SCIENTIFIC LETTER

SURGICAL RESECTION OF INFERIOR VENA CAVA LEIOMYOSARCOMA: A MULTIDISCIPLINARY APPROACH AND THERAPEUTIC INSIGHTS

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ABSTRACT

Leiomyosarcomas (LMS) are rare tumors originating in smooth muscle cells, constituting 5-7% of soft tissue sarcomas. They primarily affect the inferior vena cava (IVC) and have a grim prognosis. Standard treatment is complete surgical resection (R0), which varies by tumor location.

We present a female patient with IVC LMS in zone II who underwent complete en bloc tumor resection without any posterior reconstruction. No complications were notified.

Complete R0 surgical resection, involving tumor mass and right kidney en bloc removal, with left renal vein ligation without reconstruction, is safe in cases with sufficient collateral venous drainage, avoiding graft reconstruction complications.

Keywords: *leiomyosarcoma, inferior vena cava, resection, cardiovascular surgery.*

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INTRODUCTION

Leiomyosarcomas (LMS) are mesenchymal tumors originating from smooth muscle cells, representing 5-7% of all soft tissue sarcomas. A mere 2% of cases involve large-caliber vessels emerging from the intimal layer of the vascular wall. The inferior cava vein (IVC) is the most commonly affected vessel (60%), followed in frequency by the renal veins, great saphenous vein, pulmonary veins, and femoral veins[1-3].

Their initial description dates to 1871 by Perl[4]. To this day, fewer than 450 cases have been documented in literature2. Given their low frequency - comprising <1/100,000 of adult malignant neoplasms and about 0.5% of adult soft tissue sarcomas[2,5] - this neoplasm represents an exceedingly rare condition associated with an unfavorable prognosis, with an overall survival rate after 5 years of complete surgical resection, that goes from 51,9% to 55%, depending on the series[6,7].

It predominantly manifests in women (3:1 ratio), typically in the 5th to 6th decades of life. The most common presentation is either asymptomatic or non-specific (abdominal pain, palpable mass, weight loss, nausea, and vomiting). However, depending on the affected IVC segment and tumor growth pattern, presentations may include symptoms linked to IVC obstruction (Budd-Chiari syndrome, nephrotic syndrome, renal failure, or lower limb edema)[2].

An anatomical classification by Kieffer et al.[8] is founded on tumor location relative to the suprahepatic veins, renal veins, and IVC bifurcation. According to its frequency of appearance, 36% lie below the renal veins (zone I), 44% between the renal and suprahepatic veins (zone II), and 20% between the suprahepatic veins and the right atrium (zone III)[9,10] (*Figure 1*).

The gold standard for treating IVC LMS, associated with improved survival rates, is complete surgical resection (R0) with clear margins. This presents a notable challenge because many patients presenting with locally advanced disease will need extensive en bloc resections for oncological success. Hematogenous dissemination, particularly to the liver, lungs, aorta, and bones, is the most frequent distant spread[7,10].

This study aims to detail the multidisciplinary management of a case while reviewing contemporary therapeutic strategies.

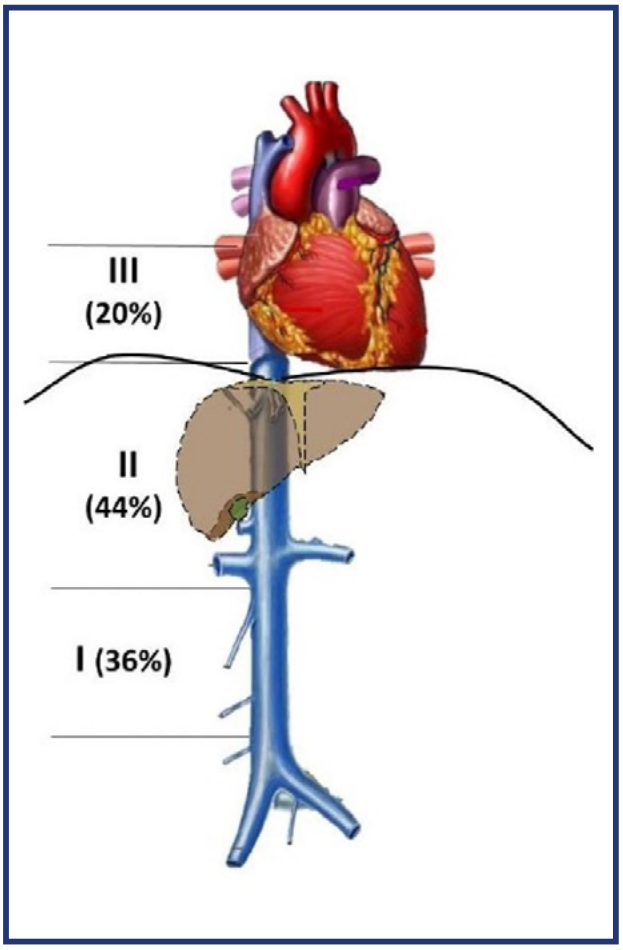

FIGURE 1. Anatomical classification and frequency of appearence of inferior cava vein leiomyosarcomas.

CASE PRESENTATION

Clinical Case

We present the case of a 42-year-old woman with an unremarkable medical history. At the annual gynecological check-up, she expressed inespecific abdominal discomfort.

An abdominal ultrasound was performed, resulting in an incidental finding of thrombosis/tumor in the inferior vena cava.

Several studies were done to classify the lesion. Initial assessments involved abdominal and pelvic angiotomography and nuclear magnetic resonance, revealing a heterogeneous lesion in the retrohepatic segment of the IVC, measuring 46.7 mm. This lesion affected the drainage of both renal veins and was accompanied by extensive collateral circulation and spleno-renal shunt. Additionally, it displaced the portal vein anteriorly and was associated with thrombosis in the distal IVC segment (*Figures 2 A-D*).

The cardiovascular, urology, and hepatobiliary surgery teams examined the case, and they jointly decided to perform surgical intervention without neoadjuvant therapy.

Surgical Approach

To access the abdominal cavity, a median supra and infraumbilical laparotomy was used with a right

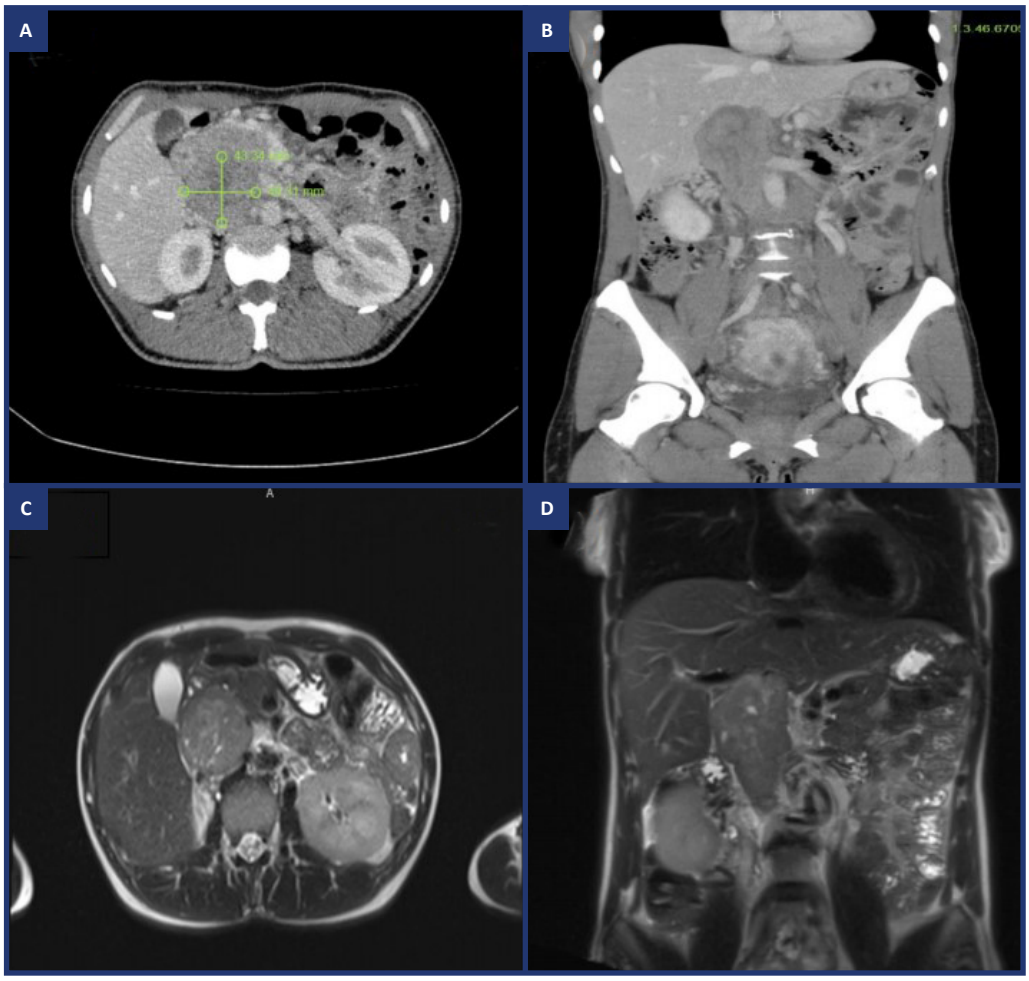

FIGURE 2. A and B. Computed tomography with intravenous contrast. **A.** Axial slide. **B.** Coronal slide. **C and D.** Magnetic resonance cholangiopancreatography. **C.** Axial slide. **D.** Coronal slide.

paramedian transverse extension and concentric exploration, unveiling no signs of carcinomatosis.

Visceral mobilization maneuvers were undertaken to expose the retroperitoneum and the inferior vena cava. A Cattell-Braasch maneuver facilitated lateral detachment and medial mobilization of the right colon, followed by a careful release of the duodenum-pancreas complex, revealing an infrahepatic vena cava tumor mass (zone II) with firm adhesions to the second portion of the duodenum. Hepatic mobilization was executed using the piggy-back technique. Vascular control of the venous drainage of the Spigelian lobe was achieved. The liver was prepared for potential total hepatic vascular exclusion through repair of the suprahepatic veins and the hepatic pedicle for a possible Pringle maneuver.

Following complete visceral mobilization, the retroperitoneum was exposed, revealing the IVC tumor affecting zones I and II. The IVC was sectioned over healthy tissue, confirmed by intraoperative transesophageal ultrasound, immediately below the junction of the suprahepatic veins, using a linear surgical stapler.

Subsequent detachment of the tumor towards the caudal direction led to the right renal hilum, where a close relationship between the tumor mass and the kidney was observed laterally, along with abutment with the aorta medially. En-bloc resection was chosen, accompanied by vascular control of the hilum and the ureter through ligation. A distinct cleavage plane was identified between the tumor and the aorta, thus avoiding significant vascular resection (*Figure 3*).

After clamp control, a cavotomy was performed at the bifurcation level, enabling thrombus extraction. The distal section of the surgical piece was executed at the iliac bifurcation level, facilitating complete extraction. Finally, the IVC was closed with two running sutures.

A team of cardiovascular, urological, and hepatobiliary surgeons performed the surgery, which ended without major complications. The operation lasted 378 minutes; there was non-significant blood loss, and no blood or derivatives transfusions were required.

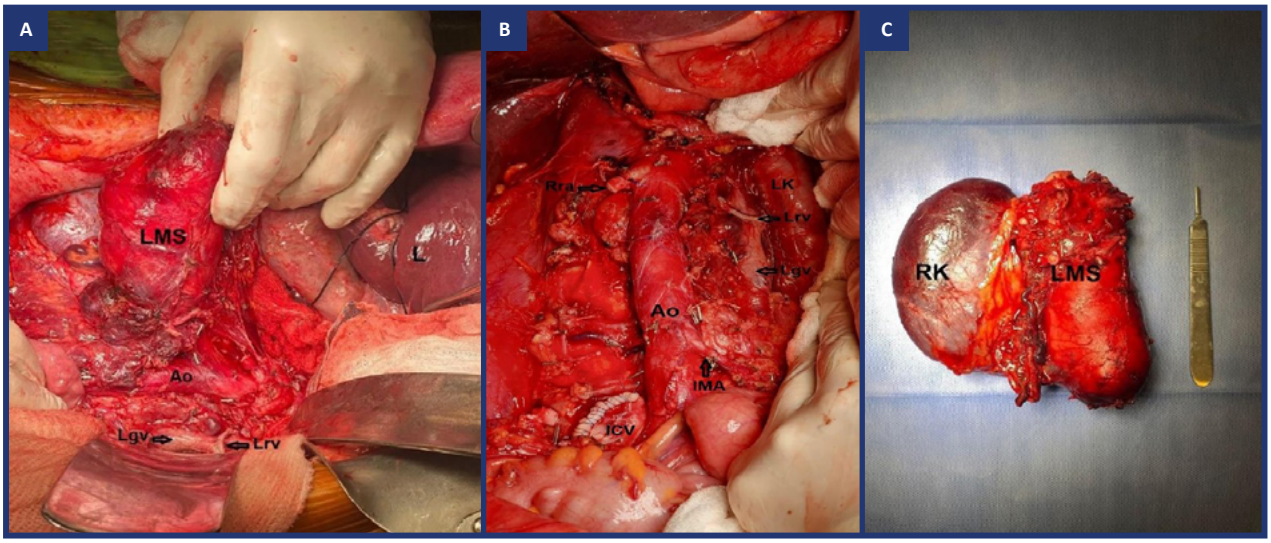

FIGURE 3. A. Tumor resection. **B.** Urgical resection site. **C.** En bloc tumor piece. (LMS: Leiomyosarcoma, L: Liver, RK: right kidney, LK: left kidney, Ao: Aorta artery, Rra: right renal artery, IMA: inferior mesenteric artery, ICV: inferior vena cava, Lrv: left renal vein, Lgv: left gonadal vein). Observe the adequate collateral venous drainage through the left gonadal vein, which allowed the simple resection without posterior reconstruction.

Postoperative management and follow-up observations

The patient remained in the cardiac intensive care unit for 8 days, showing favorable progress and suitable management of surgery-related decompensation. As per the Dindo-Clavien classification[11], Grade II complications were observed, namely, manageable pain during the initial 3 postoperative days, effectively controlled with opioid analgesics, and minor lower limb edema, resolved through diuretics and active limb mobilization. No grade III or IV complications appeared.

Subsequent pathological analysis of the surgical specimen indicated a G3 leiomyosarcoma of the FNCLCC (French Fédération Nationale des Centres de Lutte Contre le Cancer), featuring free surgical margins (pT2 pN0 according to the pTNM AJCC 8th Edition).

After the hospital discharge, the patient was evaluated once on the tenth day and one month after the surgery. The postoperative recommendations to prevent edema and deep vein thrombosis in the lower limbs were active mobilization, compression stockings, and 50 mg/day of spironolactone (which was discontinued after the first postoperative check-up), and indeed, none of these complications occurred. No renal failure was recorded. No adjuvant therapy was performed; instead, strict oncological monitoring every 3 months was decided, assessing potential recurrences.

DISCUSSION

The management of IVC LMS historically presented significant challenges for medical teams. Nowadays, it still represents a complex disease since no proper statistical information is needed to formulate standardized guidelines to deal with this entity. Advances in surgical techniques and postoperative monitoring technologies led to the first documented resection at the Lexington Memorial Hospital in Chicago in 19511[2]. Up to these days, complete R0 surgical resection with clear margins remains the gold standard for treating this condition. Reported survival rates stand at 55% at 5 years, with disease-free survival at 1 year and 5 years ranging from 57% to 6%-31%, respectively, depending on the series[6,7]. Nonetheless, due to the rarity of this disease, standardized guidelines for surgical intervention have yet to be established. Most available information comes from case series rather than randomized prospective studies. The challenge for those who confront this pathology lies in combining oncologic resection with venous return preservation. The surgical approach depends on three primary factors: the tumor's location (zones I, II, or III), the extent of IVC involvement, and the presence of established collateral circulation, determining the need for reconstruction or simple resection and ligation[9]. Consequently, surgical treatment must be personalized for each case (*Figure 4*).

For tumors in zone I, resection and ligation of both ends are preferred, obviating the necessity for reconstruction. Cases where the tumor doesn't compromise IVC bifurcation into the iliac veins demonstrate that venous return from the lower limbs is maintained through preexisting anastomoses between the internal iliac vein and pelvic venous plexuses. Kalchev et al.[13] detailed four potential pathways for lower limb venous return, involving the deep system

(lumbar veins - azygos venous system), intermediate system (internal/external iliac veins - prostatic/uterine venous plexuses - ovarian/pampiniform plexuses - left gonadal vein - renal vein), superficial system (external iliac vein - superficial epigastric vein - internal mammary vein), and portal system (internal iliac vein - rectal veins - splanchnic circulation).

Jiang et al.[14] proposed three principles for simple IVC ligation post-resection: 1) disease duration >1 year, enabling collateral development, 2) over 75% affected IVC circumference, and 3)) preoperative injection of 20 mg furosemide followed by 100 ml urination within 30 minutes after temporary IVC block.

In cases of iliac bifurcation involvement, resection alone does not guarantee venous return, necessitating reconstruction via termino-terminal anastomosis or graft interposition as dictated by the situation.

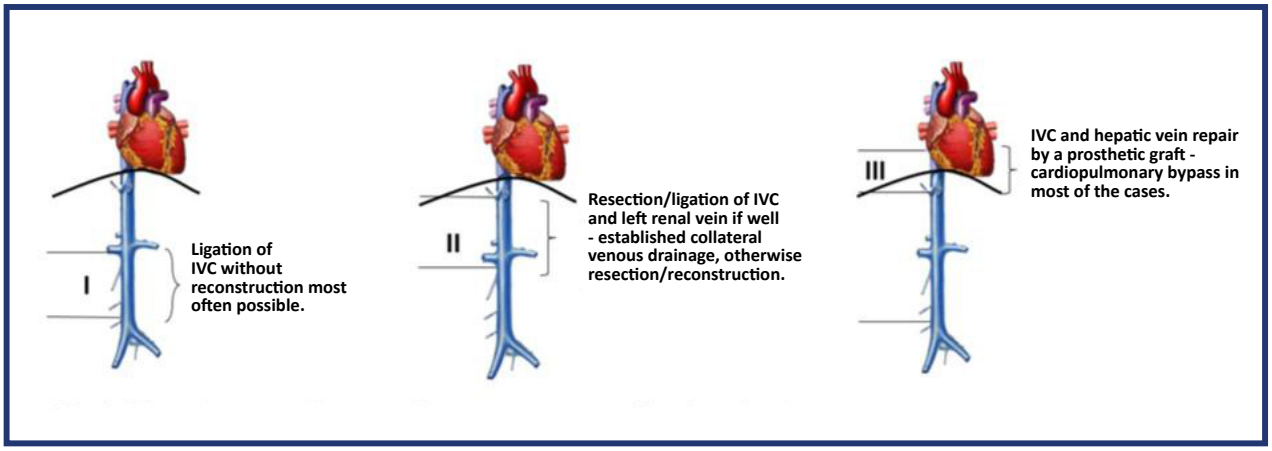

FIGURE 4. Affected areas and proposed surgical treatment. Zone I uusually has a proper venous drainage, so resection and ligation of the inferior vena cava (IVC) is the most common treatment. Reconstruction is mandatory in cases where the bifurcation is compromised. Tumors located in zone II can be resected without posterior reconstruction in cases where left gonadal and lumbar veins are free, ensuring correct venous drainage of the left kidney. Zone III demands major surgery, with IVS and hepatic vein reconstruction of cardiopulmonary bypass in most cases.

For zone II lesions, the critical point resides at the confluence of the renal veins. In cases where the right renal vein is affected, en bloc resection of the right kidney and ligation of the left renal vein is safe and avoids graft reconstruction complications. This approach is underpinned by the argument that mere ligation of the right renal vein does not ensure adequate oncological outcomes. It can lead to venous congestion and homolateral kidney failure due to its narrow trajectory. In contrast, the longer trajectory of the left renal vein incorporates various collateral veins, allowing homolateral kidney venous drainage. This enables ligation, as long as tumor involvement does not encompass the gonadal or lumbar veins, or primary venous tributaries (*Figure 5*)[9,15].

When resection extends beyond the gonadal vein, vascular reconstruction is essential via prosthesis interposition and subsequent end-to-side venous reimplantation or renal autotransplantation. Nevertheless, surgical resection without subsequent reconstruction is associated with complications related to venous obstruction and blood stasis, such as lymphedema or deep vein thrombosis (DVT). In a series of 25 treated patients with IVC resection, Mahesh Goel et al. experienced lower limb edema in one patient, and two had DVT (none of these patients showed functional impairment during the 3-month follow-up).

In another study on inferior vena cava (IVC) ligation and renal cell carcinoma, Lilian Xie et al. found that 19% of their patients developed lymphedema, all of which was resolved before 6 months, and 7% experienced lower limb thrombosis with no recorded pulmonary embolism. Therefore, lymphedema is an expected but transient complication (typically resolving within 6 months postoperatively) and is well tolerated by patients, resolving with compressive measures. Bland thrombus reformation is expected in all patients after ligation due to decreased flow and altered hemodynamic state of the IVC. Therefore, only patients with symptoms such as unilateral lower extremity redness, swelling, and pain warrant diagnosis and therapy.

Lastly, zone III involvement is the most technically demanding, necessitating a multidisciplinary team of cardiovascular, liver, and biliary tract surgeons. Cardiopulmonary bypass is often required, with resection of the retrohepatic vena cava potentially

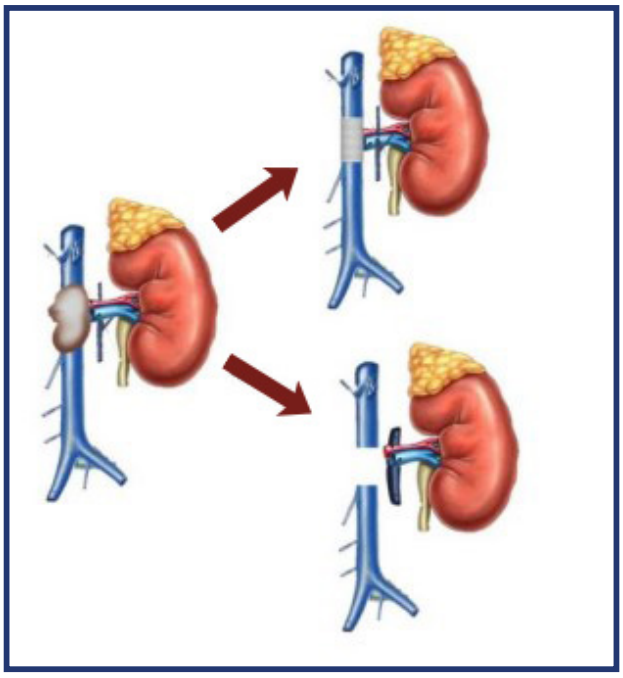

FIGURE 5. En bloc resection. The different options of zone II treatment range from only resection and ligation of IVC to reconstruction with a prosthetic graft, depending on venous return and tumor extension.

accompanied by hepatectomy if the adjacent liver is infiltrated. Complex techniques like ex-vivo and ex-situ hepatic auto-transplantation are rarely needed[16]. In this surgery, hepatic venous drainage is crucial, thus necessitating the use of prostheses followed by suprahepatic vein reimplantation.

When reconstruction is mandatory, regardless of the affected zone, various graft types have been employed, including synthetic grafts (polytetrafluoroethylene [PTFE] or Dacron), autologous graft (saphenous vein or peritoneum), and xenografts (bovine pericardium). Wachtel et al.[7] reported the largest meta-analysis with resection of the IVC for LMC, with a list of 377-patient series from diverse studies, describing 155 patients (49.2%) reconstructed with PTFE prostheses. In another multicentric analysis involving a total of 92 patients, Noorowid et al.[17] in their attempt to determine the most effective method for inferior vena cava reconstruction after a major resection due to LMS, concluded that the use of PTFE prostheses provides more excellent long-term patency compared to non-PTFE prostheses, with a permeability rate at 1-, 3- and 5- years of 97%, 92%, and 92%, respectively. This concludes that PTFE prostheses are the most widely used and recommended due to their heightened resistance to intra-abdominal compression, a key determinant of graft thrombosis. However, graft reconstruction patients are not exempt from complications such as infection, thrombosis, and those linked to chronic anticoagulation.

In cases in which the tumor is predominantly extraluminal and comprises less than one third of the circumference of the vessel, a feasible but less safe alternative, in oncological terms, is partial resection of the vessel followed by primary closure or patch angioplasty (depending on the defect size) with synthetic graft, autologous graft or xenograft. Circumferential resection of the IVC compared to this technique provides better vascular margins and, therefore, less risk of local recurrence[9,18,19].

Given the rarity of this pathology, the role of neoadjuvant and adjuvant therapy remains unclear, with no established treatment regimens. Neoadjuvant chemoradiotherapy is indicated in borderline tumors (touching a 180° circumference around the aorta) to diminish tumor size, ease dissection and resection, and avoid extensive surgeries. Adjuvant therapy is confined to patients with R1 resections or those with unfavorable prognostic factors (zone III tumors, intraluminal tumor growth, and distant disease)[2,6,7].

CONCLUSION

Leiomyosarcoma of the inferior vena cava represents a rare, highly aggressive, and grimly prognostic entity. Its management requires a multidisciplinary team operating within a tertiary healthcare institution equipped for diagnosis, treatment, and recuperation. Surgical resection of the lesion is the treatment of choice, demonstrating survival improvement. It must be customized to the clinical presentation, with resection and ligation favored in zones I and II and prosthetic reconstruction employed in segment III cases.

The complete R0 surgical resection involving en bloc resection of the tumor mass and right kidney, coupled with ligation of the left renal vein without reconstruction, is possible and secure in cases where there is adequate collateral venous drainage, therefore avoiding graft reconstruction-related complication.

Declarations

The authors declare no conflict of interest.

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