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Role of ultrasound and color Doppler in diagnosis of ectopic pregnancy and to differentiate from corpus luteum cyst of pregnancy

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ABSTRACT

Background: Ectopic pregnancy is the leading cause of direct maternal deaths. Ectopic pregnancy and corpus luteum cyst are two most common differential diagnoses in a patient with urine pregnancy test (UPT) positive and no sonographic evidence of intrauterine pregnancy. Internal echotexture and color Doppler features of the cyst wall are also considered in an attempt to differentiate the tubal ring of an ectopic pregnancy from that of a corpus luteum. **Aims and Objectives:** The aim of this study was to diagnose the presence of ectopic pregnancy and to differentiate ectopic pregnancy from corpus luteum cyst using grayscale ultrasound and color Doppler findings. **Materials and Methods:** The prospective study was conducted in 46 patients who were referred to the Department of Radiodiagnosis in R.L Jalappa Hospital with UPT positive and clinical features suggestive of ectopic pregnancy. **Results:** Out of 46 patients, 33 were diagnosed with ectopic pregnancy and 13 with corpus luteum cyst. Ectopic pregnancies had thicker walls as compared to corpus luteum cysts. Most of the ectopic pregnancies had hyperechoic walls as compared to ovaries (63.6%) and endometrium (60.6%). Free fluid with echoes was seen in the pelvis in 59.4% ectopic pregnancies whereas most of the corpus luteum cysts (69.2%) had no free fluid. Most of the corpus luteum cysts (61.5%) had clear internal echotexture whereas ectopic pregnancies were mostly lacy or solid. Yolk sac was seen exclusively in ectopic pregnancy (30.3%). RI 0.7 was found to be highly specific for diagnosing ectopic pregnancy. **Conclusion:** Significant ultrasound parameters that aid in differentiating between the two include the thickness of the mass's wall, the wall's echogenicity in relation to the ovary and endometrium, the internal echotexture of the cystic mass, the presence of the yolk sac, and the presence of free fluid with echoes. It was shown that RI 0.7 has a very good specificity in identifying ectopic pregnancy.

Key words: Luteum cyst; Ectopic pregnancies; Thickness

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INTRODUCTION

Ectopic pregnancy is the leading cause of direct maternal deaths.[1] Ectopic pregnancy and corpus luteum cyst are two most common differential diagnoses in a patient with urine pregnancy test (UPT) positive and no sonographic evidence of intrauterine pregnancy. Internal echotexture and color Doppler features of the cyst wall are also considered in an attempt to differentiate the tubal ring of an ectopic pregnancy from that of a corpus luteum.[2,3]

Color Doppler flow is seen as a ring of peripheral vascularity surrounding the adnexal structure. This is common to both ectopic pregnancy and corpus luteum cyst. In addition to searching for a vascular ring in the adnexa, measurements

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of the spectral Doppler pattern can be used to diagnose the presence of an ectopic gestation.[4]

A clinical dilemma arises in a pregnant patient without any sonographically evident intrauterine pregnancy and a thick-walled adnexal cystic structure without definite visualization of the ipsilateral ovary.[5] In a patient with no identifiable intrauterine pregnancy, it becomes extremely important to differentiate ectopic pregnancy from corpus luteum cyst of pregnancy.

Aims and objectives

This research aim has been to diagnose the presence of "ectopic pregnancy and to differentiate ectopic pregnancy from corpus luteum cyst using grey scale ultrasound and color Doppler findings.

MATERIALS AND METHODS

Source of data

This prospective study has been carried out on 46 patients from duration May 2024 to August 2024 on patients who had been referred to the Department of Radiodiagnosis in R.L Jalappa Hospital with UPT-positive status along with ectopic pregnancy clinical features. The research was reviewed and approved by the Institutional Ethics Committee.

Inclusion criteria

The following criteria were included in the study:

a. UPT positive
b. Indications of ectopic pregnancy include symptoms such as pain, vaginal bleeding, and the presence of an "adnexal mass.

Exclusion criteria

The following criteria were excluded from the study:

a. UPT negative
b. Other adnexal masses on ultrasound."

Method of collection of data

All patients received a transabdominal ultrasound scan using a curved transducer with a 2–5 MHz frequency, followed by a transvaginal ultrasound scan using a higher-frequency transducer with a 7.5 MHz frequency.

Gray scale features and color Doppler findings of the adnexal mass have been investigated.

The study examined various "gray-scale ultrasound parameters to differentiate among ectopic pregnancy as well as pregnancy corpus luteum cyst. These parameters included the mass's mobility relative to the ovary, wall thickness, wall compared to the ovary echogenicity, wall echogenicity compared to the endometrium, mass internal echotexture, the yolk sac existence, and the free fluid existence with or without echoes."

After observing the RI, peak systolic velocity (PSV), and pulsatility index (PI) values, they have been utilized "to differentiate among an ectopic pregnancy as well as a corpus luteum cyst. This had been done after a Ring of Fire was seen surrounding the adnexal mass and" a follow-up examination was conducted.

The gynecology department monitored the patients who had characteristics that would indicate an ectopic pregnancy, and either a laparotomy or methotrexate medication was administered.

Follow-up ultrasounds were performed on patients whose ultrasound characteristics suggested the presence of a corpus luteum cyst. Either an intrauterine gestational sac has been observed during the follow-up, or the cyst spontaneously resolved after D and C for RPOC.

Statistical analysis

The data were inputted into a spreadsheet of MS Excel and evaluated by utilizing the SPSS 22 software. The categorical data representation was done using frequencies along with the proportions. The Chi-square test or Fisher's exact test (only for 2×2 tables) has been utilized as a significance test for the qualitative data.

Mean and SD were utilized to depict continuous data. The independent t-test was employed as a significance measure to ascertain the average discrepancy among two quantitative variables.

Graphical representation of data

Microsoft Excel along with Microsoft Word has been utilized to generate diverse types of graphs.

Assuming statistical test rules, P-value below 0.05 was significant.

Statistical software

Data analysis was conducted using "MS Excel and SPSS version 22 (IBM SPSS Statistics, Somers NY, USA)."

RESULTS

In our research, we included 46 subjects among which 13 were corpus luteum and 33 were ectopic pregnancies.

The age distribution was 19–31 years with a mean age of 25.93.

Among subjects who had corpus luteum 61.5% of subjects had hypoechoic walls. Compared to the ovary, 15.4% of subjects had "Hyperechoic walls compared to the ovary and 23.1% of subjects had isoechoic walls. Among subjects who had ectopic pregnancy, 63.6% of subjects had hyperechoic walls compared to the ovary, 30.3% of subjects had hypoechoic walls compared to the ovary, and 6.1% of subjects had isoechoic walls. The P value is 0.010. A statistically significant variation has been seen in the wall echogenicity among corpus luteum and ectopic pregnancy when compared to the ovary.

Among subjects who had corpus luteum, 61.5% of subjects had hypoechoic walls than to endometrium, 23.1% of subjects had hyperechoic walls compared to endometrium, and 15.4% of subjects had isoechoic walls. Among subjects who had ectopic pregnancy, 60.6% of subjects had hyperechoic walls compared to the endometrium, 33.3% of subjects had hypoechoic walls compared to the endometrium, and 6.1% of subjects had isoechoic walls. P=0.069, there were no statistically significant variations observed" among corpus luteum and ectopic pregnancy with respect to wall echogenicity compared to endometrium (Table 1).

Among subjects who had corpus luteum, 61.5% of subjects "had clear Internal echotexture, 23.1% had lacy internal echotexture, and 15.4% were solid. Among subjects who had ectopic pregnancy, 48.5% of subjects had clear internal echotexture, 21.2% had lacy internal echotexture, and 30.3% were solid (Table 2)."

The P value is 0.573. No statistically significant variation has been seen in the mass interior echotexture between corpus luteum and ectopic pregnancy.

Among subjects who had corpus luteum, 69.2% of subjects did not have free fluid, 23.1% had free fluid without internal echoes, and 7.7% had free fluid with internal echoes (Table 3).

Among subjects who had ectopic pregnancy, 59.4% of subjects had free fluid with internal echoes, 21.9% had free fluid without internal echoes, and 18.8% subjects did not have free fluid.

Corpus luteum and ectopic pregnancy differ significantly in free fluid with or without internal echoes (P=0.002).

The mean PSV among corpus luteum was 20.92±14.19 and the mean PSV among ectopic pregnancy was 44.3±21.21. A statistically significant difference was seen between the groups in terms of PSV (Table 4).

The mean PI among corpus luteum was 0.76±0.218 and the mean PI among ectopic pregnancy was 0.930±0.256. PI differences across groups were statistically significant (Figure 1).

Among subjects who had corpus luteum, 84.6% of subjects had intermediate RI, 15.4% had high RI, and none had low RI (Table 5).

Among subjects who had ectopic pregnancy, 42.4% of subjects had intermediate RI, 39.4% had high RI, and 18.2% had low RI.

P=0.029 shows a statistically significant variation in the resistivity index (RI) between corpus luteum and ectopic pregnancy.

Among subjects who had corpus luteum, 69.2% of subjects had clinical presentation, and 30.8% did not have. Among subjects who had ectopic pregnancy, 63.6% of subjects did not have clinical presentation, and 36.4% had clinical presentation. The P value is 0.05. No statistically significant variations have been found in the clinical appearance among corpus luteum and ectopic pregnancy (Table 6).

DISCUSSION

An adnexal mass that has been distinct from the ovary is the most frequent observation in cases of tubal pregnancy. This mass can be visualized on ultrasound pictures in up to 89–100% of cases. Tubal pregnancy's second most common indication is the tubal ring sign. It is essential to differentiate between an ectopic pregnancy as well as a pregnancy corpus luteum cyst in a patient who does not have a clearly visible pregnancy inside the uterus. Through an analysis of the color Doppler and grayscale characteristics, our study aimed to do this.

In our study, 90% of ectopic pregnancy masses exhibited independent movement away from the ovary, while only 15% of corpus luteum cysts demonstrated separate movement from the ovary. In a study conducted by Blaivas and Lyon,[5] it was shown that 93% of ectopic pregnancy patients had mass separation by the ovary. Rottem et al.,[6] also documented comparable results.

The ectopic pregnancies' average wall thickness in our study was 6.09±1.85 mm, with a range of 3–10 mm. The corpus luteum cysts' average wall thickness was 3.73±1.29 mm, with a range of 2–6 mm. According to Algazzar et al.,[7] the average thickness of the wall in ectopic pregnancy was 7.1 mm, while it was 2.6 mm in the corpus luteum cysts.

The majority of ectopic pregnancies (63.6%) exhibited walls with increased echogenicity compared to the ovaries, while the majority of corpus luteum cysts (61.5%)

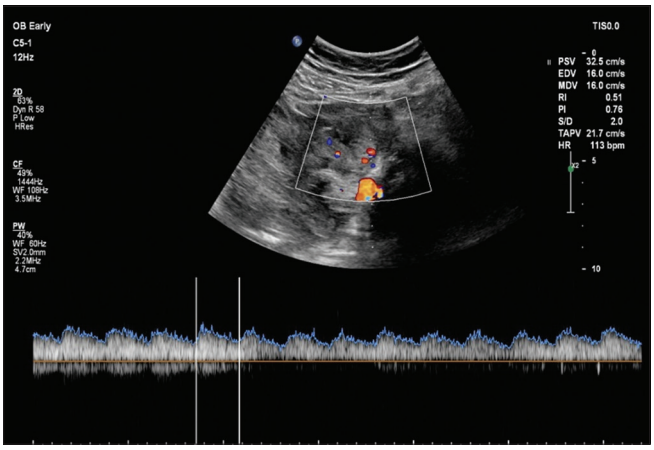

Figure 1: Doppler of ectopic pregnancy

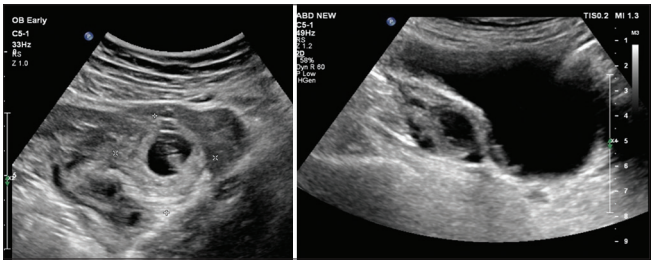

Figure 2: Hyperechoic wall of ectopic pregnancy as compared to ovary

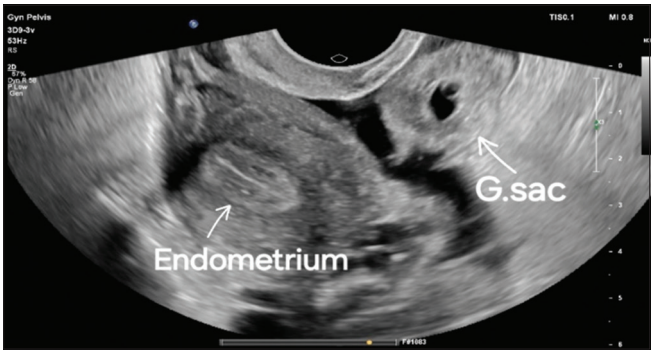

Figure 3: Hyperechoic wall of ectopic pregnancy as compared to endometrium

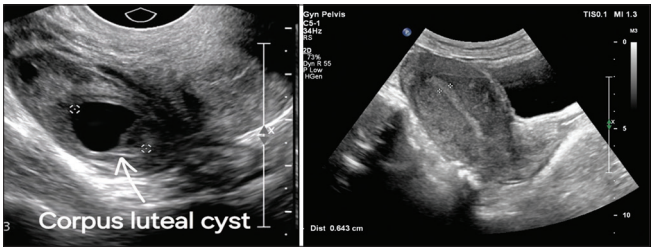

Figure 4: Hypoechoic wall of corpus luteum cyst as compared to endometrium

Table 1: Wall echogenicity compared to ovary and endometrium

Wall echogenicity	Corpus luteum		Ectopic pregnancy	
	n	%	n	%
Compared to ovary				
Hyperechoic	2	15.4	21	63.6
Hypoechoic	8	61.5	10	30.3
Isoechoic	3	23.1	2	6.1
Compared to endometrium				
Hyperechoic	3	23.1	20	60.6
Hypoechoic	8	61.5	11	33.3
Isoechoic	2	15.4	2	6.1

Table 2: Internal echotexture of mass

Internal echotexture of the mass	Corpus luteum		Ectopic pregnancy	
	n	%	n	%
Clear	8	61.5	16	48.5
Lacy	3	23.1	7	21.2
Solid	2	15.4	10	30.3

Table 3: Free fluid with or without internal echoes

Free fluid with or without internal echoes	Corpus luteum		Ectopic pregnancy	
	n	%	n	%
No free fluid	9	69.2	6	18.8
Free fluid with internal echoes	1	7.7	19	59.4
Free fluid without internal echoes	3	23.1	7	21.9

Table 4: Comparison of PSV and PI among groups

Comparison of PSV and PI among groups	Mean	SD	P-value
PSV			
Corpus luteum	20.923	14.1945	0.001
Ectopic pregnancy	44.330	21.213	
PI			
Corpus luteum	0.761	0.218	0.043
Ectopic pregnancy	0.930	0.256	

PSV: Peak systolic velocity, PI: Pulsatility index

Table 5: Comparison of RI among groups

Comparison of RI among groups	Corpus luteum		Ectopic pregnancy	
	n	%	n	%
Low RI (<0.4)	0	0.0	6	18.2
Intermediate RI (0.4–0.7)	11	84.6	14	42.4
High RI (>0.7)	2	15.4	13	39.4

exhibited walls with decreased echogenicity compared to the ovaries (Figure 2). According to Frates et al.,[8] the tubal ring wall was shown to be more echogenic as compared to "the ovary in 88% of patients having ectopic pregnancy, while the corpus luteum cyst wall has been more echogenic in only 7% of patients."

According to Stein et al.,[3] 5% of ectopic pregnancies had walls that seemed hypoechoic relative to the ovaries,

Table 6: Clinical presentation

Presentation	Corpus luteum		Ectopic pregnancy	
	n	%	n	%
Present	9	69.2	12	36.4
Absent	4	30.8	21	63.6

whereas 19% had walls that appeared isoechoic and 76% had walls that appeared hyperechoic than to the ovaries. Approximately 16% of corpus luteum cysts exhibited hypoechoic walls, while 50% displayed "isoechoic walls, and 34% had hyperechoic walls in comparison to the ovaries."

Comparing the walls of corpus luteum cysts to the endometrium, the corpus luteum cysts majority (61.5%) showed hypoechoic walls, and comparing walls of ectopic pregnancy to the endometrium, the majority of ectopic pregnancies (60.6%) showed hyperechoic walls (Figure 3).

Similar findings were also reported by "Stein et al.,[3] and Algazzar et al.,[7] who reported that the majority of corpus luteum cysts had hypoechoic walls than endometrium," and most ectopic pregnancies had hyperechoic walls.

Within our research, 16 out of the total ectopic pregnancies (48.5%) had a distinct internal echotexture, while 7 (21.2%) displayed a lacy echotexture, and 10 (30.3%) were characterized as solid. The ten corpus luteum cysts studied had 7 (70%) different interior echotextures, 3 (30%) lacy ones, and none were solid. "Algazzar et al.,[7] showed that 35.3% of ectopic pregnancies had a unique interior echotexture, 17.6% lacy, and 50% solid. In addition, 61.5% of corpus luteum cysts had obvious interior echotexture. Frates et al.,[8] found nonspecific bulk in 54% of ectopic pregnancies."

Our research found that the yolk sac presence was limited to ectopic pregnancies, accounting for 30% of cases. According to Stein et al., Frates and Laing,[9] and Frates et al.,[8] the occurrence of yolk sacs in ectopic pregnancies was observed to be 37%, 2.3%, and 8.3%, respectively.

In 59.4% of ectopic pregnancies, there was "free fluid presence with echoes in the pelvis." However, the majority of corpus luteum cysts (69.2%) did not have any free fluid. Only 7.7% of corpus luteal cysts include free fluid with internal echoes. According to Stein et al.,[3] they found that 65% of ectopic pregnancies showed the free fluid presence with echoes, but only 5% of corpus luteum cysts exhibited the same. In addition, they observed that 74% of corpus luteum cysts did not have any "free fluid. Chen et al.,[10] and Fauconnier et al.,[11] have also documented the presence of free fluid with echoes in ectopic pregnancies" majority.

In our research, the mean PSV among corpus luteum was 20.92±14.19 and the mean PSV among ectopic pregnancy was 44.3±21.21. A statistically significant difference was seen between the groups in terms of PSV. Atri[4] found that the ectopic pregnancies' average PSV was 35.4 cm/s, while it was 28.4 cm/s in the corpus luteum cysts. However, there were no significant statistical variations between the two groups (P=1).

The mean PI among corpus luteum was 0.76±0.218 and the mean PI among ectopic pregnancy was 0.930±0.256. A statistically significant difference was seen between the groups in terms of PI. Fukami et al.,[12] found that the ectopic pregnancies average peripheral vascularity index (PI) has been 0.82±0.31 (Figure 4).

Our study revealed that a RI value of <0.4 is 100% specific in detecting ectopic pregnancy, while a RI value of more than 0.7 is 84.6% specific in "diagnosing ectopic pregnancy. Algazzar et al.,[7] found that a RI of <0.4 had a 100% specificity in detecting ectopic pregnancy, while a RI of >0.7 had a 96.4% specificity" in diagnosing ectopic pregnancy. Atri reported that a resistor index (RI) >0.7 detected ectopic pregnancy with "100% positive predictive value and 100% specificity. A RI of <0.39 had 100% specificity for ectopic pregnancy" diagnosis. Kurjak et al.,[13] recommended a 0.40 threshold for adnexal trophoblast detection.

Limitations of the study

a. Accuracy of ultrasound and colour doppler imaging can be dependent on skill and experience of operator .
b. Limited follow up time can affect the ability to diagnose and monitor the progression of ectopic pregnancies or corpus luteum cysts.

CONCLUSION

The two most common potential causes for a mass around the reproductive organs in a patient who has a positive pregnancy test and no visible pregnancy inside the uterus on ultrasound are ectopic pregnancy as well as corpus luteum cyst.

A few significant grayscale ultrasound parameters that aid in distinguishing between ectopic pregnancy as well as pregnancy corpus luteum cyst are the mass's mobility in correlation to the ovary, thickness of wall, wall echogenicity as compared to the ovary, wall echogenicity than to the endometrium, cystic mass internal echotexture, yolk sac presence, and the existence of free fluid with echoes.

Differences in PSV and PI values on a "color Doppler is not very significant in distinguishing among the ectopic

pregnancy and corpus luteum; however, RI 0.7 to be 90% specific in identifying ectopic pregnancy.

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Since pregnancy corpus luteum cyst and ectopic pregnancy are frequently misidentified entities on ultrasound and in clinical settings, color Doppler added to grayscale aids in efficiently differentiating between the two.

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Authors Contribution:
PCN- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **AS-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **AD-** Design of study, statistical analysis and interpretation; **MKKN-** Reviewed manuscript.

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