Original Article

Ultrasound classification and clinical analysis of ovarian pregnancy: A study of 12 cases

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ABSTRACT

Objective: To evaluate the clinical significance of preoperative ultrasound diagnosis and classification of ovarian pregnancy (OP).

Methods: The ultrasonographic reports, medical records, and operative summaries were reviewed for twelve women with a confirmed diagnosis of OP. According to the ultrasonographic appearance, OP was classified into two types. For every type, we analyzed the possibility and clinical significance of preoperative ultrasound diagnosis, combining with its clinical manifestations and treatments.

Results: According to sonographic features, twelve cases of OP can be classified into ruptured type (n = 6) and unruptured type (n = 6), the latter was subclassified into embryo sac type (n = 2) and non-homogeneous mass type (n = 4). All the unruptured OP have the characteristic solid hyperechoic rings or masses, and 66.7% (4/6) were correctvly diagnosed by preoperative ultrasound. No characteristic ultrasonogram was detected in ruptured OP which were all diagnosed as ruptured ectopic pregnancy (EP) or corpus luteum by preoperative ultrasound.

The diagnostic and surgical procedures of four cases diagnosed by preoperative ultrasound were all laparoscopy and removal of the gestational products, and their average hemoperitoneum, operation time, hospital days was 313 ± 278 ml, 57 ± 9 min, and 4.25 ± 0.5days, respectively. While ruptured OP cases (6 cases diagnosed at first visit and 1 underdiagnosed but ruptured after 6 days), the diagnostic procedures was laparoscopy(3/7) or laparotomy(4/7), the surgical procedure was removal of the gestational products (2/7), wedge resection(3/7), or adenexectomy(2/7), and their average hemoperitoneum, operation time, and hospital days was 1914 ± 1059 ml, 93 ± 17 min, and 5.9 ± 1.3days, respectively.

Conclusions: Ultrasound plays a significant role in diagnosis of OP, and part of the unruptured OP based on the typical sonographic characteristics could be correctly diagnosed by an experienced sonographer, this is beneficial and effective in terms of the risk of patient's operation and life. Whereas ruptured OP were generally diagnosed as ruptured EP or corpus luteum because there were no characteristic ultrasound manifestations.

Introduction

Ovarian pregnancy (OP) is a specific type of non-tubal ectopic pregnancy (EP) which the gestational sac is implanted, grown, and developed in ovary; its incidence is approximately 0.5%–3% of EP and an incidence of 1/7000–1/40,000 live births [1,2]. The reported incidence of OP is growing because of the evolution of transvaginal sonography and careful histologic examination of the ovarian tissues.

An early OP is frequently misdiagnosed as a corpus luteum or tubal pregnancy (TP) by ultrasound, and an ruptured OP can cause abdominal pain, massive bleeding and even shock. Hence, early and accurate diagnosis is crucial to prevent serious outcomes and to overcome severe complications. It is challenging to make a preoperative diagnosis due to nonspecific clinical symptoms and insufficient understanding of ultrasound characteristics of OP individuals. In this article, we reviewed the ultrasonographic reports, medical records, and operative summaries of twelve OP patients. According to the ultrasonographic appearance, OP was classified into two types. For every type, we analyzed the possibility and clinical significance of preoperative ultrasound diagnosis, combining with its clinical manifestations and treatments.

Materials and methods

Twelve patients with OP were admitted to three hospitals affiliated with Shandong University which are Shandong University Qilu Hospital (Jinan), Shandong University Qilu Hospital (Qingdao) and Second Affiliated Hospital of Shandong University. These patients were recruited from January 2010 to June 2017, with an average age of 31 ± 5.3 years (range 25–40 years). All women conceived spontaneously. Four, ten, five, three, four and four women had intrauterine device (IUD), history of abortion, abdominal surgery, endometriosis, chronic pelvic inflammatory disease, and ovarian hyperstimulation during assisted reproductive technology, respectively. Ten patients presented with a 35–55 days of last menstrual period. Eight presented with abdominal pain, nine had irregular vaginal bleeding, and ten had positive human chorionic gonadotropin (HCG) urine or blood tests. Two patients did not undergo blood testing for HCG detection before surgery due to life-threatening massive intraperitoneal hemorrhage. All patients underwent operative treatment and pathological diagnosis.

Philip Elite or GE Volusion E8 color Doppler ultrasound diagnostic equipment were used. The central frequencies of the transabdominal and transvaginal probes were 3.5 MHz and 10 MHz, respectively. Upon admission, four received transvaginal ultrasonographic examinations, one had only a transabdominal ultrasonographic examination, and seven had the both. The blood flow of the masses was demonstrated by color Doppler ultrasonography in all patients. The ultrasonographic results were retrospectively compared with the pathologic findings.

Results

Among twelve patients, their baseline characteristics, ultrasonographic examinations, clinical manifestations and treatments were all showed in Table 1. Of these, two patients had no history of amenorrhoea due to irregular menstruation and two were not allowed to undergo gynecological examination due to life-threatening massive hemorrhage.

Ultrasonographic examination revealed a normal uterus or slight uterine enlargement. No gestational sac was observed within the uterine cavity. OP can be roughly divided into two types according to ultrasonogram: ruptured type (6 cases) and unruptured type (6 cases), the latter can be subdivided into embryo sac type (2 cases) and heterogeneous mass type (4 cases). The ultrasonographic images of unruptured embryo sac type revealed a characteristic solid hyperechoic ring in ovary in wihch a yolk sac, fetal bud even primitive heart beat was detected (Fig. 1). The unruptured non-homogeneous mass also revealed a characteristic solid hyperechoic mass but no regular ring, yolk sac or fetal bud were detected, and the color Doppler flow imaging revealed that the masses were partially or completely surrounded by slightly abundant blood flow (Fig. 2). The hyperechoic ring or mass was more echogenic than corpus luteum and normal ovary. Ultrasonographic features of ruptured OP revealed that a large irregular mass was mixed with hyperechoic and hypoechoic structures in the adnexa. In some cases, ovary tissue with unclear edges could be identified, and in some cases the masses with characteristic hyperechoic ring or mass could be detected (Fig. 3).

For the unruptured OP, preoperative ultrasound diagnostic accuracy rate was 66.7% (4/6), including two cases of embryo sac type and two cases wither non-homogeneous mass type, and one case of non-homogeneous mass type was misdiagnosed as a TP, the other was underdiagnosed (as a corpus luteum) due to thickness of the endometrium (15 mm) and increased levels of β-hCG (156.28mIU/ml) at the first visit. Six days later, the patient presented with a ruptured OP and underwent emergent surgery. In the cases of ruptured OP, five were diagnosed with ruptured EP, and one was suspected to be ruptured corpus luteum due to irregular menstruation.

The diagnostic and surgical procedures of four cases diagnosed by preoperative ultrasound were all laparoscopy and removal of the gestational products, and their average hemoperitoneum, operation time, hospital days was 313 ± 278 ml, 57 ± 9 min, and 4.25 ± 0.5days, respectively. While ruptured OP cases (6 cases diagnosed at first visit and 1 underdiagnosed but ruptured after 6 days), the diagnostic procedures was laparoscopy (3/7) or laparotomy (4/7), the surgical procedure was removal of the gestational products (2/7), wedge resection (3/7), or adenexectomy (2/7), and their average hemoperitoneum, operation time, and hospital days was 1914 ± 1059 ml, 93 ± 17 min, and 5.9 ± 1.3days, respectively. Five patients received blood transfusion more or less.

Discussion

The pathogenic mechanism underlying OP is thought to be fertilization occurring outside the tube followed by implantation within the ovary, or the failure of ovulation and fertilization in ovary. The ovarian surface is covered by tunica albuginea and lacks muscle fibers, and the ovary interior consists of loose connective tissues and a large quantity of blood vessels. Therefore, early rupture is likely to occur when the fertilized egg grows within the ovary. No specific clinical manifestations were noted prior to rupture.

A review of the literature shows the major risk factors for OP include the use of IUD, a history of tubal surgery or infertility, previous EP or endometriosis, pelvic inflammatory disease, ovarian hyperstimulation during assisted reproductive technology, etc. [3–6]. It seems that the important associated risk factors are use of IUD, fertility treatment and endometriosis, but some different studies also found that from 39.5% to 50% of women had none of these risk factors [7]. In our study, IUD, fertility and endometriosis were found in 33.3% (4/12), 33.3% (4/12) and 25% (3/12), respectively, and 16.6% (2/12) had no known risk factors. We consider that any operation or disease which has adverse effects on internal genitalia is likely to lead to OP, because pregnancy itself and abnormal pregnancy are all complicated, wonderful and subtle, their specific mechanism has not been clear by now.

The classic clinical symptoms of OP are amenorrhea, abdominal pain, and vaginal bleeding, none of which is sufficient to distinguish from EP alone. Most patients without vaginal bleeding will have abdominal pain, and others without abdominal pain will have a history of amenorrhoea, which are similar to EP [8]. In this study, there were 5 patients (42%) with all three symptoms, 5 patients with two symptoms, 2 patients (17%) with only one symptom, and no one with none. As for clinical signs, 4 of 12 patients with adnexal mass can be detected, 2 patients can not carry out physical examination because of more intraperitoneal hemorrhage leading to acute shock, and other 6 patients could not touch the adnexal mass because the OP mass was too small to touch, or the abdominal hemorrhage affected the physical examination of gynecology. In addition to the above clinical manifestations much more serious, a ruptured OP also present with dizziness, syncope and hemorrhagic shock. In our study, circulatory collapse was present in 4 (33.3%) of 12 OP patients. The difference of clinical presentation such as the time of vaginal bleeding, abdominal pain and hypovolemia may be a reflection of timing of diagnosis and severity of disease progression, which is the important basis of clinical treatment.

In the past, the preoperative diagnosis of OP is thought to be quite difficult, because the clinical presentations are similar to those of TP which both present amenorrhea, irregular vaginal

Table 1
Clinical symptoms, ultrasound diagnosis and surgical findings of 12 patients with ovarian pregnancy.

| Case No.	Age (yrs)	Clinical symptoms				Preoperative Ultrasound			INOP diagnosis	Diagnostic procedure	Surgical procedure	Hemop (ml)	Blood transfusion	Operation time (mins)	Hospital days
		GA (days)	Abd pain	Vaginal bleeding	Adnexal mass	Method	Type	Diagnosis							
I	29	55	Y	Y	N	TVS	Embryo sac type	LOP	LOP	laparoscopy	RGP	50	\	40	4
II	33	45	N	Y	N	TAS TVS	Embryo sac type	LOP	LOP	laparoscopy	RGP	100	\	58	4
III	35	50	Y	N	Y	TAS TVS	Non-homogeneous mass type	LOP	LOP	laparoscopy	RGP	500	\	55	4
IV	29	42	N	Y	N	TVS	Non-homogeneous mass type	ROP	ROP	laparoscopy	RGP	600	\	60	5
V	25	35	Y	Y	N	TAS TVS	Non-homogeneous mass type	Misdiagnose to RTP	ROP	laparoscopy	RGP	800	\	72	3
VI	39	IM	N	Y	N	TVS	Non-homogeneous mass type	Underdiagnosis (Ruptured later)	ROP	laparotomy	AE	2800	PL 400 ml, RBC6U, CP480U	85	7
7	26	40	N	N	Y	TVS	Ruptured type	Ruptured REP	ROP	laparoscopy	RGP	300	\	77	4
8	32	40	Y	N	Y	TAS TVS	Ruptured type	Ruptured LEP	LOP	laparoscopy	WR	1000	\	70	5
9	27	48	Y	Y	N	TAS TVS	Ruptured type	Ruptured REP	ROP	laparoscopy	RGP	1200	RBC2U	116	5
10	40	51	Y	Y	ND	TAS TVS	Ruptured type	Ruptured REP	ROP	laparotomy	WR	2500	PL400 ml, RBC5U, CP400U	95	6
11	26	42	Y	Y	Y	TAS TVS	Ruptured type	Ruptured REP	ROP	laparotomy	WR	2600	PL400 ml, RBC6U, CP400U	110	6
12	37	IM	Y	Y	ND	TAS	Ruptured type	Ruptured corpus luteum	LOP	laparotomy	AE	3000	PL600, RBC8U, CP800U	98	8

Notes: GA, gestational age; IM, irregular menstruation; ABD, Abdominal; Y, yes; N, no; ND, Not detected; TVS, transvaginal scan; TAS, transabdominal scan; OP, ovarian pregnancy; TP,tubal pregnancy; EP = ectopic pregnancy; INOP, Intraoperative; RGP, removal of the gestational products; WR, wedge resection; AE, adenexectomy; Hemop, Hemoperitoneum; PL, plasma; RBC, red blood cells; CP, cryoprecipitate.

Fig. 1. Transvaginal ultrasound images of OP with unruptured embryo sac type. (A) showed the normal right ovary (ROV) and uterus (UT). (B) showed the left OP with embryo sac. The yolk sac (YS), embryo bud (EB) and color flow signals in the primitive heart were detected. White arrowheads showed the gestational sac and the rest of the ovarian tissue in the same envelope. (C) White arrowheads showed the characteristic solid hyperechoic ring of OP.
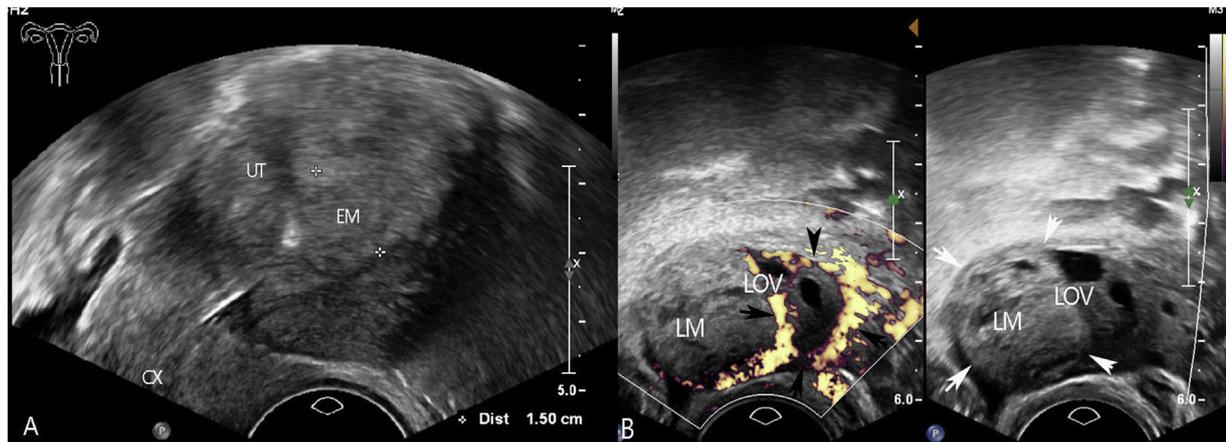
Fig. 2. Transvaginal ultrasound images of OP with unruptured non-homogeneous mass type. (A) showed endometrial thickness and empty uterine cavity. (B) showed a non-homogeneous mass (LM) with a characteristic solid hyperechoic mass (white arrows) in the left ovary (LOV), which was partially or completely (black arrowheads showed corpus luteum) surrounded by abundant blood flow.
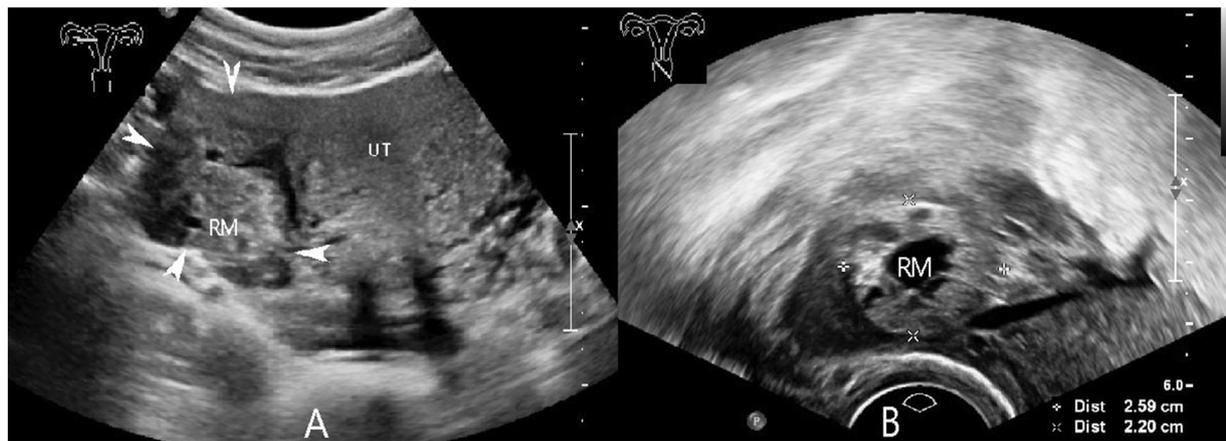

Fig. 3. Ultrasound images of ruptured OP. (A) Transabdominal ultrasound examination showed the right adnexal mass (RM), a small amount of liquid and flocculent blood clots echo (white arrowheads) were around the mass. (B) Transvaginal ultrasound examination showed a characteristic solid hyperechoic ring (RM) (measured by the cursors) with surrounding flocculent blood clots.

bleeding, abdominal pain and adnexal masss [9]. It was reported that a correct surgical diagnosis was only made in 28% of cases, in the remaining cases the diagnosis depended on the histopathological findings [10,11]. But in recent decades, with the advancement of transvaginal sonography, ultrasound instruments, and diagnostic techniques, some studies have reported that preoperative ultrasound diagnosis of OP is possible [12–14]. However, these reports all lacked the detailed description and analysis of the ultrasound characteristics and ultrasound typing. In our study, four patients who receivd correct preoperative ultrasonography diognosis had the common characteristics of the wide hyperechoic ring or mass formed by gestational trophocyte infiltrating into surrounding tissues, which is greater than the echogenicity of normal ovary and corpus luteum [12]. It should be emphasized that

all gestational sacs or pregnant tissues of first trimester share these features. Not only the normal uterine gestational sac but also a majority of EP (cornual, scar, cervical, interstitial, and OP, etc.) possess this typical structure and ultrasonogram (Fig. 4). This typical structure (ring or mass) was more echogenic than uterine wall, normal fallopian tube and the ovary [15]. We retrospectively reviewed the ultrasonogram images of all patients with EP within the last two years in one of our medical centres. Among 19 patients with intrauterine EP (7 with cornual pregnancies, 11 with cesarean scar pregnancies, and 1 cervical pregnancy), 74% (14/19) presented with this typical structure. In 176 women with TP, this typical structure was identified in 85% (101/119) of patients with unruptured type and in 23% (13/57) of patients with ruptured type. Therefore, understanding of the ultrasonographic characteristics of this tipical structure plays a significant role in the diagnosis of intrauterine and extrauterine EP which should be brought to attention enough by ultrasonography technicians and physicians.

In our study, all the OP patients with unruptured embryo sac type were correctly diagnosed which was due to identifiable yolk sac, embryo or fetal heart beat besides the characteristic hyperechoic ring. As for this type, just do ultrasound examination carefully and the misdiagnosis should be reduced even avoided. Without the identifiable yolk sac and embryo, the ultrasound diagnosis of OP with unruptured non-homogeneous mass type have to only depend on the characteristic hyperechoic mass and half (2/4) of the patients were misdiagnosed (as TP) or underdiagnosed (as corpus luteum). The differential diagnosis between unruptured TP and OP depends on whether or not the gestational mass is inside the ovary. For OP, it is located in the same envelope with ovarian tissues (Fig. 1B). As for TP, the mass is located along the course of oviduct and has a dividing line with the ipsilateral ovary. It has been reported that OP group had more ruptured ectopic gestational sacs than TP group in surgical findings, because preoperative diagnosis of TP was relatively easy whereas the underdiagnosis or misdiagnosis of unruptured OP was more
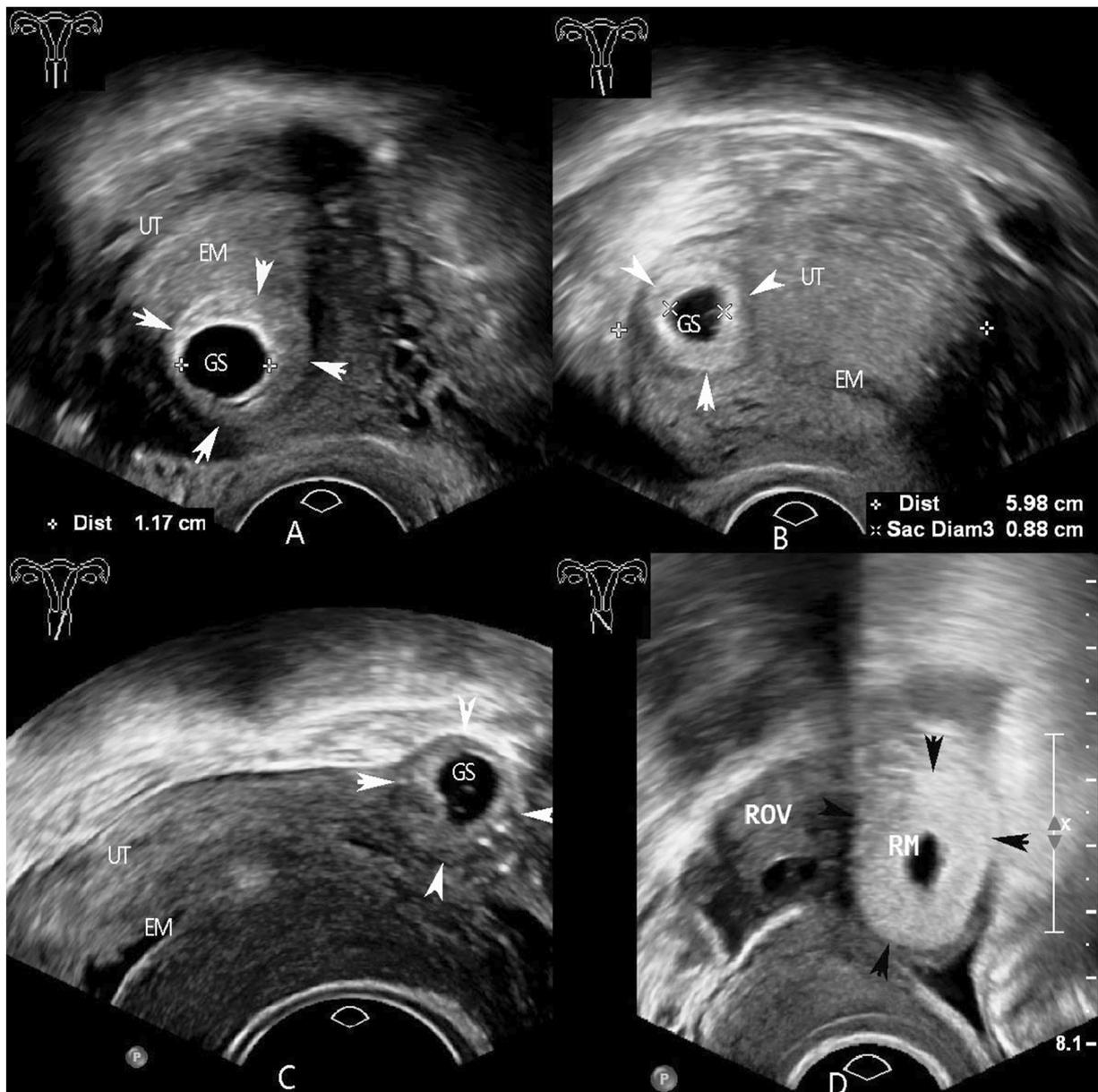
Fig. 4. The characteristic solid hyperechoic ring (white and black arrowheads) in normal intrauterine pregnancy and EP. (A) Normal intrauterine pregnancy. (B) Right cornual pregnancy. (C) Left interstitial TP. (D) Right ampulla TP. (UT: uterus; GS: gestational sac; EM: endometrium; RM: Right mass; ROV: right ovary).

common which lead to rupture and subsequent emergency operation [16]. For the differential diagnosis between unruptured OP and corpus luteum, we only emphasized that characteristic hyperechoic ring or mass of OP is more echogenic than ovary itself or corpus luteum and corpus luteum is less echogenic than the ovary itself or OP [12,15], because their configuration and dimensions are really similar. Therefore, the ultrasonographer's experience and training is especially important in differential diagnosis of this type.

It is difficult to differentiate diagnosis between a ruptured OP and a ruptured TP or corpus luteum due to the similar ultrasonographic manifestations. Terzic reported that purely in terms of ultrasonogram, the ruptured OP is confused with the ruptured corpus luteum in up to 75% [17]. However, their principles of management are consistent mainly based upon relevant symptoms, the β-hCG level, mass size, and volume of hemorrhage. For a experienced staff, comprehensive and extensive considerations are required to deliver an accurate diagnosis especially for patients with intrauterine pregnancy associated with OP or OP associated with a ruptured corpus luteum.

Although the successful medical treatment of OP with systemic methotrexate was reported [18,19], the clinical practice is rare. The premise of all medical treatment is to make a definite diagnosis, and the definitive diagnosis of OP by ultrasound will increase the proportion of cases managed medically in future. It is a pity that we did not administer medication in the four cases of OP diagnosed by preoperative ultrasound. The most commonly used surgical treatment of OP is laparoscopy with gestational lesion removal or wedge resection which are all surgical procedures to preserve fertility [13]. The advantages of laparoscopic surgery for OP are similar to TP which include shorter operating times, shorter hospital stay and faster recovery. A definite preoperative diagnosis seems to be more conducive to the surgical procedure. Laparotomy will be done in order to quickly control of bleeding if the patient has an emergency as circulatory collapse. When patients have no fertility requirements and/or the ovarian function can not be remained, the adnexectomy can be performed. In our study, all the cases were intraoperativly diagnosed as OP, but sometimes it can be misdiagnosed as hemorrhagic corpus luteum or ovarian cysts or granulosa cell tumor, and occasionally only the enlarged or normal ovaries, normal adnexae and uterus are detected under laparoscopy. In this case, a correct preoperative ultrasonic outcomes are effective indicators and aids.

Although limited to 12 cases, our study includes all ultrasonography types of OP. Emphasis of the characteristic structure make it possible for a preoperative diagnosis, which can avoid the major rupture hemorrhage via drug conservative treatment or effective surgical management. All four cases of OP diagnosed preoperatively accepted gestational lesion removal surgery via laparoscopy with the minimal trauma, and the intraoperative bleeding, operation time and hospital stay were less compared with ruptured OP. For ruptured OP, only three cases were treated with laparoscopy, but four with laparotomy; only two with gestational lesion removal surgery, but three with wedge resection and two with adenexectomy. Intraoperative bleeding was more and operation time and hospital stay were longer than unruptured ones. Furthermore, five patients of ruptured OP received blood transfusion more or less because of lower hemoglobin or circulatory collapse.

The sixth OP case was underdiagnosed as corpus luteum because of the thick endometrium (16 mm), and we presumed that the gestational sac had implanted within the uterine cavity which is too small to detect. Suggestions of follow-up after one week, but just six days later, a sudden gestational mass rupture happened accompany with major bleeding. Then, an open-surgery including adenexectomy was operated because of serious ovary destruction

with bleeding of 2800 ml. A misdiagnosis of ruptured corpus luteum was made to the twelfth OP due to an unobvious history of amenorrhoea, who had a hemorrhagic shock required emergency surgery to recover life. The most effective method to reduce the harmness of ruptured OP depends on diagnosing and treating it when it has not ruptured. So, as in the table, the clinical significance of early diagnose for OP is self-evident.

Conclusion

Despite the advantages of modern diagnostic methods, ruptured OP is still difficult to be defined by preoperative ultrasound, and there will still be patients with circulatory collapse, whose rupture may occur before or after outpatient treatment and may be life-threatening. On the other way, the unruptured OP is possible to be preoperatively diagnosed due to their ultrasonographic characteristics, especially when the sonographer be familiar with this characteristics. Early diagnosis (ultrasound diagnosis before rupture) is beneficial to the process of conservative laparoscopic surgery to preserve fertility of the patients, avoid emergency laparotomy and improve clinical prognosis. At the same time, preoperative ultrasound diagnosis contributes to the selection and monitoring of drug treatment. Of course, larger studies are warranted to gather more data on this rare form of EP.

Disclosure of interest

The authors declare that they have no competing interest.

Support

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