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Aggressive Resection of Malignant Paraaortic and Pelvic Tumors Accompanied by Arterial Reconstruction with Synthetic Arterial Graft

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Case series

Patients: Female, 53-year-old • Female, 70-year-old • Female, 53-year-old • Female, 48-year-old • Male, 66-year-old • Female, 43-year-old • Male, 76-year-old

Final Diagnosis: Local recurrence

Symptoms: Asymptomatic

Medication: —

Clinical Procedure: Surgical resection

Specialty: Surgery

Objective: Unusual setting of medical care

Background: Advanced malignancies in the lower abdomen easily invade the retroperitoneal and pelvic space and often metastasize to the paraaortic and pelvic lymph nodes (LNs), resulting in paraaortic and/or pelvic tumor (PPT).

Case Reports: A total of 7 cases of aggressive malignant PPT resection and orthotopic replacement of the abdominal aorta and/or iliac arteries with synthetic arterial graft (SAG) were experienced during 16 years. We present our experience with aggressive resection of malignant PPTs accompanied by arterial reconstruction with SAG in detail. The primary diseases included 2 cases endometrial cancer and 2 cases of rectal cancer, and 1 case each of ovarian carcinosarcoma, vaginal malignant melanoma, and sigmoid cancer. Surgical procedures are described in detail. Briefly, the abdominal aorta and iliac arteries were anastomosed to the SAG by continuous running suture using unabsorbent polypropylene. Five Y-shaped and 2 I-shaped SAGs were used. This *en bloc* resection actually provided safe surgical margins, and tumor exposures were not pathologically observed in the cut surfaces. Graphical and surgical curability were obtained in all cases in which aggressive malignant PPT resections were performed. The short-term postoperative course of our patients was uneventful. From a vascular perspective, the SAGs remained patent over the long term after surgery, and long-term oncologic outcomes were satisfactory.

Conclusions: To our knowledge, this case series is the first report of aggressive malignant PPT resection accompanied by arterial reconstruction with SAG. This procedure is safe and feasible, shows curative potential, and may play a role in multidisciplinary management of malignant PPTs.

Keywords: Arteries • Neoplasms • Prostheses and Implants

Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/931569

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Background

Advanced malignancies in the lower abdomen (eg, colorectal, urological, and gynecological neoplasms) easily invade the retroperitoneal and pelvic space and often metastasize to the paraaortic and pelvic lymph nodes (LNs), resulting in paraaortic and/or pelvic tumors (PPT) [1-4]. Even after radical surgery, local recurrence and/or LN metastasis can cause PPT formation [4,5]. We present our experience with aggressive malignant PPT resection and orthotopic replacement of the abdominal aorta and/or iliac arteries with a synthetic arterial graft (SAG), which has not been previously reported, and discuss treatment of locally invasive, metastatic, and recurrent PPTs.

Case Reports

During 16 years (from January 2005 to December 2020), we experienced a total of 7 cases of aggressive malignant PPT resection and orthotopic replacement of the abdominal aorta and/or iliac arteries with synthetic arterial graft (SAG). Clinical characteristics are summarized in **Tables 1-3** as follows: **Table 1**, patient profiles; **Table 2**, PPT intraoperative and pathological findings; and **Table 3**, postoperative courses and patient outcomes. Malignancies were classified according to the Union for International Cancer Control Tumor, Node, Metastasis (TNM) classification [6]. Hemashield Platinum Woven Double Velour (Getinge AB, Göteborg, Sweden) was used as SAG in all patients. Fixation or anchor suture was not placed before the anastomotic procedure. In all cases, the abdominal aorta and iliac arteries were anastomosed to SAG by continuous running suture, and unabsorbent polypropylene (4-0 Prolene, Ethicon, Inc., Bridgewater, NJ, USA) was used for hand suture. Postoperative complications were evaluated using the Clavien-Dindo classification [7]. Actual survival after diagnosis is plotted in **Figure 1**.

Case 1

A 53-year-old woman diagnosed with T3N0M0 stage IIIC ovarian carcinosarcoma underwent neoadjuvant chemotherapy followed by non-curative unilateral resection of the appendicular organ, total omentectomy, and adjuvant chemotherapy. Metachronous recurrence of PPT occurred 1.8 years after the initial surgery. Aggressive tumor resection accompanied by arterial reconstruction with SAG and inferior vena cava (IVC) resection was then performed. An I-shaped SAG was used to replace the abdominal aorta from the lower level of the renal

Table 1. Patients' profiles.

Case	Primary disease	TNM classification*	Resectability**	PPT: Timing of appearance	PPT: The greatest size [cm]	Aggressive resection accompanied with arterial reconstruction using SAG***	Neoadjuvant chemotherapy****
1	Ovarian carcinosarcoma (malignant mixed Müllerian tumor [homologous type])	T3 N0 M0 Stage IIIC	No	Metachronous	3.5	Secondary surgery	Yes
2	Endometrial cancer	T1b N1 M0 Stage IIIC	Yes	Synchronous	2.5	Initial surgery	No
3	Vaginal malignant melanoma	T4b N0 M0 Stage IVA	Yes	Metachronous	4.5	Secondary surgery	No
4	Endometrial cancer	T3b N2 M0 Stage IIIC	Yes	Synchronous	2.6	Initial surgery	No
5	Rectal cancer	T3 N2b M0 Stage IIIC	Yes	Metachronous	3.1	Secondary surgery	Yes
6	Sigmoid colon cancer	T3 N2a M0 Stage IIIB	Yes	Metachronous	4.1	Secondary surgery	Yes
7	Rectal cancer	T3 N0 M0 Stage IIA	Yes	Metachronous	2.9	Secondary surgery	No

* TNM classification at the initial diagnosis; ** resectability at the initial surgery; *** timing of aggressive resection accompanied with arterial reconstruction using SAG for PPT; **** neoadjuvant chemotherapy before aggressive resection accompanied with arterial reconstruction using SAG. LN – lymph node; PPT – paraaortic and/or pelvic tumor; SAG – synthetic arterial graft; TNM – tumor-node-metastasis.

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Table 2. Intraoperative findings and pathological assessments of PPTs.

Case	Operative time [minute]	Blood loss [ml]	Blood transfusion [unit or ml]	Arterial reconstruction with SAG			Resection of the IVC	Curability*
				The range of prosthetic replacement	Orthotopically replaced artery	Graft type		
1	376	1546	RBC, 4 units	The lower level of the RA to the upper level of the IMA	Abdominal aorta	I-shaped	Yes (IVC and LRV)	Yes
2	520	1851	RBC, 4 units / Autotransfusion, 400 ml	The root of the IMA to the CIAs 1 cm distal to the bifurcation bilaterally	Abdominal aorta / CIAs	Y-shaped	Yes (partial resection)	Yes
3	250	885	RBC, 2 units	The lower level of the RA to the CIAs distal to the bifurcation bilaterally	Abdominal aorta / CIAs	Y-shaped	No	Yes
4	679	3280	RBC, 4 units / Fresh frozen plasma, 4 units	The lower level of the RA to the CIAs distal to the bifurcation bilaterally	Abdominal aorta / CIAs	Y-shaped	No	Yes
5	193	430	None	The lower level of the RA to the lower level of the IMA	Abdominal aorta	I-shaped	No	Yes
6	246	3489	RBC, 10 units / Fresh frozen plasma, 18 units	The lower level of the RA to the CIAs distal to the bifurcation bilaterally	CIAs / Abdominal aorta	Y-shaped	No	Yes
7	234	1076	RBC, 2 units	The lower level of the RA to the CIAs distal to the bifurcation bilaterally	CIAs / Abdominal aorta	Y-shaped	No	Yes

Case	Postoperative course** [grade]	Pathological assessments				
		PPT	Paraaortic and/or pelvic LNs***		Tumor exposure on the cut surface	Tumor invasion into the arterial wall
			Harvested LNs	Metastatic LNs		
1	0	Carcinosarcoma (malignant mixed Müllerian tumor [homologous type])	2	2	No	No
2	0	Endometrial carcinoma (endometrioid adenocarcinoma)	22	17	No	No
3	0	Malignant melanoma	1	1	No	Yes
4	0	Endometrial carcinoma with squamous differentiation	21	2	No	No
5	0	Moderately-differentiated tubular adenocarcinoma	7	7	No	Yes
6	1	Moderately-differentiated tubular adenocarcinoma	2	0	No	Yes
7	0	Moderately-differentiated tubular adenocarcinoma	2	2	No	Yes

* Graphical and surgical findings; ** Clavien-Dindo classification; *** the numbers of LNs in the PPT. CIA – common iliac artery; IMA – inferior mesenteric artery; IVC – inferior vena cava; LRV – left renal vein; LN – lymph node; PPT – paraaortic and/or pelvic tumor; RA – renal artery; RBC – red blood cell; SAG – synthetic arterial graft.

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Table 3. Postoperative courses and prognostic outcomes after aggressive resection accompanied with arterial reconstruction using SAG.

Case	Adjuvant chemotherapy* [POD]	Postoperative hospital stay [day]	Patency of SAG**	Postoperative recurrence***		Prognosis		
				Target site	Timing [year]	Survival*** [year]	Duration**** [year]	Current status
1	Yes (14)	23	Yes	Lung and mediastinal LN	1.3	5.9	3.6	Dead
2	Yes (18)	32	Yes	Mediastinal LN	1.6	9.0	8.9	Alive
3	Yes (26)	16	Yes	Lung	0.5	9.4	6.7	Alive
4	Yes (43)	21	Yes	Peritoneal space	0.8	2.1	2.0	Alive
5	No	11	Yes	Cervical and mediastinal LNs, lung and bone	0.3	4.8	0.8	Dead
6	Yes (52)	12	Yes	Lung and liver	0.3	3.2	0.8	Dead
7	No	16	Yes	Peritoneal space and lung	2.9	9.2	6.0	Dead

* Adjuvant chemotherapy after intentional resection accompanied with arterial reconstruction using SAG and the POD when adjuvant chemotherapy was introduced; ** the latest imaging studies; *** recurrence and prognosis after diagnosis of the primary disease; **** recurrence and prognosis after intentional resection accompanied with arterial reconstruction using SAG. LN – lymph node; POD – postoperative day; SAG – synthetic arterial graft.

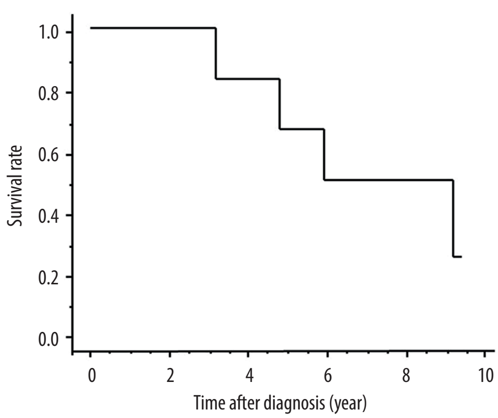

Figure 1. Actual patient survival after diagnosis.

artery (RA) to the upper level of the inferior mesenteric artery (IMA) (Figure 2A). The IVC and left renal vein were resected, but venous reconstruction was not performed. Venous flow into the IVC was kept via developed collaterals in the pelvic space, gluteus maximus muscle, mesorectum and mesocolon, retroperitoneal space around the iliopsoas muscle, and Gerota fascia (Figure 3A-3E). These developed collaterals from the IVC flowed into the inferior and superior mesenteric veins and splenic vein (Figure 3A-3E). Venous flow of the left renal vein was kept mainly via splenorenal shunt, and other developed collaterals from the left renal vein flowed into the superior mesenteric vein and IVC (Figure 3A-3E). Congestion or flow disorder was not observed in the left kidney. Hence, venous flow from the IVC and left renal vein were well preserved by developed collaterals and splenorenal shunt from the early postoperative period. Lung and mediastinal LN metastases were detected 1.3 years later and she died 5.9 years after diagnosis.

Case 2

A 70-year-old woman diagnosed with T1bN1M0 stage IIIC endometrial cancer of the uterus with PPT underwent extended total hysterectomy, bilateral resection of the appendicular organs, paraaortic and pelvic lymphadenectomy, and partial resection of the IVC. A Y-shaped SAG was used to replace the aorta from the root of the IMA to the common iliac arteries (CIAs) 1 cm distal to the bifurcation bilaterally (Figure 2B). The patency of the partially resected IVC was well preserved from the early postoperative period (Figure 3F). Adjuvant chemotherapy was administered after surgery. Mediastinal LN metastases were detected 1.6 years after surgery and she remained alive at 9.0 years after diagnosis.

Case 3

A 53-year-old woman diagnosed with T4bN0M0 stage IVA vaginal malignant melanoma underwent partial resection of the vaginal wall and postoperative chemotherapy. Subsequent local recurrences at the urethral orifice and vaginal wall and metastatic inguinal LN were resected. PPT was detected 2.6 years after the initial surgery and removed *en bloc* by extensive surgery that included partial vertebral body resection. A Y-shaped SAG was used to replace the aorta from the lower

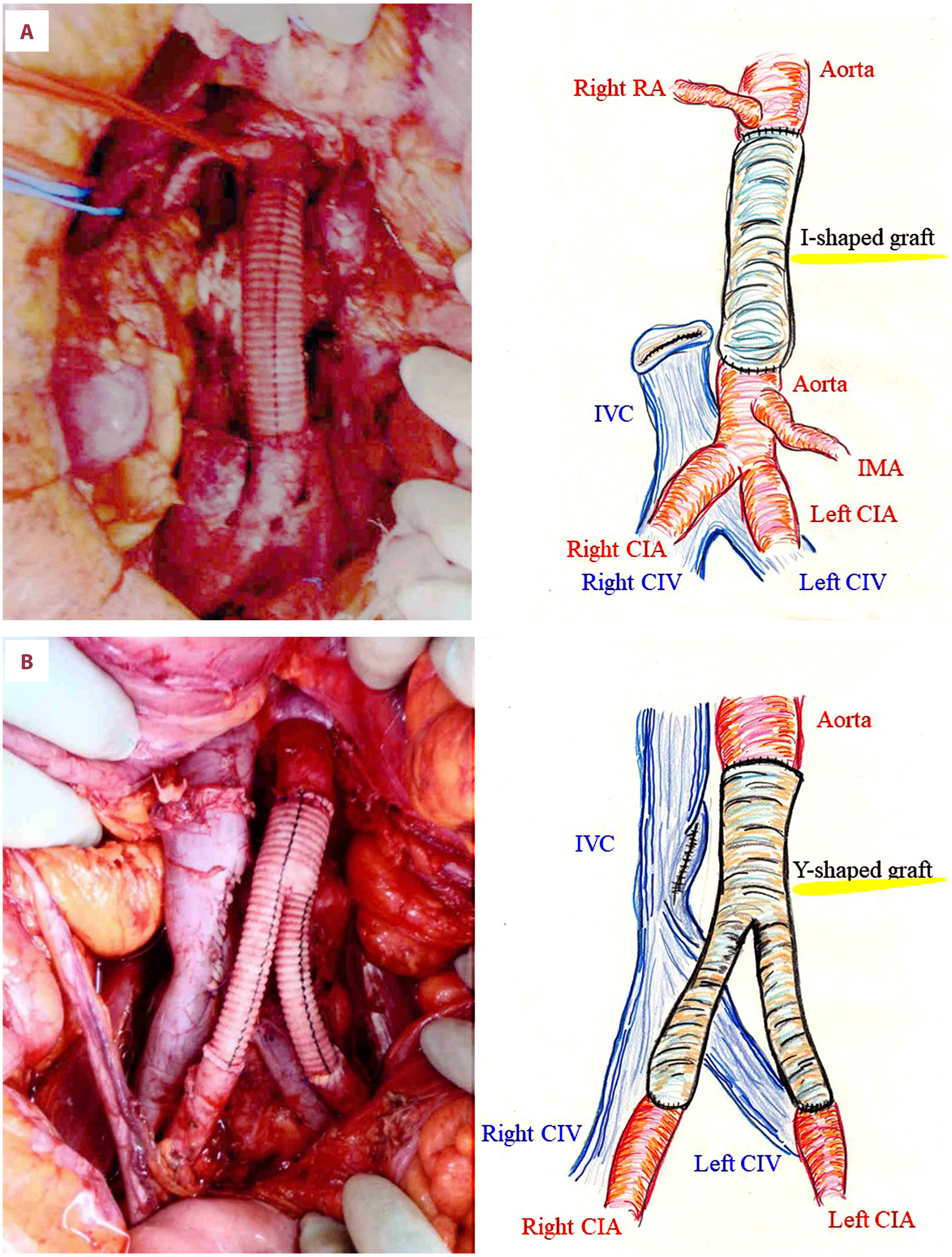

Figure 2. Arterial reconstruction using synthetic arterial graft. (**A**) An I-shaped graft was used to replace the abdominal aorta from the lower level of the renal artery to the upper level of the inferior mesenteric artery (Case 1). (**B**) A Y-shaped graft was used to replace the aorta from the root of the inferior mesenteric artery to the common iliac arteries 1 cm distal to the bifurcation bilaterally (Case 2). CIA – common iliac artery; CIV – common iliac vein; IMA – inferior mesenteric artery; IVC – inferior vena cava; SAG – synthetic arterial graft; RA – renal artery.

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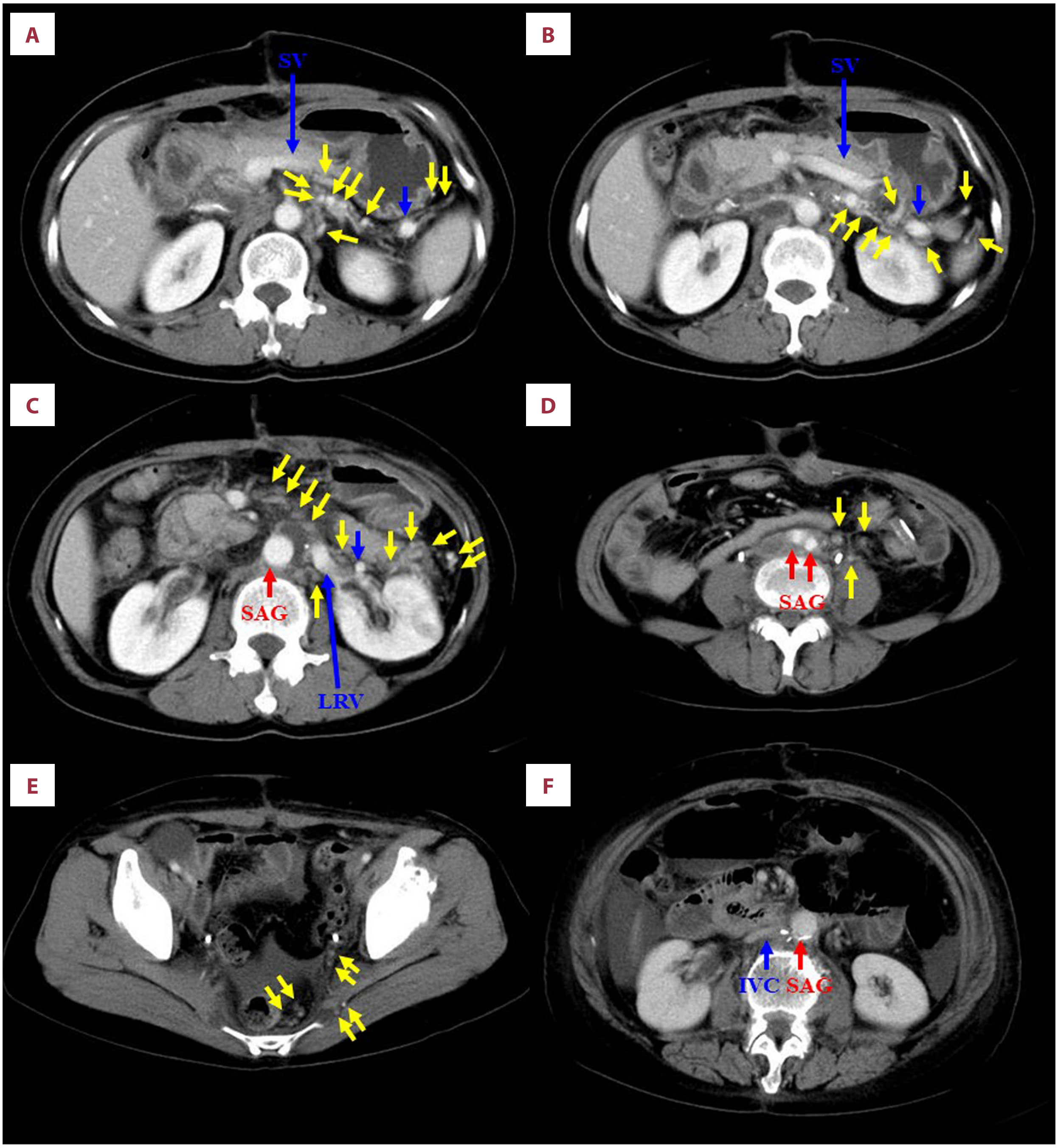

Figure 3. Venous flows of the IVC and left renal vein in early postoperative period after en bloc resection. (**A-E**) The IVC and LRV were resected for en bloc resection of PPT and actual findings of dynamic computed tomography at 13 days after surgery. Venous flow into the IVC was kept via developed collaterals in the pelvic space, gluteus maximus muscle, mesorectum and mesocolon, retroperitoneal space around the iliopsoas muscle and Gerota fascia (yellow arrows). These developed collaterals from the IVC flowed into the inferior and superior mesenteric veins and SV (yellow arrows). Venous flow of the LRV was kept mainly via splenorenal shunt (blue arrows), and other developed collaterals from the left renal vein flowed into the superior mesenteric vein and IVC (yellow arrows). Congestion or flow disorder was not observed in the left kidney. Hence, venous flow from the IVC and LRV were well preserved by developed collaterals and splenorenal shunt in the early postoperative period (Case 1). (**F**) The IVC was partially resected for en bloc resection of PPT, and actual findings of dynamic computed tomography at 14 days after surgery are shown. The patency of partially resected IVC was well kept from early postoperative period (Case 2). IVC – inferior vena cava; LRV – left renal vein; PPT – paraaortic and/or pelvic tumor; SAG – synthetic arterial graft; SV – splenic vein.

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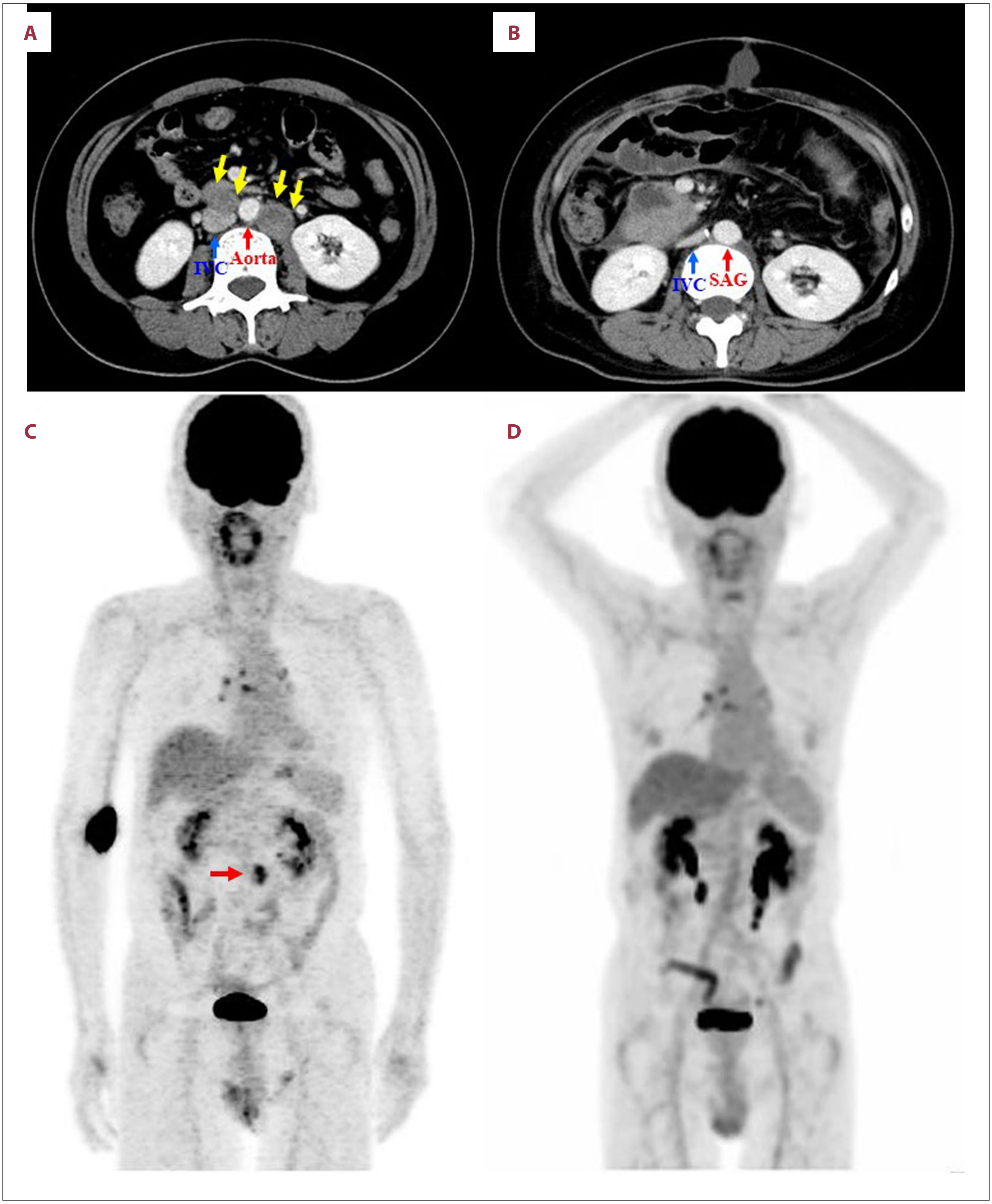

Figure 4. Graphical and surgical curability as institutional indication of aggressive resection of PPT. (**A, B**) Actual findings of dynamic computed tomography before aggressive resection of PPTs (yellow arrows, A) and at 10 days after surgery (**B**) are shown. Graphical and surgical curability was obtained (Case 4). (**C, D**) Actual findings of 18F-fluorodeoxyglucose positron emission tomography before aggressive resection of PPT (red arrow, **C**) and at 1 year after surgery (**B**) are shown. Graphical and surgical curability was obtained (Case 7). IVC – inferior vena cava; PPT – paraaortic and/or pelvic tumor; SAG – synthetic arterial graft.

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level of the RA to the CIAs distal to the bifurcation bilaterally. Adjuvant chemotherapy was administered after surgery. A solitary lung metastasis was detected 0.5 years after PPT resection and was surgically removed. She remains in good health without recurrence or metastasis at 9.4 years after diagnosis.

Case 4

A 48-year-old woman diagnosed with T3bN2M0 stage IIIC endometrial cancer of the uterus with PPT underwent total abdominal hysterectomy, bilateral resection of the appendicular organs, and paraaortic and pelvic lymphadenectomy. The PPT was removed in *en bloc* and a Y-shaped SAG was used to replace the aorta from the lower level of the RA to the CIAs distal to the bifurcation bilaterally. Graphical and surgical curability was obtained (**Figure 4A, 4B**). Adjuvant chemotherapy was administered after surgery. Peritoneal dissemination was detected 0.8 years after surgery and she remains alive 2.1 years after diagnosis.

Case 5

A 66-year-old man diagnosed with T3N2bM0 stage IIIC moderately-differentiated adenocarcinoma of the rectum underwent anterior resection. After paraaortic LN metastases were detected 1.4 years later, they were resected and chemotherapy was introduced. PPT was detected 4.0 years after surgery and aggressive resection accompanied by arterial reconstruction with SAG was performed. An I-shaped graft was used to replace the aorta from the lower level of the RA to the lower level of the IMA. Lung and mediastinal LN metastases were detected 0.3 years after PPT resection and chemotherapy was resumed. He died 4.8 years after diagnosis.

Case 6

A 43-year-old woman diagnosed with T3N2aM0 stage IIIB well-differentiated adenocarcinoma of the sigmoid colon underwent radical resection with lymphadenectomy. After paraaortic LN metastases were detected 0.6 years later and removed, chemotherapy was introduced. PPT was detected 4.0 years after the initial surgery and aggressive resection accompanied by arterial reconstruction with SAG and IVC resection was performed. A Y-shaped graft was used to replace the aorta from the lower level of the RA to the CIAs distal to the bifurcation bilaterally and adjuvant chemotherapy was resumed. Lung and mediastinal LN metastases were detected 0.3 years after PPT resection. She died 3.2 years after diagnosis.

Case 7

A 76-year-old man diagnosed with T3N0M0 stage IIA well-differentiated adenocarcinoma of the rectum underwent low anterior resection with lymphadenectomy. PPT was detected 1.7 years after surgery and aggressive resection accompanied by arterial reconstruction with SAG and left ureter resection was performed. A Y-shaped graft was used to replace the aorta from the lower level of the RA to the CIAs distal to the bifurcation bilaterally. The ureter was reconstructed with an end-to-end anastomosis. Graphical and surgical curability was obtained (**Figure 4C, 4D**). Image studies by dynamic computed tomography and ^{18}F-fluorodeoxyglucose positron emission tomography were repeated every 6 months after *en bloc* resection of the PPT. Peritoneal dissemination and lung metastasis were detected 2.9 years after PPT resection and chemotherapy was introduced. He died 9.2 years after diagnosis.

Discussion

Advanced malignancies in the lower abdomen can easily invade regional structures, metastasize to local and regional LNs, and disseminate throughout the intraperitoneal space [3,4]. Although intentional removal of local recurrence and extended lymphadenectomy of paraaortic and/or pelvic LNs may have oncologic therapeutic potential for some malignancies [1-5], extended lymphadenectomy is clearly contraindicated in some diseases [8,9]. Therefore, few cases of aggressive resection for malignant PPTs have been reported [10-12]. Arterial reconstruction was not performed in these cases; however, arterial bypass (ie, heterotopic replacement) via SAG has been described [11,12]. To our knowledge, our case series is the first report of aggressive PPT resection accompanied by arterial reconstruction (ie, orthotopic replacement) with SAG.

Pathological examination in our case series revealed that direct invasion of the arterial wall may not be observed in some cases, even when nervous plexuses, lymphatic ducts, and surrounding vessels are clearly invaded. In all of our cases, the PPT was removed *en bloc* and surgical cure was achieved (**Table 2**). We propose that intention to cure should be the goal of aggressive PPT resection with arterial reconstruction using SAG, as an oncological benefit is possible.

Details of our surgical procedures are shown in **Table 2 and Figure 2**. The short-term postoperative course in our patients was uneventful (**Tables 2, 3**). From a vascular perspective, the SAGs remained patent over the long term after surgery (**Table 3**) and long-term oncologic outcomes were satisfactory (**Table 3, Figure 1**), suggesting that our results are acceptable. Multidisciplinary therapy is crucial for advanced cancers [13]. Aggressive resection accompanied by arterial reconstruction with SAG may have a role in multidisciplinary treatment of malignant PPTs.

To our knowledge, this case series is the first report of aggressive malignant PPT resection accompanied by arterial reconstruction with SAG. This procedure is safe and feasible, shows curative potential, and may play a role in multidisciplinary management of malignant PPTs. Surgical indications for aggressive resection of malignant PPTs accompanied by arterial reconstruction (ie, orthotopic replacement) with SAG should be carefully decided on a case-by-case basis. This *en bloc* resection actually provided safe surgical margins, and tumor exposures were not pathologically observed in the cut surfaces (**Table 2**). Although the *en bloc* resection of malignant PPTs with surgical curability is ideal, extended resection accompanied by arterial reconstruction with SAG may be too invasive for patients with advanced cancer. In fact, tumor invasions into the arterial wall were not pathologically observed in 3 of 7 cases (42.9%) (**Table 2**). Regarding graphical and surgical curability (ie, graphical and surgical R0), intraoperative and postoperative findings were actually shown (**Figures 2, 4**). In all patients, graphical and surgical curability were obtained when aggressive malignant PPT resection accompanied by arterial reconstruction with SAG was performed (**Table 2**). Our institutional indication for aggressive malignant PPT resection accompanied by arterial reconstruction with SAG is simple, and it achieves graphical and surgical curability. Long-term survival seemed to be acceptable in our patients who received multidisciplinary therapy including aggressive malignant PPT resection (**Figure 1**). If graphical and surgical curability can be obtained, aggressive resection accompanied by arterial reconstruction with SAG may play a role in multidisciplinary management of malignant PPTs.

Conclusions

We reported our experience with aggressive resection of malignant PPTs accompanied by arterial reconstruction (ie, orthotopic replacement) with SAG. Our results suggest that this approach is safe and feasible, with satisfactory outcomes.

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Conflict of Interest

None.

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