Original Research

Differential-diagnostic and therapeutic challenges in the management of ruptured corpus luteum cyst with undiagnosed intrauterine pregnancy in the early first trimester and ruptured ovarian pregnancy

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Abstract

Background: The similarities in clinical features between ruptured corpus luteum cyst (RCLC) with undiagnosed intrauterine pregnancy in the early first trimester (RCLC-P) and ruptured ovarian pregnancy are well established. However, the identification of differences between these two morbid conditions is important to determine the causes and manage the hemoperitoneum without devastation of pregnancy in RCLC-P. Furthermore, the pregnancy outcomes after laparoscopic surgery in women with RCLC-P are not recognized. **Methods**: Retrospective observational study of six women with RCLC-P and seven women with ruptured ovarian pregnancy. **Results**: All cases were referred under strong suspicion of ruptured ectopic pregnancy due to lower abdominal pain and positive urinary pregnancy test after spontaneous conception. The estimated median number of gestational weeks in RCLC-P (5 weeks) was significantly lower than that for ruptured ovarian pregnancy (7 weeks). At triage, the median serum levels of beta-human chorionic gonadotropin (β-hCG) were significantly lower in RCLC-P (592 IU/L) than ruptured ovarian pregnancy (3723 IU/L) ($p = 0.01$). In all six cases with RCLC-P, laparoscopic ovary-sparing surgery was performed. Among the four women who received postoperative supplementation of progesterone, uneventful vaginal delivery occurred at term in three cases. **Conclusions**: Early gestational age and lower serum β-hCG levels at triage, as well as non-declining levels of serum β-hCG on the day after surgery, were significant predictors of RCLC-P rather than ruptured ovarian pregnancy. Laparoscopic surgery was a feasible option for the management of RCLC-P with appropriate postoperative luteal support to achieve successful obstetric outcomes.

Keywords: Early first trimester; Intrauterine pregnancy; Laparoscopic surgery; Ovarian pregnancy; Ruptured corpus luteum cyst

1. Introduction

The occurrence of both a ruptured corpus luteum cyst (RCLC) with an undiagnosed intrauterine pregnancy in the early first trimester (RCLC-P) [1–3] and a ruptured ovarian pregnancy [4] is rare. Nevertheless, these are potentially life-threatening acute abdominal events that can manifest with similar clinical signs and symptoms, including sudden abdominal pain with hemoperitoneum, undetectable intrauterine gestation, and a positive urinary pregnancy test at triage [1–4].

The differentiation of RCLC-P from ruptured ovarian pregnancy is empirically difficult [2,3]. Therefore, an unidentifiable intrauterine gestational sac in women with a RCLC due to an early gestational age presents a diagnostic and therapeutic challenge to treating physicians, particularly in the emergency setting. There are other potential morbid conditions with acute hemoperitoneum and/or acute abdomen in the presence of an undiagnosed intrauterine pregnancy that need to be differentiated from a RCLC-P. These include ruptured heterotopic pregnancy [5], ruptured ovarian endometrioma in early pregnancy [6], indolent ovarian cyst with an alternative bleeding source in early pregnancy [7], and ovarian hyperstimulation syndrome with massive ascites mimicking hemoperitoneum in early pregnancy [8] (Table 1, Ref. [4–8]).

An RCLC can be conservatively managed in most cases, regardless of the presence of pregnancy [9,10]. However, following the manifestation of increased peritoneal bleeding and/or worsening of uncontrollable symptoms (e.g., abdominal pain), surgical intervention is required [11]. When pregnant women with RCLCs require surgical intervention, minimizing the perioperative risks for both the mother and fetus poses a challenge to treating physicians [1]. Furthermore, if the corpus luteum cyst ruptures in the early first trimester prior to completion of the luteo-placental shift, maintaining the pregnancy through progesterone supplementation in a timely manner to minimize the potential risk of miscarriage is also a concern [1,12,13].

In recent years, the laparoscopic approach has become a feasible option for the surgical management of a RCLC [1–3,11]. However, reports on the surgical management of acute hemoperitoneum due to RCLC-P, particularly those focused on the perioperative differential diagnosis from a ruptured ovarian pregnancy, remain limited [2,3]. In addition, the pregnancy outcomes of cases with RCLC-P after surgery have not been well documented in case series.

Table 1. Potential morbid conditions with acute hemoperitoneum and/or acute abdomen in presence of an undiagnosed intrauterine pregnancy that need to be differentiated from a ruptured corpus luteum cyst with an undiagnosed intrauterine pregnancy in the early first trimester.

Morbid condition	Reference
Ruptured ovarian pregnancy	[4]
Ruptured heterotopic pregnancy	[5]
Ruptured ovarian endometrioma in early pregnancy	[6]
Indolent ovarian cyst with an alternative bleeding source in early pregnancy	[7]
Ovarian hyperstimulation syndrome with massive ascites mimicking hemoperitoneum in early pregnancy	[8]

The objective of this study was to report the similarities and differences in clinical features between RCLC-P and ruptured ovarian pregnancy in a small case series. In addition, the pregnancy outcomes after single-port laparoscopic surgery [14,15] and immediate initiation of postoperative supplementation of progesterone in women with RCLP-P were assessed.

2. Materials and methods

2.1 Patient selection

This retrospective observational study was performed by reviewing the electronic chart records at Gifu Prefectural Tajimi Hospital (Tajimi, Japan) between January 2015 and December 2020. The collected data included patient demographics, surgical outcomes in women with RCLC-P or ruptured ovarian pregnancy, and postoperative obstetric outcomes in women with RCLC-P (Fig. 1). Only women with an estimated gestational duration that had been calculated from their last menstrual period and available history of sexual intercourse were enrolled.

2.2 Preoperative management of patients

For women with a positive urinary pregnancy test and acute abdominal symptoms who were transferred to the emergency department, the presence of an intrauterine gestational sac was examined. This was achieved through transvaginal ultrasonography along with assessment and management of the hemodynamic condition of patients [14].

The serum levels of beta-human chorionic gonadotropin (β-hCG) were immediately determined. In case of concern for hemodynamic instability due to the presence of significant hemoperitoneum on ultrasonography, rapid fluid resuscitation was initiated for emergency surgical intervention.

2.3 Surgical procedures

In each case, gasless single-port laparoscopic surgery with a surgical view secured by the abdominal wall-lift method [14,15] was performed under endotracheal general anesthesia. Placement of a uterine manipulator was avoided when the possibility of an intrauterine pregnancy could not be completely ruled out.

If increased peritoneal bleeding (>500 mL) was en-

countered during surgery (Fig. 2A), an intraoperative blood salvage unit was operated, and processed autologous blood was transfused back into the patient [16]. To achieve hemostasis in cases with a RCLC, the hemorrhaging portion of the ruptured cyst (Fig. 2C, arrow) was exposed by removing blood coagula (Fig. 2B, arrow). This was followed by hemostatic suturing with an Endo Stitch suturing device (Covidien Japan, Tokyo, Japan) (Fig. 2D). In case suturing was insufficient to achieve hemostasis, partial ovarian resection was concomitantly performed.

2.4 Postoperative management

At 1 and 3 days after surgery, a complete blood count was conducted to assess anemia, and the levels of C-reactive protein were measured to examine infectious morbidity. In cases with ruptured ovarian pregnancy, serial measurements of the serum levels of β-hCG were performed every other day, until 50% of the pre-treatment levels were achieved. This was followed by weekly measurements until the serum levels of β-hCG were decreased below the cutoff level (<6 mIU/mL) [14]. In cases with strong suspicion of RCLC-P based on surgical findings, ultrasonography was repeated for the detection of intrauterine gestational sac. This was accompanied by serial measurements of the serum levels of β-hCG by the time of intrauterine gestational sac detection [1]. In cases with confirmed RCLC-P, progesterone (50 mg/body) was administered intramuscularly every other day until 8–9 weeks of gestation under a local management policy [1].

In cases with RCLC-P, patients were discharged after confirming the absence of pregnancy-related morbidity. Thereafter, early postoperative complications (within 30 days) were monitored. In addition, the obstetric course was carefully managed in women with RCLC-P.

2.5. Statistical analyses

All statistical analyses were performed using the Microsoft Excel software Version 16.52 (Redmond, WA, USA) with the add-in software StatPlus:mac Pro (AnalystSoft Inc., Walnut, CA, USA). Because of the non-normal distribution of variables in the current case series, as assessed by the Kolmogorov–Smirnoff test, the median and range (minimum–maximum) were used to express the results. The Mann–Whitney U test was used to compare the
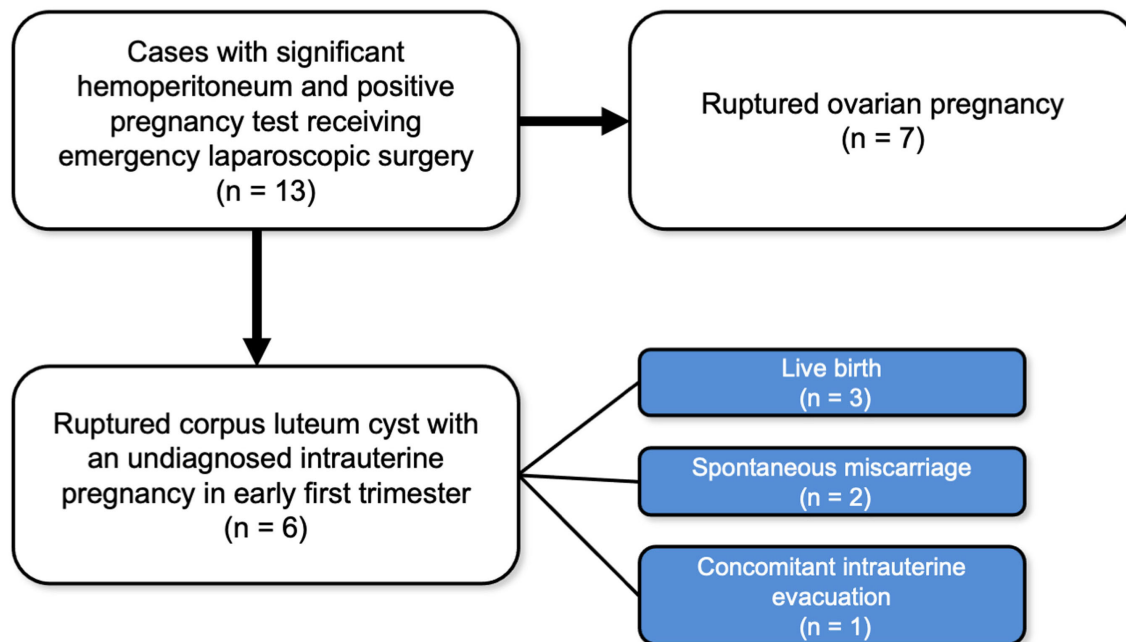
Fig. 1. Flow chart of the case series. Among thirteen cases with significant hemoperitoneum and positive pregnancy test receiving emergency laparoscopic surgery, six cases with ruptured corpus luteum cyst with an undiagnosed intrauterine pregnancy in early first trimester (RCLC-P) and seven cases of ruptured ovarian pregnancy with histological confirmation of chorionic villi in the excised tissue materials were identified. In cases with RCLC-P, who wished continuation of pregnancy, live birth was achieved in three cases while spontaneous miscarriage occurred in two cases.

continuous variables between the two groups. The differences in the proportions of the categorical variables were evaluated using the chi-squared test. A *p*-value < 0.05 denoted statistically significant difference.

The present study was approved (Protocol #2020-35) by the institutional review board of Gifu Prefectural Tajimi Hospital. Only women who consented to have their clinical information used for research purposes were included in the study cohort. The datasets generated and analyzed during the present study are not publicly available, as they contain information that could compromise patient confidentiality. They are available from the corresponding author on reasonable request.

3. Results

Seven cases after spontaneous conception were complicated by a RCLC during pregnancy in the first trimester. After excluding one case with a RCLC at 7 weeks of gestation, in which the presence of an intrauterine gestational sac was evident at triage, six cases with RCLC-P were enrolled. Seven cases of ruptured ovarian pregnancy after spontaneous conception were included after histological confirmation of chorionic villi in the excised tissue materials.

The clinical background characteristics of the women who underwent emergent laparoscopic surgery for RCLC-P or ruptured ovarian pregnancy are shown in Table 2. There were no differences between the two groups in age, body

mass index, mode of conception, parity, initial symptoms, or hemoglobin levels at triage.

The number of RCLC-P cases for a given estimated gestational age at the time of surgery were two, three, and one cases at 4, 5, and 6 weeks, respectively. The number of ruptured ovarian pregnancies were two, four, and one cases at 6, 7, and 8 weeks, respectively. The median number of estimated gestational weeks in RCLC-P (5 weeks) was significantly lower than that for ruptured ovarian pregnancy (7 weeks). The median serum levels of β-hCG at triage were significantly lower in RCLC-P (592 IU/L, range: 112–1684 IU/L; 95% confidence interval: 81–1362 IU/L) versus ruptured ovarian pregnancy (3723 IU/L, range: 1099–40,250 IU/L; 95% confidence interval: –657–27,124 IU/L).

The surgical outcomes are shown in Table 3. In RCLC-P, the surgical procedures employed were partial ovarian resection with hemostatic suturing in three cases and hemostatic suturing in two cases. In one patient who did not wish to continue her pregnancy, intrauterine evacuation was performed after hemostatic suturing. In cases of ruptured ovarian pregnancy, the surgical procedures employed were removal of gestational products with hemostatic suturing in three cases, partial ovarian resection with hemostatic suturing in two cases, and salpingo-oophorectomy in two cases. Conversion to multi-port laparoscopic surgery or laparotomy was not necessary in the current case series.
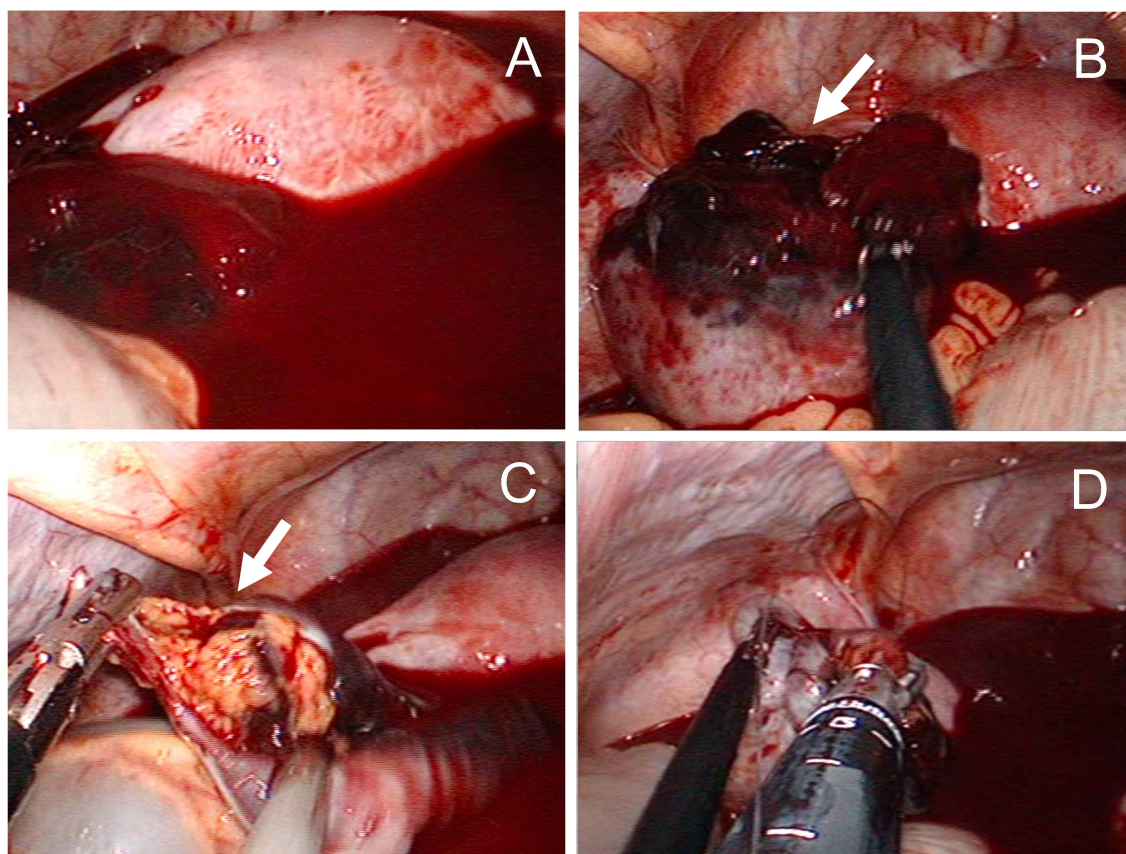
Fig. 2. A ruptured corpus luteum cyst without identification of intrauterine gestational sac at 4 weeks of gestation after spontaneous conception in a 21-year-old, gravida 1 para 0, woman. The serum levels of β-hCG at triage were 409 IU/L. (A) Under single-port laparoscopic observation, pooled blood (930 mL) was rapidly irrigated and suctioned for processing of intraoperative salvage and transfusion of autologous blood (460 mL). (B) Blood coagula over the hemorrhaging corpus luteum (arrow) was removed. (C) The ruptured site of the corpus luteum cyst with continuous bleeding (arrow) was exposed. (D) Hemostasis was achieved by suturing with an Endo Stitch suturing device. Progesterone was not supplemented due to the unwillingness of the patient to continue the pregnancy. Spontaneous miscarriage occurred after postoperative identification of the intrauterine gestational sac.

Table 2. The clinical features of the women who underwent emergent laparoscopic surgery for a ruptured corpus luteum cyst with an undiagnosed intrauterine pregnancy in the early first trimester ($n = 6$) and ruptured ovarian pregnancy ($n = 7$).

Variables	Ruptured corpus luteum cyst	Ruptured ovarian pregnancy	p value
Age (year; Median [range]) (Mean $\pm$ SD)	29 (21–35) (28.2 $\pm$ 5.7)	32 (30–35) (31.7 $\pm$ 1.9)	0.25
Body mass index (kg/m^2; Median [range]) (Mean $\pm$ SD)	20.3 (18.4–23.3) (20.8 $\pm$ 1.9)	19.5 (18.8–28.1) (21.4 $\pm$ 3.4)	0.83
Parity (number [%])			0.72
Nulliparity	4 (66.7)	4 (57.1)	
Multiparity	2 (33.3)	3 (42.9)	
Mode of conception			
Spontaneous	6 (100)	7 (100)	N.S.
Signs and symptoms (number [%])			N.S.
Lower abdominal pain	6 (100)	7 (100)	
Estimated gestational weeks (weeks; Median [range]) (Mean $\pm$ SD)	5 (4–6) (4.8 $\pm$ 0.8)	7 (6–8) (6.9 $\pm$ 0.7)	<0.005
Pre-operative diagnosis at referral (number [%])			N.S.
Ruptured ectopic pregnancy	6 (100)	7 (100)	
Hemoglobin value at triage (g/dL; Median [range]) (Mean $\pm$ SD)	10.0 (8.4–11.9) (10.2 $\pm$ 1.2)	11.3 (9.0–13.5) (11.4 $\pm$ 1.8)	0.22
Serum β-hCG value at triage (IU/L; Median [range]) (Mean $\pm$ SD)	592 (112–1684) (721.5 $\pm$ 610)	3723 (1099–40,250) (13,233 $\pm$ 15,019)	0.01

SD, standard deviation; N.S., not significant; hCG, human chorionic gonadotropin.

Table 3. The surgical outcomes of women who underwent emergent laparoscopic surgery for a ruptured corpus luteum cyst with an undiagnosed intrauterine pregnancy in the early first trimester (*n* = 6) and ruptured ovarian pregnancy (*n* = 7).

Variables	Ruptured corpus luteum cyst	Ruptured ovarian pregnancy	*p* value
Surgical procedure (number [%])			N.S.
Partial ovarian resection with hemostatic suturing	3 (50.0)	2 (28.6)	
Hemostatic suturing	2 (33.3)	-	
Hemostatic suturing with intrauterine evacuation	1 (16.7)	-	
Removal of gestational products with hemostatic suturing	-	3 (42.9)	
Salpingo-oophorectomy	-	2 (28.6)	
Operation time (minute; Median [range]) (Mean $\pm$ SD)	62.5 (47.0–95.0) (66.8 $\pm$ 19.3)	59.0 (43.0–93.0) (62.9 $\pm$ 16.4)	0.67
Blood loss (mL; Median [range]) (Mean $\pm$ SD)	325 (50–930) (395 $\pm$ 305)	180 (20–900) (324 $\pm$ 335)	0.5
Blood transfusion (number [%])			N.S.
Bank blood	0 (0)	0 (0)	
Intraoperative blood salvage and donation, amounts of transfused autologous blood (mL)	2 (33.3), 200, 460	2 (28.5), 450, 507	
Serum β-hCG a day after surgery (IU/L; Median [range]) (Mean $\pm$ SD)	649 (72–1632)* (773 $\pm$ 567)	1545 (530–10,285) (4114 $\pm$ 4305)	0.09
Ratio of serum β-hCG change (value of a day after surgery divided by value at triage) (Median [range]) (Mean $\pm$ SD)	1.04 (0.64–2.51)* (1.25 $\pm$ 0.73)	0.40 (0.24–0.52) (0.39 $\pm$ 0.11)	0.004
C-reactive protein a day after surgery (mg/dL; Median [range]) (Mean $\pm$ SD)	1.25 (0.32–6.18) (2.30 $\pm$ 2.08)	0.78 (0.29–1.42) (0.83 $\pm$ 0.46)	0.21
Postoperative days at identification of intrauterine gestational sac (days; Median [range]) (Mean $\pm$ SD)	5 (2–6) (4.4 $\pm$ 1.5)	N/A	
Additional treatment (number [%])		N/A	
Progesterone supplementation	4 (66.7)		
None without wish to continue pregnancy	2 (33.3)		
Postoperative hospital stay (day; Median [range]) (Mean $\pm$ SD)	5 (4–14) (7.8 $\pm$ 4.8)	4 (3–4) (3.7 $\pm$ 0.5)	0.008

*After excluding a case with concomitant intrauterine evacuation.

N.S., not significant; hCG, human chorionic gonadotropin; N/A, not applicable.

Table 5. Summarized conclusions showing the similarities and differences between the women who underwent emergent laparoscopic surgery for a ruptured corpus luteum cyst with an undiagnosed intrauterine pregnancy in the early first trimester and ruptured ovarian pregnancy.

	Ruptured corpus luteum cyst	Ruptured ovarian pregnancy
Similarities		
Diagnosis of ruptured ectopic pregnancy at referral	Yes	Yes
Significant hemoperitoneum	Yes	Yes
Acute abdomen	Yes	Yes
Positive pregnancy test	Yes	Yes
Heterogeneous adnexal mass	Yes	Yes
Identification of intrauterine gestational sac at triage	No	No
Differences		
Serum β-hCG value at triage (IU/L: Median value)	592	3723
Estimated gestational weeks calculated from last menstrual period (weeks: Median value)	5	7

There were no statistically significant differences between the two groups in the operation time, blood loss, serum levels of β-hCG 1 day after surgery, or duration of postoperative hospital stay. The ratio of the serum levels of β-hCG 1 day after surgery divided by those measured at triage was significantly higher in the RCLC-P group (1.04) versus the ruptured ovarian pregnancy group (0.40). On postoperative day 1, the levels of C-reactive protein were higher in RCLC-P versus ruptured ovarian pregnancy; however, the difference was not statistically significant.

In both cases with significant hemoperitoneum in the two groups, intraoperative blood salvage and transfusion [16] negated the need for transfusion of bank blood. In the RCLC-P group, supplementation of progesterone for luteal support was performed, except in one patient with concomitant intrauterine evacuation and another patient who did not wish to continue her pregnancy after the postoperative identification of intrauterine gestation. In the RCLC-P group, an intrauterine gestational sac was identified at a median of 5 postoperative days (a median of estimated 5.6 gestational weeks). There were no significant postoperative complications observed in the two groups.

The pregnancy outcomes are shown in Table 4. Spontaneous miscarriage occurred in one patient who did not receive supplementation of progesterone. The pregnancy was maintained in three of four patients who received progesterone, without any significant morbidities and an uneventful vaginal delivery at term; spontaneous miscarriage occurred in the remaining patient.

4. Discussion

Typically, the detection of significant hemoperitoneum without a visible intrauterine gestational sac in women of reproductive age presenting with acute abdominal pain and a positive urinary pregnancy test supports a presumptive diagnosis of ruptured ectopic pregnancy [2].

A ruptured ovarian pregnancy is a significant concern, particularly when a heterogenous ovarian mass is identified on ultrasonography [4]. Ovarian pregnancy is a rare type of non-tubal ectopic pregnancy, in which the gestational sac develops after implantation of a fertilized ovum in an ovary [4]. Its incidence after natural conception ranges from 1/2000 to 1/60,000 deliveries, accounting for 3% of all ectopic pregnancies [4]. Following the occurrence of rupture, ovarian pregnancy can cause sudden bleeding even with hypovolemic shock. Thus, early and accurate diagnosis of ovarian pregnancy is crucial to prevent the development of serious complications [4].

However, even under conditions supporting a tentative diagnosis of ruptured ovarian pregnancy, the possibility that the intrauterine gestational sac cannot be identified simply due to an early gestational age should always be considered in cases with a RCLC [1–3]. This is because both morbidities may present with similar clinical manifestations, as shown in the current case series.

The corpus luteum begins to develop from a follicle that houses a maturing ovum [12]. This structure is essential for conception and the maintenance of pregnancy, as the corpus luteum remains the primary source of progesterone during the first 4 weeks following ovulation [12].

A cystic corpus luteum with a diameter exceeding 3 cm is termed a corpus luteum cyst [3]. Because the anatomical structure of the corpus luteum is characterized by intense angiogenesis [3], intracystic hemorrhaging is frequent and may manifest as abdominal pain. In addition, when delayed menstruation is reported, the concomitant presence of an intrauterine pregnancy should always be carefully assessed [9,10].

Usually, corpus luteum hemorrhaging resolves spontaneously from a few hours to days later. Therefore, observational management is recommended for most cases [9,10]. However, if the corpus luteum cyst ruptures into the peritoneal cavity and consecutive acute hemoperitoneum does not resolve spontaneously, a potentially life-threatening condition requiring immediate intervention may occur [11].

Typical ovary-sparing surgery for a RCLC may result in intended luteectomy or unintended destruction of the cor-

pus luteum during the process of thermal or non-thermal hemostasis [1–3]. It has been shown that the application of a hemostatic matrix or plant-based hemostatic agents is successful in achieving hemostasis in cases of tubal ectopic pregnancy [17] and ruptured ovarian endometrioma in early pregnancy [3]. Moreover, destruction of the corpus luteum prior to completion of the luteo-placental shift, which occurs at approximately 7 weeks of gestation, typically results in spontaneous miscarriage due to a decline in progesterone [12].

Therefore, when functional insufficiency of the corpus luteum is of concern in women with a strong wish to continue the gestation, immediate supplementation of progesterone is necessary to attenuate the negative effect [1]. Therefore, early identification of the similarities and differences in clinical features between RCLC-P and ruptured ovarian pregnancy is particularly important for successful pregnancy outcomes after surgery in women with RCLC-P.

Under conditions with elevated serum levels of β-hCG, imaging modalities alone have been associated with limited success for differentiating RCLC-P from a ruptured ovarian pregnancy. This is because both morbidities only show a heterogenous adnexal mass and hemoperitoneum without identification of an intrauterine gestational sac [1–3].

Previous findings in large case series have shown that the mean duration from the last menstrual period to the diagnosis of ovarian pregnancy is 6 to 7.25 weeks, and all patients showed serum levels of β-hCG >1000 IU/mL [4]. Furthermore, even late diagnosis of ovarian pregnancy at a more advanced age of gestation has been reported [4].

These observations are compatible with the results obtained in the present investigation. Preoperative differential diagnosis remains challenging and further accumulation of cases is warranted. Nevertheless, a gestational age ≤ 6 weeks and serum levels of β-hCG <1000 IU/mL at triage are strongly suggestive of RCLC-P. Thus, intrauterine manipulation should be avoided during surgery to minimize the damage to intrauterine gestational products that may exist.

Furthermore, in cases with non-declining serum levels of β-hCG following surgery, ultrasonography should be repeated during the postoperative period for the earlier detection of intrauterine gestational sac along with supplementation of progesterone to avoid the occurrence of miscarriage due to luteectomy or luteal destruction during surgery.

Concerning the potential negative impact of laparoscopic surgery on ongoing pregnancy, efforts have been made to establish the feasibility and safety of the management of variety of gynecological and non-gynecological disorders during pregnancy in any trimester [18]. However, the risk of miscarriage in the immediate postoperative period remains a significant concern, particularly when laparoscopic surgery is performed in the early first trimester during the process of embryonic organogenesis [18].

In general, it is well established that approximately 15%–20% of pregnant women experience spontaneous miscarriages during the first 7 weeks of gestation prior to the detection of fetal heartbeat due to various reasons [1,13]. In the present investigation, three of four women (75%) with RCLC-P at 4–6 weeks of gestation wishing to continue pregnancy achieved successful pregnancy outcomes through appropriate supplementation of progesterone after surgery.

These results are consistent with those of previous reports, which have shown that obstetric outcomes are favorable after laparoscopic surgery for adnexal pathologies, including RCLC-P [1–3]. The limited number of cases due to the rarity of this condition did not allow us to reach a clear conclusion. However, in the present case series, pregnancy outcomes in women with RCLC-P were acceptable even after appropriate laparoscopic management [1].

5. Conclusions

As summarized in Table 5, early gestational age and lower serum β-hCG levels at triage could be predictors of RCLC-P rather than ruptured ovarian pregnancy, despite many similarities between these two morbid conditions. Laparoscopic surgery appeared to be a feasible option for the management of RCLC-P with appropriate postoperative luteal support. The risk for bias with this small population (six versus seven women) is high. Therefore, further larger studies are warranted to validate our conclusions.

Author contributions

AT contributed to the conception of the study. AT, ST, and SI contributed significantly to the data analysis. AT wrote the manuscript. ST and SI assisted in data collection. AT performed the analysis after constructive discussions with the other authors. All authors reviewed the manuscript. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

All patients provided informed consent prior to participation in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Gifu Prefectural Tajimi Hospital (IRB number: Protocol #2020-35).

Conflict of interest

The authors declare no conflict of interest. AT is the Editorial board member of this journal, given his role as Editorial board member, AT had no involvement in the peer-review of this article and has no access to information regarding its peer-review.

References

[1] Takeda A, Hayashi S, Imoto S, Sugiyama C, Nakamura H. Pregnancy outcomes after emergent laparoscopic surgery for acute adnexal disorders at less than 10 weeks of gestation. Journal of Obstetrics and Gynaecology Research. 2014; 40: 1281–1287.

[2] Bauman R. Horvat G. Management of Ruptured Corpus Luteum with Hemoperitoneum in Early Pregnancy-a Case Report. Acta Clinica Croatica. 2018; 57: 785–787.

[3] Watrowski R. Pregnancy-Preserving Laparoscopic Treatment of Acute Hemoperitoneum Following Lutein Cyst Rupture in Early Gestation. Zeitschrift Für Geburtshilfe Und Neonatologie. 2019; 223: 109–112.

[4] Odejinmi F, Rizzuto MI, MacRae R, Olowu O, Hussain M. Diagnosis and Laparoscopic Management of 12 Consecutive Cases of Ovarian Pregnancy and Review of Literature. Journal of Minimally Invasive Gynecology. 2009; 16: 354–359.

[5] Hong YH, Kim H, Kim SK, Lee BC. A case of heterotopic ovarian pregnancy after in vitro fertilization: early diagnosis and single-port access conservative laparoscopic treatment. Gynecology and Minimally Invasive Therapy. 2021; 10: 57–60.

[6] Reif P, Schöll W, Klaritsch P, Lang U. Rupture of endometriotic ovarian cyst causes acute hemoperitoneum in twin pregnancy. Fertility and Sterility. 2011; 95: 2125.e1–2125.e3.

[7] Graham A, Devarajan S, Datta S. Complications in early pregnancy. Obstetrics, Gynaecology & Reproductive Medicine. 2015; 25: 1–5.

[8] Timmons D, Montrief T, Koyfman A, Long B. Ovarian hyperstimulation syndrome: a review for emergency clinicians. the American Journal of Emergency Medicine. 2019; 37: 1577–1584.

[9] Hallatt JG, Steele CH, Snyder M. Ruptured corpus luteum with hemoperitoneum: a study of 173 surgical cases. American Journal of Obstetrics and Gynecology. 1984; 149: 5–9.

[10] Ho WK, Wang YF, Wu HH, Tsai HD, Chen TH, Chen M. Ruptured Corpus Luteum with Hemoperitoneum: Case Characteristics and Demographic Changes over Time. Taiwanese Journal of Obstetrics and Gynecology. 2009; 48: 108–112.

[11] Takeda A, Sakai K, Mitsui T, Nakamura H. Management of Ruptured Corpus Luteum Cyst of Pregnancy Occurring in a 15-Year-Old Girl by Laparoscopic Surgery with Intraoperative Autologous Blood Transfusion. Journal of Pediatric and Adolescent Gynecology. 2007; 20: 97–100.

[12] Csapo AI, Pulkkinen M. Indispensability of the human corpus luteum in the maintenance of early pregnancy luteectomy evidence. Obstetrical & Gynecological Survey. 1978; 33: 69–81.

[13] Oliver A, Overton C. Diagnosis and management of miscarriage. Practitioner. 2014; 258: 25–28

[14] Takeda A, Imoto S, Mori M, Nakano T, Nakamura H. Early experience with isobaric laparoendoscopic single-site surgery using a wound retractor for the management of ectopic pregnancy. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2011; 154: 209–214.

[15] Takeda A, Imoto S, Nakamura H. Gasless laparoendoscopic single-site surgery for management of adnexal masses during pregnancy. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2014; 180: 28–34.

[16] Takeda A, Manabe S, Mitsui T, Nakamura H. Management of patients with ectopic pregnancy with massive hemoperitoneum by laparoscopic surgery with intraoperative autologous blood transfusion. Journal of Minimally Invasive Gynecology. 2006; 13: 43–48.

[17] Watrowski R. Hemostatic gelatine–thrombin matrix (Floseal®) facilitates hemostasis and organ preservation in laparoscopic treatment of tubal pregnancy. Archives of Gynecology and Obstetrics. 2014; 290: 411–415.

[18] Pearl JP, Price RR, Tonkin AE, Richardson WS, Stefanidis D. SAGES guidelines for the use of laparoscopy during pregnancy. Surgical Endoscopy. 2017; 31: 3767–3782.