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HOW I DO IT

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Complete and partial replacement of the inferior vena cava with autologous peritoneum in cancer surgery

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Abstract

Resection of the inferior vena cava may be required in the courses of oncological surgeries for the tumors originating from or invading it. Management of the remaining defect depends on the extension of the resection. Partial or complete replacement of the inferior vena cava, with a patch or interposition graft, may be required. Standard techniques for the reconstruction with a prosthetic material or the autologous veins can be associated with the prosthetic graft infection, high cost, long-standing anticoagulation, technical difficulties, and/or need for extra incisions. The use of the autologous peritoneum represents an easy and inexpensive alternative for the partial and complete inferior vena cava reconstructions.

KEYWORDS

inferior vena cava, peritoneum, reconstructive surgical procedures, vascular neoplasms, vascular surgical procedures

1 | INTRODUCTION

Curative surgery for leiomyosarcoma of the inferior vena cava (IVC) often requires segmental resection of this vessel.[1,2] Based on the tumor extension, the management of the remaining defect in the IVC varies. Lateral partial resection of the IVC can be followed by a primary repair or replacement with a patch-shaped graft (to prevent venous narrowing). Resection of a complete segment of the IVC can be followed by a direct end-to-end anastomosis or replacement of the resected segment with a tubular graft. Complete or partial replacement of the IVC can be challenging. Synthetic grafts have certain drawbacks including the high risk of thrombosis (requiring long-term anticoagulation), especially when associated with the digestive tract resection (requiring graft removal or long-term antibiotic therapy), and high cost. Biological grafts such as bovine pericardium, or cryopreserved venous allografts may reduce the need for anticoagulation, and the infection risk, however, availability is often limited, and the cost remains an issue. Autologous biological venous grafts (such as the jugular, renal, iliac, or saphenous veins) require additional abdominal dissection (the renal or iliac veins) or incisions (the neck or leg). The use of autologous peritoneum has been reported as a venous substitute, with some advantages such as low thrombogenic risk, prompt availability, low cost, and wide versatility. The technical aspects of autologous peritoneum harvesting, venous patching, and complete tubular venous graft for the IVC reconstruction are described herein.

The study was previously approved by the institutional ethics committee and registered online (www.plataformabrasil.com; CAAE: 19718819.6.0000.5343).

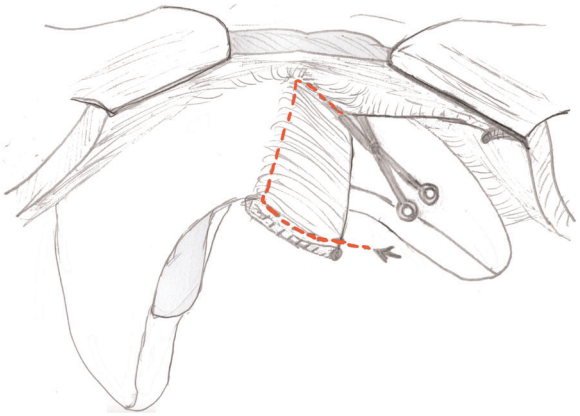

FIGURE 1 Autologous non-fascial parietal peritoneum harvesting from the falciform ligament. Both sides of the graft have mesothelium and can be positioned as the inner side of the reconstructed vessel

FIGURE 2 The intraoperative aspect of harvesting the autologous fascial parietal peritoneum from the left anterior abdominal wall

2 | TECHNIQUE

2.1 | Peritoneal substitute harvesting

The choice of the parietal peritoneum for the IVC replacement differed according to the type of reconstruction. The falciform ligament peritoneum was preferred for venous patches, while the peritoneo-fascial graft from the anterior abdominal wall was favored for tubular venous grafts.

Harvesting of the falciform ligament peritoneum was initiated by sectioning of the round ligament close to the anterior abdominal wall. Thereafter, the falciform ligament was sectioned close to the round ligament, and the liver parenchyma to the triangular ligaments. The falciform ligament was later sectioned close to the anterior abdominal wall, and diaphragm to join the previous line of resection (Figure 1).

Harvesting of the peritoneo-fascial graft was performed including the parietal peritoneum with the posterior rectus sheath (Figure 2). The peritoneo-fascial segment procurement started with a section near the midline and progresses with sharp and blunt dissections laterally. The extension of the dissection depended on the IVC segment to be replaced.

Peritoneal harvesting should be performed without diathermic tools to avoid thermal injury to the graft. Also, excessive traction should be avoided. Once harvested, the graft was immediately placed in an isotonic saline solution. For reconstruction, the peritoneal surface would be used for the intraluminal side.

2.2 | Complete IVC reconstruction

The tubular graft for a segmental IVC reconstruction should be manufactured before the venous resection to minimize the vascular clamping time. The tubular graft was created by wrapping the peritoneo-fascial flap around a cylinder (the anal dilator or syringe) to match the diameter of the IVC (Figure 3A). A continuous 5–0 polypropylene suture was used to assemble the graft with the expected length to be replaced. Additional interrupted stitches were placed in case a longer graft was needed. A continuous suture longer than the expected length should not be done as the suture line would be sectioned while fitting the graft; otherwise, the construction of the conduit could be performed with a mechanical stapler.

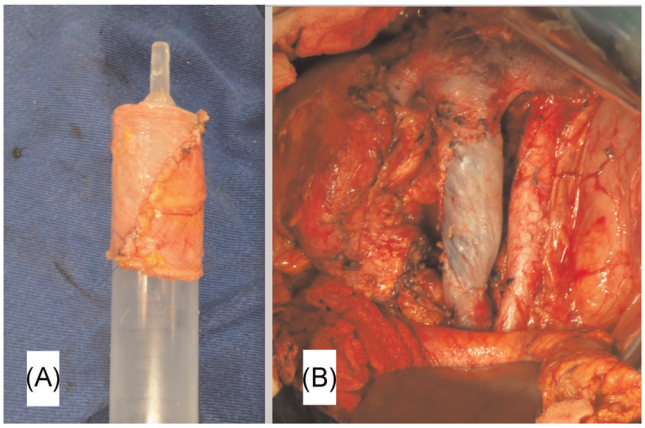

FIGURE 3 Intraoperative customization of an autologous parietal peritoneal tubular graft for the inferior vena cava replacement after segmental resection of a primary sarcoma (A) and final aspect after reconstruction of the infrarenal inferior vena cava (B)

Immediately before the vascular clamping for the IVC resection, the patient was fully anticoagulated with unfractionated heparin (activated partial thromboplastin time [aPTT] two times control). Anastomosis between the tubular graft and native IVC was performed in a standard fashion (Figure 3B). The suture line used to create the tubular graft was placed anteriorly to facilitate the identification of leakage following revascularization. The distal clamp was removed first to fill the graft with blood avoiding any air embolism

and allowing the identification of all possible clots. After removal of the clamps, protamine was used for the reversal of anticoagulation. Subcutaneous administration of unfractionated heparin at a dose of 5000 U t.i.d. was continued postoperatively, until hospital discharge. Anticoagulants were not routinely used following hospital discharge. The patency of the graft was documented at regular follow-up imaging exams.

2.3 | Partial IVC reconstruction

Most partial IVC reconstructions were performed with a flap of the peritoneum from the falciform ligament. In this case, both sides were peritoneal surfaces and could be used in the inner side. Similar to segmental resection, the patient was fully anticoagulated with unfractionated heparin (aPTT two times control), immediately before the vascular clamping for the IVC resection. The flap was initially placed using stay stitches on extremities of the IVC defect followed by continuous 5–0 polypropylene sutures. Usually, the most posterior suture line was first performed. Subsequently, the flap was progressively shaped to cover the venous defect by resecting the excessive peritoneal tissue. (Figure 4). Following removal of the clamps, protamine was used for reversal of anticoagulation. Subcutaneous administration of unfractionated heparin at a dose of 5000 U t.i.d. was continued postoperatively, until hospital discharge. Anticoagulants were not routinely used following the hospital discharge. The patency of the graft was documented at regular follow-up imaging exams (Figure 4).

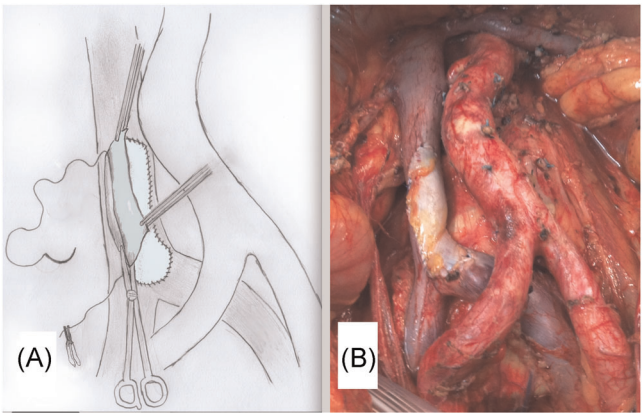

FIGURE 4 Partial inferior vena cava reconstruction using an autologous non-fascial parietal peritoneum graft. (A) Schematic representation showing the possibility of adjusting the repair size. (B) Final aspect after venous reconstruction following inferior vena cava and colonic resections

3 | DISCUSSION

Resection of the IVC has been increasingly reported as a reliable, safe, and valuable procedure for the surgical treatment of tumors that originate from or invade the IVC.[1,2] Surgery with curative intent is possible whenever a complete resection can be achieved. Reconstruction of the IVC is preferable, if technically feasible.

Reconstruction after partial or segmental IVC resection can be challenging. Following lateral resection, a venoplasty (or even a circumferential reconstruction if resection is >75%) may be required if the primary repair narrows the lumen to over 50%. Moreover, following segmental resection, it is rarely possible to accomplish an end-to-end primary anastomosis, and an interposition graft is needed. The usual venous grafts include prosthetic material (commonly, polytetrafluoroethylene [PTFE]), biological grafts (such as cryopreserved venous allograft or bovine pericardium), or autologous veins (such as renal, iliac, saphenous, or jugular veins). Prosthetic grafts are associated with a risk of graft infection (requiring long-term antibiotic therapy and occasionally graft removal), usually requiring long-term anticoagulation, and are expensive. Non-autologous biological grafts are often not available and are also expensive. Autologous veins usually require additional incisions or visceral dissection, and longer operative times. Thus, reconstruction of IVC with autologous peritoneum represents an attractive alternative, as the parietal peritoneum is readily available, easy to customize, and requires no long-term anticoagulant or antiplatelet drugs. Its endothelialization process seems to be more effective than that observed in autologous veins or PTFE.[3,4] Additionally, this technique may reduce the graft infection risk and is of low cost.

The use of the peritoneum as a vascular patch was described by Alexis Carrell[5]; however, the first reported series of patients using peritoneum patch for venous reconstruction was published in 1999.[6] The authors proposed the use of autogenous peritoneo-fascial graft as an alternative for reconstruction after the partial resection of the IVC during extended hepatic resections in six patients. Later, the same group reported a larger series of 32 patients who underwent IVC resections and reconstructions with biological grafts and included 22 patients with autogenous peritoneo-fascial grafts for the IVC reconstruction with similar results.[7] The autogenous parietal peritoneum has also been used as a repair for other abdominal veins, such as the hepatic and portal veins. For these vessels, the use of autologous non-fascial parietal peritoneum, harvested from different sites including the diaphragm, hypochondrium, falciform ligament, and prerenal area was preferred.[8] This technique of the peritoneal patch without the backing by the posterior rectus sheath seems to be more easily applicable to smaller vessels. More recently, the autologous non-fascial parietal peritoneum has also been applied for IVC reconstruction, even for tubular repair after the resection of a complete vein segment.[9]

Harvesting of the parietal peritoneum graft is a simple technique with minimal risk of complications. We have used the autologous peritoneo-facial graft (backed by posterior rectus sheath) to replace the IVC in one case and as a tubular repair to replace the portal vein in another patient. After this initial experience, we preferably used the falciform ligament (both partial patches and tubular grafts) for portal vein reconstructions, as it was relatively

easy to handle. Segmental IVC reconstruction with the tubular repair could be done either with the backed (peritoneo-fascial) or non-backed (non-fascial) parietal peritoneum graft, the former being our preference.

Despite the lack of large series with long-term results and the heterogeneity of the reported cases, current evidence suggested that the use of peritoneum represented a safe and versatile alternative for venous repair.

4 | CONCLUSION

Autologous peritoneum, backed or non-backed by the posterior rectus sheath, represented a simple and inexpensive alternative for complete or partial IVC reconstruction. This technique avoided the use of prosthetic material and more laborious procedures for harvesting autologous venous substitutes. Concerns such as the prosthetic graft infection, need for continuous anticoagulation and technical difficulties might further be prevented while using peritoneal grafts.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

1. Blair AB, Reames BN, Singh J, et al. Resection of retroperitoneal sarcoma en-bloc with inferior vena cava: 20 year outcomes of a single institution. *J Surg Oncol*. 2018;118:127-137.
2. Ruiz CS, Kalbaugh CA, Browder SE, et al. Operative strategies for inferior vena cava repair in oncologic surgery. *J Vasc Surg Venous Lymphat Disord*. 2020;8:396-404.
3. Akimaru K, Onda M, Tajiri T, et al. Reconstruction of the vena cava with the peritoneum. *Am J Surg*. 2000;179:289-293.
4. Yoshioka M, Onda M, Tajiri T, et al. Reconstruction of the portal vein using a peritoneal patch-graft. *Am J Surg*. 2001;181:247-250.
5. Carrel A. Peritoneal patching of the aorta. *J Exp Med*. 1910;12:139-145.
6. Chin PT, Gallagher PJ, Stephen MS. Inferior vena caval resection with autogenous peritoneo-fascial patch graft caval repair: a new technique. *Aust N Z J Surg*. 1999;69:391-392.
7. Pulitanó C, Crawford M, Ho P, et al. The use of biological grafts for reconstruction of the inferior vena cava is a safe and valid alternative: results in 32 patients in a single institution. *HPB (Oxford)*. 2013;15:628-632.
8. Dokmak S, Aussilhou B, Sauvanet A, Nagarajan G, Farges O, Belghiti J. Parietal peritoneum as an autologous substitute for venous reconstruction in hepatopancreatobiliary surgery. *Ann Surg*. 2015;262:366-371.
9. Coubeau L, Rico Juri JM, Ciccarelli O, Jabbour N, Lerut J. The use of autologous peritoneum for complete caval replacement following resection of major intra-abdominal malignancies. *World J Surg*. 2017;41:1005-1011.

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