Original article

Usefulness of Grey Scale and Doppler transvaginal sonography in diagnosis of ovarian torsion

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ABSTRACT

Background: Ovarian torsion diagnosis is a great challenge as delay in diagnosis can cause severe morbidity. Early accurate diagnosis is crucial to preserve ovarian function. Ultrasonography being the primary imaging modality plays a vital role in the evaluation of suspected ovarian torsion by helping surgeons reach the correct diagnosis, thus avoiding unnecessary intervention. This study aims to determine the diagnostic accuracy of isolated and combined sonographic features of ovarian torsion on grey scale and Doppler transvaginal ultrasonography.

Patients and methods: From radiology database, from January 2016 till December 2019, sonographic signs of ovarian torsion in 113 women with suspected ovarian torsion on ultrasonography and subsequent surgical diagnosis were evaluated. Ultrasound findings were compared with surgical findings to determine the accuracy, sensitivity, specificity, and positive and negative predictive values of individual and combined ultrasound signs.

Results: Diagnostic accuracy of ultrasound for ovarian torsion was 85.8%. Abnormal ovarian Doppler flow was the most accurate individual sonographic sign with accuracy, sensitivity, specificity and positive predictive value of 85.8%, 83.5%, 100% and 100% respectively followed by ovarian enlargement and ovarian edema. Combined ultrasound signs resulted in higher sensitivity and positive predictive values, and lower specificity and negative predictive values for ovarian torsion. Increasing the number of sonographic parameters increased the specificity but decreased sensitivity. High accuracy, sensitivity, positive predictive value, specificity and negative predictive value was seen when combination of three or two sonographic parameters was used as diagnostic criteria.

Conclusion: Transvaginal sonography is a convenient, reliable and extremely useful imaging modality for preoperative diagnosis of ovarian torsion with high specificity, sensitivity, positive predictive value and diagnostic accuracy helping treating physicians to take prompt decisions regarding timely surgical intervention. However, due to low negative predictive values, absence of sonographic signs does not rule out ovarian torsion and high index of clinical suspicion remains of utmost importance.

Keywords:
Ultrasonography, Ovarian torsion; Accuracy

INTRODUCTION

Torsion of ovary is referred to as the total or incomplete twisting of ovary on its ligamentous supports resulting in ovarian ischemia. Among the surgical emergencies of gynecology, torsion of ovary is the fifth most common having 2.7% to 3% prevalence rate.[1-4] It most commonly occurs in women between 14 and 45 years of age.[5] Risk of ovarian torsion is increased when an ovarian mass more than 5 cm is present.[6,7] Failure to diagnose complete ovarian torsion can lead to ovarian necrosis with peritonitis, loss of ovary, infertility and sometimes death. Prompt accurate diagnosis and urgent surgical intervention are therefore vital to salvage ovarian function, prevent adverse sequelae and at the same time avoid unnecessary surgeries.[8,9]

Ovarian torsion diagnosis is tough and challenging due to variable and misleading clinical findings, and non-specific examination findings. The most common regular symptom is acute pain in lower abdomen.[8,10,11] Ultrasonography is the primary imaging modality for female patients presenting with acute pain in lower abdomen. Recent advances in sonography have allowed conventional sonography with ovarian vasculature Doppler flow studies to help clinicians correctly diagnose ovarian torsion with accuracy of 74.6% which is operator-dependent.[3,12-17]

The aim of this study was to evaluate the usefulness of transvaginal sonography in diagnosis of ovarian torsion by evaluating sonographic signs of

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ovarian torsion, and determining the accuracy and predictive value of isolated and combinations of sonographic signs. This will help treating physicians in taking immediate correct decisions regarding early surgical intervention.

PATIENTS AND METHODS

This was a retrospective study conducted at Sir Ganga Ram Hospital, Fatima Jinnah Medical University, Lahore from January 2016 till December 2019. All female patients aged between 10 and 40 years referred from the Departments of Obstetrics and Gynecology with clinical suspicion of ovarian torsion were studied. Transvaginal ultrasound was performed on Toshiba Aplio 100 by a consultant radiologist having at least 10 years of experience in radiology, using endovaginal transducer with 7-11 MHz frequency. Patients in whom sonographic findings raised a suspicion of ovarian torsion and who underwent surgical intervention were included in the study. Patients who were not managed surgically were excluded from the study. A total of 113 cases fulfilled the criteria and were further evaluated. From radiology database, sonographic findings of unilateral ovarian enlargement more than 4 cm, ovarian edema (hypoechoic or heterogenous central stroma with multiple small peripherally displaced follicles), abnormal ovarian Doppler flow (absent arterial and venous flow, absent venous flow only, absence or reversal of diastolic flow), periovarian free fluid, cyst or mass in ovary, abnormal location of ovary, and surgical diagnosis in terms of presence or absence of ovarian torsion on surgery were recorded.

SPSS version 19.0 was used to analyze data. Frequencies and percentages were calculated for individual sonographic signs, number of sonographic signs, side of torsion and rate of torsion. Comparison of presence of ultrasound signs between patients with and without surgical evidence of torsion was done with Fisher's Exact test. Accuracy, sensitivity, positive predictive value, specificity and negative predictive value were calculated using 2 x 2 table for isolated sonographic signs, all combinations of sonographic signs and number of sonographic signs taking surgical diagnosis as gold standard. Combinations of sonographic signs with significant diagnostic accuracies have only been mentioned in the results.

RESULTS

Out of the 113 patients, 97 patients (85.8%) had ovarian torsion on surgery and 16 patients (14.2%), reported to have torsion on sonography did not have evidence of torsion on surgical exploration. Total 66 patients (68%) had ovarian torsion on right side and 31 patients (32%) had ovarian torsion on left side. Mean age of patients was 26.26 years.

Sonographic features identified in the 97 surgically proven ovarian torsion patients were abnormal ovarian Doppler flow, ovarian enlargement, ovarian edema, periovarian free fluid, cyst/mass in ovary, and abnormal location of ovary in order of frequency. (Table 1) All 81 patients showing abnormal ovarian blood flow on Doppler ultrasound were proven to have torsion on surgery. Forty-one (42.3%) out of 45 patients having an associated cyst or mass on ultrasound were proven to have torsion on surgery with benign mature cystic teratoma being the most common (28.9%).

The sensitivity and specificity of individual sonographic signs ranged from 37.1% to 83.5% and 56.3% to 100% respectively. The positive and negative predictive values of individual sonographic signs ranged from 91.1% to 100% and 17.6% to 50% respectively. The accuracy of individual sonographic signs ranged from 45.1% to 85.8%. Ultrasound had an overall accuracy of 85.8% for ovarian torsion diagnosis. Abnormal ovarian Doppler flow showed the highest

Table 1. Frequency of Isolated Sonographic Signs of Ovarian Torsion with respect to Surgical Findings

Isolated sonographic signs	Torsion present on surgery (*n* = 97)	Torsion absent on surgery (*n* = 16)
Abnormal ovarian blood flow	81 (83.5%)	0
Absence of arterial and venous flow	58 (59.8%)	0
Absence of venous flow only	21 (21.6%)	0
Absence or reversal of diastolic flow	2 (2.1%)	0
Ovarian enlargement	80 (82.5%)	7 (43.8%)
Ovarian edema	78 (80.4%)	5 (31.3%)
Periovarian free fluid	72 (74.2%)	2 (12.5%)
Ovarian cyst / mass	41 (42.3%)	4 (25%)
Benign mature cystic teratoma	28 (28.9%)	1 (6.3%)
Haemorrhagic cyst	9 (9.3%)	2 (12.5%)
Serous cystadenoma	4 (4.1%)	1 (6.3%)
Abnormal ovarian location	36 (37.1%)	1 (6.3%)

Table 2. Accuracy of individual and combined sonographic signs for ovarian torsion diagnosis

Sonographic Signs	Torsion rate, %		Accuracy, %				
	If signs present	If signs absent	Sensitivity	Specificity	PPV	NPV	Accuracy
Individual sonographic signs							
Abnormal ovarian blood flow	100	50	83.5	100	100	50	85.8
Ovarian enlargement	92	65.4	82.5	56.3	92	34.6	78.8
Ovarian edema	94	63.3	80.4	68.8	94	36.7	78.8
Periovarian free fluid	97.3	64.1	74.2	87.5	97.3	35.9	76.1
Ovarian cyst or mass	91.1	82.4	42.3	75	91.1	17.6	46.9
Abnormal ovarian location	97.3	80.3	37.1	93.8	97.3	19.7	45.1
Combination of sonographic signs							
Abnormal flow + enlargement	100	65.2	69.1	100	100	34.8	73.5
Abnormal flow + edema	100	67.3	66	100	100	32.7	70.8
Edema + enlargement	100	67.3	66	100	100	32.7	70.8
Abnormal flow + free fluid	100	69.2	62.9	100	100	30.8	68.1
Enlargement + free fluid	98.4	71.2	61.9	93.8	98.4	28.8	66.4
Edema + free fluid	98.3	73.7	58.8	93.8	98.3	26.3	63.7
Abnormal flow + edema + enlargement	100	73.3	54.6	100	100	26.7	61.1
Abnormal flow + enlargement + free fluid	100	74.2	52.6	100	100	25.8	59.3
Edema + enlargement + free fluid	100	75.8	48.5	100	100	24.2	55.8
Abnormal flow + edema + free fluid	100	76.1	47.4	100	100	23.9	54.9
Abnormal flow + edema + enlargement + free fluid	100	78.4	40.2	100	100	21.6	48.7

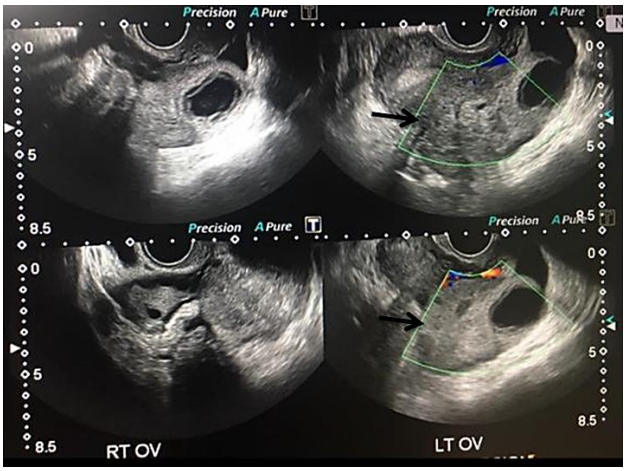

Figure 1. Right ovary is normal. Left ovary is enlarged with a cyst. No blood flow seen on doppler evaluation - Left ovarian torsion (black arrow)

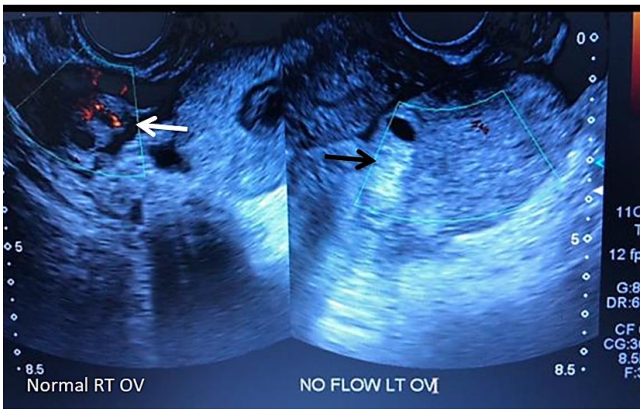

Figure 2. (A) Right ovary shows normal blood flow (white arrow). (B) Left ovary is enlarged with absence of blood flow - Left ovarian torsion (black arrow).

specificity, positive predictive value, sensitivity, accuracy and negative predictive value among all the individual sonographic signs. In addition to abnormal ovarian Doppler flow, ipsilateral ovarian enlargement and ovarian edema also showed relatively high sensitivity, and abnormal location of ovary and periovarian free fluid also showed relatively high specificity. (Table 2)

Variable combinations of sonographic markers showed sensitivity and accuracy up to 69.1% and 73.5% respectively. The specificity and positive predictive value were 100% for almost all variable combinations of sonographic markers. (Table 2)

Using a single sonographic marker for ovarian torsion diagnosis showed high sensitivity and low specificity whereas combination of sonographic markers showed progressively lower sensitivities and higher specificities. Combination of two or three sonographic markers showed high accuracy, sensitivity, positive predictive value, specificity and negative predictive value. (Table 3)

DISCUSSION

Irreversible ovarian damage can be prevented by early ovarian torsion diagnosis and timely ovarian blood flow restoration.[18] Failure to make timely diagnosis and delayed treatment can lead to fatal thrombophlebitis and peritonitis.[3,19] Ultrasonography is a well-established reliable technique for rapid preoperative diagnosis of ovarian torsion, thus helping surgeons in making quick decisions regarding surgery. The accuracy of ultrasound should be high for a surgeon to be confident in taking

Table 3. Frequency and accuracy of number of sonographic markers for ovarian torsion diagnosis

Number of Sonographic Signs	Torsion (n = 97)	No Torsion (n = 16)	Accuracy, %				
			Sensitivity	Specificity	PPV	NPV	Accuracy
1	0	13 (81.2%)	100	0	85.8	0	85.8
2	1 (1%)	3 (18.8%)	100	81.3	97	100	97.3
3	30 (30.9%)	0	99	100	100	94.1	99.1
4	38 (39.2%)	0	68	100	100	34	72.6
5	24 (24.8%)	0	28.9	100	100	18.8	38.9
6	4 (4.1%)	0	4.1	100	100	14.7	17.7

this decision. Ultrasound is also helpful in differentiating ovarian torsion from ectopic pregnancy, mesenteric lymphadenitis, renal calculi and appendicitis.[20,21] This study shows the importance of sonography in detection of ovarian torsion with a higher accuracy as clinical findings are of non-specific nature.

Right-sided predominance of ovarian torsion has been reported in literature accounting for 67-71% of cases.[22,23] This is due to physiologically longer right uteroovarian ligament as compared to left one and decreased space on left side as sigmoid colon is present which protects the left ovary.[23-25] This study also showed right-sided predominance accounting for 68% of torsions on right side with a ratio of 2.2:1. Ultrasound had an overall accuracy of 85.8% for ovarian torsion diagnosis in this study which has been previously reported by Mashiach and colleagues to be 74.6% in their study.[17]

Abnormal ovarian Doppler flow was the most specific, sensitive and accurate marker for ovarian torsion diagnosis in this study with a specificity of 100%, positive predictive value of 100%, sensitivity of 83.5%, and accuracy of 85.8% which is in accordance to previous studies.[17,26] All cases having abnormal ovarian Doppler flow were confirmed to be ovarian torsion on surgery. Several previous studies have shown that it is very unlikely for ovarian torsion cases to have completely normal venous waveforms.[24,26] 16.5% of cases showed normal ovarian Doppler flow in this study which means that normal Doppler studies do not necessarily exclude ovarian torsion. Higher false negatives (cases with normal arterial and venous flow) have been reported in previous literature which may be due to ovaries having dual arterial supply from ovarian artery and uterine artery branches, and venous thrombosis preceding arterial thrombosis.[22,27,28] Therefore, surgical intervention should not be postponed in case of normal Doppler studies if there is high clinical suspicion.

Ovarian enlargement and ovarian edema also show high sensitivities of 82.5% and 80.4% respectively which is in accordance to previous literature.[17] Comparison of affected ovary with unaffected ovary is very important. 17.5% and 19.6% of cases were false negative for ovarian enlargement and ovarian edema respectively which means that normal ovarian size and normal ovarian appearance do not necessarily exclude ovarian torsion.[17,29] Abnormal location of ovary and periovarian free fluid showed high specificities of 93.8% and 87.5% respectively which were also seen in a study by Mashiach and coauthors.[17]

Using combination of sonographic markers increased the specificity but at the same time reducing sensitivity. Higher specificity and lower sensitivity values for combination of sonographic markers have been previously described by Reuven et al. and Ghulmiyyah and coauthers.[5,17] Very high positive predictive values were seen for combination of sonographic markers, 100% for almost all combinations. Combination of three sonographic markers showed high specificity, positive predictive value, accuracy, sensitivity, and negative predictive value of 100%, 100%, 99.1%, 99%, and 94.1% respectively followed by two sonographic markers for which they were 81.3%, 97%, 97.3%, 100%, and 100% respectively. However, combination of more than three sonographic markers would reduce the sensitivity significantly thus causing a large number of false negatives which means that a large number of ovarian torsion cases will be missed. Variable combinations of sonographic markers showed variable sensitivity and accuracy with combination of abnormal ovarian Doppler flow with ipsilateral ovarian enlargement showing the highest sensitivity and accuracy of 69.1% and 73.5% respectively among all the combinations. Low negative predictive values for isolated sonographic signs and all combinations of sonographic signs suggest that absent ultrasound features do not exclude torsion of ovary.

Number of cases of ovarian torsion is increasing worldwide due to increase in polycystic ovarian disease and hyperstimulation ovarian syndrome. Early accurate ovarian torsion diagnosis is still hard. Timely detection

of ovarian torsion is essential for planning further management in order to avoid complications. MRI and CT have been used as alternative imaging modalities for improved diagnosis, but ultrasound is the most easily available and cost-effective technique for ovarian torsion diagnosis worldwide[30-32]. Sonographic signs especially abnormal ovarian Doppler studies are quite reliable in predicting and confirming the presence of ovarian torsion.

Sonographic interpretation depends on experience. Ultrasonography when performed by an experienced radiologist decreases error rate thereby leading to a high diagnostic accuracy.

CONCLUSION

Transvaginal ultrasonography is a highly accurate, non-invasive, safe, convenient and cost-effective imaging technique for the preoperative diagnosis of ovarian torsion and is valuable in guiding surgeons in taking timely appropriate decisions regarding further management thereby preventing unnecessary surgeries. Sonographic signs in experienced hands especially abnormal ovarian Doppler studies play an integral role in early detection and confirmation of ovarian torsion thus avoiding its catastrophic consequences. However, even in the absence of typical sonographic features, treating physicians must maintain a high index of clinical suspicion for possibility of ovarian torsion as one of the important differential diagnosis of acute/recurrent lower abdominal pain.

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