asymptomatic.

Table 2: Distribution of adnexal masses as benign and malignant as detected by MDCT.

Type	Number (n)	Percentage (%)
Benign	56	50
Malignant	56	50
Total	**112**	**100.0**

Table 3: MDCT diagnosis of adnexal mass lesions.

Diagnosis	Number (n)	Percentage (%)
Left benign ovarian cyst	24	21.4
left malignant ovarian tumour	23	20.5
Right malignant ovarian tumour	18	16.1
Right benign ovarian cyst	17	15.2
B/L malignant ovarian tumour	15	13.4
Right dermoid cyst	8	7.1
B/L benign ovarian tumour	4	3.6
Left dermoid cyst	2	1.8
B/L haemorrhagic ovarian cyst	1	0.9
Total	**112**	**100.0**

Table 4: Distribution of adnexal masses as benign and malignant as diagnosed in histopathology.

Type	Number (n)	Percentage (%)
Benign	55	49.1
Malignant	57	50.9
Total	**112**	**100.0**

MDCT evaluation revealed adnexal masses were unilateral in maximum (82%) cases while in 18% cases they were bilateral. In most (51%) of the cases, adnexal masses were cystic and in 18% cases adnexal masses were solid, while in 31% cases both cystic-solid components were observed. Most of the adnexal masses were thin walled (52%) having necrosis (57%) and absent septation (54%). Papillary projections in the adnexal masses were observed only in 36% cases, while in 64% adnexal masses papillary growths were absent. Thirty four percent patients had ascites. MDCT detected adnexal masses as malignant in 56 cases, while in other 56 cases it read adnexal masses as benign (Table 2). Common MDCT diagnosis of adnexal mass lesion included left benign ovarian cyst (21.4%), left malignant ovarian tumour (20.5%), right malignant ovarian tumour

(16.1%), right benign ovarian cyst (15.2%), bilateral malignant ovarian tumour (13.4%) and right dermoid cyst (7.1%) (Table 3).

Table 5: Histopathological diagnosis of adnexal mass lesions.

Histopathological diagnosis	Number (n)	Percentage (%)
Serous cyst adenocarcinoma	30	26.8
Serous cyst adenoma	29	25.9
Mucinous cyst adenocarcinoma	17	15.2
Mucinous cyst adenoma	8	7.1
Mature cystic teratoma	10	8.9
Malignant dysgerminoma	5	4.5
Paraovarian cyst	5	4.5
Immature teratoma	4	3.6
Endometrioma	2	1.8
Non-gestational ovarian Choriocarcinoma	1	0.9
Congested serous cyst adenoma	1	0.9
Total	**112**	**100.0**

Of the 112 cases, final histopathology revealed adnexal masses in 57 (51%) cases as malignant while in 55 (49%) cases as benign (Table 4). The common benign masses included serous cystadenoma (29), mature cystic teratoma (10) and mucinous cyst adenoma (8). The common malignant lesions were serous cyst adenocarcinoma (30), mucinous cyst adenocarcinoma (17) and malignant dysgerminoma (5) (Table 5).

There were three cases which on MDCT appeared as malignant were subsequently found to be benign in histopathology (false positives). One case had solid component with papillary projections and necrosis, while other two had both cystic and solid component with septations and necrosis. All the three cases had ascites as an ancillary finding which lead us to an erroneous diagnosis as malignant.

Similarly there were four cases which on MDCT appeared as benign were subsequently proved to malignant in histopathology (false negatives).

In two cases adnexal masses were thin walled unilocular cystic mass without any evidence of hameorrhage or necrosis were found to be serous cyst adenocarcinoma on histopathology. One well defined adnexal mass with cystic-solid component and fat deposits diagnosed as mature teratoma were found to be immature teratoma in histopathology, while the other cases was found to be a mucinous cystadenocarcinoma on histopathology.

Table 6: Sensitivity, specificity, positive predictive value and negative predictive value of MDCT in the detection and differentiation of adnexal mass lesions.

MDCT diagnosis	Histopathological diagnosis		Total
	Malignant	Benign	
Malignant	53	3	**56**
Benign	4	52	**56**
Total	**57**	**55**	**112**
	Sensitivity	93.0%	
	Specificity	94.5%	
	Positive predictive value (PPV)	94.6%	
	Negative predictive value (NPV)	92.8%	
	False negatives	7.0%	
	False positive	5.5%	

The specificity, i.e. ability of MDCT to identify correctly those adnexal masses that are not malignant (i.e. true negatives) was high, 94.5% in our study. The Sensitivity, i.e. ability of MDCT to identify correctly those adnexal masses which are malignant (i.e. true positives) was 93% in the present study. Negative Predictive Value, i.e. the probability that a patient with adnexal mass found to be benign on MDCT, in fact will not have malignancy on histopathology was 92.8% in this study. Positive Predictive Value i.e. the probability that a patient with adnexal mass found to be malignant on MDCT will have, in fact malignancy on histopathology was found to be 94.6% in our study. False Negatives of MDCT i.e. those cases with adnexal masses which were malignant (on histopathology) but were not detected (i.e. shown as benign) by MDCT was low (7%) in our study. False Positives i.e. those cases with adnexal masses which were benign (on histopathology) but were shown malignant by MDCT was also low (5.5%) in this study (Table 6).

DISCUSSION

An adnexal mass may be found in women of all ages and they are one of the leading causes of death in industrialized countries among female population. Prevalence of ovarian malignancy in prepubertal girls

varies 5-35%, while in postmenopausal women approximately 30% adnexal masses are malignant.[3-7,10]

Precise characterization of an adnexal lesion is important as it dictates further management; hence, the role of radiology is very important. Until the last decade, exploratory laparotomy was used for the diagnosis and staging of adnexal masses, however, modern imaging techniques have demonstrated similar accuracy in the diagnosing and staging of ovarian carcinoma. Ultrasound is the first line modality to evaluate adnexal pathologies, however, most of the time it is unable to differentiate between benign and malignant lesions and the extent of disease in malignant cases. Sometimes when conventional ultrasound reveals complex morphology then other diagnostic tools can be used. CT is the investigation of choice in planning further management in patients believed to have metastatic disease. Multidetector computed tomography also allows comprehensive evaluation of primary tumour and the site of peritoneal metastasis and lymphadenopathy. On CT scan, masses can be characterized and features pertaining to benignity and malignancy can be observed.[21]

Patients with ovarian cancer present with nonspecific symptoms. The most common symptoms reported by women with ovarian cancer are pelvic or abdominal pain; increased size of the abdomen.[1,9] In our study 76% patients presented with pelvic and abdomen pain followed by abdominal distension (59%). Fifteen percent patients were asymptomatic.

There were three cases which on MDCT appeared as malignant were subsequently found to be benign in histopathology (false positives). Similarly there were four cases which on MDCT appeared as benign were subsequently proved to malignant in histopathology (false negatives).

Several studies have suggested that MDCT can play an important role in characterizing ovarian masses, emphasizing the comparability of CT to other imaging modalities such as magnetic resonance imaging or USG. The sensitivity of morphologic analysis with MDCT in predicting ovarian malignancy has been shown to be 80-97%, where as its specificity ranged from 85-97%.[22-30] The sensitivity and specificity of MDCT for diagnosing a malignant adnexal mass was 93.0% and 94.5%, respectively in this study compared to gold standard histopathological evaluation of post-operative specimens.

Our results are comparable to previously reported international literature (Table 7). A study conducted by Gatreh-Samani et al, described sensitivity and specificity of MDCT to be 92.8% and 88.0% respectively when used for indeterminate masses seen on USG.[28] Tsili et al, also reported the sensitivity of the16-slice MDCT to be 90% and accuracy of 89.1% for detecting malignant tumors in patients with an adnexal mass.[23] However, higher

sensitivity (90.5%) and accuracy (92.9%) were reported by the same MDCT imaging method later.[25]

Table 7: Sensitivity, specificity, PPV and NPV of MDCT in differentiation of adnexal masses by different studies.

Author	Sensitivity	Specificity	PPV	NPV
Byrom et al[20]	90%	85%	85%	-
Tsili et al[26]	90.5%	93.7%	-	-
Firoozabadi et al[27]	79.2%	91.6%	-	-
Mubarak et al[21]	97.3%	91.6%	97.3%	91.6%
Gatreh-Samani al[28]	92.8%	88.0%	95.5%	81.4%
Khattak et al[29]	92.0%	86.7%	94.5%	86.7%
Khalda E*	93.0%	94.5%	94.6%	92.8%

*Present study

Positive predictive value (PPV) and negative predictive value (NPV) in our study was 94.6% and 92.8% respectively. Gatreh-Samani et al, also described 95.5% PPV and 81.4% NPV in their study (Table 7).[28]

Our study shows high sensitivity (93%) and specificity (94%) of MDCT evaluation of adnexal masses, however, there were three false positive and four false negative results. Lesions characterized as benign have imaging characteristics similar to benign lesions, i.e., smooth walls without thick septations, making evaluation of these tumors difficult. Similarly, regarding false positive results, these lesions have characteristics of malignant lesions, i.e., solid lesions or solid components with necrosis, image appearance of involvement to adjacent organs and the presence of ascites. These features make it difficult to recognize on images, resulting in false positive and negative results. Other possibilities include interpretation error or not using reformatted images properly.

The results of the present study describe the significant agreement between MDCT and histopathology in detection and differentiation of adnexal masses. Also, it has been demonstrated that MDCT have high efficacy and accuracy in defining the nature of a pelvic mass and detecting extension of malignant tumours which could be very useful in planning of treatment.

The sensitivity, specificity, positive and negative predictive value of CT has some potential limitations which are the topic of today researches to be improved. The sensitivity of CT for detecting peritoneal metastasis is reported about 85-93%, while it decreases to 20-25% when the metastasis is lesser than 1 cm in diameter. This may be minimized by thinner slices, loss of artefacts due to partial volume effect and multiplanar reformatting which makes it possible to evaluate bending planes as well.[25]

Our study has a few limitations. Besides the small number of samples, only those patients who were referred for MDCT evaluation were included, which introduces bias. No inter-observer agreement for MDCT images evaluation was calculated.

CONCLUSION

MDCT is an excellent and accurate non-invasive modality in the detection and characterization of adnexal masses from benign and malignant with high sensitivity and specificity. Further research with large number of subject is recommended to remove the potential limitations in detecting smaller peritoneal metastasis and inter-observer agreement evaluation.

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