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CASE REPORT

Temporary Vascular Debranching to Facilitate Retroperitoneal Tumour *en bloc* Resection

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Background: Oncovascular teams are known to be a cornerstone in planning and facilitating *en bloc* resection of large retroperitoneal masses. Vascular surgeons can help with dissection close to major vessels by vascular reconstruction when necessary, and also in performing specific procedures that can facilitate safe and optimal tumour mass resection. Two cases are reported where temporary vascular debranching of major arteries allowed safe tumour harvesting.

Case reports: A 68 year old man with a necrotic retroperitoneal carcinoma underwent *en bloc* resection with temporary debranching of the coeliac trunk, superior mesenteric artery, and right renal artery using a multibranching bypass from the axillary artery. The post-operative course included septic shock related to pulmonary infection requiring a 10 day stay in the intensive care unit (ICU). Renal function was normalised on day two. The patient was discharged on day 18. However, he died 78 months post-operatively from pulmonary metastases after anti-angiogenic treatment.

A 34 year old man with a retroperitoneal mature teratoma underwent *en bloc* resection with temporary debranching of the coeliac trunk, superior mesenteric artery, left and right renal arteries, and left and right common iliac arteries, with a multibranching bypass from the axillary artery. Post-operatively he required a five day stay in the ICU. Acute kidney injury (AKI) was noted, but it resolved without dialysis. The patient was discharged on day 16. After 78 months follow up he presented with chronic renal failure requiring dialysis. Follow up computed tomography angiography showed pulmonary metastases; although the metastases were manageable with surgical treatment, the patient refused further care.

Conclusions: Temporary extra-anatomical bypass from the axillary artery to the visceral arteries could be considered as an option to provide adequate perfusion and to prevent visceral ischaemia during *en bloc* resection of large retroperitoneal masses.

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INTRODUCTION

Retroperitoneal tumour masses often involve major abdominal vessels and planning surgical management by multidisciplinary oncovascular teams has been recommended.¹ *En bloc* resection with free resection margins and reconstruction of involved vessels has been shown to provide the best results.¹ However, this strategy often requires long operating times, with a high risk of massive bleeding and organ ischaemia.^{2,3}

Two cases are reported of large retroperitoneal tumour mass resections involving the abdominal aorta and its branches, successfully managed by performing temporary debranching of the visceral arteries involved in the tumour with extra-anatomical bypasses from the axillary artery.

CASE REPORTS

Case 1

A 68 year old man was admitted with left sided abdominal pain. Twenty-three years previously he had undergone left nephrectomy for kidney carcinoma without adjuvant treatment. Computed tomography angiography (CTA) found a 73 × 61 × 33 mm mass lateral to the aorta extending to the superior mesenteric artery (SMA) with aortic wall infiltration, and extension to the inferior vena

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cava (IVC) close to the previous left renal vein ostium, and right renal artery (RRA). The coeliac trunk (CTr) was not invaded (Fig. 1A). There was no inter-aortic-caval adenopathy or metastasis.

Needle tumour biopsy was performed and histology confirmed a necrotic carcinoma with a high Ki67 proliferative index without similarities to the primary left renal carcinoma.

Three cycles of chemotherapy (Carboplatine-VP 16 protocol) followed by *en bloc* resection was chosen, according to multidisciplinary consensus.

A midline laparotomy associated to a transverse abdominal approach was performed, which allowed for control of the supraceliac aorta, the CTr, the SMA, the RRA, and the abdominal aorta below the inferior mesenteric artery. After systemic heparinisation with 150 units/kg, a 7 mm polyethylene terephthalate (PET) bypass originating from the left infraclavicular axillary artery (chosen according to the size of the axillary artery [LeMaitre Vascular, Burlington, MA, USA]), with three PET branches allowing end to end anastomoses to the CTr (7 mm diameter, seven minutes of ischaemia), SMA (6 mm diameter, nine minutes of ischaemia), and the RRA (6 mm diameter, 12 minutes of ischaemia) was performed (Fig. 1B; Supplementary Video S1). The bypass and the branches were long enough to allow easy mobilisation outside the operating field (Fig. 1B). After supraceliac and abdominal aortic cross clamping, the tumour was resected *en bloc* (Fig. 1C and D). Blood loss was 1000 mL during the surgery, and the patient received six

units of packed red blood cells (pRBC) and three units of fresh frozen plasma (FFP).

The following is/are the supplementary data related to this article: Supplementary Video S1 This video shows the bypass originating from the infraclavicular left axillary artery with a 7 mm diameter polyethylene terephthalate graft (PET; LeMaitre Vascular, Inc, Burlington, MA, USA) with three PET branches allowing anastomoses to the target vessels: the coeliac trunk, the superior mesenteric artery, and the right and left renal arteries. Blood pressure was assessed clinically by a good graft pulse.

Supplementary video related to this article can be found at doi:10.1016/j.ejvsf.2022.01.001.

Arterial continuity was re-established using a 16 mm diameter PET graft with short branches to allow indirect re-implantation of all the visceral branches (Fig. 1E). The axillary anastomosis was disconnected and closed with a patch. Although the overall operating time was six hours, the lower limb ischaemia time was only 61 minutes.

The post-operative course included septic shock related to pulmonary infection, which required a 10 day stay in the intensive care unit (ICU). Renal function was normalised on day two. The patient was discharged on day 18.

Anatomopathological examination confirmed free margins. Histology confirmed kidney adenocarcinomatosis

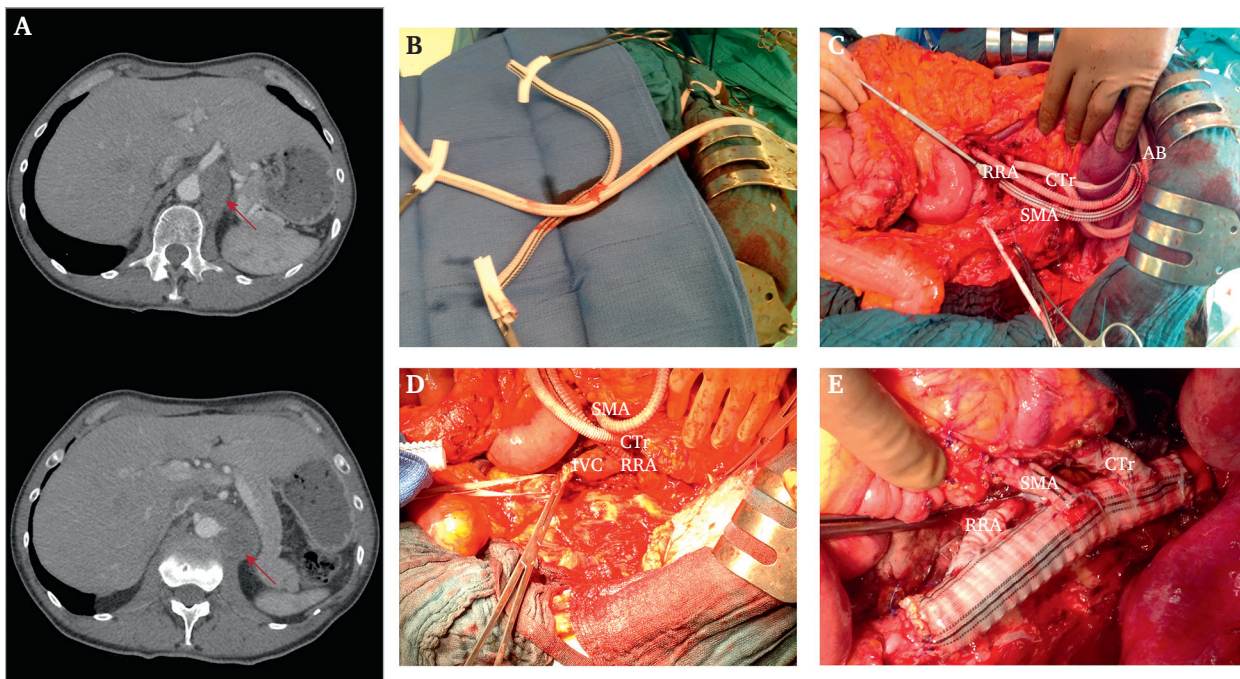


Figure 1. A 68 year old man with a necrotic retroperitoneal carcinoma. (A) Pre-operative computed tomography angiography; red arrow points to the tumour. (B) Bypass and its branches. (C, D) Operative view with the long branches of the bypass allowing mobilisation. (E) Final reconstruction. AB = axillary bypass; CTr = coeliac trunk; IVC = inferior vena cava; RRA = right renal artery; SMA = superior mesenteric artery.

proliferation with acidophilic cells corresponding to Fuhrman grade III. There were small metastatic lymph nodes and aortic infiltration. No adjuvant treatment was required, according to the conclusion of the multidisciplinary meeting. Eighteen months later, the patient presented with mediastinal lymphadenopathy with pulmonary metastasis, and received anti-angiogenic treatment. After 79 months, the patient died from disease progression.

Case 2

A 34 year old man was admitted with left abdominal pain related to an abdominal mass.

The patient had undergone a left orchidectomy 18 months earlier for a non-seminoma germinal tumour with 80% embryonal, teratoma, and seminoma components.

CTA showed a $152 \times 184 \times 127$ mm mass lateral to the aorta compressing the IVC (Fig. 2A). Five cycles of chemotherapy (BEP 500) followed by *en bloc* resection was chosen at the multidisciplinary meeting. Post-chemotherapy CTA revealed an increase in the size of the mass, measuring $176 \times 210 \times 155$ mm involving the infrarenal aorta and the left common iliac artery (CIA). A hepatic nodule in segment IV evoking a metastasis was seen. A second $85 \times 81 \times 55$ mm pelvic mass was found in contact with the left iliac vein. Needle tumour biopsy was performed and histology confirmed a mature teratoma.

As no results were obtained with chemotherapy, *en bloc* surgical resection of the mass associated with surgical resection of the hepatic nodule and the second pelvic mass were decided on at a multidisciplinary meeting.

Via a xyphopubic and transverse abdominal approach, the supraceliac aorta, the CTr at the level of the ostium, the SMA, the RRA and the left renal artery, and both CIAs were controlled. The second pelvic mass was resected. After systemic heparinisation with 150 units/kg, a bypass originating from the right axillary artery with a 6 mm diameter PET bypass (LeMaitre Vascular) was performed, allowing anastomoses to the RRA (6 mm PET, eight minutes of ischaemia), the SMA (6 mm diameter PET, nine minutes of ischaemia), the right CIA (6 mm PET, 10 minutes of ischaemia), and the left CIA (6 mm PET, 18 minutes of ischaemia) through four branches in an end to end fashion. The bypass and its branches were long enough to allow for easy mobilisation outside the operating field (Fig. 2B).

After cross clamping of the supraceliac aorta and both CIAs, the tumour was excised *en bloc* (Fig. 2C). The aorta, and the origins of the SMA and RRA were resected with the mass. No venous resection was necessary. The resection was associated with a left colectomy, a left adrenalectomy and nephrectomy, a partial resection of the left psoas muscle, and the hepatic metastasis. Arterial continuity was re-established by an aortobi-iliac bypass using a

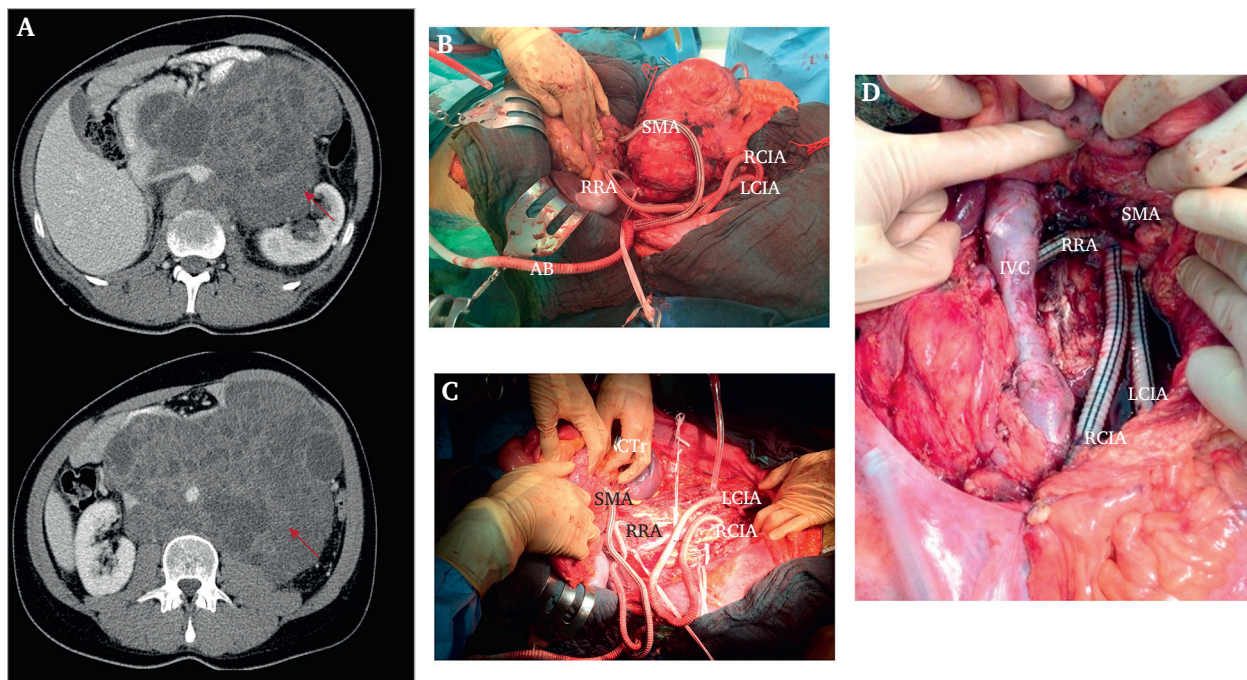


Figure 2. A 34 year old man with a mature retroperitoneal teratoma. (A) Pre-operative computed tomography angiography; red arrow points to the tumour. (B, C) Operative views with the long branches from the axillary bypass allowing mobilisation for the *en bloc* resection. (D) The final reconstruction. AB = axillary bypass; CTr = coeliac trunk; IVC = inferior vena cava; RRA = right renal artery; SMA = superior mesenteric artery; LCIA = left common iliac artery; RCIA = right common iliac artery.

Table 1. Literature review: characteristics of the seven reported cases.

Patient	Reference	Age – y/sex	Type of tumour	First operation	Vascular invasion	Temporary debranching	Vessel resected
1	Homsy ¹	59/F	Leiomyosarcoma	Yes	Yes	Axillo-bi-renal bypass	Infrarenal aorta and IVC
2	Homsy ¹	26/M	Leiomyosarcoma	Yes	Yes	Axillary to common hepatic artery, SMA, and RRA bypass	Aorta, SMA, hepatic artery and RRA
3	Homsy ¹	64/M	Undifferentiated pleiomorphic sarcoma	Yes	Arises from IVC	Axillorenal bypass	Aorta, IVC, LRA, LRV
4	Homsy ¹	32/M	Angiosarcoma epithelioides	Yes	Arises from aorta	Axillorenal bypass	Aorta, IVC, patch, coeliac trunk
5	Bjorkmann ⁵	31/M	Aortic angiosarcoma	Yes	—	Axillary to SMA and LRA bypass	Aorta, CTr, SMA, RRA, and LRA
6	Kuntz ⁸	68/M	Necrotic carcinoma	No	Yes	Axillary to CTr, SMA, and RRA bypass	Aorta, SMA
7	Kuntz ⁸	34/M	Mature teratoma	Yes	Yes	Axillary to SMA, RRA, LCIA, and RCIA bypass	Aorta, SMA, RRA, LCIA, and RCIA

ICU = intensive care unit; AKI, acute kidney injury; F, female; IVC, inferior vena cava; PET, polyethylene terephthalate; UTI, urinary tract infection; M, male; SMA, superior mesenteric artery; RRA, right renal artery; LRA, left renal artery; LRV, left renal vein; CTr, coeliac trunk; LCIA, left common iliac artery; RCIA, right common iliac artery.

16/8 mm diameter PET graft with short branches allowing indirect re-implantation of the RRA and SMA (Fig. 2D). The axillary anastomosis was disconnected and closed with a patch. The overall procedure time was 12 hours. Operative blood loss was 3000 mL, and the patient received 11 units of pRBC, eight units of FFP, and three units of platelet concentrates.

The post-operative course included a five day stay in the ICU. AKI was noted, but it resolved without dialysis. The patient was discharged on day 16. Anatomopathological examination confirmed free margins. Histology confirmed a mature teratoma. No complementary chemotherapy was performed after the surgery. After 78 months follow up, the patient presented with chronic renal failure requiring dialysis. Follow up CTA showed pulmonary metastases. These lesions were amenable to surgical treatment, but the patient refused further care.

DISCUSSION

These two cases highlight the potential usefulness of temporary debranching of the main arteries involved in the tumour mass to allow an *en bloc* resection.

Even with accurate pre-operative CTA images, it is difficult to predict the degree to which the tumour adheres to or invades the arterial wall. Starting with temporary debranching provides several advantages. It allows control of the distal part of the involved arteries, ensuring that the later anastomosis will be performed to a tumour free arterial segment. Once the bypass is in place, it protects the corresponding target organs from the risk of prolonged ischaemia in the event of emergency proximal clamping for inadvertent arterial injury during dissection, or for unexpectedly prolonged tumour harvesting. Blood pressure (BP) was not monitored during the procedure but was clinically assessed by a good graft and target vessel pulse. Invasive BP measurement could be performed in future cases. Finally, once all the arteries proximal to the anastomoses are ligated the tumour area can be totally excluded, decreasing the risk of bleeding once the aorta is clamped proximally and distally. Moreover, the temporary axillary bypass is less invasive than other possible feeders such as the aorta above the CTr and easier to perform, creating a large loop that does not hamper access during tumour mass excision. When temporary extra-anatomical bypasses from the axillary artery has been proposed for

Vessel reconstruction	Resection margins	Duration of surgery — h	ICU length of stay — d	AKI	Post-operative complication	Graft complication	Length of follow up —mo	Status
Aorta with PET prosthesis, IVC with bovine pericardium patch	Marginal	5.1	6	Yes	Chylous leak, UTI	IVC thrombosis (33 mo)	55	Free
PET	Marginal	7.2	4	Yes	No	No	25	Free
Arteries with PET, veins with autologous vein graft	Marginal	11.7	4	No	Laparotomy (haemorrhage on day 8)	No	84	Free
Aorta, CTr, SMA, renal vein, and both internal iliac arteries with PET, IVC with bovine pericardium patch	Marginal	13.2	5	Yes	Chylous leak, persistent diarrhoea	No	23	Free
Aorta, CTr, SMA, LRA with PET, IVC with bovine pericardial patch	Marginal	6.5	5	No	Persistent diarrhoea	No	24	Free
Aorta, SMA, RRA, and LRA with PET	Marginal	6.0	2	No	Pulmonary septic shock	No	79	Death
Aorta, RRA, SMA, LCIA, and RCIA with PET	Marginal	12	5	Yes	No	No	78	Free

complex renal artery reconstruction,⁴ there have only a few cases reported in the oncological surgery literature.^{1,5} However, femorofemoral bypass in one or two steps prior to the resection of retroperitoneal masses or inside the surgical field have been proposed to decrease the risk of ischaemia.^{6,7}

To the authors' knowledge, only seven cases of visceral artery debranching for retroperitoneal masses have been described in the literature (Table 1).^{1,5} The temporary bypass originated from the axillary artery in all cases and perfused a mean of 2.3 arteries (range one to four arteries). In all cases, the aorta, as well as the proximal part of the visceral arteries, were resected. PET was the material used in all cases. Despite the long operating time (mean 8.8 hours; range 5.1–13.2 hours) and the associated colectomy, no post-operative graft infection has been reported. Mean patient follow up was 52 months (range 23–84 months) and no vascular recurrences or lesions were found *in situ*.

CONCLUSION

If *en bloc* resection of retroperitoneal tumour masses is the cornerstone in oncological surgery, it can be very challenging when the abdominal vessels are involved. Temporary extra-anatomic bypass originating from the axillary artery could be considered as an option to perfuse

the visceral arteries during major oncological procedures involving the abdominal vessels.

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