

World Journal of *Clinical Cases*

World J Clin Cases 2022 January 14; 10(2): 397-752



EDITORIAL

- 397 New trends in treatment of muscle fatigue throughout rehabilitation of elderlies with motor neuron diseases
Mohamed A

MINIREVIEWS

- 401 What emotion dimensions can affect working memory performance in healthy adults? A review
Hou TY, Cai WP
- 412 Quadrilateral plate fractures of the acetabulum: Classification, approach, implant therapy and related research progress
Zhou XF, Gu SC, Zhu WB, Yang JZ, Xu L, Fang SY

ORIGINAL ARTICLE**Case Control Study**

- 426 Methylprednisolone accelerate chest computed tomography absorption in COVID-19: A three-centered retrospective case control study from China
Lin L, Xue D, Chen JH, Wei QY, Huang ZH

Retrospective Study

- 437 Analysis of photostimulable phosphor image plate artifacts and their prevalence
Elkhateeb SM, Aloyouny AY, Omer MMS, Mansour SM
- 448 N6-methyladenine-modified DNA was decreased in Alzheimer's disease patients
Lv S, Zhou X, Li YM, Yang T, Zhang SJ, Wang Y, Jia SH, Peng DT
- 458 Inflammation-related indicators to distinguish between gastric stromal tumors and leiomyomas: A retrospective study
Zhai YH, Zheng Z, Deng W, Yin J, Bai ZG, Liu XY, Zhang J, Zhang ZT
- 469 Relationship between Ki-67 and CD44 expression and microvascular formation in gastric stromal tumor tissues
Ma B, Huang XT, Zou GJ, Hou WY, Du XH
- 477 Modified surgical method of supra- and infratentorial epidural hematoma and the related anatomical study of the squamous part of the occipital bone
Li RC, Guo SW, Liang C
- 485 Combined molybdenum target X-ray and magnetic resonance imaging examinations improve breast cancer diagnostic efficacy
Gu WQ, Cai SM, Liu WD, Zhang Q, Shi Y, Du LJ

- 492 Value of thyroglobulin combined with ultrasound-guided fine-needle aspiration cytology for diagnosis of lymph node metastasis of thyroid carcinoma

Zhang LY, Chen Y, Ao YZ

- 502 Locking compression plate + T-type steel plate for postoperative weight bearing and functional recovery in complex tibial plateau fractures

Li HF, Yu T, Zhu XF, Wang H, Zhang YQ

- 511 Effect of Mirena placement on reproductive hormone levels at different time intervals after artificial abortion

Jin XX, Sun L, Lai XL, Li J, Liang ML, Ma X

- 518 Diagnostic value of artificial intelligence automatic detection systems for breast BI-RADS 4 nodules

Lyu SY, Zhang Y, Zhang MW, Zhang BS, Gao LB, Bai LT, Wang J

Clinical Trials Study

- 528 Analysis of 20 patients with laparoscopic extended right colectomy

Zheng HD, Xu JH, Liu YR, Sun YF

Observational Study

- 538 Knowledge, attitude, practice and factors that influence the awareness of college students with regards to breast cancer

Zhang QN, Lu HX

- 547 Diagnosing early scar pregnancy in the lower uterine segment after cesarean section by intracavitary ultrasound

Cheng XL, Cao XY, Wang XQ, Lin HL, Fang JC, Wang L

- 554 Impact of failure mode and effects analysis-based emergency management on the effectiveness of craniocerebral injury treatment

Shao XL, Wang YZ, Chen XH, Ding WJ

- 563 Predictive value of alarm symptoms in Rome IV irritable bowel syndrome: A multicenter cross-sectional study

Yang Q, Wei ZC, Liu N, Pan YL, Jiang XS, Tantai XX, Yang Q, Yang J, Wang JJ, Shang L, Lin Q, Xiao CL, Wang JH

Prospective Study

- 576 5-min mindfulness audio induction alleviates psychological distress and sleep disorders in patients with COVID-19

Li J, Zhang YY, Cong XY, Ren SR, Tu XM, Wu JF

META-ANALYSIS

- 585 Efficacy and safety of argatroban in treatment of acute ischemic stroke: A meta-analysis

Lv B, Guo FF, Lin JC, Jing F

SCIENTOMETRICS

- 594 Biologic therapy for Crohn's disease over the last 3 decades
Shen JL, Zhou Z, Cao JS, Zhang B, Hu JH, Li JY, Liu XM, Juengpanich S, Li MS, Feng X

CASE REPORT

- 607 Novel compound heterozygous GPR56 gene mutation in a twin with lissencephaly: A case report
Lin WX, Chai YY, Huang TT, Zhang X, Zheng G, Zhang G, Peng F, Huang YJ
- 618 Patients with SERPINC1 rs2227589 polymorphism found to have multiple cerebral venous sinus thromboses despite a normal antithrombin level: A case report
Liao F, Zeng JL, Pan JG, Ma J, Zhang ZJ, Lin ZJ, Lin LF, Chen YS, Ma XT
- 625 Successful management of delirium with dexmedetomidine in a patient with haloperidol-induced neuroleptic malignant syndrome: A case report
Yang CJ, Chiu CT, Yeh YC, Chao A
- 631 Malignant solitary fibrous tumor in the central nervous system treated with surgery, radiotherapy and anlotinib: A case report
Zhang DY, Su L, Wang YW
- 643 Anesthesia and perioperative management for giant adrenal Ewing's sarcoma with inferior vena cava and right atrium tumor thrombus: A case report
Wang JL, Xu CY, Geng CJ, Liu L, Zhang MZ, Wang H, Xiao RT, Liu L, Zhang G, Ni C, Guo XY
- 656 Full-endoscopic spine surgery treatment of lumbar foraminal stenosis after osteoporotic vertebral compression fractures: A case report
Zhao QL, Hou KP, Wu ZX, Xiao L, Xu HG
- 663 Ethambutol-induced optic neuropathy with rare bilateral asymmetry onset: A case report
Sheng WY, Wu SQ, Su LY, Zhu LW
- 671 Vitrectomy with residual internal limiting membrane covering and autologous blood for a secondary macular hole: A case report
Ying HF, Wu SQ, Hu WP, Ni LY, Zhang ZL, Xu YG
- 677 Intervertebral bridging ossification after kyphoplasty in a Parkinson's patient with Kummell's disease: A case report
Li J, Liu Y, Peng L, Liu J, Cao ZD, He M
- 685 Synovial chondromatosis of the hip joint in a 6 year-old child: A case report
Yi RB, Gong HL, Arthur DT, Wen J, Xiao S, Tang ZW, Xiang F, Wang KJ, Song ZQ
- 691 Orthodontic retreatment of an adult woman with mandibular backward positioning and temporomandibular joint disorder: A case report
Yu LY, Xia K, Sun WT, Huang XQ, Chi JY, Wang LJ, Zhao ZH, Liu J

- 703** Autosomal recessive spinocerebellar ataxia type 4 with a *VPS13D* mutation: A case report
Huang X, Fan DS
- 709** Primary adrenal diffuse large B-cell lymphoma with normal adrenal cortex function: A case report
Fan ZN, Shi HJ, Xiong BB, Zhang JS, Wang HF, Wang JS
- 717** Varicella-zoster virus-associated meningitis, encephalitis, and myelitis with sporadic skin blisters: A case report
Takami K, Kenzaka T, Kumabe A, Fukuzawa M, Eto Y, Nakata S, Shinohara K, Endo K
- 725** Tension pneumocephalus following endoscopic resection of a mediastinal thoracic spinal tumor: A case report
Chang CY, Hung CC, Liu JM, Chiu CD
- 733** Accelerated Infliximab Induction for Severe Lower Gastrointestinal Bleeding in a Young Patient with Crohn's Disease: A Case Report
Zeng J, Shen F, Fan JG, Ge WS
- 741** Occupational fibrotic hypersensitivity pneumonia in a halogen dishes manufacturer: A case report
Wang M, Fang HH, Jiang ZF, Ye W, Liu RY
- 747** Using a fretsaw in treating chronic penial incarceration: A case report
Zhao Y, Xue XQ, Huang HF, Xie Y, Ji ZG, Fan XR

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Anesthesia and perioperative management for giant adrenal Ewing's sarcoma with inferior vena cava and right atrium tumor thrombus: A case report

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Abstract

BACKGROUND

Ewing's sarcoma of the adrenal gland with inferior vena cava (IVC) and right atrium thrombus is extremely rare. Here, we report a case of giant adrenal Ewing's sarcoma with IVC and right atrium tumor thrombus and summarize the anesthesia and perioperative management.

CASE SUMMARY

A young female was admitted to the Department of Urology with intermittent pain under the right costal arch for four months. Enhanced abdominal computed tomography revealed a large retroperitoneal mass (22 cm in diameter), which may have originated from the right adrenal gland and was closely related to the liver. Transthoracic echocardiography showed a strong echogenic filling measuring 70 mm extended from the IVC into the right atrium and ventricle. After preoperative preparation with cardiopulmonary bypass, sufficient blood products, transesophageal echocardiography and multiple monitoring, tumor and thrombus

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resection by IVC exploration and right atriotomy were successfully performed by a multidisciplinary team. Intraoperative hemodynamic stability was the major concern of anesthesiologists and the status of tumor thrombus and pulmonary embolism were monitored continuously. During transfer of the patient to the intensive care unit (ICU), cardiac arrest occurred without external stimulus. Cardiopulmonary resuscitation was performed immediately and cardiac function was restored after 1 min. In the ICU, extracorporeal membrane oxygenation (ECMO) and continuous renal replacement therapy (CRRT) were provided to maintain cardiac, liver and kidney function. Histopathologic examination confirmed the diagnosis of Ewing's sarcoma. After postoperative treatments and rehabilitation, the patient was discharged from the urology ward.

CONCLUSION

An adrenal Ewing's sarcoma with IVC and right atrium thrombus is extremely rare, and its anesthesia and perioperative management have not been reported. Thus, this report provides significant insights in the perioperative management of patients with adrenal Ewing's sarcoma and IVC tumor thrombus. Intraoperative circulation fluctuations and sudden cardiovascular events are the major challenges during surgery. In addition, postoperative treatments including ECMO and CRRT provide essential support in critically ill patients. Moreover, this case report also highlights the importance of multidisciplinary cooperation during treatment of the disease.

Key Words: Ewing's sarcoma; Anesthesia; Inferior vena cava; Cardiac arrest; Tumor thrombus

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Core Tip: An adrenal Ewing's sarcoma with IVC and right atrium thrombus is extremely rare, and its anesthesia and perioperative management have not been reported. We report tumor resection and perioperative management in a case of adrenal Ewing's sarcoma with IVC and right atrium thrombus. After surgery, cardiac arrest occurred and CPR was successfully performed. Following postoperative treatment and rehabilitation, the patient was discharged from the hospital and then survived for more than 17 mo. Therefore, this report provides insights for the perioperative management of adrenal Ewing's sarcoma with distant vascular extension.

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INTRODUCTION

The Ewing's sarcoma family is an aggressive group of childhood cancers, including classic Ewing's sarcoma, Askin tumor, and peripheral primitive neuroectodermal tumor[1]. Extrasosseous Ewing's sarcoma is a rare, rapidly growing, round-cell, malignant tumor that starts anywhere in soft tissues. The average age of patients with extrasosseous Ewing's sarcoma is higher than those with bone cancer[2]. Nkx2.2 is a transcription factor that functions in neuronal and neuroendocrine differentiation, which is upregulated in Ewing's sarcoma and required for its oncogenesis[3]. The tumor cells characteristically express CD99 (MIC2 antigen), a glycoprotein localized on cell membrane. The defining feature of Ewing's sarcoma is a characteristic t(11;22)(q24;q12) translocation involving the Ewing's sarcoma breakpoint region 1 (EWSR1) gene on chromosome 22 and the FLI1 gene on chromosome 11[4]. Currently, localized Ewing's sarcoma has a relative survival rate of 75%, while the survival rate

for patients with metastases is only 30% [5,6].

Thrombus of the inferior vena cava (IVC) is very rare in the absence of congenital abnormalities and is usually a result of hypercoagulable state along with acquired pathological changes in the IVC or its adjacent structures. There are two main causes of thrombus. One is the abnormal prothrombotic function caused by various diseases, and the other one relates to the changes in abdominal pathophysiology [7-9]. For renal cell carcinoma, the incidence of IVC tumor thrombus has been reported in 4% to 10% [10], and the incidence of tumor thrombus in the right atrium was 0.3% to 1.0% [11]. The prognosis is mainly related to the grade of tumor thrombus. The perioperative mortality rate ranges from 2.7% to 40% and the major complications include bleeding, pulmonary embolism, wound infection and acute renal failure [12]. According to research on adrenocortical carcinoma by the *Mayo Clinic*, IVC tumor thrombus is an independent prognostic factor that contributes to worse overall survival [13]. To date, there are five cases of adrenal Ewing's sarcoma with IVC tumor thrombus focusing on the diagnosis and treatment (Table 1). However, due to the rarity of cases, anesthetic management of adrenal Ewing's sarcoma has not been reported.

The anesthetic management for adrenal Ewing's sarcoma with IVC thrombus has perioperative challenges. One of the challenges during surgery is tumor infiltration of the liver, which may not be resected completely, leading to a poor prognosis. The other challenge relates to anesthetic management, including long surgery time, massive hemorrhage, hemodynamic instability, tumor thrombus spread and pulmonary embolism, *etc.* Here, we summarize the anesthesia treatment strategy and perioperative management of our patient and provide a basis for treating similar cases in the future.

CASE PRESENTATION

Chief complaints

The patient presented with intermittent pain under the right costal arch for four months.

History of present illness

A 20-year old female patient presented with intermittent pain under the right costal arch for four months, and was diagnosed with an adrenal tumor with IVC and right atrium tumor thrombus. Before admission, the patient had visited a number of different hospitals. However, due to the position and size of the tumor, and complications such as pulmonary embolism, no surgery was performed. The Department of Urology in our hospital has treated more than 100 cases of adrenal or renal tumors with Mayo Clinic stage I-IV tumor thrombus [17,18]. Thus, we have experience in tumor excision and emergency treatment for these circumstances. Considering the rapid development of the tumor and risks of a stuck valve that could occur at any time, the patient was admitted to hospital. Prior to admission, the patient and her family members were fully informed that the operation was a form of palliative treatment.

History of past illness

The patient had no remarkable past medical history.

Personal and family history

The patient had no remarkable personal and family history.

Physical examination

Physical examination showed a temperature of 37 °C, heart rate (HR) of 101 bpm, blood pressure (BP) of 92/60 mmHg, respiratory rate of 17 breaths/min, and oxygen saturation (SpO₂) of 91% in room air.

Laboratory examinations

Laboratory examinations showed an elevation of renin 1.51 ng/mL/h (normal range: 0.05-0.79 ng/mL/h) and angiotensin II 191.01 pg/L (normal range: 55.3-115.3 pg/L). The high renin-angiotensin secretion was possibly attributed to decreased renal perfusion. The 24 h urine catecholamine levels were normal and pheochromocytoma was excluded. Although endocrine changes were not typical, adrenal cortical carcinoma was highly suspected. Reduced platelets (PLT, 68 × 10⁹/L) and an abnormal

Table 1 Summary of reported cases of Ewing's sarcoma rising from the adrenal gland with inferior vena cava tumor thrombus

No	Ref.	Age	Gender	Position	Tumor size, cm	Initial infiltration or metastasis	Surgical procedure	Outcome at time of report
1	Zhang <i>et al</i> [14]	30	M	R	12	IVC tumor thrombus	Adr	Dead (8 mo)
2	Zhang <i>et al</i> [14]	22	M	L	17	IVC tumor thrombus	Adr + Neph + Spl + IVCT	Alive
3	Abi-Raad <i>et al</i> [4]	26	F	L	11.3	IVC tumor thrombus	Adr + Neph + Spl + IVCT	Alive (8 mo)
4	Kim <i>et al</i> [15]	25	F	L	15.2	lung, IVC, RA tumor thrombus	NR	NR
5	Saboo <i>et al</i> [16]	26	F	L	Large	IVC tumor thrombus	No surgery	NR
6	Present case	20	F	R	22	Liver, IVC, RA tumor thrombus	Liver + Adr + IVCT + RA _t	Alive

F: Female; M: Male; L: Left; R: Right; Adr: Adrenalectomy; Neph: Nephrectomy; Spl: Splenectomy; IVCT: Inferior vena cava thrombectomy; RA: Right atrium; NR: Not recorded.

coagulation test (prothrombin time (PT): 15.5 s and international normalized ratio (INR): 1.45) were present. The hematologist recommended maintaining perioperative PLT > 80 × 10⁹ in order to reduce intraoperative blood loss.

Imaging examinations

Enhanced abdominal computed tomography (CT) showed a retroperitoneal mass with a diameter of 22 cm, which most likely originated from the right adrenal gland and was closely related to the liver (Figure 1). Positron emission tomography-CT (PET-CT) revealed a huge heterogeneous mass with elevated glucose metabolism in the right hepatic lobe and the space between the liver and the right kidney. Transthoracic echocardiography (TTE) showed that the proximal IVC was 25.7 mm wide with a strong echogenic filling extending into the right atrium and ventricle and the distant tumor thrombus was 70 mm approximately. Preoperative left ventricular ejection fraction (LVEF) was 64% (Figure 2A). Cardiac enhanced magnetic resonance imaging (MRI) confirmed the filling in the right atrium and ventricle (Figure 2B).

MULTIDISCIPLINARY EXPERT CONSULTATION

Five days before surgery, the patient developed a sudden shortness of breath at rest, accompanied by a sense of pressure behind the sternum and in the scapular area for one hour. During this time, her BP and HR were 105/79 mmHg and 116 bpm, respectively. Immediate arterial blood gas analysis showed: pH 7.49, PaCO₂ 22.5 mmHg, PaO₂ 58 mmHg, lactate 3 mmol/L, SpO₂ 94%. Electrocardiogram showed sinus tachycardia (118 bpm), inverted T waves were observed in chest leads, and visible Q waves in II, III, aVF leads, but there were no significant changes in myocardial injury markers. Cardiac MRI and pulmonary artery Computed Tomography Angiography (CTA) showed no pulmonary embolism. Her symptoms were relieved after 4 L/min oxygen therapy (nasal cannula). The cardiologist examined the patient and speculated that the tumor thrombus in the right atrium and ventricle affected tricuspid valve motion, as well as the occurrence of pulmonary embolism.

Several days later, the multidisciplinary team composed of urological surgeons, cardiac surgeons, general surgeons, anesthesiologists and ICU physicians evaluated the tumor status and cardiac function and decided to perform surgery to prevent a severe stuck valve and right heart failure. The most significant indication for a stuck valve is the "roller coaster"-like BP, accompanied by clinical symptoms such as dyspnea at rest, chest pain, low output, shock, embolization, and even cardiac arrest [19,20]. Considering that a severe stuck valve and right heart failure could occur at any time, the multidisciplinary team decided to perform tumor and thrombus resection directly, but not after preoperative biopsy.



Figure 1 Retroperitoneal mass detected on enhanced abdominal computed tomography. The yellow arrow indicates the tumor was closely related to the liver.

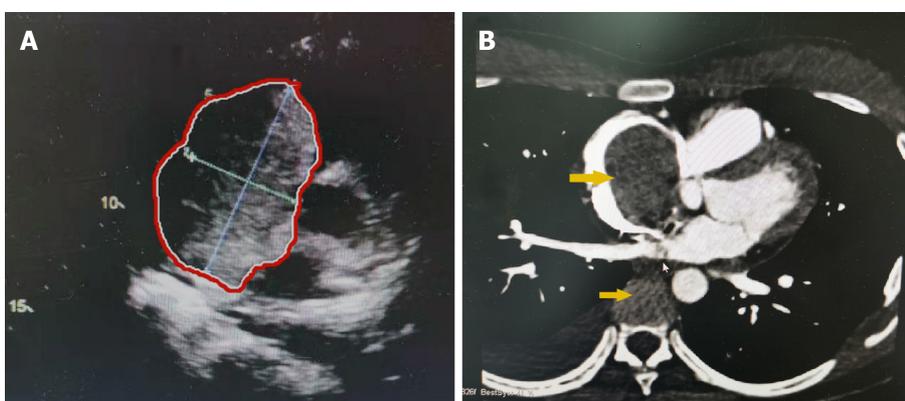


Figure 2 Tumor thrombus detected in the inferior vena cava and right atrium. A: Preoperative transthoracic echocardiography showed that the tumor thrombus extended into the right atrium. Red areas indicate tumor thrombus; B: Cardiac enhanced magnetic resonance imaging showed tumor thrombus in the inferior vena cava (IVC) and the right atrium. The upper yellow arrow indicates tumor thrombus in the right atrium. The lower yellow arrow indicates tumor thrombus in the IVC.

FINAL DIAGNOSIS

Histopathologic examination of the resected tissue showed that the tumor was surrounded by normal adrenal tissue, which suggested that the tumor originated in the adrenal gland (Figure 3A and B). Figure 3C shows tumor cells with round nuclei and pale cytoplasm, as well as their rosette structures, which confirmed the diagnosis of Ewing's sarcoma. Immunohistochemistry revealed that the tumor cells were positive for CD99 and Nkx2.2, well-known markers for Ewing's sarcoma (Figure 3D and E). Furthermore, fluorescence in situ hybridization studies showed rearrangement of the EWSR1 gene in the nuclei of tumor cells (Figure 3F). These results confirmed that the tumor was Ewing's sarcoma with an adrenal origin.

TREATMENT

Intraoperative treatment

The patient underwent surgery. In the pre-operation room, 10 mg diazepam was given intravenously to relieve the patient's anxiety, and she was then transferred to the operating room. The initial BP, HR and SpO₂ were 93/65 mmHg, 110 bpm and 90% (in room air), respectively. Two peripheral venous access points (16 G) were established, and the left radial artery was cannulated for continuous arterial blood pressure monitoring. Following the above preparation, a 10-min preoxygenation (FiO₂: 50%) was performed prior to induction. For anesthesia induction, 20 µg sufentanil, 10 mg etomidate and 6 mg cisatracurium were injected in sequence. After 2 min of positive

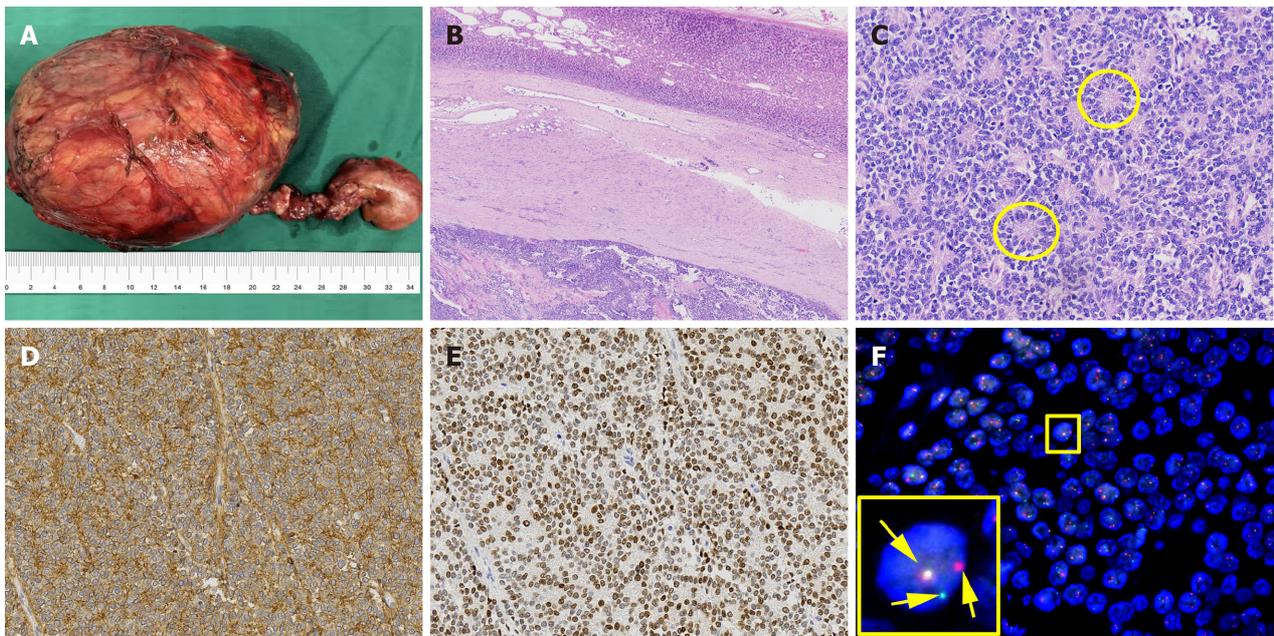


Figure 3 Pathological findings of the resected primary tumor. A: Image of the resected tumor and thrombus; B: Hematoxylin-Eosin staining shows that the tumor (the lower part of the image) was surrounded by normal adrenal tissue (the upper part of the image), which suggested that the tumor arose in the adrenal gland (2 × magnification); C: Hematoxylin-Eosin staining shows the tumor cells with round nuclei and pale cytoplasm, as well as their rosette structures (inside the yellow circles) (20 × magnification); D: Immunohistochemistry showed CD99 positive tumor cells (20 × magnification); E: Immunohistochemistry showed Nkx2.2 positive tumor cells (20 × magnification); F: Separation of the red signal and green signal (the right two signals) by fluorescence in situ hybridization reveals Ewing's sarcoma breakpoint region 1 gene rearrangement in the nuclei of tumor cells, while the yellow signal (the left signal) shows the normal allele.

mask ventilation, a reinforced tracheal tube was intubated. Anesthesia induction was relatively stable without obvious variation in both BP and HR. Sufentanil at 25 µg/h, 1-2 MAC of sevoflurane and intermittent cisatracurium were used for anesthesia maintenance. The bispectral index (BIS) was maintained within 40 and 60. Right internal jugular vein puncture was performed to place the central venous catheter for central venous pressure (CVP) monitoring. The TEE probe was inserted to assist surgeons and anesthesiologists to determine the clearance of thrombus, the changes in heart function and the occurrence of pulmonary embolism.

After a series of preparations, the surgery was performed on schedule. As the tumor was closely related to the liver, laparotomy was chosen to reduce blood loss. At the beginning of surgery, an incision was made 2 cm below the right costal margin from the xiphoid to the posterior line of the axilla and was extended about 10 cm below the left costal margin. It was found that the liver was compressed to the left by the tumor. Firstly, the liver and duodenum were dissociated to expose the right kidney and IVC. Then, the dissociation between the lower pole of the tumor and the kidney was extended, and other parts of the tumor were dissociated to expose the right renal vein, right renal artery, right ureter, and to retain the right kidney. During tumor dissociation, the circulation was unstable with the lowest BP of 70/40 mmHg (Table 2). The reasons for this were as follows: (1) The tumor was closely related to the liver and the lower margin of liver bleeding was serious during the dissociation process; and (2) The tumor was huge, and its dissociation caused obstruction of the heart outflow tract by IVC thrombus resulting in decreased BP. In order to maintain BP and HR within a relatively safe range, norepinephrine (0.02-0.04 µg/kg/min) and dopamine (5-15 µg/kg/min) were continuously infused, and 1 g/h tranexamic acid was administered as an anti-fibrinolytic to reduce bleeding[21]. After careful dissociation, the tumor was successfully dissected from the kidney, liver and retroperitoneum.

The cardiac surgeon continued with a median sternotomy, and after systemic heparinization, the IVC, superior vena cava and the ascending aorta were cannulated to establish cardiopulmonary bypass. Blood gas analysis was performed hourly and parameters were modulated. Before the ascending aorta was cross-clamped, the patient was gradually cooled to 32 °C. After the infusion of cold cardioplegia into the aortic root, cardiac arrest was achieved. The right atrium was opened to reveal part of the tumor thrombus. The remaining tumor thrombus was pushed into the IVC, which was removed after blocking the proximal and distal ends of the IVC. Intraoperative TEE examination confirmed the removal of tumor thrombus in the right atrium and

Table 2 Vital signs and ventilation parameters during surgery

Time point	Preoperative	After intubation	During dissociation	After CPB	After Surgery	After CPR
HR (bpm)	110	112	120	120	80	100
ABP (mmHg)	92/60	102/70	70/40	90/60	105/70	140/100
SpO ₂ (%)	90	98	100	100	100	100
CVP (cmH ₂ O)	13	13	9	18	20	11
BIS	90	50	43	45	40	/

CPB: Cardiopulmonary bypass; CPR: Cardiopulmonary resuscitation; ABP: Arterial blood pressure; CVP: Central venous pressure; BIS: Bispectral index.

ventricle. However, tough cord-like thrombus remained in the IVC closely related to the liver. Blind removal could damage the IVC and tumor fragmentation may cause pulmonary embolism[22], and satisfactory complete resection can only be achieved *via* liver transplantation[23,24]. Furthermore, the previous reports of renal cell carcinoma indicated that resection of the residual thrombus did not improve the prognosis[10]. After repairing the right atrium and vena cava, the patient was rewarmed and weaned off cardiopulmonary bypass. During cardiopulmonary bypass, her BP remained relatively stable. Vital signs and ventilation parameters during surgery are shown in Table 2, and arterial gas results during surgery are shown in Table 3. The resected tumor is shown in Figure 3A.

In summary, the surgical time was 587 min, intraoperative blood loss and urine were 4,500 mL and 600 mL, respectively. 14 U of red blood cells, 2200 mL of plasma, 1000 mL of colloid solution and 7200 mL of crystal solution were infused. Intraoperative complications were limited to blood loss of 500 mL from the lower margin of the liver during the dissociation and incomplete tumor and thrombus resection. Based on previous studies, blind removal may not improve the prognosis obviously in some patients[10], and the main focus of intraoperative anesthesia management was circulation maintenance and monitoring.

Postoperative treatment

When the patient was transferred to the ICU, the normal ECG waveform and pulse oxygen waveform suddenly disappeared, along with the carotid pulse. Cardiopulmonary resuscitation (CPR) was performed immediately, 1 mg adrenaline was injected intravenously, and the defibrillator was prepared. One minute later, the heartbeat was restored. After 5 min, the BP, HR and SpO₂ were 140/100 mmHg, 120 bpm and 100%, respectively. Emergency TTE examination indicated that the chamber of ventricles was small with hypokinesis, and LVEF was 34%, but no obvious tumor thrombus was detected in the right atrium or pulmonary arteries.

After the vital signs of the patient had stabilized for 30 min, she was transferred to the ICU. On the first day, the patient developed acute liver failure (AST 7,448 U/L, ALT 3,458 U/L, ALB 24.2 g/L, TBIL 72.2 μmol/L) and renal failure (no urine with Cr 136 μmol/L). CRRT was performed, hepatoprotective agents including magnesium isoglycyrrhizinate and glutathione were used, and coagulation factors were supplemented to improve coagulation function. Cardiogenic shock and acidosis occurred after cardiac resuscitation and could not be corrected by medication. TTE indicated abnormal motion in the wall of the right ventricle and the middle and apex of the left ventricle (LVEF 38%). Therefore, ECMO was given on day two. The principle of treatment in the ICU was mainly to improve liver, kidney and heart function. During CRRT and ECMO treatment, anticoagulation was provided, which caused bleeding in the surgical area. On day twelve in the ICU, TTE showed a cord-like mass in the IVC (Figure 4), which was consistent with the intraoperative TEE result, without obvious progress. ECMO was successfully withdrawn on day twelve when the LVEF recovered (LVEF 46%) and BP was relatively stable. A total of 12 U of red blood cells, 3600 mL of plasma and 6 U of platelets were infused. On day thirteen in the ICU, the patient was conscious. The BP and HR were 99-120/50-60 mmHg and 85 bpm, respectively. TTE indicated that LVEF was 58%. The endotracheal tube was removed, and the patient was transferred to the urology ward.

In the urology ward, treatment was focused on postoperative pleural effusion and rehabilitation. Closed thoracic drainage was used for pleural effusion, and opioids and flurbiprofen were used for pain management. Eventually, the patient was discharged

Table 3 Arterial gas analysis during surgery

Time point	After intubation	Before CPB	After CPB	Postoperative	After CPR
pH	7.29	7.20	7.32	7.46	7.35
PaO ₂ (mmHg)	198	385	372	419	370
PaCO ₂ (mmHg)	44	36	32	30	44
BE (mEq/L)	-5.9	-12.9	-4.5	-2.5	-1.9
Hb (g/L)	120	82	54	55	70
K ⁺ (mmol/L)	4.3	5.6	4.7	3.8	4.4
HCO ₃ ⁻ (mmol/L)	20.5	14	21.1	21.0	23.6
Glu (mmol/L)	4.7	8.4	7.8	7.2	8.7

CPB: Cardiopulmonary bypass; CPR: Cardiopulmonary resuscitation.

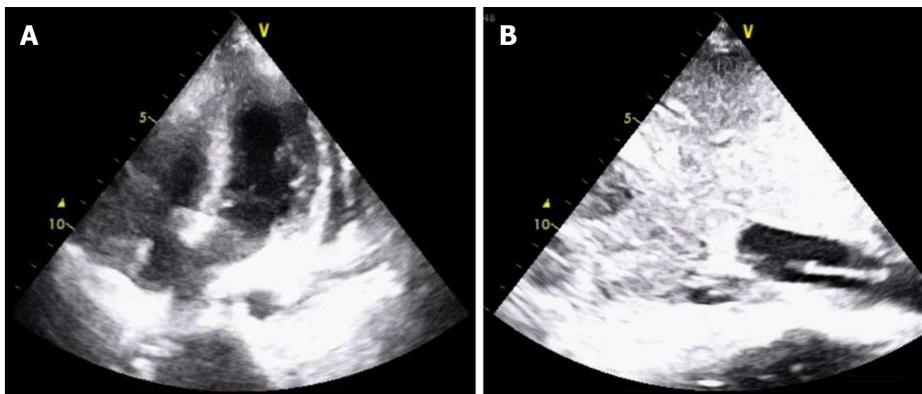


Figure 4 Echocardiogram. A: The postoperative transthoracic echocardiography examination in the intensive care unit showed that there was no obvious tumor thrombus in the right atrium; B: There was a 7 cm diameter mass in the inferior vena cava.

with improved physical status and sleep quality, and without chest pain. Cardiac function was restored to the preoperative level (LVEF 63%). Perioperative blood tests for red and white cells, hemoglobin, coagulation and inflammation (procalcitonin, PCT, a parameter to estimate the severity, prognosis, and time course of the inflammatory response) are summarized in [Table 4](#).

OUTCOME AND FOLLOW-UP

The patient received chemotherapy after surgery. Firstly, she received three courses of Ifosfamide and Etoposide combination chemotherapy every 21 d. Considering the local recurrence of liver metastasis, she received another six courses of Gemcitabine and Taxotere combination chemotherapy every 21 d. So far, liver metastasis has reduced and the IVC tumor thrombus has not changed since surgery. The timeline of perioperative therapies and outcome are summarized in [Figure 5](#). There was no obvious progression of the residual IVC tumor thrombus. Since discharge, the patient has survived for 20 mo, and we will continue to monitor her for some time.

DISCUSSION

Extrasosseous Ewing's sarcoma is rare, and its overall incidence is 1% of all sarcomas [25]. To date, 39 cases of Ewing's sarcoma arising from the adrenal gland have been reported [26-29], five of which were initially diagnosed with IVC thrombus ([Table 1](#)). The follow-up time ranged from 1 to 36 mo and the survival time was correlated with the clinical stage at diagnosis. There are two prognostic factors to predict the

Table 4 Perioperative vital laboratory data

Time point	Preoperative	Postoperative	Discharged
Red blood cell ($\times 10^9$)	5.02	3.15	3.09
Hemoglobin (g/L)	113	96	94
White cell count ($\times 10^9$)	5.27	8.02	2.86
Neutrophils (%)	57.7	84.7	70
Lymphocytes (%)	22.7	11.1	8.5
Procalcitonin (ng/mL)	---	1.82	0.126
Platelets ($\times 10^9$)	113	63	156
APTT (s)	32	32.5	29.5
PT (s)	15.5	14.5	12.1
INR	1.45	1.36	1.21
Coagulation factor VIII (%)	---	94.2	150
D-dimer	---	8.31	2.78
Fibrinogen (g/L)	3.8	1.08	2.9

PCT: Procalcitonin.

recurrence of Ewing's sarcoma: disease-free interval (DFI) between diagnosis and first relapse and the site of recurrence. The patients with DFI > 2 years have an estimated 5-year overall survival of approximately 30%, but those with DFI < 2 years have an estimated 5-year overall survival of only 7%. In addition, patients with combined local and distant relapse have the worst outcomes, while those with isolated local recurrences appear to fare better[30].

Laparotomy combined with thoracotomy is the primary treatment and has become a major significant challenge for anesthesia and perioperative management. Furthermore, the present case was unconventional in anesthetic practice according to the adrenal Ewing's sarcoma and its combination with IVC and right atrium thrombus, which resulted in vascular obstruction and hemodynamic disturbance. Besides, the primary tumor also directly induced abnormal hormone levels. During transfer to the ICU, the patient developed sudden cardiac arrest. Although the heartbeat was soon restored, cardiac function was still poor, requiring ECMO support. Liver and kidney dysfunction were also a problem. Appropriate treatment has led to improved prognosis, but the underlying mechanisms and therapeutic improvements are still worth exploring.

To date, published cases with tumor thrombus have focused on adrenal pheochromocytoma/renal cell carcinoma with tumor thrombus, and radical surgery with cardiopulmonary bypass and hypothermic circulatory arrest are recommended[31-33]. Extrasosseous Ewing's sarcoma has a neuroendocrine function and secretes endocrine markers including CD56, Syn and CgA[34], and could affect the cardiovascular stabilization and internal environment. Surgical resection could be the treatment for patients with Ewing's sarcoma[35,36], while surgery and anesthetic management for patients with IVC and atrium thrombus have numerous unpredictable risks and challenges.

In this case, the tumor was approximately 22 cm in diameter, and the thrombus extended from the IVC into the right atrium and ventricle. According to the Mayo Clinic classification, the thrombus level was grade IV[33]. The key point of anesthetic management is to maintain perioperative hemodynamic stability, and multiple monitoring including EEG, IABP, CVP, temperature, respiratory parameters and blood gas analysis was employed during the perioperative period. Diazepam was given to relieve preoperative anxiety, and anesthetics with little effect on hemodynamics including etomidate, sevoflurane, sufentanil and cisatracurium were used for anesthetic induction and maintenance. Fluid management and vasoactive drugs are also important components for perioperative hemodynamic management. It has been reported that the perioperative outcomes favored goal directed therapy rather than liberal fluid therapy[37]. Considering infiltration of the tumor in the liver and possible bleeding, we performed volume preloading, and used norepinephrine and dopamine

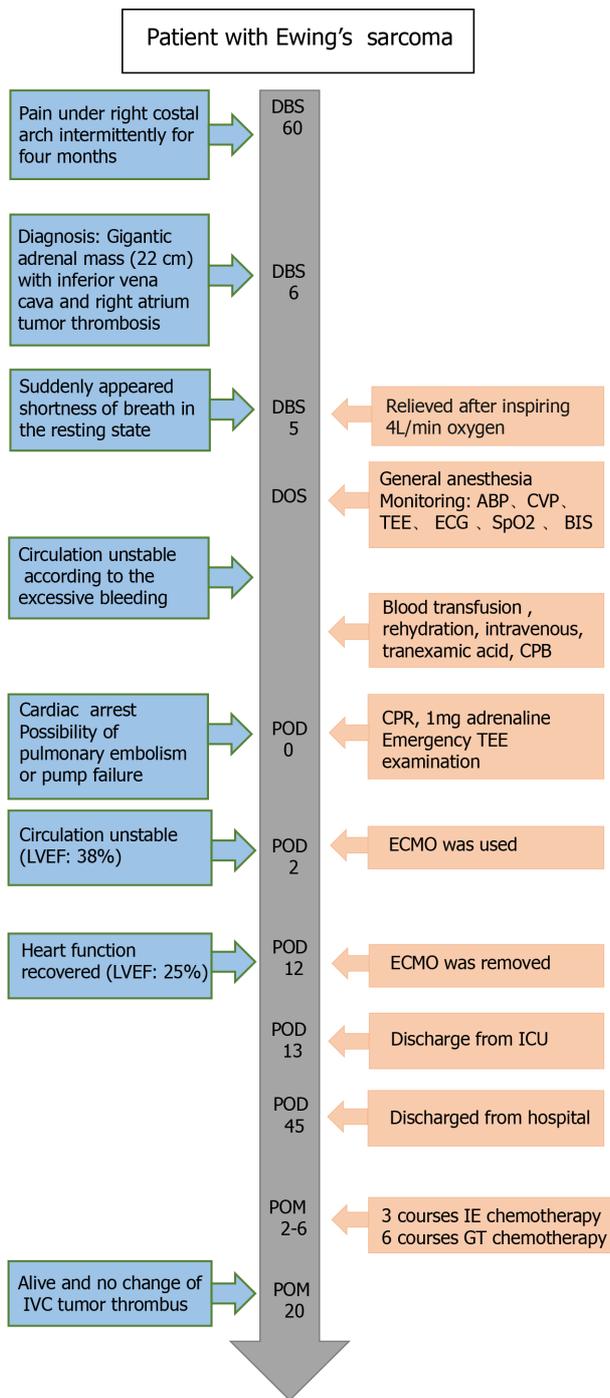


Figure 5 Timeline of perioperative situation, therapies and outcome. DBS: Day before surgery; DOS: Day of surgery; POD: Postoperative day; LVEF: Left ventricular ejection fraction; TEE: Transesophageal echocardiography; ABP: Arterial blood pressure; CVP: Central venous pressure; ECG: Electrocardiogram; BIS: Bispectral index; CPB: Cardiopulmonary bypass; CPR: Cardiopulmonary resuscitation; TTE: Transthoracic echocardiography; ECMO: Extracorporeal membrane oxygenation; ICU: Intensive care unit.

to prevent hypotension during the process of dissociation. During and after cardiopulmonary bypass, her BP remained relatively stable, and transfusion was performed according to blood loss. The total intraoperative transfusion included 14 U of red blood cells, 3200 mL of plasma and colloid solution, and 7200 mL of crystal solution. TEE can be used for these procedures, as close monitoring is pivotal for hemodynamic maintenance[38]. Furthermore, TTE was used in the ICU to monitor heart function and residual thrombus, as well as the occurrence of pulmonary embolism.

During surgery, although the circulation fluctuated due to excessive bleeding, the circulation was controlled by a series of therapies. However, the patient experienced a sudden cardiac arrest after surgery. The multidisciplinary team considered that this was due to the following reasons: (1) According to the liver infiltration, the tumor was

not completely resected, thus, pulmonary embolism caused by residual tumor was considered as the primary cause. Although TTE did not provide definite evidence of the embolus, the chamber of the right ventricle was small with hypokinesis, which could be the result of acute pulmonary embolism; (2) During surgery, the patient lost 4,500 mL of blood and received 13,550 mL fluid and blood transfusions. The bleeding and rehydration, as well as cardiopulmonary bypass, could be an unusual burden on the heart and result in acute coronary syndrome, even cardiac arrest; and (3) Pathological examination indicated that the tumor was Ewing's sarcoma, which can secrete a range of pro-inflammatory cytokines, and lead to perioperative septic shock [33,39,40]. In addition, the tumor excision process promoted the release of these mediators and could invoke a systemic inflammatory response (SIRS) and shock. Perioperative vital laboratory data are shown in Table 4. The level of PCT (1.82 ng/mL) and the percentage of neutrophils (84.7%) increased after surgery. PCT has been reported to be a better parameter for estimating the severity, prognosis, and time course of SIRS, than CRP[41]. These results indicated possible postoperative SIRS in the present case.

CONCLUSION

In conclusion, giant adrenal Ewing's sarcoma with IVC and right atrium thrombus is a rare and challenging scenario. In the present case, a comprehensive evaluation of tumor thrombus extension was performed preoperatively. For tumor resection with excessive bleeding, adequate blood product preparation, proper selection of anesthetics and vasoactive agents, as well as intraoperative monitoring including TEE, BP, CVP, airway pressure and blood gas analysis are equally important. Perioperative compromised cardiac function and circulation fluctuations, as well as pulmonary embolism and acute cardiovascular event, are the major difficulties in anesthetic management.

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