

Computed Tomography Characteristics of Ruptured Corpus Luteum: Does Prior Coitus Modify Findings?

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Abstract

Background & Aims: To determine the effect of prior coitus on CT findings of ruptured corpus luteum.

Methods: The subjects were female patients complaining of acute lower abdominal pain, who underwent CT examination. Patients meeting the following criteria were diagnosed with ruptured corpus luteum: 1) an adnexal cystic mass with thick wall, 2) high density ascites (≥ 20 Hounsfield Units [H.U.]), 3) no CT evidence of acute abdominal diseases, 4) no pregnancy, 5) no prior history of chronic lower abdominal pain, and 6) relief of pain within two weeks. These patients were classified into two groups: with and without coitus within three days before the onset. Then, CT findings were evaluated.

Results: A total of 18 patients fulfilled the criteria. Patients with prior coitus ($n=9$) showed a larger maximum diameter of the adnexal cyst (38.8 vs 23.5 mm, $p=0.005$), higher attenuation of ascites (41 vs 25 H.U., $p=0.017$), and a larger amount of ascites (pelvis-limited or beyond pelvis) ($p=0.015$), compared to the others ($n=9$).

Conclusions: Prior coitus affected CT findings such as a larger amount of ascites with higher attenuation.

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Introduction

Ruptured corpus luteum has been recognized as an important differential diagnosis of acute abdominal pain in women of reproductive age.^{1,2} The most common gynecological disorders causing peritoneal hemorrhage are ectopic pregnancy and ruptured corpus luteum. The latter is not widely recognized among radiologists.² Ruptured corpus luteum is most commonly observed in women who are in their late twenties.¹⁻⁴

Ultrasonography is the principal modality for evaluation of suspected acute gynecological disorders.⁵⁻⁹ For the diagnosis of acute abdominal pain, however, computed tomography (CT) occasionally provides useful information. There have been detailed reports describing CT findings of ruptured corpus luteum.¹⁰⁻¹² Most reports describe ruptured corpus luteum as a mixed-attenuation adnexal mass with a high-attenuation cyst component (12–45 Hounsfield units [H.U.]). A fluid-fluid level may be observed in the cyst. Associated hemoperitoneum is seen on occasion. Interestingly, this disorder is known to be associated with prior coitus,^{1,2,4,11} but there have been no reports so far which evaluate the influence of coitus on the CT findings.

The aims of this study are to review the CT findings of ruptured corpus luteum, and to determine the influence of prior coitus on CT findings.

Materials and Methods

The Gunma Chuo Hospital Ethics Committee approved all aspects of this study (approval number 2019-044). The subjects in this study are patients of child-bearing age (11–50 years old) who came to our hospital complaining of acute lower abdominal pain. The patients underwent abdominal CT between April 2010 and January 2015. The CT findings were retrospectively reviewed. In this study, patients who fulfilled the following radiological and clinical criteria were diagnosed with ruptured corpus luteum, based on findings described in previous reports¹⁰⁻¹²: 1) presence of an adnexal cystic mass with thick wall on CT, 2) high density ascites (≥ 20 H.U.) at least in the pouch of Douglas, 3) no CT evidence of appendicitis, diverticulitis, or other focal acute inflammatory bowel diseases, 4) no pregnancy (virginity, negative pregnancy test, or strong denial of the possibility of pregnancy), 5) no prior history of chronic lower abdominal pain, and 6) relief of symptoms within two weeks. All patients were checked the pregnancy status prior to a CT scan.

All CT examinations were performed with a 64-multidetector row CT (LightSpeed VCT, GE Healthcare, Milwaukee, WI, USA). Images were obtained from the level of diaphragm to the lower base of the pelvis. After unenhanced CT, unless contraindicated, 100 mL of iodinated contrast media (Iopamiron 300, Bayer Yakuhin, Ltd., Osaka, Japan) was administered from the antecubital vein, and post-contrast images were acquired in the portal venous phase using a scan delay of 70 s. At the discretion of the attending physicians, dynamic imaging was also performed in some patients: images were obtained at 35 s, 70 s, and 180 s after the contrast injection. All CT examinations were performed using a helical scan mode with a tube voltage of 120 kVp.

CT images were reviewed by two diagnostic radiologists: one was an experienced radiologist specialized in abdominal imaging with more than 30 years of experience (JA), and the other had five-years of experience as a general diagnostic radiologist (YK). Both radiologists evaluated images for the following: 1) laterality of the adnexal cyst (right or left) on a transaxial CT image, 2) the maximum diameter of the cyst, 3) shape (oval or

collapsed) of the cyst, 4) attenuation of the cyst contents (H.U.), 5) maximum thickness of the cyst wall, 6) contrast enhancement of the cyst wall (mild or strong), 7) amount of ascites (small or large), and 8) attenuation of the ascites (H.U.). To assess attenuation value of the contents, an oval region of interest (ROI) was placed in the center of the cyst to be as large as possible while excluding the wall, and the mean CT number was recorded. Attenuation value of the ascites was measured in the maximum attenuation area using a ROI of 1 cm² or larger. All attenuation values were measured on unenhanced CT. The amount of the ascites was classified as small when it was located in only the pelvis, and large when it extended beyond the pelvic space.

The referring physicians interviewed the patients on whether they had coitus within 72 hours prior to onset of pain. Based on their answers, the participants were classified into two groups: coitus (+) and coitus (-). CT findings, menstrual cycle phase (luteal phase, follicular phase, or undetermined), and laboratory data (hemoglobin [Hb], white blood cell [WBC] and C-reactive protein [CRP] obtained at hospital visits) were compared between two groups. The first clinic consulted (gynecological or non-gynecological) and the ultrasound examination performed (transvaginal [TVUS] or transabdominal [TAUS]) were also recorded.

Quantitative variables were described as median (range). Characteristics of patients and CT findings in the two groups were compared using Fisher's exact test for categorical variables and Mann-Whitney U test for continuous variables. Logistic regression analysis was used to determine the impact of each factor. The median value for each continuous scale was employed as a cut-off in logistic regression analyses. The Haldane-Anscombe correction was applied to calculate the odds ratio when one of the cells has zero value. A *p*-value of <0.05 was considered significant. A commercially available software package (SPSS Statistics, v25, IBM Japan, Tokyo, Japan) was used.

Results

A total of 18 female patients fulfilled the inclusion criteria. Table 1 and 2 summarize the patients' back-

Table 1 Patients' background

	Coitus (+) (n= 9)	Coitus (-) (n= 9)	<i>p</i> -value
Age (years) *	23 (18–31)	19 (11–50)	0.375
Menstrual phase			
luteal phase	6	9	0.103
undetermined	3	0	
Clinic consulted initially			
gynecological	6	1	0.025
non-gynecological	3	8	
Cyst on ultrasonography			
detected	8	4	0.066
missed	1	5	

* median (range)

Table 2 Comparison of CT findings in patients with and without coitus

CT Findings	Coitus (+) (n= 9)	Coitus (-) (n= 9)	p-value
Cyst, laterality			
right	7	6	0.500
left	2	3	
Cyst, maximum diameter (mm)	38.8 (18.1–46.3)	23.5 (14.5–35.0)	0.005
Cyst, shape			
oval	7	4	0.167
collapsed	2	5	
Cyst, wall thickness (mm)	2.1 (1.0–2.5)	2.0 (1.3–4.2)	0.450
Cyst, wall enhancement			
mild	3	3	0.627
strong	6	5	
Cyst, contents, density (HU)	24 (21–48)	24 (19–50)	0.625
Ascites, density (HU)	41 (32–54)	25 (20–50)	0.017
Ascites, volume			
small amount	4	9	0.015
large amount	5	0	

Table 3 Results of logistic regression analysis

CT Findings	Coitus (+) (n= 9)	Coitus (-) (n= 9)	Odds ratio (95% CI)	p-value
Cyst, laterality				
right	7	6	1.75 (0.22, 14.22)	0.601
left	2	3		
Cyst, maximum diameter				
< 3 mm	2	7	12.25 (1.33, 113.06)	0.027
≥ 3 mm	7	2		
Cyst, shape				
oval	7	4	0.23 (0.03, 1.77)	0.158
collapsed	2	5		
Cyst, wall thickness				
< 2 mm	4	4	1.00 (0.16, 6.42)	1.000
≥ 2 mm	5	5		
Cyst, wall enhancement				
mild	3	3	0.83 (0.11, 6.11)	0.858
strong	6	5		
Cyst, contents, density				
< 24 HU	4	4	1.00 (0.16, 6.42)	1.000
≥ 24 HU	5	5		
Ascites, density				
< 39 HU	2	7	12.25 (1.33, 113.06)	0.027
≥ 39 HU	7	2		
Ascites, volume				
small amount	4	9	23.22 (1.04, 517.96)*	0.047
large amount	5	0		

*Haldane-Anscombe correction was applied to calculate the odds ratio

ground data and CT findings. The results of the logistic regression analysis are summarized in Table 3. The coitus (–) group consisted of nine patients, including five self-reported virgins. In the coitus (+) group, seven patients had intercourse 24 hours before onset of pain, and two patients had intercourse 48 hours before onset of pain. All the patients, except three undetermined, were in the luteal phase. Pregnancy and ectopic pregnancy were excluded with self-reported virginity in five patients and

the verbal denial of pregnancy in five patients. Negative beta-HCG test was confirmed in eight patients.

Six (67%) of the nine coitus (+) patients first consulted a gynecologist, and three (33%) were referred from a non-gynecological department to a gynecologist based on the results of the CT. TVUS was performed for all nine coitus (+) patients, and adnexal mass lesions were detected in eight cases (89%). On the other hand, only one (11%) of the nine coitus (–) patients first consulted a



Fig. 1 A 22-year-old woman with right pelvic pain reporting prior coitus. Contrast-enhanced CT scan shows a 4.0 cm cyst with thick enhancing wall in right adnexa (arrow). The cyst is round. The cystic content and peritoneal fluid (arrowheads) show high attenuation.

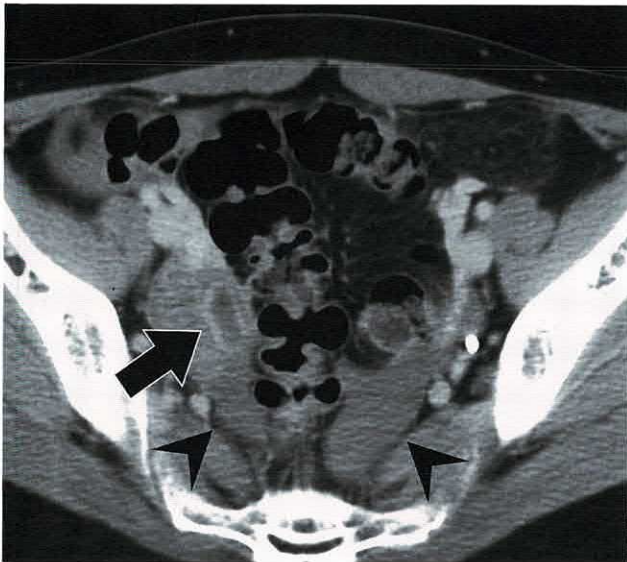


Fig. 2 A 28-year old woman with right pelvic pain denying prior coitus. Contrast-enhanced CT scan shows a 2.4 cm cyst with thick enhancing wall in right adnexa (arrow). The cyst is oval. The cystic content and peritoneal fluid (arrowheads) show high attenuation. Note the presence of high-attenuated peritoneal fluid around cystic mass.

gynecologist, and eight (89%) were referred from a non-gynecological department to a gynecologist based on the results of the CT. TVUS was performed on three patients (33%) and TAUS was performed for six patients (67%). Adnexal mass lesions were detected in two of three patients of TVUS, and two of six cases of TAUS respectively.

One patient was evaluated by unenhanced CT only, because she refused to have contrast media administered. Dynamic studies were performed on five patients. On CT examinations, adnexal cystic lesions were on the right side in 13 patients (72%), and on the left side in five (28%). The maximum diameter of the adnexal cystic

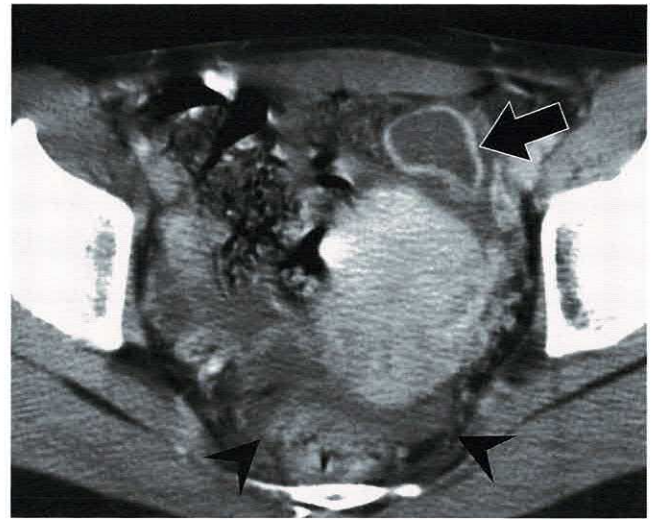


Fig. 3 A 19-year-old woman with left pelvic pain denying prior coitus. Contrast-enhanced CT scan shows a 3.3 cm cyst with strong-enhancing wall in left adnexa (arrow). The cyst shape is collapsed. Attenuation values of the cyst and ascites (arrowheads) on plain CT were 21 and 31 H.U., respectively.

lesions measured was 30.0 mm (range, 14.5–46.3 mm), and the coitus (+) group showed a larger cyst size (odds ratio [OR]=12.25; 95% confidence interval [CI], 1.33–113.06; $p=0.027$) compared to the coitus (–) group. In all 17 patients with contrast-enhanced CT, the cyst walls were enhanced, and the wall thickness of the cysts was 2.0 mm (1.0–4.2 mm). There were no differences in the attenuation values of the cyst contents or the mass shape between two groups (Figs. 1–3).

The attenuation value of the ascites was 38 H.U. (20–54 H.U.). The coitus (+) group had a higher attenuation value (OR=12.25; 95% CI, 1.33–113.06; $p=0.027$) and a larger amount of ascites (OR=23.22; 95% CI, 1.04–517.96; $p=0.047$) compared to the coitus (–) group.

Although blood test results showed slightly increased CRP (0.08 vs 0.03 mg/dL) and WBC (12700 vs 8000/ μ L) and decreased Hb (11.7 vs 13.3 g/dL) in the coitus (+) group, there were no statistically significant differences between two groups.

Discussion

In the current study, ruptured corpus luteum was shown to be a mostly right-sided cystic adnexal mass and the walls of the cysts were enhanced on CT. The presence of coitus affected the CT findings, i.e. in the coitus (+) group had a larger cyst size, and more ascites with a higher attenuation value.

Two most frequent causes of intraperitoneal hemorrhage in reproductive-aged women are ectopic pregnancy and hemorrhagic adnexal cysts.³ The latter are most commonly hemorrhagic corpus luteum cysts or follicular cysts.^{13–15} Ruptured corpus luteum may result from continuous hemorrhage within a corpus luteum and usually has a thicker wall than a follicular cyst.¹⁶ Although

mentioning hemorrhagic follicular cysts as an additional source of hemoperitoneum in non-pregnant women would be helpful, the management is likely similar to that of a corpus luteum cyst, so distinguishing between the two has no clinical importance.

Although the diagnosis of ectopic pregnancy is established based on a positive pregnancy test and relevant ultrasound findings, corpus luteum hemorrhage or rupture is probably less familiar to general physicians or radiologists. Rupture of a corpus luteum cyst may cause intraperitoneal hemorrhage. After ovulation, the number of blood vessels begins to increase during the early luteal phase. Vascularization is completed in the middle luteal phase. The number of vascular wall cells, which stabilize vessels, increases gradually from the early period to the middle period, but then decreases during the later period of the luteal phase. This results in vessel fragility when pregnancy does not occur.^{17,18} The thin-walled, fragile vascular structure of the corpus luteum tends to bleed easily. Blood pooling may occur within the corpus luteum initially, potentially followed by rupture, resulting in massive intraperitoneal hemorrhage. Although any functional ovarian cyst can be ruptured, the vessel fragility in the luteal phase may increase the risk of rupture.⁴ In fact, our study showed that 15 of 18 patients were at the luteal phase of their menstrual cycle.

There have been only a few reports on the CT findings of ruptured corpus luteum.¹⁰⁻¹² A final diagnosis is usually made clinically because most patients with a ruptured corpus luteum can recover without specific treatment, and pathological confirmation is rarely obtained. This disease is most commonly observed in young females, and CT examination is often avoided unless pregnancy can be ruled out. To evaluate female patients of reproductive age with acute pelvic pain, the choice of the imaging modality is usually determined by a suspected clinical differential diagnosis. Whereas TVUS is recommended when a gynecologic or obstetric etiology is suspected, CT is often more useful when gastrointestinal disease is thought to be more likely.¹⁹ TVUS plays an important role in diagnosing the ruptured corpus luteum cyst and usually it is the first imaging modality utilized. TVUS may reveal a cystic component in the adnexal area associated with free hypoechoic fluid in the peritoneal cavity.²⁰ These may be the reasons why only a few reports of CT have been published.

The reported CT findings of ruptured corpus luteum are: 1) generally right-sided adnexal cystic mass around 3 to 4 cm, 2) high attenuation cyst contents, 3) thick contrast-enhanced wall, and 4) high attenuation ascites.¹⁰⁻¹² In the current study, the coitus (-) group showed a smaller cyst size, a lower attenuation value of ascites and a smaller amount of ascites compared to the coitus (+) group. The knowledge of the spectrum of these CT findings may prevent overlooking and misdiagnosis of ruptured corpus luteum without sexual intercourse, especially when it is not specifically suspected.

Ruptured corpus luteum has been known to be often associated with prior coitus. Blood flow of uterine or ovarian vessels may increase by coitus, and direct

mechanical stimulation by coitus may trigger rupture.²¹ While the relationship between ruptured corpus luteum and coitus has been said to follow a "90% rule" in the gynecological field, the actual frequency of ruptured corpus luteum being caused by coitus has been reported to be 57.1%.²² The higher prevalence on the right side can be explained as being the result of protection by the sigmoid colon on the left, consistent with the relationship of the disease and coitus.² In this study, women who had coitus within 72 hours of presentation had larger cyst sizes and more severe hemoperitoneum (both volume and density). These differences are supposedly caused by blood vessel damage due to stimulation from coitus, and this might be the cause of the more severe bleeding. The changes in intraluminal pressure created during coitus might possibly be a catalyst for cyst rupture.²³

In our study, many patients first consulted a gynecologist, probably because patients considered a possible relationship between acute lower abdominal pain and coitus. In this situation, TVUS is usually performed, as seen in this study, and an accurate diagnosis can be made (in our study, 89%). On the other hand, in the coitus (-) group, only one patient visited a gynecologist first. Some of the patients stated that they were virgins, and TVUS was performed in only one-third of the patients. As a result, the adnexal abnormality was missed in more than half of these patients (56%).

This study had several limitations. First, the diagnosis of ruptured corpus luteum was based on clinical and imaging findings, and we had no pathological confirmation. Intraperitoneal bleeding was suspected based on the attenuation value of ascites, and not directly confirmed. Although the possibility of pregnancy (including ectopic pregnancy) was excluded by self-reported virginity or strong verbal denial of pregnancy in five patients respectively, menstruation was later confirmed on follow-up in all patients, ruling out pregnancy with reasonable reliability. Second, there was a possibility that the mechanical stimulation of TVUS caused peritoneal bleeding. Third, it was a retrospective single-center study with a limited number of patients. Patients with ruptured corpus luteum, diagnosed only by TVUS might not undergo CT examination. These patients were not included in this study, leading selection bias. Finally, the presence (or lack) of coitus was also self-reported and could be inaccurate.

In conclusion, ruptured corpus luteum showed generally right-sided cystic adnexal masses with enhancing walls. Both cyst contents and ascites showed high attenuation, which were suspected to be due to bleeding. The presence of coitus affected to the CT findings: a larger cyst size, and ascites of a larger amount and higher attenuation value. In other words, ruptured corpus luteum without coitus tends to lack these typical findings. Gynecologists, surgeons, and radiologists should know the spectrum of these CT findings, as well as consider it as a differential diagnosis of acute abdominal pain in female patients of reproductive age even if she has no sexual intercourse.

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Declaration

The authors declare no conflict of interest.

References

- Hallatt JG, Steele CH Jr, Snyder M. Ruptured corpus luteum with hemoperitoneum: a study of 173 surgical cases. *Am J Obstet Gynecol* 1984; 149: 5-9.
- Fiaschetti V, Ricci A, Scarano AL, et al. Hemoperitoneum from corpus luteal cyst rupture: a practical approach in emergency room. *Case Rep Emerg Med* 2014; 2014: 252657.
- Anjali A, Poonam G, Madhvi W, et al. Ruptured corpus luteum with hemoperitoneum. *J Obstet Gynecol Ind* 2004; 54: 488-490.
- Raziel A, Ron-El R, Pansky M, et al. Current management of ruptured corpus luteum. *Eur J Obstet Gynecol Reprod Biol* 1993; 50: 77-81.
- Brown DL, Dudiak KM, Laing FC. Adnexal masses: US characterization and reporting. *Radiology* 2010; 254: 342-354.
- Hall DA, Hann LE, Ferrucci JT Jr, et al. Sonographic morphology of the normal menstrual cycle. *Radiology* 1979; 133: 185-188.
- Harris RD, Holtzman SR, Poppe AM. Clinical outcome in female patients with pelvic pain and normal pelvic US findings. *Radiology* 2000; 216: 440-443.
- Amirbekian S, Hooley RJ. Ultrasound evaluation of pelvic pain. *Radiol Clin North Am* 2014; 52: 1215-1235.
- Laing FC, Allison SJ. US of the ovary and adnexa: To worry or not to worry? *Radiographics* 2012; 32: 1621-1639.
- Bennett GL, Slywotzky CM, Giovanniello G. Gynecologic causes of acute pelvic pain: spectrum of CT findings. *Radiographics* 2002; 22: 785-801.
- Choi HJ, Kim SH, Kim SH, et al. Ruptured corpus luteal cyst: CT findings. *Korean J Radiol* 2003; 4: 42-45.
- Potter AW, Chandrasekhar CA. US and CT evaluation of acute pelvic pain of gynecologic origin in nonpregnant premenopausal patients. *Radiographics* 2008; 28: 1645-1659.
- Nyberg DA, Porter BA, Olds MO, et al. MR imaging of hemorrhagic adnexal masses. *J Comput Assist Tomogr* 1987; 11: 664-669.
- Baltarowich OH, Kurtz AB, Pasto ME, et al. The spectrum of sonographic findings in hemorrhagic ovarian cysts. *AJR Am J Roentgenol* 1987; 148: 901-905.
- Bass IS, Haller JO, Friedman AP, et al. The sonographic appearance of the hemorrhagic ovarian cyst in adolescents. *J Ultrasound Med* 1984; 3: 509-513.
- Fleischer AC, Javitt MC, Jefferey RB, et al. Clinical gynecologic imaging, 3rd ed. Philadelphia: Lippincott Raven; 1997, 51-52.
- Christenson LK, Stouffer RL. Proliferation of microvascular endothelial cell in the primate corpus luteum during the menstrual cycle and simulated early pregnancy. *Endocrinology* 1996; 137: 367-374.
- Sugino N, Suzuki T, Sakata A, et al. Angiogenesis in the human corpus luteum: changes in expression of angiopoietins in the corpus luteum throughout the menstrual cycle and in early pregnancy. *J Clin Endocrinol Metab* 2005; 90: 6141-6148.
- Bhosale PR, Javitt MC, Atri M, et al. ACR appropriateness criteria[®] acute pelvic pain in the reproductive age group. *ultrasound Q*. 2016; 32: 108-115.
- Roche O, Chavan N, Aquilina J, et al. Radiological appearances of gynaecological emergencies. *Insights Imaging* 2012; 3: 265-275.
- McColgin SW, Williams LM, Sorrells TL, et al. Hemoperitoneum as a result of coital injury without associated vaginal injury. *Am J Obstet Gynecol* 1990; 163: 1503-1505.
- Ho WK, Wang YF, Wu HH, et al. Ruptured corpus luteum with hemoperitoneum: case characteristics and demographic changes over time. *Taiwan J Obstet Gynecol* 2009; 48: 108-112.
- Belsky JB, Nagarwala JF, Tokarski GF. Massive hemoperitoneum from a ruptured corpus luteum cyst masquerading as biliary colic. *Int J Case Rep Imag* 2015; 6: 168-172.