Case Reports in Oncology

Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991
Received: May 2, 2023
Accepted: July 6, 2023
Published online: August 25, 2023

Case Report

Krukenberg Tumor of Gastric Origin in Pregnant Women with Preeclampsia

Yongke Zhang[a, b, c] Hui Du[a, b, c] Taili Li[d] Huan Li[a, b, c] Yuqing Deng[a, b, c] Ruifang Wu[a, b, c]

[a]Department of Obstetrics and Gynecology, Peking University Shenzhen Hospital, Shenzhen, China; [b]Institute of Obstetrics and Gynecology, Shenzhen PKU-HKUST Medical Center, Shenzhen, China; [c]Shenzhen Key Laboratory on Technology for Early Diagnosis of Major Gynecologic Diseases, Shenzhen, China; [d]Department of Pathology, Peking University Shenzhen Hospital, Shenzhen, China

Keywords
Krukenberg tumor · Pregnancy · Gastric cancer · Preeclampsia

Abstract
Krukenberg tumor refers to a malignancy in the ovary that metastasizes from a primary site, classically the gastrointestinal tract. Pregnancy complicated with a Krukenberg tumor is very rare. In this report, we present two unusual cases of pregnant women with Krukenberg tumors of gastric origin. One case was a full-term pregnant woman with preeclampsia (PE) who underwent a caesarean section when bilateral enlarged ovaries were incidentally identified. Histopathology of the wedge resection biopsy showed single-ring cell carcinoma; this was followed by gastroscopy, which indicated a gastric origin. The woman received chemotherapy but died 6 months later. Another case was a pregnant woman at 30 gestational weeks with abdominal pain complicated with early-onset PE. Ultrasonography and magnetic resonance imaging showed bilateral enlarged ovaries and elevated tumor markers. Gastroscopy indicated linitis plastica. After an emergency caesarean section, adnexectomy was performed, and postoperative histopathology confirmed a Krukenberg tumor. The woman died 2 months after delivery. Gastrointestinal symptoms during pregnancy may indicate a malignancy of rare gastrointestinal origin. PE complicated with Krukenberg tumors in pregnancy should be considered in future studies.

Introduction

A Krukenberg tumor, composed of mucin-rich signet-ring cells, is a disease of gastrointestinal tract origin that is metastatic to the ovaries. The stomach is the most common primary site for this tumor (approximately 70%) [1]. Pregnancy complicated with

Correspondence to:
Ruifang Wu, wurf100@126.com

Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991

Krukenberg tumors is very rare; however, Krukenberg tumors can be asymptomatic or may manifest with nonspecific gastrointestinal signs and symptoms such as nausea, vomiting, abdominal or pelvic pain, bloating, and ascites, which may be obscured in pregnancy; thus, the prognosis of the disease is very poor. The median overall survival of patients with Krukenberg tumors is reportedly 11 months for cases with a gastric origin.

Preeclampsia (PE) is defined as new-onset hypertension after 20 weeks of gestation with evidence of maternal organ or uteroplacental dysfunction or proteinuria. PE is a major cause of maternal and perinatal morbidity and mortality. According to the World Health Organization, 16% of maternal deaths are attributable to PE and related gestational hypertensive disorders [2]. PE is understood to originate in the placenta, and its initial stages can be understood as placental syndrome. Physiological transformation with remodeling of the uteroplacental spiral arteries is key to successful placentation and normal placental function [3]. Studies have found that impaired trophoblast invasion is the main pathophysiological mechanism in inadequate remodeling of the spiral arteries [4].

We report here 2 cases of Krukenberg tumors of gastric origin in pregnant women complicated by PE. The first case was occasionally observed in the cesarean section 10 years ago, and another 5 years later. We decided to summarize the literature because they were both complicated with preeclampsia, which is an interesting situation that needs to be explored. Previously reported cases retrieved from PubMed with full text in English and published between January 1960 and April 2022 were reviewed.

Case Presentation

Case 1

A 32-year-old pregnant woman at 39 weeks, gravida 7, para 1, was admitted to the hospital because of PE. She did not have regular antenatal examinations but declared no obviously abnormal symptoms during pregnancy. She gained 9 kg during pregnancy. She had undergone a cesarean section for an unknown reason 10 years earlier. Before pregnancy, her blood pressure was normal. Physical examination showed a high BP, 156/105 mm Hg, soft abdomen, no abdominal mass palpated, no visual impairment, and no swelling of the lower limbs. The obstetrical examination was normal. The urine test showed proteinuria. The woman chose to deliver by cesarean section.

During the operation, a few deep-red, solid nodule-like lesions were found on the surface of the lower uterine segment when the abdominal cavity was opened. The neonate, a female, with a birth weight of 3,600 g and Apgar score of 9’ in 1 min and 10’ in 5 min, was delivered normally. The amniotic fluid was clear. The placenta was intact, weighing approximately 500 g, with a size of 20 cm × 20 cm × 2 cm. Bilateral enlarged dark purple kidney-shaped soft ovaries were explored, with a size of approximately 7 cm × 6 cm × 5 cm on the left side and 12 cm × 10 cm × 9 cm on the opposite side. After suturing the uterus, a right ovarian wedge resection biopsy and uterine surface neoplasm-like lesion biopsy were performed, followed by rapid freezing histopathology showing signet-ring cells from a primary or secondary malignancy. Pelvic and abdominal cavity exploration revealed miliary nodules covering the surface of the pelvic and abdominal organs, especially the greater curvature. An urgent multidisciplinary consultation was performed. Primary ovarian cancer or ovarian metastasis stage IIIc was considered. Because the patient had not undergone gastrointestinal preparation, she underwent general anesthesia and hysterectomy, bilateral adnexectomy, pelvic and para-aortic lymph node dissection, appendectomy, and omentectomy. No obvious lymph node enlargement was found in any group during the operation. Final histopathology reported a metastatic adenocarcinoma possibly of digestive tract origin (Fig. 1a–d). Subsequent

Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991

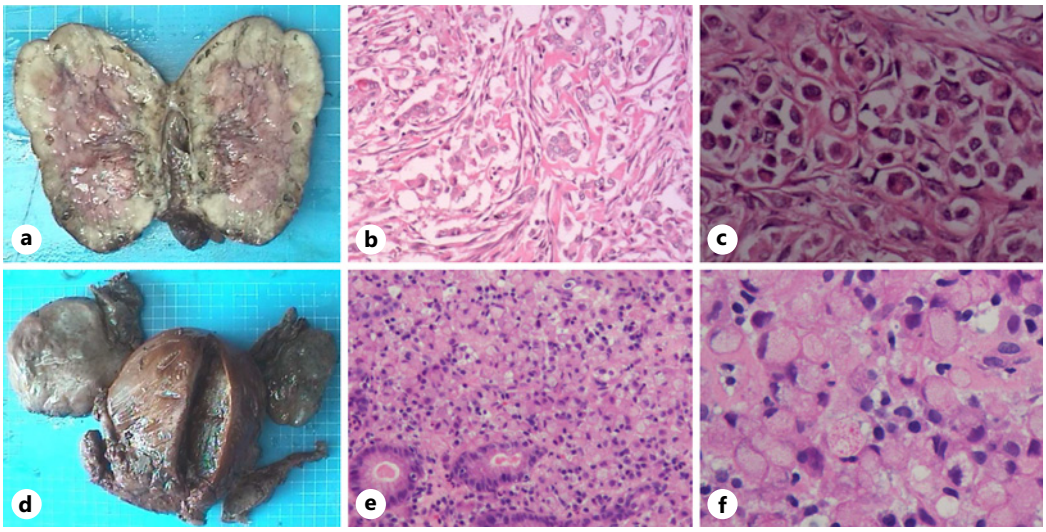

Fig. 1. Histopathological findings of case 1. **a** The left ovary was 8 cm × 6 cm × 3 cm in size; the cut surface was greyish yellow or greyish red and soft, and several vesicles could be seen. The tumor tissue was composed of tubular and acinar structures, and characteristic signet-ring cells were observed (HE staining, ×200 **b** and ×400 **c**). **d** Gross specimen of the uterus and bilateral ovaries. Gastroscopy and subsequent histopathological examination showed poorly differentiated adenocarcinoma, a portion of which was signet-ring cell carcinoma (HE staining, ×100 **e** and ×400 **f**).

gastroscopy showed poorly differentiated adenocarcinoma, a portion of which was signet-ring cell carcinoma (Lauren classification: diffuse type) and immunohistochemical human epidermal growth factor receptor 2 (HER2)-(1+) (Fig. 1e, f). The ovarian tumor was confirmed to be a Krukenberg tumor from gastric adenocarcinoma.

The patient was admitted to the oncology department for chemotherapy 1 month later after dilivery. Baseline carbohydrate antigens were cancer antigen (CA) 199 (724.73 U/mL) and CA125 (87.00). She suffered intestinal obstruction, and the symptoms recurred during chemotherapy. She was treated with docetaxel (117 mg, ivgtt, d1) combined with capecitabine (1.5, bid, d1~d14) for a total of 2 cycles. A mild rise in CA199 of 949.79 U/mL was observed 1 month later. In the third month, the CA199 was sharply elevated to 3,059.54 U/mL. When another episode of intestinal obstruction occurred, the chemotherapy plan was changed to liposomal paclitaxel (120 mg, ivgtt, d1, d8, d15) combined with fluorouracil (5-FU) (3.0, CIV48 h, d1) for 1 cycle. A CA199 of 9,984.61 U/mL was observed in the fourth month. The patient died in the fifth month.

Case 2

A 34-year-old 30-week-old pregnant woman, gravida 2, para 1, was admitted to the hospital because of intermittent abdominal pain, a uterine appendage mass, and early-onset PE. Her routine antenatal checks were normal, and her weight gain was 2 kg until hospitalization, which was remarkably low. She had not undergone surgery before, except for a cesarean section of her first baby. She was diagnosed with hyperthyroidism 3 years earlier but did not need to take any medication. She had been suffering from chronic gastritis and reflux esophagitis for 3 years, but her condition was relatively stable and did not require medication. Approximately 4 months earlier, she complained of intermittent upper middle abdominal pain accompanied by abdominal bloating, nausea, occasional vomiting, and diarrhea. The pain was relieved after conservative treatment and was thereby considered acute gastroenteritis. Then, the episodes recurred monthly.

Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991

A color Doppler ultrasound showed a hypoechoic mass on the right side of the uterus, with a size of approximately 201 × 180 × 141 mm, and ascites could be seen with a diameter of approximately 39 mm. Dilation of the right upper ureter and right hydronephrosis were also reported (Fig. 2a). A high blood pressure 143/97 mm Hg, CA125 of 420.6 U/mL, human epididymis protein 4 (HE4) 47.4 pmol/L, and urine protein 2+ dipstick were detected. Magnetic resonance imaging was recommended for further evaluation. A Krukenberg tumor of stomach origin was considered because of the bilateral ovarian mass, diffuse thickening and stiffness of the stomach wall, and abdominal and pelvic effusion (Fig. 2b, c). Gastric endoscopy was urgently performed, and histopathology suggested the possibility of a leather-bottle stomach (Fig. 3a–c).

During hospitalization, the patient's blood pressure increased to 158/114 mm Hg, accompanied by aggravation of abdominal distension and abdominal pain. After multidisciplinary consultation, an emergency cesarean section was performed, which lasted over 7 h. The physically normal newborn, a male, with Apgar scores of 2' and 7' in 1 min and 5 min, weighing 1,600 g, was delivered and transferred to the neonatal intensive care unit for further treatment. The placenta was delivered naturally and seemed intact. Exploration of the appendages revealed a mass with a diameter of 20 cm on the right ovary and another 7 cm mass on the left ovary. Bilateral adnexectomy was carried out. A solid texture was observed upon biopsy of the left ovary mass. Rapid freezing histopathology revealed single-net ring adenocarcinoma (Fig. 3d–f), and immunohistochemistry was HER2 negative. Further exploration revealed that the small intestine, ascending colon, transverse colon, and part of the descending colon were significantly expanded and inflated; the small intestine and colon were palpable with multiple metastases and intestinal lumen stenosis; and the farthest point of obstruction was in the descending colon, leading to intestinal obstruction. Considering that a diagnosis of stage IV gastric cancer was confirmed, palliative surgery (subtotal colectomy and partial small bowel resection) that relieved the intestinal obstruction was performed to improve the quality of the patient's life.

The patient and her family chose to receive palliative care. She died 2 months later. The CARE Checklist has been completed by the authors for this case report, attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000531991).

Discussion

Given the delays in diagnosis and more advanced stages at presentation, the overall prognosis of Krukenberg tumors is poor. Early recognition of abnormal symptoms is indispensable for diagnosis. Nausea and vomiting are common experiences during pregnancy, affecting 70% to 80% of all pregnant women. However, pregnant women with gastrointestinal symptoms before pregnancy should be considered, especially when symptoms such as abdominal pain or swelling progress or continue. However, these are often atypical in early pregnancy. Therefore, gastroenteroscopy should be performed in the second trimester when there is a strong indication, such as worsening abdominal pain, new onset ascites, persistent hyperemesis gravidarum, or virilization. Weight loss was a common symptom in Krukenberg tumors; however, owing to weight gain of the enlarged uterus, amniotic fluid, and the fetus, maternal weight loss may not be noticeable, but this symptom appeared early after delivery.

Imaging is essential in detecting this rare situation. Ultrasound is the most important inspection measure for the detection of adnexal cysts in the first trimester, but gravidity could mask the adnexal masses, thus allowing the finding of the abnormality to be delayed. Magnetic resonance imaging examination also has an important diagnostic role for pregnant women with suspected adnexal cysts on ultrasound, especially in cases with related digestive or other system abnormalities.

Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991

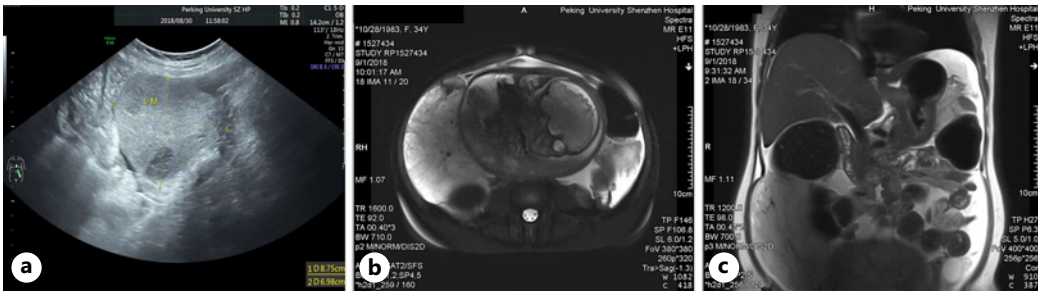

Fig. 2. Preoperative images of case 2. **a** Ultrasonography revealed a solid, heterogeneous mass in the left adnexal area, which was approximately 9 cm × 7 cm in size, with clear boundaries. MRI examination was performed, which showed diffuse gastric wall thickening and stiffness (**c**). Bilateral mass images (**b**), with an equal T1 long T2 signal shadow, uniform, contained multibarreled shadows, with sizes of 17 cm × 15 cm × 11 cm (right) and 8 cm × 7 cm × 4 cm (left). MRI, magnetic resonance imaging.

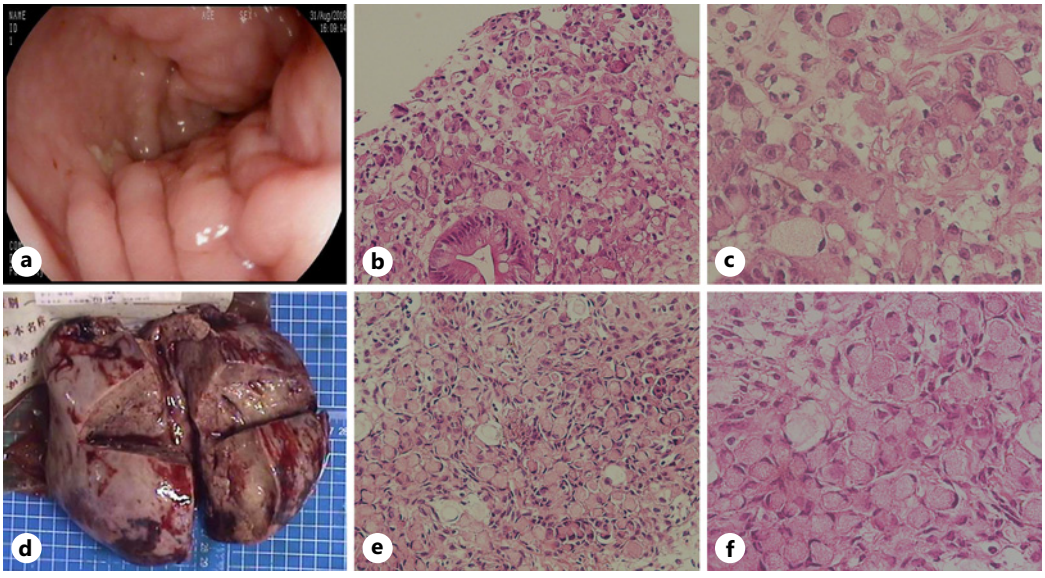

Fig. 3. Histopathological findings of case 2. Gastroscopy (**a**) showed a deformed gastric body, a narrowing gastric cavity, nodular hyperplasia of the inner wall, and ulcer-like lesions, which indicated a leather stomach. Biopsy and subsequent histopathological examination showed signet-ring cell carcinoma (HE staining, ×200 **b** and ×400 **c**). The right ovary was 15 cm × 15 cm × 6 cm in size, the cross section was greyish red, partially greyish brown, solid (**d**), and multiple signet-ring cells were seen (HE staining, ×200 **e** and ×400 **f**).

Hematological indicators such as CA125 testing alone may have low sensitivity and specificity in differentiating the benign and malignant effects of early pregnancy with adnexal cysts, and they may be used in combination with other findings. However, certain tumor markers may play an important role in the assessment of tumor prognosis [5].

Gastric adenocarcinoma remains a global health problem. Due to the high recurrence and mortality, a systemic treatment including surgery, radiation, chemotherapy, targeted therapy, immunotherapy, and palliative care should be considered according to the patient's situation. A multidisciplinary team should be established to address the treatment of the patient. Surgery is considered the primary therapy for early or locally advanced gastric cancer. Endoscopic or surgical treatment is considered for early gastric cancer according to the depth of tumor invasion. For locally advanced gastric cancer or early-stage gastric cancer with lymph node metastasis,

Table 1. Overview of cases complicated with PE in pregnant women with Krukenberg tumors

Case (Ref.)	Age at diagnosis, years	AGP, gestational age at diagnosis, weeks	Symptoms at diagnosis	Diagnosis criteria of PE	Tumor markers when diagnosed	Diagnostic examinations	Histopathology	Primary sites	Surgery during pregnancy	Chemotherapy	Obstetric outcome, gestational age at delivery, weeks	Fetal outcome	Maternal outcome, months after diagnosis
1 (Kim et al. [8], 2014)	27	A1G2P0, 29	No	Raised alanine transaminase	AFP 104.3 ng/mL, CA125.1266 U/mL	Ultrasound and MRI of the pelvis, exploratory laparotomy	Adenocarcinoma with signet-ring cells	unknown	Right salpingo-oophorectomy and partial left oophorectomy	EOX chemotherapy	Emergency CS, fetal distress on cardiotocography, 31	No information	No information
2 (Zhang et al. [9], 2014)	31	A0G1P0, 32	Nausea and vomiting, epigastric discomfort	Epigastric discomfort, mildly abnormal hepatic and renal function, proteinuria	AFP 542.2 ng/mL, CEA 20.64 ng/mL, CA19-9 204.01 U/mL, CA125 >600 U/mL	Abdominal ultrasound and MRI, gastroscopy, positron emission tomography-computed tomography scan	Poorly differentiated adenocarcinoma with signet-ring cell carcinoma of the stomach	Stomach	Adnexectomy	Intraperitoneal chemotherapy	Elective CS, abdominal exploration, 38	Male, 1,300 g, NICU admission	No information
3 (Meng et al. [10], 2016)	26	A0G1P0, 29	Headache and dizziness, clouded vision, abdominal distension	BP 160/120 mm Hg, proteinuria, headache and dizziness, clouded vision	CA125 92.49 U/mL, AFP 79.19 ng/mL	Abdominal ultrasound, ovary biopsy in exploratory laparotomy, esophagogastroduodenoscopy	Low differentiation adenocarcinoma confirmed with numerous mucin-filled signet-ring cells	Stomach	Exploratory laparotomy with bilateral adnexectomy, omentectomy and lymph node biopsies	Palliative chemotherapy for 16 cycles	Emergency CS, PE, 29	Male, 1,100 g, NICU admission, respiratory distress syndrome, died	Well at 1.5-year follow-up
4 (Montoro García et al. [11], 2017)	36	Multiparous, 37	Tachycardia	BP 180/106 mm Hg, proteinuria	/	Abdominal ultrasound, MRI, CT, gastroscopy	Signet-ring cells compatible with a mucosecretory adenocarcinoma	Stomach	Adnexectomy, hysterectomy	4 cycles of CT (taxotere, cisplatin and 5-fluorouracil)	NICE 1 urgent CS, risk of fetal distress, 37	No information	No information
5 (Maggen et al. [12], 2019)	27	A0G2P1, 28	Nausea and vomiting	No information	No information	Abdominal ultrasound, gastroscopy and MRI abdomen	Poorly differentiated carcinoma with signet-ring cells		No	5-FU and epirubicin, 1 cycle, 29	Emergency CS, PE, 32	2,265 g, NICU admission pneumonia and IRDS	Disease progression with bone marrow metastasis, DOD, 7 months
6 (Maggen et al. [12], 2019)	37	A0G2P1, 26	Distended abdomen, ascites	No information	No information	Ascites punction, MRI abdomen	Moderately differentiated adenocarcinoma, HER2 overexpression		No	No	Emergency CS, severe PE, 27	1,080 g, NICU admission	Progression to pulmonary lymphangitis carcinomatosis, DOD, 3 months

(Continued on following page)

Case Reports in Oncology
Case Rep Oncol 2023;16:712–721
DOI: 10.1159/000531991

Table 1 (continued)

Case (Ref.)	Age at diagnosis, years	AGP, gestational age at diagnosis, weeks	Symptoms at diagnosis	Diagnosis criteria of PE	Tumor markers when diagnosed	Diagnostic examinations	Histopathology	Primary sites	Surgery during pregnancy	Chemotherapy	Obstetric outcome, gestational age at delivery, weeks	Fetal outcome	Maternal outcome, months after diagnosis
7 (Maggen et al. [12], 2019)	39	A0G1P0, first trimester	Cervical lymphadenopathy	No information	No information	Diagnosis by palpable cervical lymphadenopathy (ultrasound guided biopsy)	Poorly differentiated adenocarcinoma		No	Carboplatin and paclitaxel, 3 cycles, 19	Emergency CS, PE, 32	1,195 g, dysmature, brain abscess, NICU admission	DOD, 26 months
8 (present case 1)	32	A6G7P1, 39	No	BP 156/ 105 mm Hg, proteinuria	/	Ovarian wedge resection biopsy, gastroscopy and biopsy	Poorly differentiated adenocarcinoma with signet-ring cells	Stomach	Hysterectomy, Adnexectomy, pelvic and para-aortic lymph node dissection, appendectomy, omentectomy	After surgery, docetaxel and capecitabine for 2 cycles, changed to liposomal paclitaxel and fluorouracil for 1 cycle	Elective CS, PE, 39	Female, 3,600 g, discharged	intestinal obstruction, DOD, 6 months
9 (present case 2)	34	A0G2P1, 30	Abdominal bloating, nausea, vomiting, diarrhea, abdominal pain	BP 143/ 97 mm Hg, proteinuria	CA125 420.6 U/mL, HE4 47.4 pmol/L	Abdominal ultrasound and MRI, gastric endoscopy, exploratory laparotomy	Leather-bottle stomach, adenocarcinoma with signet-ring cells	Stomach	Exploratory laparotomy with bilateral adnexectomy, colectomy and partial small bowel resection	No	Emergency CS, PE, 31	Male, 1,600 g, NICU admission	DOD, 2 months

BP, blood pressure; PE, preeclampsia; CS, cesarean section; EOX, E-epirubicin/O-oxaliplatin/X-capecitabine (Xeloda); AGP, abortion (miscarriage)/gravidity/parity; NICU, neonatal intensive care unit; DOD, dead of disease; MRI, magnetic resonance imaging; CT, computerized tomography; HER2, human epidermal growth factor receptor 2; CA, cancer antigen; HE4, human epididymis protein 4; AFP, alpha-fetoprotein; CEA, carcinoembryonic antigen; NICE, the National Institute for Health and Care Excellence.

surgery is suggested as the main treatment, along with other treatments such as chemotherapy or radiation. However, metastatic gastric cancer should be treated with comprehensive treatment based on drug therapy, supplemented with palliative surgery, radiotherapy, targeted therapy, and immunotherapy, and, if necessary, supportive treatment such as analgesia, nutritional support, and palliative care should also be provided. Chemotherapy can be divided into palliative chemotherapy, adjuvant/neoadjuvant chemotherapy, and conversion therapy. It is useful for cancer that has spread to organs beyond where it started. Many different chemotherapy drugs can be used to treat stomach cancer, including 5-FU (fluorouracil), capecitabine, carboplatin, and cisplatin. Most often, 2 or 3 of these drugs are combined to treat high-grade tumors. For advanced stomach cancer, some common drug combinations used before and/or after surgery include oxaliplatin plus 5-FU/leucovorin (FOLFOX), oxaliplatin plus capecitabine (CAPOX), cisplatin plus either 5-FU or capecitabine, and paclitaxel plus either cisplatin or carboplatin.

HER2 belongs to the human epidermal growth factor receptor tyrosine kinase family, which is poorly expressed in normal epithelial cells but is overexpressed or expanded in a variety of tumor types including breast, gastric, and colorectal cancer [6]. It is prone to form heterodimers with other family receptors of HER, resulting in phosphorylation of receptor tyrosine residues and initiating a variety of signaling pathways, thus leading to cell proliferation and tumorigenesis. HER2 is overexpressed in 15–25% of gastric cancer patients and is one of the most common gastric cancer therapeutic targets. The Trastuzumab for Gastric Cancer (ToGA) trial announcing trastuzumab in combination with chemotherapy can be considered as a new standard option for patients with HER2-positive advanced gastric or gastroesophageal junction cancer [7], making HER2 a star target for gastric cancer treatment.

Unlike hirsutism, virilization, or ascites, pregnancy with a Krukenberg tumor complicated with PE is rare. A literature search was conducted on PubMed up to April 2022, selecting the most relevant studies on the basis of the scope of the review, and to our knowledge, only 7 cases with full English texts have been published to date; see Table 1 [8–12]. In healthy humans, vascular endothelial growth factor (VEGF) promotes angiogenesis in embryonic development and is important in wound healing in adults. While tumors growth relies on blood supply, the VEGF-VEGFR (VEGF receptor) system also plays a pivotal role in pathological angiogenesis in malignancy [13]. The cause of PE is still unclear, but the disorder is thought to be due to placental malperfusion resulting from abnormal remodeling of maternal spiral arteries. We already know that the antiangiogenic factor soluble fms-like tyrosine kinase-1 (sFlt-1) binds to placental growth factor (PlGF), neutralizing the proangiogenic effect in the placenta [14]. The ratio of sFlt-1 to PlGF is elevated in pregnant women before the clinical onset of PE. PlGF is a member of the VEGF family, with high amino acid homology with VEGF. A study confirmed that increased sFlt-1 is accompanied by a decrease in PlGF approximately 5 weeks prior to the development of PE [15]. We assume that abnormally high VEGF accompanied by malignant tumors affects the binding of PIGF to receptors, resulting in a significant decrease in PIGF, thereby affecting the proliferation of placental blood vessels and eventually leading to PE. Unfortunately, we were unable to detect the serum level of VEGF or other related proteins in these patients. However, this may be a possible research field facilitating the early diagnosis of Krukenberg tumors in pregnancy in the future.

Acknowledgments

The authors thank Dr. Chun Wang and Dr. Yuhua Huang for their assistance in the pathological analysis and Dr. Dirong Zhang and Dr. Yi Dai for their assistance with the imaging technology.

Statement of Ethics

The case report was waived by the Ethics Committee of Peking University Shenzhen Hospital. Written informed consent was obtained from the patients' husbands, and they both confirmed that they were permitted to publish these case reports and any accompanying images.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

This work was supported by the Shenzhen High-level Hospital Construction Fund (YBH2019-260), Shenzhen Key Medical Discipline Construction Fund (No. SZXK027), and Sanming Project of Medicine in Shenzhen (No. SZSM202011016).

Author Contributions

Y.Z. participated in the patient's diagnosis, therapy, and follow-up, conceived the study, and drafted the manuscript. T.L. prepared the pathological sections and performed the histopathology analysis. H.D., H.L., Y.D., and R.W. performed the surgery and carried out the postoperative treatment. R.W. organized the research and reviewed the manuscript. All authors read and approved the final manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

References

1 Agnes A, Biondi A, Ricci R, Gallotta V, D'Ugo D, Persiani R. Krukenberg tumors: seed, route and soil. Surg Oncol. 2017 Dec;26(4):438–45.
2 Högberg U. The world health report 2005: "make every mother and child count" – including Africans. Scand J Public Health. 2005;33(6):409–11.
3 Staff AC, Fjeldstad HE, Fosheim IK, Moe K, Turowski G, Johnsen GM, et al. Failure of physiological transformation and spiral artery atherosis: their roles in preeclampsia. Am J Obstet Gynecol. 2022 Feb;226(2S):S895–906.
4 Poon LC, Shennan A, Hyett JA, Kapur A, Hadar E, Divakar H, et al. The International Federation of Gynecology and Obstetrics (FIGO) initiative on pre-eclampsia: a pragmatic guide for first-trimester screening and prevention. Int J Gynaecol Obstet. 2019 May;145(Suppl 1):1–33.
5 Lionetti R, De Luca M, Travaglino A, Raffone A, Saccone G, Di Cicco A, et al. Prognostic factors in Krukenberg tumor. Arch Gynecol Obstet. 2019 Nov;300(5):1155–65.
6 Ricci AD, Rizzo A, Rojas Llimpe FL, Di Fabio F, De Biase D, Rihawi K. Novel HER2-directed treatments in advanced gastric carcinoma: AnotHER paradigm shift? Cancers. 2021 Apr 1;13(7):1664.
7 Bang YJ, Van Cutsem E, Feyereislova A, Chung HC, Shen L, Sawaki A, et al. Trastuzumab in combination with chemotherapy versus chemotherapy alone for treatment of HER2-positive advanced gastric or gastro-oesophageal junction cancer (ToGA): a phase 3, open-label, randomised controlled trial. Lancet. 2010 Aug 28;376(9742):687–97.

8 Kim SH, Abd Halim SR, Siddiqui N, Park WH. Disseminated cancer in pregnancy: krukenberg tumour. Case Rep Obstet Gynecol. 2014;2014:216969.
9 Zhang J, Cheng X, Han C, Li Z, Wang M, Zhu Y. Krukenberg tumor in a pregnant patient with severe pre-eclampsia. Exp Ther Med. 2014 Jun;7(6):1476–80.
10 Meng J, Kang Y, Cheng H, Gu Y, Zhang X, Wang S. Misdiagnosed ovarian Krukenberg tumor during pregnancy with virilization. Eur J Gynaecol Oncol. 2016 Aug;37(4):587–90.
11 Montoro García J, Cabellos Olivares M, Cabana Navia A, López Saña J, Rodríguez Fraile JR. Unexpected obstetric haemorrhage. Krukenberg tumour. Rev Esp Anestesiol Reanim. 2017 Oct;64(8):479–82.
12 Maggen C, Lok CA, Cardonick E, van Gerwen M, Ottevanger PB, Boere IA, et al. Gastric cancer during pregnancy: a report on 13 cases and review of the literature with focus on chemotherapy during pregnancy. Acta Obstet Gynecol Scand. 2020 Jan;99(1):79–88.
13 Shibuya M. Involvement of Flt-1 (VEGF receptor-1) in cancer and preeclampsia. Proc Jpn Acad Ser B Phys Biol Sci. 2011;87(4):167–78.
14 Opichka MA, Rappelt MW, Gutterman DD, Grobe JL, McIntosh JJ. Vascular dysfunction in preeclampsia. Cells. 2021 Nov 6;10(11):3055.
15 Levine RJ, Maynard SE, Qian C, Lim KH, England LJ, Yu KF, et al. Circulating angiogenic factors and the risk of preeclampsia. N Engl J Med. 2004 Feb 12;350(7):672–83.