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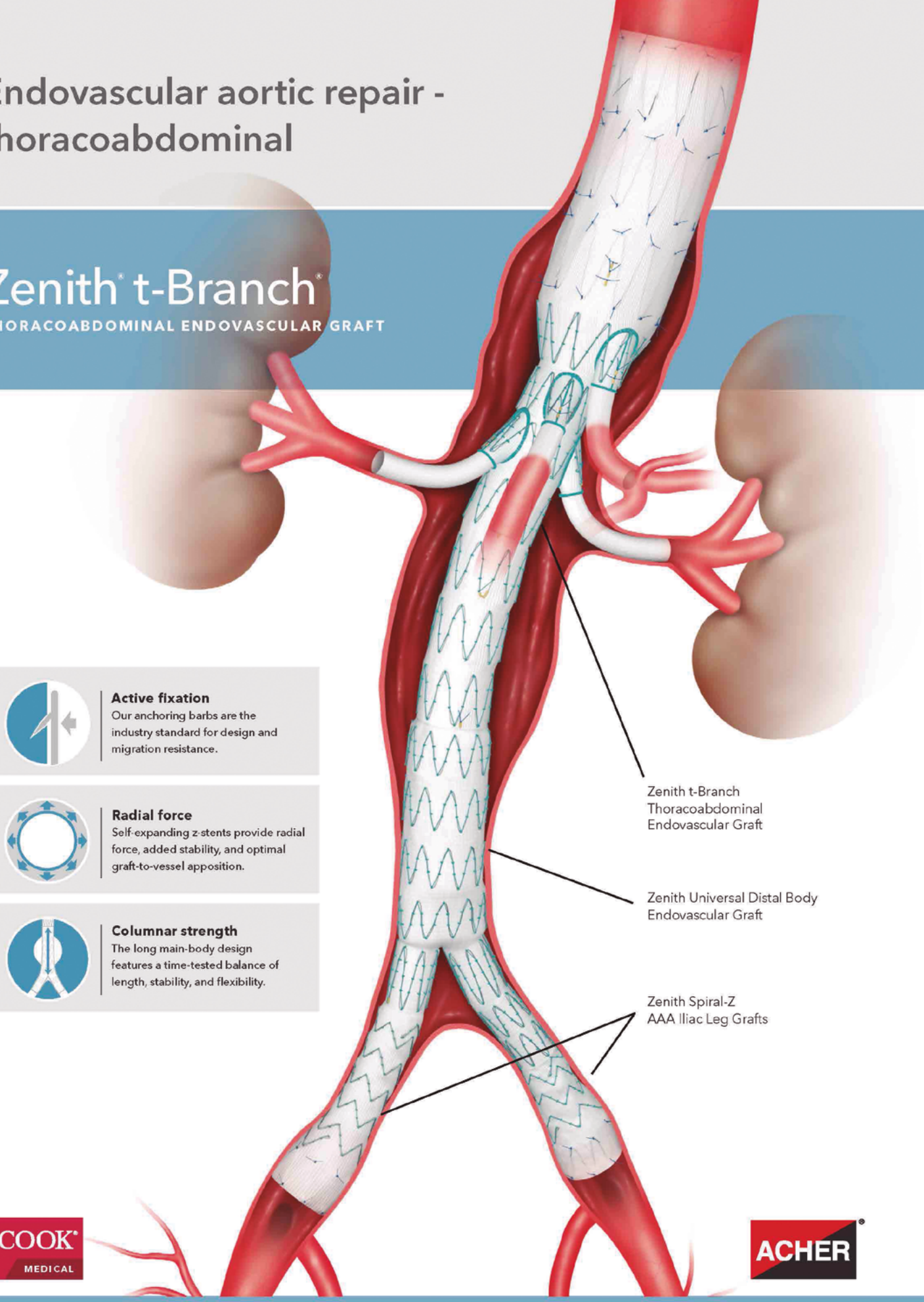

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SUMMARY

ORIGINAL ARTICLE

AMPUTATION PREVENTION: EXPERIENCE IN BYPASS SURGERY

ABSTRACT

Introduction: The development of chronic peripheral arteriopathy in the infrapatellar axis is closely related to diabetes. The disease's most advanced stages are a frequent reason for consultation and hospitalization, generally due to unhealed lesions of long evolution. In many cases, the need to revascularize the axis is crucial to prevent its progression and improve its evolution. Failure to act in the resolution may lead to the compromise of the limb up to its loss.

Objective: To disseminate a surgical team's experience using infrapatellar bypass as a valuable resource in preventing amputations due to ischemia.

Material and methods: A retrospective study of 87 infrapatellar revascularizations by the same surgical team from April 2023 to June 2024, with venous bypass as the revascularization method.

Results: The most frequent complication after the procedure was wound dehiscence (28%); major amputation was observed in approximately 6%. Of the sample, 89 % (78 patients) maintained the bypass permeable at 3 months. Of the remaining patients, 5 underwent amputation, and 4 had thrombosis within the first 10 days.

Conclusion: Infrapatellar bypass has proven to be an effective revascularization option. It can improve the quality of life and survival rate by avoiding serious complications associated with ischemia.

Keywords: *infrapatellar bypass, revascularization, diabetes.*

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INTRODUCTION

The current prevalence of chronic peripheral atheropathy worldwide is unknown, although it is estimated to affect more than 200 million people[1]. In the more advanced stages of the disease, there may be severe involvement of the lower limbs, which may lead to amputation[2]. Limb revascularization attempts to limit the progression of the disease and prevent its loss.

The number of people with diabetes in the world increased from 108 million in 1980 to 830 million in 2022. The progression of this disease has increased most rapidly in low- and middle-income countries[3]. The prevalence of diabetes mellitus in Argentina is 8% in the adult population, and almost 50% are undiagnosed. Diabetes is a significant cause of blindness, renal failure, myocardial infarction, and stroke[4]. In vascular disease, as it progresses, the marked relationship between diabetes and the alteration in the infrapatellar axis, which is usually observed in arteriography, is frequent (*Figures 1A and 1B*). Moreover, it is the most significant risk factor for non-traumatic lower limb amputation. Approximately 60-70% of patients with lower limb amputation have diabetes. The 5-year mortality rate after lower limb amputation is high and can exceed 50% in patients with comorbidities such as diabetes and peripheral arterial disease[5-7].

The primary goal of bypass is to restore adequate blood flow to the lower extremities compromised by arterial blockages. Improving blood flow results in symptom relief, improves ulcer healing, and reduces the need for amputation in patients with severe ischemia. Venous bypass as a revascularization strategy increases the likelihood of prolonged improvement of the ischemic foot[8,9].

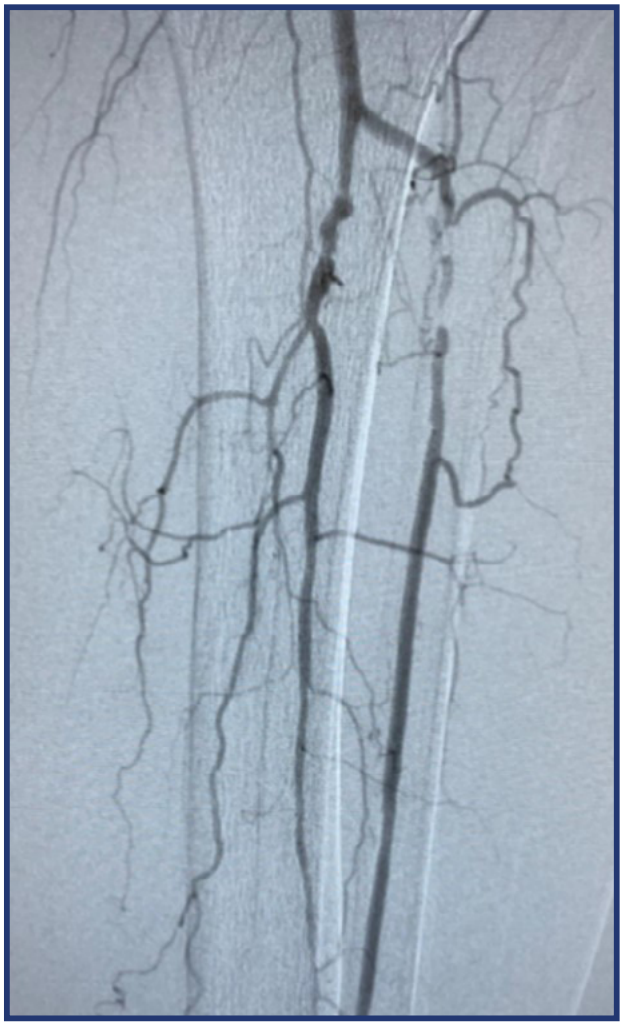

FIGURE 1A. Critical anterior tibial artery lesion with occlusive lesion of the posterior tibial artery.

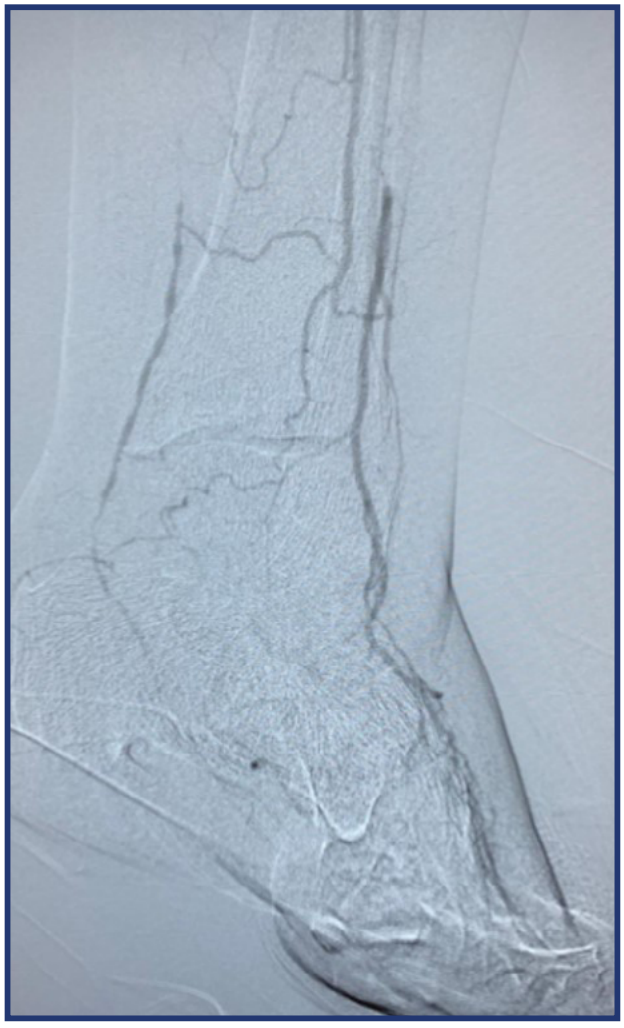

FIGURE 1B. Recanalization of the anterior tibial and posterior tibial arteries by the peroneal artery.

METHODS

Retrospective study of 87 infrapatellar revascularizations by the same surgical team, including 51 popliteal-pedial (*Figures 1C and 1D*) and 36 posterior popliteal-tibial bypasses between April 2023 and June 2024. Internal saphenous vein grafting was used in all. In addition, the study included patients with previous revascularization of the same or contralateral limb or even myocardial revascularization (*Table 1*). More than 88% of the revascularizations were performed in a condition of threatening limb ischemia with the presence of associated trophic and necrotic lesions. The pharmacological strategy in 14 patients requiring endarterectomy included acetylsalicylic acid at 100 mg every 24 h plus enoxaparin at an anticoagulant dose until discharge. After discharge, they continued with oral anticoagulation for 3 months and only with antiplatelet agents.

FIGURE 1C. Distal anastomosis over the pedicle artery.

RESULTS

To evaluate the efficiency of the procedure, we considered the presence of a pulse on the bypass, the improvement of the patient's symptoms and the size of the previous lesions, the lack of need for amputations and surgical cleaning beyond the necrotic tissue existing before the time of revascularization, if present, and Doppler ultrasound three months after the procedure with the presence of flow in the bypass. Among the associated complications, the most frequent was wound dehiscence due to reperfusion edema (approximately 28%), followed by infections (9%). Complications extended the hospitalization period, always longer than 7 days, in all patients. The most serious events (major amputations) occurred in almost 6%. Death was not recorded in the 3 months after surgery. The most frequent risk factor in these patients with chronic infrapatellar peripheral arterial disease was diabetes (93.1%). One hundred percent of the patients (78) evaluated at 3 months by the outpatient clinic maintained a patent bypass. This number of patients had to be adjusted from the initial sample since 4 patients presented thrombosis within the first 10 days and were referred to hemodynamics; in another 5 patients, supracondylar amputation was performed on the revascularized limb. Despite the clinical improvement with the procedure, most patients required some minor amputation and surgical cleaning after revascularization.

DISCUSSION

The worldwide prevalence of chronic peripheral artery disease has shown a significant increase in recent decades, affecting more than 200 million people worldwide. It has a remarkable progression in patients with type 2 diabetes mellitus[1]. In this context, diabetes is one of the most prevalent risk factors for the development of this disease, and the relationship with lower limb amputations is increasingly recognized in medical literature[2]. The 5-year mortality rate after lower limb amputation can exceed 50% in patients with comorbidities such as diabetes and peripheral arterial disease, which underlines the importance of therapeutic interventions to prevent[5-7].

In this retrospective study of 87 infrapatellar revascularizations performed by a single surgical team, the results of the use of popliteal-pedial (51 cases) and posterior popliteal-tibial (36 cases) bypass with internal saphenous vein grafting were evaluated in patients who were mostly in life-threatening critical ischemia of the lower limbs.

FIGURE 1D. Popliteal-pedial bypass.

Characteristics	N (87)	Percentage (%)
Sex		
Male	49	56.33
Female	38	43.67
Age (years)		
50-60	13	14.95
61-70	39	44.83
71-80	29	33.33
81-90	6	6.89
Revascularizaed vessel		
Pedial artery	51	58.62
Posterior tibial artery	36	41.38
Associated endarterectomy		
Yes	14	16.09
Comorbilidities		
Diabetes mellitus	81	93.10
Arterial hypertension	75	86.20
Smoking	15	17.24
Ex-smoker	58	66.66
Complications		
Wound dehiscence	24	27.58
Infection	8	9.19
Thrombosis	4	4.59
Major amputation	5	5.74
Restenosis	2	2.29

TABLE 1. Summary of patient demographic and clinical characteristics.

The choice of venous bypass in all cases reflects its efficacy and long-term durability, and it is widely used due to its favorable hemodynamic properties and easy availability. The literature supports this approach, as venous grafting is a safe and effective option for the revascularization of patients.

The finding that more than 88% of revascularized patients had limb-threatening ischemia with associated trophic or necrotic lesions reinforces the severity of the disease in the population studied. This fact highlights the need for early intervention in these patients to avoid progression to amputations and improve functional prognoses and quality of life. In line with this need, bypass revascularization has proven to be an effective strategy to restore blood flow to the lower extremities, alleviate symptoms, improve ulcer healing, reperfuse the affected territory rapidly, and ultimately reduce the need for amputations. In 2024, a study analyzed 665 revascularized patients; 326 received open tibial bypass, and 339 received tibial endovascular intervention. It was concluded that an adequate single segment of the internal saphenous vein in infrapopliteal revascularization for chronic limb-threatening ischemia: open bypass surgery was associated with a lower incidence of death and fewer major amputations compared with endovascular intervention. Amputation-free survival was similar between groups[8].

CONCLUSION

Revascularization can improve quality of life and survival by avoiding serious complications associated with ischemia. Infrapatellar bypass is an effective and fast-access revascularization option in the need to reverse the last stage of chronic peripheral arterial disease, such as limb-threatening critical ischemia. In our setting, other revascularization methods carry a higher risk of amputation depending on the time and the elements necessary to perform them. Diabetes was present in 93% of the cases and is the most influential factor for the development of infrapatellar pathology.

As a limitation of this study, the follow-up of patients at 6 months was less than 60%, with patent bypass in all of them.

Declarations

The authors declare no conflict of interest.

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SCIENTIFIC LETTER

ABDOMINAL AORTIC SURGERY ASSOCIATED WITH SHAGGY AORTA: A CATASTROPHIC EVENT

Authors
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ABSTRACT
Both open and endovascular surgery of abdominal aortic aneurysm associated with a "shaggy aorta" cause multiple atheromatous embolism phenomena usually associated with high mortality. We present a clinical case of abdominal aortic aneurysm associated with this entity that resulted in early death secondary to multiple atheromatous embolisms affecting the lower extremities, abdominal wall, and severe renal damage requiring emergency dialysis.

Keywords: *Abdominal aortic aneurysm, shaggy aorta.*

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INTRODUCTION

Atheroembolization in open or endovascular abdominal aortic surgery is a well-recognized entity. Spontaneous embolization to visceral and peripheral territories due to diffuse atheromatosis of the thoracic and abdominal aorta is also described. This condition is called shaggy aorta syndrome (hairy aorta). This diffuse chemoembolization is formed by microembolization of cholesterol released from these plaques. It usually reaches the smallest terminal vessels, with thrombosis of this microcirculation[1].

Although the name "shaggy aorta" refers to an irregularly shaped and spiculated aorta, as determined by visual features on computed tomography (CT) angiography, there is still no consensus definition.

We present here a clinical case of multiple atheromatous embolisms in a patient with abdominal aortic aneurysm and involvement of the iliac arteries who underwent open surgery and died early because of this serious complication[2].

CLINICAL CASE

A 64-year-old woman, hypertensive, smoking, and hypothyroid, with a history of claudication of the left leg, was consulted for severe left foot pain associated with toes' ischemia with preserved pulses associated with small purplish plaques on both soles of the foot compatible with atheromatous embolism. Angiotomography reveals the presence of an aortic aneurysm with involvement of the iliac arteries (*Figure 1*) associated with thoracic and abdominal aorta compatible with shaggy aorta (*Figures 2A* and *2B*).

In open surgery, an aortoiliac bypass is performed without complications. During the opening of the aneurysm, soft and friable atheromatous material compromises the proximal aorta and the aneurysmal sac. The area of the proximal anastomosis and the sac are cleaned, this friable material is removed, and the proximal aorta and iliac arteries are purged before closure.

In the immediate postoperative period, some plaques in both thighs were observed, which were compatible with atheromatous embolism. At 24 hours, severe embolic involvement was observed in both thighs and the lower abdominal wall (*Figures 3A* and *3B*). The picture is associated with creatinine levels of more than 3 mg/dl, hyperkalemia of 7 mEq/l, and severe metabolic acidosis. Transient catheter hemodialysis is started; however, she begins to require the use of vasoactive drugs to try to maintain hemodynamics associated with multiorgan failure. The patient died 36 hours later.

COMMENT

Although there are several definitions of shaggy aorta, there is consensus in defining it as a severe arterial degeneration of the aorta, whose surface is highly friable and susceptible to cause atheroembolism. Abdominal aortic aneurysm surgery, whether open or endovascular, associated with a shaggy aorta is a catastrophic event associated with high mortality[3].

This entity represents a severe degeneration of the aortic surface, extremely friable, and likely to cause peripheral and visceral embolization spontaneously or during catheterization, aortic manipulation, surgery, or minimally invasive procedures. It is a microembolization characterized by small particles formed by cholesterol crystals that cause a severe

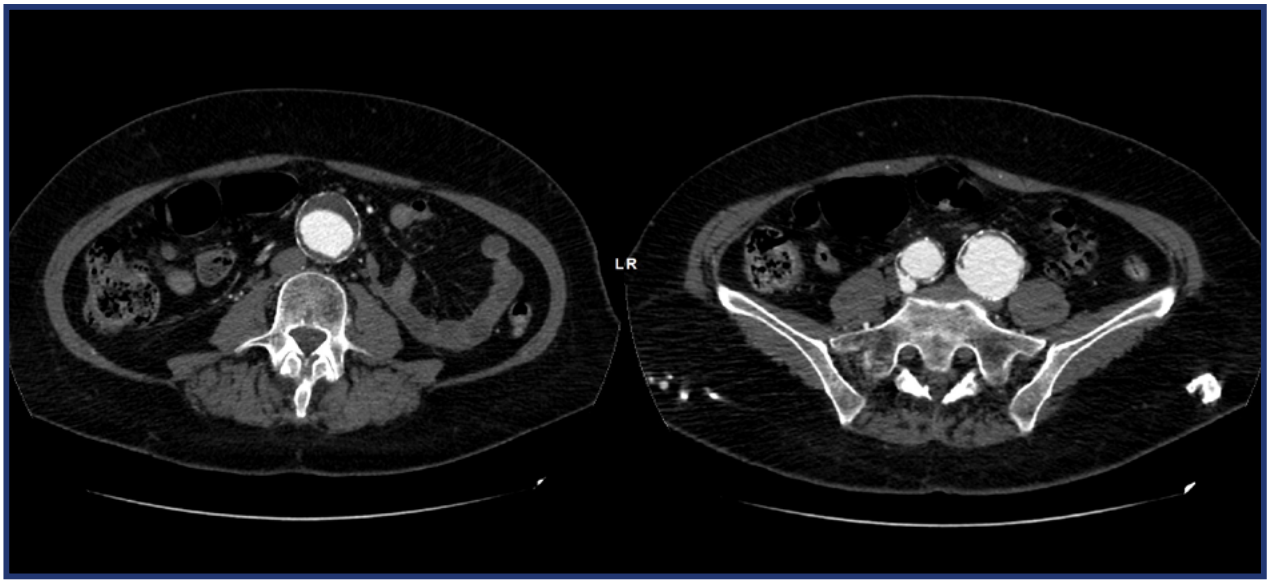

FIGURE 1. Tomographic image showing an abdominal aortic aneurysm involving the iliac arteries.

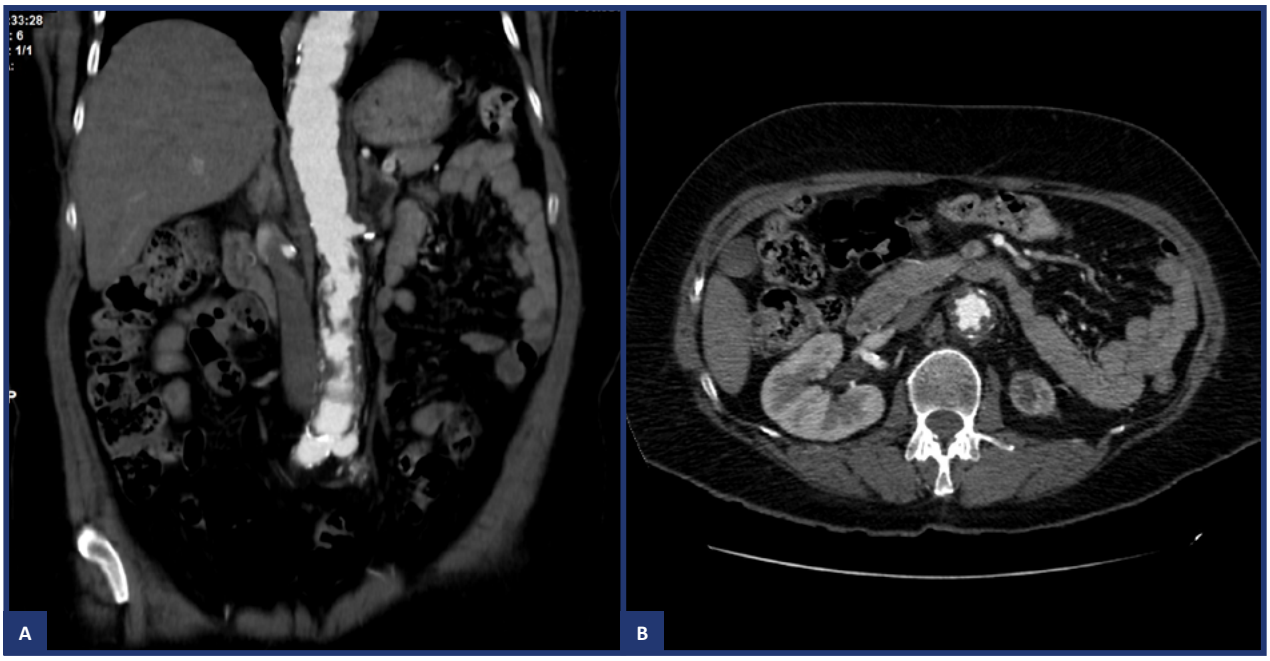

FIGURE 2. A and B. Tomographic image showing a shaggy aorta.

FIGURE 3. A. Preoperative atheromatous embolism. **B.** Severe atheromatous embolism 24 hours after surgery.

alteration of the microcirculation, affecting all territories and, in the case of the abdominal aorta, involves the intestine and kidneys and causes spinal ischemia and lower extremities[4]. In the case of abdominal aortic surgery in any of its modalities, the shaggy artery also presents atheroembolism phenomena[5]. In our case, the patient had already presented atheromatous embolism of both feet in the preoperative period of the aortic aneurysm. Although during surgery, atheromatous material was removed from the proximal aorta before repair and the prosthesis was purged before anastomosis of the iliac arteries, immediately after leaving the operating room, she presented significant atheromatous embolism of both thighs and, 24 hours later, severe deterioration of renal function with severe hyperkalemia, although early dialysis had been started. The patient died 36 hours after surgery. Although medical treatments such as high-dose atorvastatin, anticoagulation, and corticosteroids

are available, their effectiveness has not been proven. The use of a supra celiac intra-aortic filter has also been proposed with some effectiveness[6], as well as early ligation of both iliac arteries associated with an axilla-bifemoral bypass, which helps to reduce damage to the extremities; however, it does not prevent embolization of the visceral territory. Perhaps an alternative to diminishing this massive visceral atheroembolism is a suprarenal clamping associated with clamping of the renal and superior mesenteric arteries to clean before repairing with a prosthesis, as emerged after the analysis and study of this patient.

In this case, measures to reduce this serious complication were ineffective, although this complication was foreseen before surgery.

Declarations

The authors declare no conflict of interest.

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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.

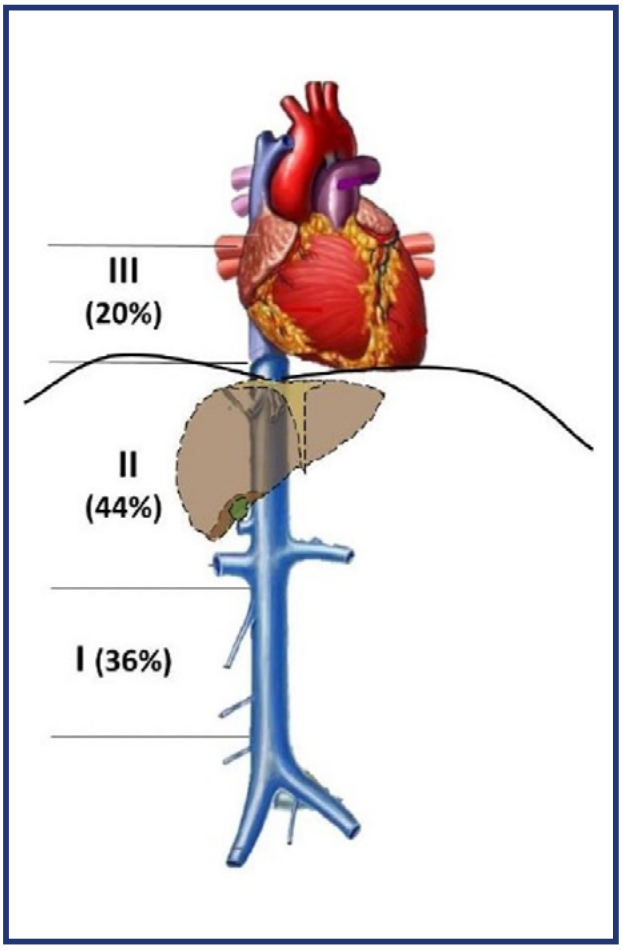

FIGURE 1. Anatomical classification and frequency of appearence of inferior cava vein leiomyosarcomas.

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

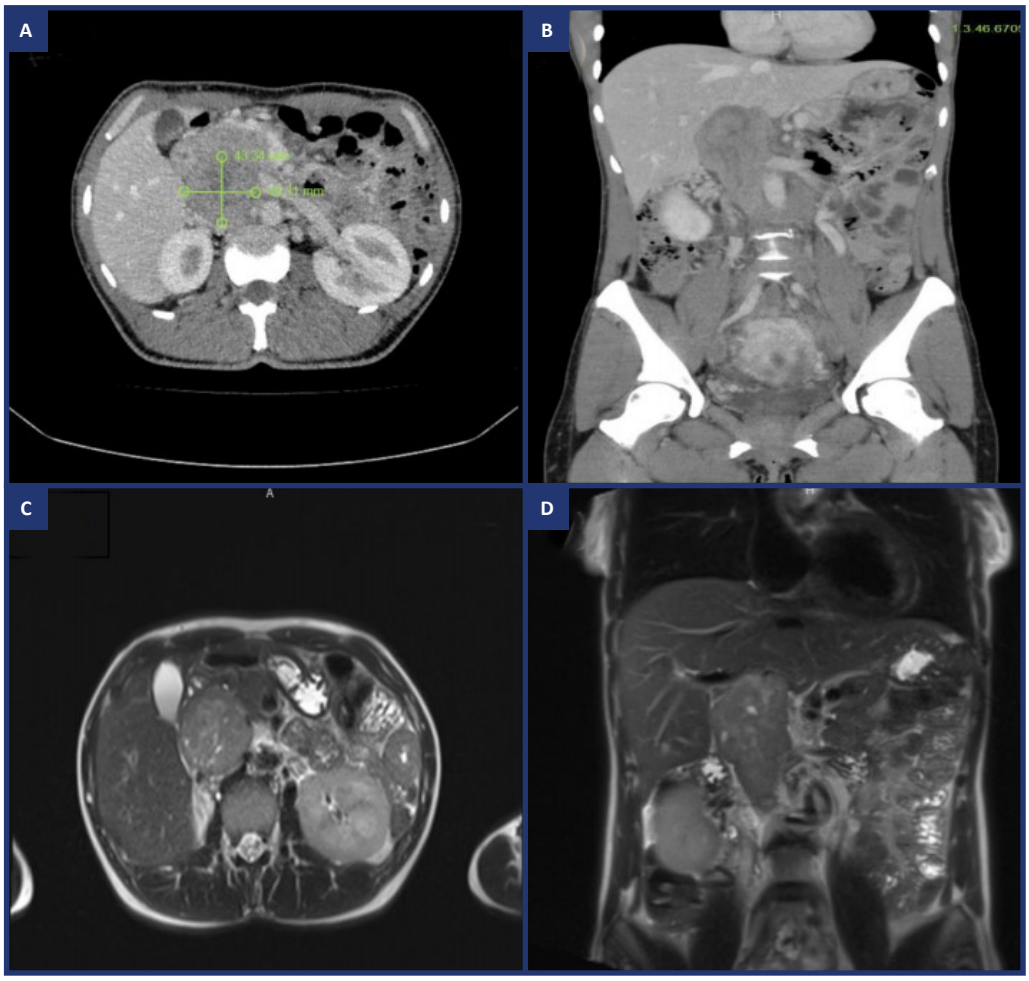

FIGURE 2. A and B. Computed tomography with intravenous contrast. **A.** Axial slide. **B.** Coronal slide. **C and D.** Magnetic resonance cholangiopancreatography. **C.** Axial slide. **D.** Coronal slide.

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.

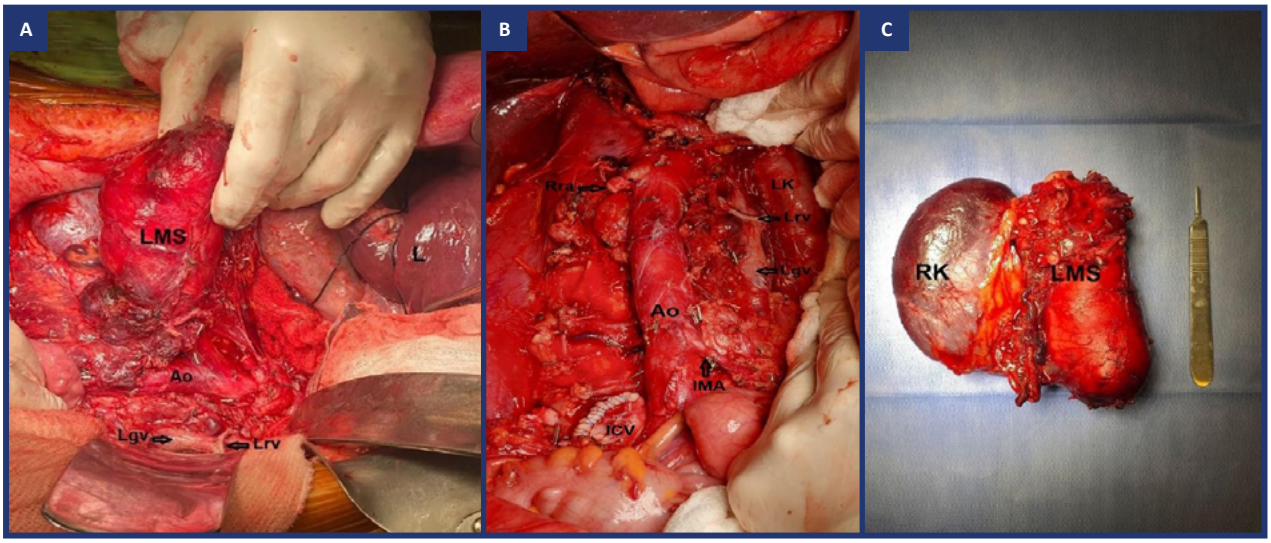

FIGURE 3. A. Tumor resection. **B.** Urgical resection site. **C.** En bloc tumor piece. (LMS: Leiomyosarcoma, L: Liver, RK: right kidney, LK: left kidney, Ao: Aorta artery, Rra: right renal artery, IMA: inferior mesenteric artery, ICV: inferior vena cava, Lrv: left renal vein, Lgv: left gonadal vein). 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.

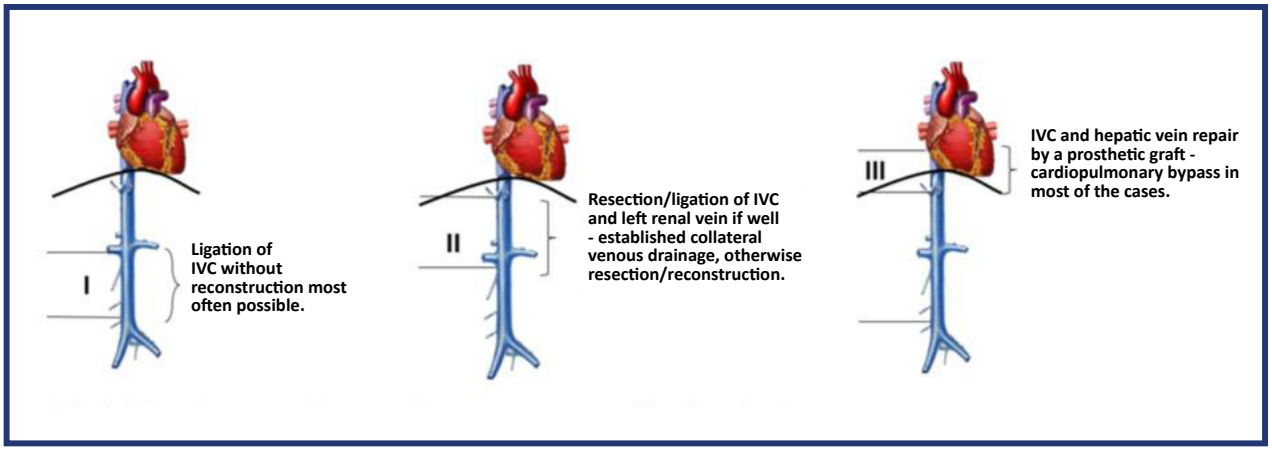

FIGURE 4. Affected areas and proposed surgical treatment. Zone I uusually has a proper venous drainage, so resection and ligation of the inferior vena cava (IVC) is the most common treatment. Reconstruction is mandatory in cases where the bifurcation is compromised. Tumors located in zone II can be resected 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

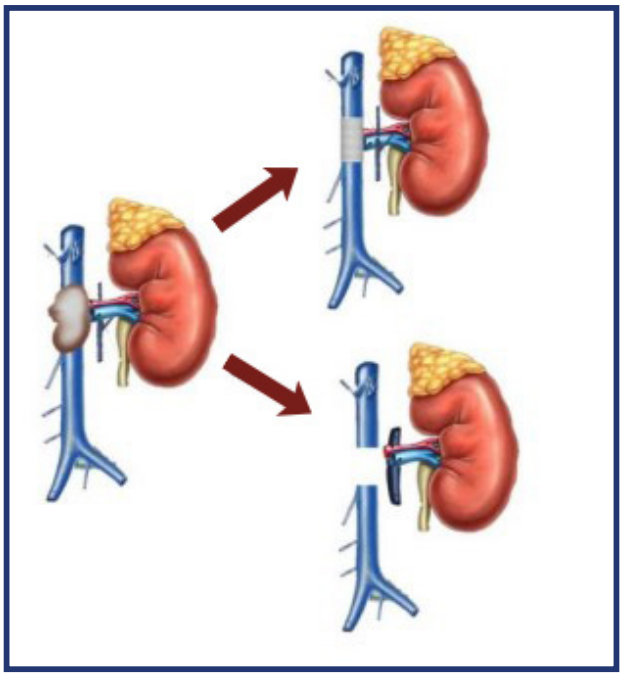

FIGURE 5. En bloc resection. The different options of zone II treatment range from only resection and ligation of IVC to reconstruction with a prosthetic graft, depending on venous return and tumor extension.

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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SCIENTIFIC LETTER

CYSTIC TUMOR OF THE ATRIOVENTRICULAR NODE: A CASE REPORT

ABSTRACT

Primary cardiac tumors are rare anomalies, with an incidence ranging from 0.0017% to 0.03% in autopsies. Among them, atrioventricular (AV) node cystic tumors present as benign congenital anomalies located in the trigone of the atrioventricular node. This type of tumor accounts for approximately 2.7% of all primary cardiac tumors and has the potential to cause severe arrhythmias or sudden death.

This article reviews AV node cystic tumors and discusses its etiology, symptoms, diagnosis, and treatment. Although its exact origin is still uncertain, it is considered a significant congenital anomaly because of its association with sudden cardiac death, which constitutes about 50% of cardiovascular mortality. The absence of visible macroscopic signs underlines the importance of maintaining a high index of suspicion in patients presenting with AV node localized heart block or sudden death, particularly in children, young adults, and women.

Early detection and accurate diagnosis are critical, requiring a thorough evaluation of the cardiac conduction system and detailed tissue analysis. Careful investigation and prompt intervention can significantly improve clinical outcomes and reduce the risk of sudden cardiac death.

Keywords: *cardiac tumors, aortic valve, cystic tumor, AV node.*

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INTRODUCTION

Primary cardiac tumors are rare clinical anomalies; their incidence varies from 0.0017% to 0.03% in autopsies[1]. Among these tumors, benign tumors are much more frequent than malignant tumors[2]. Within this category, an atrioventricular (AV) node cystic tumor, also known as AV node mesothelioma, stands out as a congenital benign entity located in the trigone of the atrioventricular node in the AV nodal region of the atrial septum[3].

The AV node is a crucial part of the electrical conduction system; it transmits signals from the sinoatrial node to the ventricles and facilitates heart contraction[4]. Any disruption in the atrioventricular node can trigger severe arrhythmias and even sudden death[5]. AV node cystic tumor accounts for 2.7% of all primary cardiac tumors and is the most frequent cause of death among these tumors[6].

This article provides a detailed review of this tumor type, including its etiology, clinical presentation, differential diagnosis, diagnostic methods, surgical and management approaches, and associated outcomes.

CASE PRESENTATION

A 42-year-old male patient with a history of hypertension controlled with angiotensin II receptor blockers (ARAII) in whom, during routine examinations, a mass on the aortic valve suggestive of fibroelastoma was discovered as an incidental finding. The electroencephalogram (ECG) showed a first-degree AV block. Physical examination revealed no obvious clinical signs.

The transthoracic echocardiogram showed an ejection fraction of 73%, with normal diameters in both ventricles and a tricuspid aortic valve with preserved valvular opening. On the ventricular side of the right and left coronary valve leaflets (LVOT), an adherent mass measuring 13 × 20 mm (area: 2.4 cm^2) with a wide base, regular borders, heterogeneous appearance, mobile and prolapsing toward the aortic root in systole was observed. In the first instance, these findings were compatible with a myxoma or fibroelastoma. The mass caused an increase in peak transvalvular pressures. Mild to moderate aortic regurgitation secondary to prolapse of the right coronary valve leaflet into the LVOT with eccentric jet to the anterior leaflet of the mitral valve.

Chest angiotomography revealed that the aortic valve was tricuspid. A mass of heterogeneous density, with regular borders and implantation base, was observed infiltrating the interventricular septum in intimate contact with the right coronary leaflet at the level of the ventricular face and in the left ventricular outflow tract. The mobile mass measured 19.4 × 15.5 mm and prolapsed toward the aortic root during systole. The measurements of the aortic structures were as follows: aortic valvular plane of 20.2 mm × 30.2 mm; sinus aorta with a diameter of 36.1 mm; sino-tubular aorta with a diameter of 29.6 mm; ascending aorta with an anteroposterior diameter of 29.5 mm and lateral diameter of 30.1 mm; aortic arch with a maximum diameter of 25.6 mm; and descending aorta with a diameter of 22.1 mm. The coronary arteries had no anomalies or obstructive plaques (*Figure 1*).

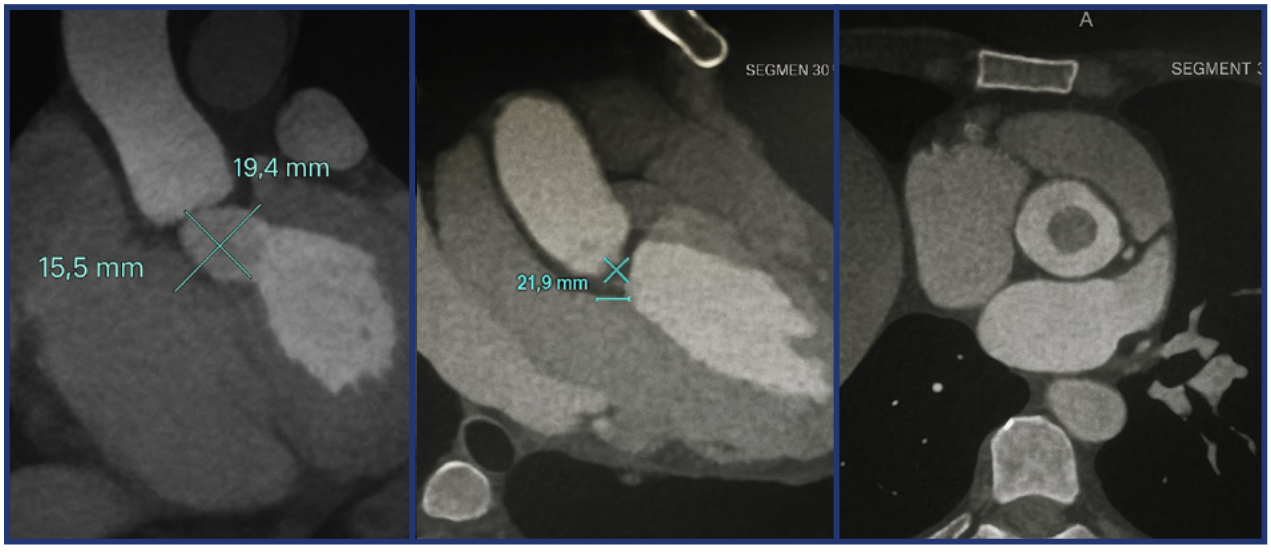

FIGURE 1. Angiotomography of the thorax shows a mass of heterogeneous density.

MRI confirms normal diameters of the left and right ventricles, a slight dilatation of the left atrium, and a mass of 15.7 × 13.6 mm attached to the right coronary leaflet, which could correspond to a papillary fibroelastoma.

In this context, it was decided to perform surgery for valve exploration and resection of the tumor. Among the intraoperative findings, a tricuspid aortic valve with the presence of a mass with a wide implantation base that infiltrated the right coronary leaflet (*Figures 2 and 3*) and the subvalvar plane was evidenced. Complete removal of the native valve, partial resection of the membranous septum, and valve replacement with a mechanical prosthesis n.° 23 were indicated. The patient was postoperatively paced with a backup epicardial pacemaker lead with self-pacing.

The obtained samples were sent to the pathology department for analysis, where it was concluded that they were compatible with a cystic tumor, positive for pan keratin (AE1/AE3). Positive carcinoembryonic antigen and positive synaptophysin were detected.

The patient was discharged from the hospital 7 days after surgery, with favorable postoperative evolution.

FIGURE 2. Wide implantation mass attached to the right coronary leaflet.

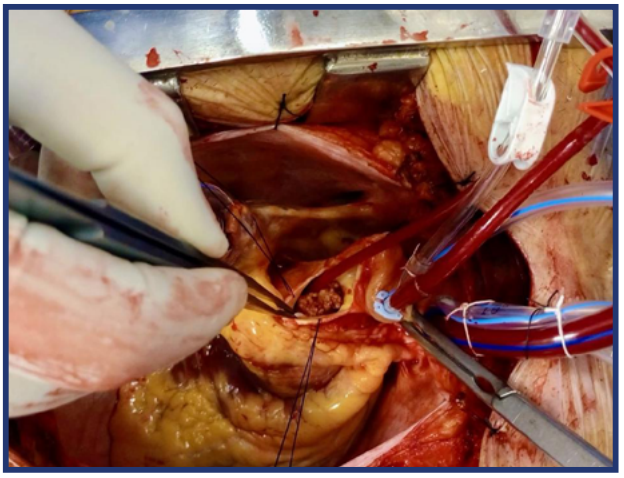

FIGURE 3. Excision of the right coronary valve mass.

DISCUSSION

Etiology and presentation

Although its precise etiology is not fully elucidated, AV node cystic tumor is considered a congenital anomaly[2]. Clinically, patients may present with symptoms related to conduction system dysfunction, ranging from palpitations to syncope or sudden death[7].

The cystic tumor of the atrioventricular node has raised several discussions about its origin and histological characteristics. Despite its name, this tumor does not appear to have a mesothelial origin. The term "mesothelioma" proves inappropriate since it is based on historical observations on the similarity of the tumor cells to mesothelial cells and an adenomatoid tumor[3,5].

Histological origin and controversies

The histogenesis of AV node cystic tumors is still controversial. The prevailing theory suggests this tumor originates from endodermal tissue remnants during the heart's embryogenesis. These elements may be similar to the solid cell nests in the thyroid, raising the possibility that the tumor is derived from tissue trapped in the AV nodal region during embryonic development[3,5].

Studies have indicated that 10% of individuals with AV node cystic tumors also have defects in midline development along the central vertical body axis, suggesting a genetic defect in embryologic tissue migration with a possible familial component[2].

This type of tumor was first described in 1911. Although it is a rare entity, it has been diagnosed in a wide range of ages, from birth to 89. The mean age at diagnosis is approximately 38 years, and it shows a marked predominance in women, with a female-to-male ratio of 3:1[7].

Demographic and epidemiological characteristics

These tumors can occur in individuals of any or all ethnicities, suggesting a relatively even distribution worldwide[4].

Clinical associations and related conditions

AV node cystic tumor has been associated with several congenital anomalies and medical conditions, including:

- Complex congenital heart disease: This suggests a possible relationship between the tumor and the development of congenital heart defects[6].

- Thyroglossal cysts: An association has been observed since they are anomalies of the thyroid gland derived from embryonic remains[3].
- Ovarian and breast cysts: Cysts in other areas of the body, such as the ovaries and breasts, have also been reported in association with AV node tumor[7].
- Encephalocele: This is a brain malformation in which a portion of the brain protrudes through a defect in the skull[2].
- Emery-Dreifuss muscular dystrophy: This X-linked recessive genetic disorder, which affects skeletal and cardiac musculature, has also been associated with the presence of AV node cystic tumors[5].

AV node cystic tumor is a lesion that, in most cases reported in the literature, is detected post-mortem. Due to its location in a critical heart area, this neoplasm can significantly interfere with the electrical conduction system, leading to various cardiac conduction problems[1,8].

Impact on the cardiac conduction system

AV node cystic tumors can cause defects in the cardiac conduction system. In more than 65% of affected patients, this can result in complete heart block, a condition in which electrical impulses fail to pass from the atrium to the ventricle. In addition, in approximately 15% of patients, partial AV block is observed, which involves a partial interruption in the transmission of impulses between the atria and ventricles[1].

This tumor can lead to other abnormalities in the electrical conduction of the heart, including:

- Intra-atrial conduction defect[5].
- Paroxysmal atrial arrhythmias[3].
- Spontaneous intermittent preexcitation[7].

These abnormalities can lead to arrhythmias and manifest with symptoms such as palpitations, chest pain, dyspnea, dizziness, and syncope[4].

Potential Complications

Complications associated with AV node cystic tumors can be severe, including the following:

- Myocardial infarction: interruption of blood flow due to severe arrhythmias can lead to cardiac tissue death[8].
- Stroke: Arrhythmias can increase the risk of clot formation, which could travel to the brain and cause a stroke[9].
- Sudden cardiac death: Severe interference with the conduction system can lead to sudden cardiac arrest[1].

Diagnosis

Diagnosis requires a comprehensive approach, beginning with a thorough evaluation of the patient's medical and family history, complemented by a complete physical examination. This process includes a thorough physical examination to identify abnormal heart sounds that may indicate underlying pathology[1].

A series of diagnostic studies is essential for accurate evaluation. Echocardiography is a fundamental tool in detecting and evaluating cystic tumors, as it allows visualization of the heart's structure and the lesion in question. Electrocardiogram (ECG) and electrophysiological studies allow one to analyze the heart's electrical activity and detect possible alterations[3].

Imaging studies, such as magnetic resonance imaging (MRI) and computed tomography (CT) of the heart, provide detailed information on the location and characteristics of the lesion.

Laboratory studies, including those of electrolytes, complete blood count, and thyroid hormone levels, are also advisable. These tests can help identify arrhythmia triggers related to the cystic tumor[4].

The AV node supply usually originates predominantly from the right coronary artery. In this context, selective angiography may be a key tool in identifying cystic tumors[7].

A tumor tissue biopsy is essential for an accurate and definitive diagnosis. This procedure includes standard tissue blocks covering the atrioventricular region and surrounding areas such as the sinoatrial region, the His bundle, and regional samples from both ventricles[8].

The combination of advanced imaging techniques and targeted biopsies provides a complete view of the tumor, facilitating a more accurate diagnosis and an appropriate treatment plan for affected patients[10].

Pathological anatomy

The macroscopic findings of a cystic tumor of the atrioventricular (AV) node can be highly variable. These tumors usually present as small multicystic lesions, ranging in size from 2 mm to 2 cm. In most cases, they manifest as a thickening of the atrial septum or as a slightly elevated lesion in the region where the AV node is typically located, i.e., at the base of the atrial septum within the trigone of the atrioventricular node[1].

Often, the tumor extends from the coronary sinus ostium in the right atrium to the membranous septum and encompasses the upper part of the valvular septal valve. Occasionally, the lesion is not prominent and goes unnoticed during routine examinations[2].

Microscopically, these tumors have a distinctive composition that includes cysts, ducts, and solid nests of cells. The cysts within these tumors are

lined by benign, non-ciliated cells with an epithelial appearance. These cells may be flat or cubic and are arranged in single or multiple layers. The nuclei of these cells are bland, and the cell nests may resemble squamous or transitional epithelium. These nests are embedded in a dense fibrous stroma containing collagen and elastin fibers. In some cases, squamous differentiation and calcification of the luminal debris may be observed[3].

The remains of the AV node can be identified only rarely. Inflammatory cells and fibrosis may also be found in the specimen. It is relevant to note that smooth muscle, mitotic figures, and atypia are not observed, characteristics that would be indicative of malignancy[5].

From the immunohistochemical point of view, the AV node cystic tumor cells show positive staining with alcian blue and PAS, evidencing resistance to digestion by hyaluronidase and diastase, respectively. The main cells of the lesion are positive for cytokeratins, epithelial membrane antigen (SMA), carcinoembryonic antigen (CEA), CA19.9 carbohydrate antigen, p63, BCL2, and galectin 3.

On the other hand, neuroendocrine cells in the lesion show positive staining for CAM5.2, pan-keratin (AE1/AE3), ACE, calcitonin, chromogranin, synaptophysin, and thyroid transcription factor 1 (TTF1). In contrast, the lesion is negative for keratin 20 (CK20), p53, Bcl-2, cyclin D1, vimentin, CD31, factor VIII-related antigen, estrogen and progesterone receptors, thrombomodulin, Wilms tumor 1, and calretinin. These findings provide a detailed profile and aid in accurately identifying and classifying AV cystic tumors[4].

Management

Surgical intervention should always be considered urgently at the time of diagnosis.

Surgical resection methods

Several surgical methods have been developed for the removal of AV node cystic tumors. However, because of the rarity of these tumors and the difficulties associated with their ante-mortem diagnosis, no uniform protocol for surgical resection has been established. This has resulted in a lack of standardization in surgical and therapeutic approaches to treat these lesions.

The decision to perform a total or partial resection of the tumor is still controversial. The appropriate surgical approach depends on several factors, including the patient's clinical presentation, the diagnostic methods used, and the size of the tumor and its location. These factors influence surgical planning and treatment results[3].

Complete excision of the tumor can be performed by sternotomy, with extracorporeal circulation (ECC) support, including ascending aortic cannulation, direct bicaval venous cannulation, and atriotomy is performed.

During surgery, a thorough exploration of the valvular and subvalvular plane should be performed to define the surgical strategy. Partial or complete resection of the tumor material is performed and sent for rapid cytodiagnosis to detect malignant cells or possible bacterial infections. Subsequently, the cavity is washed, the tumor is resected along with a portion of the interatrial or interventricular septum to which it is attached, and the excised tissue is sent to pathology for definitive analysis.

Complete resection is often necessary regardless of the need for implantation. Partial excision has been explored as an alternative to complete resection to minimize the risk of damage to the cardiac conduction system and reduce the likelihood of heart block, which may require pacemaker implantation.

Despite the lack of reports on tumor recurrence after complete resection, **partial excision** may offer advantages in minimizing the risk of complications[10].

The technique for partial excision is similar to that used in complete resection, with the main exception being managing the tumor mass. The key to this technique is thoroughly evaluating the boundaries between the atrial and cyst walls. Careful drainage of the cystic fluid and detailed examination from inside and outside the cyst are required. Resection is limited to the cyst wall protruding into the right atrium and is performed by opening the atrial surface.

Close follow-up after partial excision is crucial to detect residual AV node dysfunction. Depending on postoperative findings, antiarrhythmic medications may be necessary, and pacemaker implantation may need to be considered to manage any AV block that may arise after surgery.

The prognosis for patients with AV node cystic tumors is usually favorable with early diagnosis and complete surgical resection. Although these tumors are benign, they may be associated with severe cardiac arrhythmias that, in turn, can lead to sudden death. These tumors are often only discovered during a post-mortem examination, as the symptoms may be subtle or misinterpreted[7].

Relationship to the tumor site

Patients with tumors located in the atrial region tend to have a more favorable prognosis, with partial rather than complete heart block. This location may be associated with less severe symptoms and a reduced risk of lethal arrhythmias.

Tumor location may influence prognosis, while tumor size does not appear to be a determining factor in the severity of symptoms[4].

CONCLUSIONS

AV node cystic tumor is the most frequent primary cardiac tumor associated with sudden cardiac death. Sudden death accounts for approximately 50% of cardiovascular mortality, highlighting the seriousness and importance of addressing this type of tumor urgently.

Due to the lack of obvious macroscopic signs that may indicate the presence of the tumor, it is crucial to maintain a high index of suspicion in patients presenting with heart block located in the AV node or suffering from sudden cardiac death. This is especially relevant to children, young adults, and women, who can be affected by this condition.

Early identification and accurate diagnosis require a thorough evaluation of the cardiac conduction system, including tissue sampling for definitive analysis.

In summary, thorough investigation and prompt intervention can significantly improve clinical outcomes and reduce the risk of sudden cardiac death in these patients.

Declarations

The authors declare no conflict of interest.

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SCIENTIFIC LETTER

MINIMALLY INVASIVE VIDEO-ASSISTED CARDIAC SURGERY

ABSTRACT

Technological advances and expertise have allowed progress towards surgical treatment through mini-invasive techniques.

Video surgery has been tracing the progress of all surgical specialties, being introduced as part of the arsenal of cardiac surgery treatment. Despite the technique's benefits, it is not considered a gold standard due to technical complexity. A retrospective observational study was carried out of our experience (n = 89) in minimally invasive video-assisted cardiac surgery by right mini-thoracotomy, including various procedures, mostly mitral valve surgeries. Fifteen complications were reported, with no in-hospital mortality.

This approach has been successfully incorporated into our treatment armamentarium, and it is a safe and effective procedure.

Keywords: *cardiac surgery, video-assisted mini-invasive, mini-thoracotomy.*

Authors

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INTRODUCTION

Traditionally, cardiac surgery was performed through a complete median sternotomy, which provides generous surgical exposure of most of the heart's structures. This approach allows all cardiac procedures to be performed effectively and safely[1].

Since the advent of closed chest cardiopulmonary bypass techniques, reduction of incision size and tissue manipulation has become possible; this has allowed some procedures to be performed by partial sternotomy or thoracotomy[2].

Video-assisted surgery has gained ground in all surgical specialties and has shown, in some cases, results similar to those of conventional surgery, with a decrease in surgical trauma. Video-assisted cardiac surgery has advanced in specific procedures. However, it has not yet become the gold standard treatment, despite demonstrated advantages over the conventional approach, due to technical complexities that make it challenging to reproduce[3-5].

This article aims to perform a descriptive analysis of our experience in mini-invasive cardiac surgery using video-assisted right mini-thoracotomy.

METHODOLOGY

A descriptive and retrospective observational analysis was performed to present the initial experience of a video-assisted right mini-thoracotomy cardiac surgery program at the Instituto Cardiovascular de Rosario (ICR). All patients operated on through right mini-thoracotomy, with extracorporeal circulation, from the beginning of our program in 2019 until July 2024 were analyzed and included. The ICR cardiovascular surgery database was used. Patient selection was randomized; we began with surgeries of low complexity, excluding patients who would likely benefit more from the outcome than the method (i.e., those in whom valvuloplasty was expected to be superior to replacement). As we gained experience, we included all patients who could be treated with this technique.

All patients underwent right femoral arterial and venous cannulation through an oblique incision coincident with the inguinal crease. In cases where the right cavities were approached, a bicaval cannulation was performed (*Figure 1*). In most patients, a small 3- to 8-cm right thoracotomy was performed in the fourth intercostal space (on some occasions, in the third intercostal space), with three 1-cm working ports for the camera, Chitwood clamp, and cavity aspirator. Traction sutures were also placed (*Figure 2*). In all patients, a guide with a transesophageal echocardiogram was used for cannulation, surgical outcome assessment, and measurement of extracorporeal circulation output.

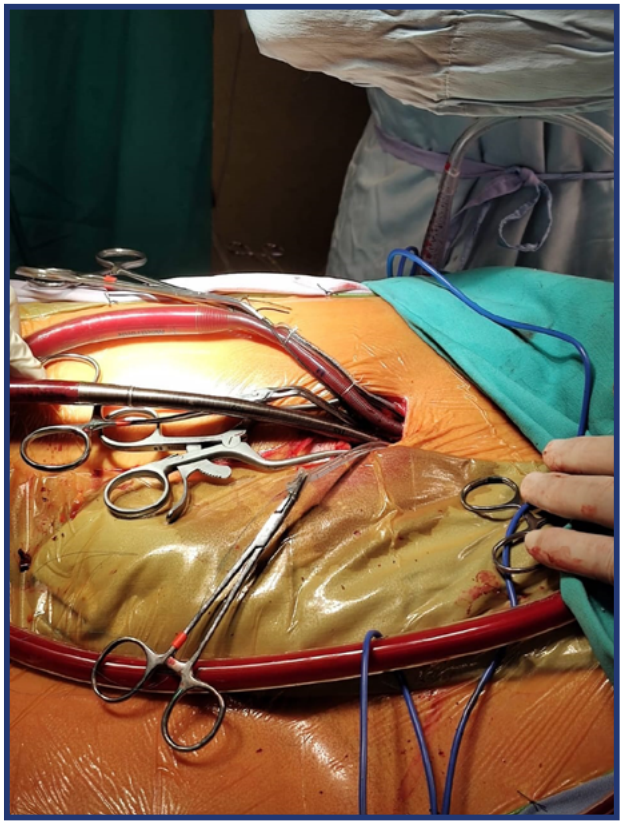

FIGURE 1. Femoral arteriovenous cannulation.

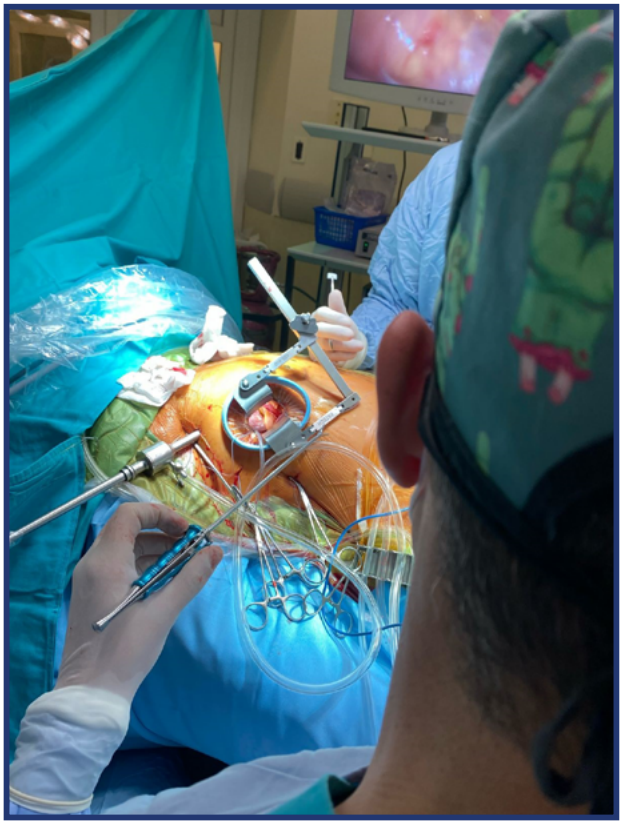

FIGURE 2. Photograph of the surgical field.

RESULTS

During this period, 89 video-assisted cardiac surgeries with extracorporeal circulation by right mini-thoracotomy were performed in our service: 54 in women and 35 in men, with an average age of 61 years (*Table 1*).

The procedures became increasingly complex, ranging from resection of benign tumors (atrial myxoma, fibroelastomas) and closure of atrial septal defects to valve replacement and valvuloplasty, culminating in combined surgeries and reoperations.

Of the total 89 cases, 75 involved mitral valve surgeries, 5 were atrial septal defect corrections, 4 were atrial myxoma resections, 3 were fibroelastoma resections, 1 was a pacemaker lead extraction, and 1 was an isolated tricuspid valvuloplasty (*Table 2*). Of the total number of ASDs, 4 were ostium secundum repairs and 1 was a venous sinus repair with anomalous pulmonary venous return associated with duplication of the superior vena cava, which was resolved by percutaneous double jugular cannulation guided by fluoroscopy. Of the fibroelastomas, 1 was located in the apex of the left ventricle and 2 in the tricuspid valve, which we were able to resect without the need to replace the valve (*Figure 3*). Of the total number of mitral surgeries, 29 replacements and 46 valvuloplasties were performed out of 58 attempts, excluding 7 cases of endocarditis, 5 reoperations, and 5 cases of mitral stenosis, resulting in a percentage of valvuloplasty attempts that were intended to be performed of 79.5%. In 16 cases, surgeries were combined with another procedure, including 8 tricuspid valvuloplasties, 1 atrial fibrillation ablation, 2 aortic valve replacements (via axillary mini-thoracotomy in the third intercostal space), 1 thymoma resection, and 4 left atrial appendage closures (*Figure 4*). On average, extracorporeal circulation (172 minutes) and clamp times (123 minutes) were prolonged but improved progressively over time.

No deaths were reported. Two surgeries were converted to complete sternotomy at the end of the procedure due to bleeding, one at the site of aortic cannulation for cardioplegia infusion and another due to injury to the anterior wall of the right ventricle in a purging maneuver. Seven patients presented with postoperative heart failure requiring assistance with inotropic drugs, and 1 of them required intra-aortic balloon counterpulsation, which resulted in prolonged hospitalization in cardiovascular recovery therapy and the general ward. Among the adverse events, 2 deep vein thromboses with minor pulmonary thromboembolism, 1 atrioventricular block requiring pacemaker implantation, 1 inguinal hematoma at the cannulation site, 1 chylothorax, and 4 right pleural effusions that resolved with pleurocentesis and 1 clotted hemothorax that required drainage by video thoracoscopy were also detected (*Table 3*). An early endocarditis requiring surgical treatment was also observed.

The average total hospital stay was 5.51 days, with an average stay in cardiovascular recovery of 2.4 days.

The aesthetic result was satisfactory in all cases, and we were able to make hidden periareolar incisions (*Figure 5*)[6].

Age (years, mean)	61 (29-83)
Sex	
Male	35
Female	54
Extracorporeal circulation time (minutes, mean)	172 (62-270)
Clamping time (minutes, mean)	123 (50-238)
Length of stay in cardiovascular recovery (days, mean)	2,4 (1-12)
Time of hospitalization	5,51 (2-22)

TABLE 1. Characteristics of the cases included in the study.

Minimally invasive surgeries	**N**
Mitral valve surgery	75
Atrial septal defect closure	5
Resection of myxomas	4
Resection of fibroelastosis	3
Removal of pacemaker leads	1
Isolated tricuspid valvuloplasty	1
Total	89

TABLE 2. Detail of types of surgeries performed.

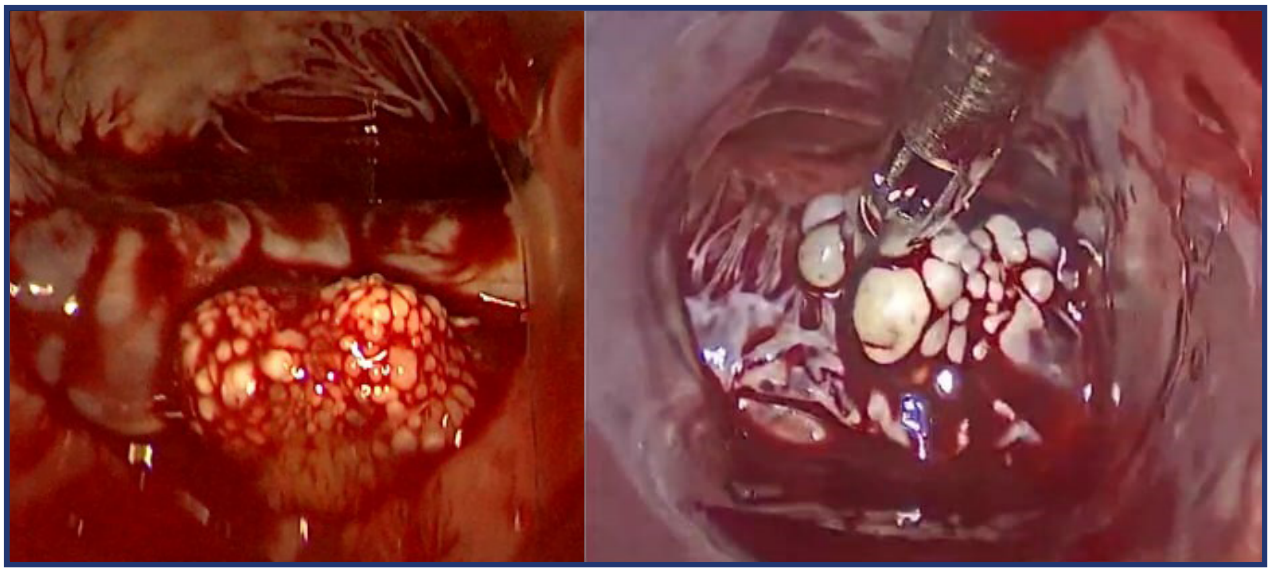

FIGURE 3. Tricuspid fibroelastomas.

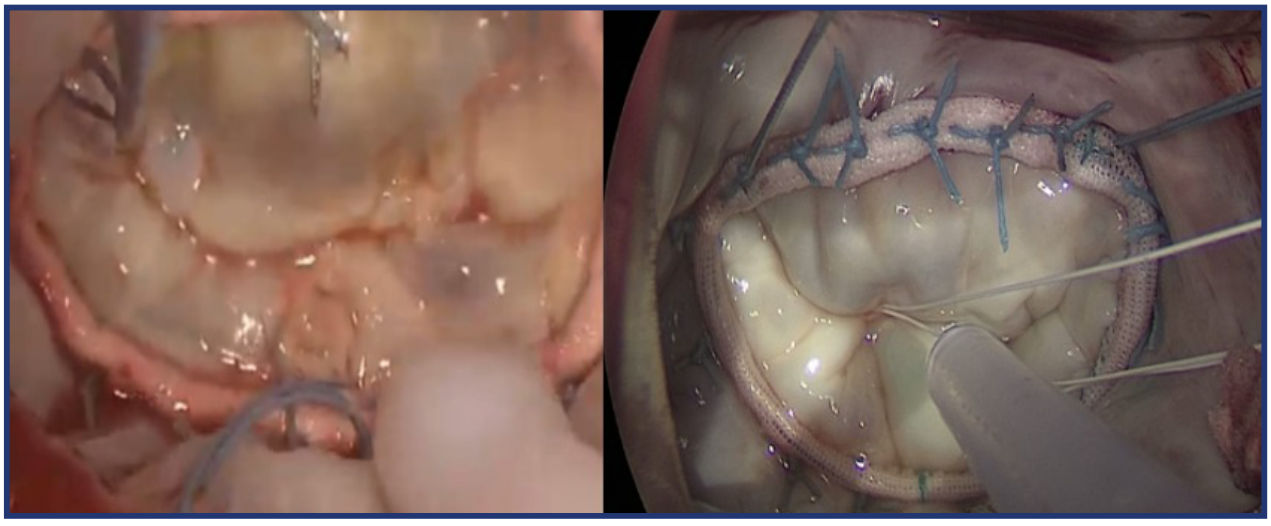

FIGURE 4. Results of mitral valvuloplasties using the quadrangular resection technique and neochord implantation.

Complications	N
Vasoplegic shock	8
Cardiogenic shock	7
Prolonged mechanical ventilation	7
Pleural effusion	4
Deep vein thrombosis	2
Diaphragmatic paresis	2
Pulmonary thromboembolism	1
Clotted hemothorax	1
Hematoma at the cannulation site	1
Early endocarditis	1
Atrioventricular block	1
Death	0

TABLE 3. Details of the complications that occurred.

FIGURE 5. Final aesthetic result in the submammary and periareolar incision.

CONCLUSIONS

The video-assisted right mini-thoracotomy approach has been successfully incorporated into our treatment options. For the past four years, this approach has been the preferred method for treating mitral and tricuspid valve disease, as well as the right and left atrial approaches.

Despite being a relatively young program, video-assisted mini-invasive cardiac surgery, which involves prolonged extracorporeal circulation and clamping times, has become a safe and effective procedure in our environment, offering numerous benefits for patients in terms of physical and aesthetic recovery.

Declarations

The authors declare no conflict of interest.

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REVIEW ARTICLE

TRANSCATHETER AORTIC VALVE IMPLANTATION IN MEXICO

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ABSTRACT

The procedure has become increasingly frequent since transcatheter aortic valve implantation began. However, the existing literature on this subject in our environment has not been reviewed, so we decided to conduct an intentional search for Mexican publications. A review of journals and authors focused on transcatheter aortic valve prostheses was performed between May 1, 2012, and May 31, 2024. Sixteen publications were found in the period analyzed. There is little dissemination in scientific journals about using transcatheter valve prostheses in Mexico and their advantages and risks. It is advisable that hospital referral centers, in addition to performing the procedure, disseminate their results.

Keywords: *TAVI, publications, transcatheter prosthesis, clinical case, literature.*

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INTRODUCTION

Aortic stenosis is the most frequent valve lesion; the leading cause is degenerative pathology associated with aging and increased life expectancy. It affects approximately 7% of patients over 65 years[1].

The accepted treatment is the replacement of the diseased valve with a prosthesis that can be mechanical or biological. This procedure is performed by open heart surgery, which is not free of risks that must be considered when proposing this type of treatment to patients[2].

If the patients' clinical conditions are added to the above, the procedure may be contraindicated due to the high risk of performing it on a patient with a complex condition. Initially, such patients were left untreated. However, techniques and valve prostheses that can be implanted endovascularly (TAVI) have been developed, with less possibility of complications and an earlier recovery in high-risk patients[2,3].

The first procedure of this type in the world was performed by Alain Cribier in 2002[4]. In Mexico, Joel Estrada et al. (Estrada J et al., unpublished observations) first performed this procedure at the Instituto Mexicano del Seguro Social (IMSS) in 2012, the year in which this type of prosthesis was also implanted at the Instituto Nacional de Cardiología Ignacio Chávez[3]. Since then, and up to the present, in Mexico this procedure has been performed in various hospital centers[1-3,5-9]. With the increase in life expectancy in our country and the possibility of a higher frequency of aortic valve stenosis in patients over 65 years of age, we consider it necessary to evaluate the impact of this procedure in terms of the dissemination of its indications, results, complications, and perspectives, with the experience of national authors who would be an appropriate source to generalize the use of the procedure with scientific support in our country.

Based on this condition, we analyzed the dissemination of Mexican authors' use of TAVI and whether these publications were published in national medical journals.

UNSTRUCTURED LITERATURE REVIEW

Based on the recommendations of Page et al.[8], an unstructured literature review was performed in Mexican medical journals to which the full text was available. The search criteria were publications related to TAVI performed between May 1, 2012, the month in which TAVI implants began in Mexico, and May 31, 2024, by Mexican authors who perform their clinical activity in this country and, in addition, publications in foreign journals by Mexican authors with case reports from national hospitals.

The articles found were classified based on their format as "clinical case", "case series" (report including between two and ten patients), "review article", "research article", "editorial article" and "guidelines".

It was verified that the publication's content included at least one of the following topics: indications for the procedure, description of the approach and implantation technique, results of the procedure, including complications and their type-if any-, mortality, follow-up, and perspectives.

RESULTS

During the period analyzed, we found 16 publications that included articles with the following characteristics:

- Six clinical cases (one in a Mexican journal, performed in a foreign hospital center, which was excluded from the review). The five reviewed studies present the indications, the approach route (four of them through femoral vessels), the brief description of the technique, and the perioperative follow-up (defined as a period of 60 days post-implantation) at 90 days and at two years in which one case of atrioventricular block was reported as a complication, the rest without complications and none with mortality[1,3,5,7,9].
- Five case series: three foreign cases were excluded from the analysis, one of them with a national author included in the working group; the remaining two present the indications, the approach route (one by femoral vessels and the other by open technique due to the inaccessibility of peripheral vascular routes), the technique and morbidity. One reports a two-year follow-up[10,11].
- Three research studies[2,12,13]; two of them describe the indications, the approach, the technique, the complications observed (hemorrhage at the access site resolved by local compression, atrioventricular block, cerebral vascular event, and acute renal failure) and the mortality attributed to pulmonary hypertension, metabolic complications, severe pneumopathy in one case, mesenteric thrombosis in another and one due to unknown cause. One of these studies has a five-year follow-up with 36 patients[2,12].
- An evaluation of the measurement procedure for diagnosis and planning of the procedure or association with complications in 134 patients[13].
- An editorial article[14] and an expert paper with guidelines for using TAVI that includes all the items to be evaluated, described, and defined for an adequate application by the readers[15].
- One of the case reports focuses more on anesthetic care during the procedure, and another describes

the combined approach with surgery via mini sternotomy.
- One of the case series focuses on the transapical surgical approach for prosthesis implantation.

It is worth mentioning that the search shows the first TAVI explant published in Mexico in 2017 in a foreign journal by Mexican authors, and it is the only report of these characteristics[8].

DISCUSSION

The first TAVI implantation in humans was performed in Rouen (France) in 2002[4]; this technique began 10 years later in Mexico. When comparing the type of publications and the number of patients analyzed in other countries[16,17], it is striking that there are very few publications on the technique in our environment. It is especially striking when recently, in an academic forum, a casuistry of more than 400 cases was presented (Arizmendi et al., unpublished observations), a product of the compilation of information from various hospital units, which undoubtedly reflects a reality very different from the one that appears in the reviewed bibliography. At the same time, it may be a reason for reflection in the sense that the procedure has more application than that reported in the Mexican literature and that, on the other hand, the follow-up of this large number of patients may provide more clarity on the risks and benefits of the procedure. All of the above becomes more relevant if we take into account, above all, that in the international literature, there are major case reports, multicenter studies, and even meta-analyses related to the use of transcatheter aortic valve prosthesis in which the advantages of femoral endovascular access compared to conventional surgery are demonstrated, as well as complications such as atrioventricular block, cerebral vascular event, hemorrhage, among others[18-21]. These data are also reported in the short term in the reviewed studies[1,2,12] and in the five-year follow-up, which is only reported in one of the national publications[2], after which an even more significant benefit is observed with traditional surgery in international studies[16,18,19], which also report an increase in the removal of prostheses placed via endovascular[22]. This should be a reason for analysis in our environment[9] since there is increasing national and international interest in expanding the use of TAVI in lower-risk or younger patients, in whom the morbidity and durability of endovascular prostheses should be analyzed among other variables[17,18,20]. New indications for the use of TAVI in patients with ventricular support should also be considered, not only with stenosis but also in cases with aortic valvular insufficiency or venous access routes in cases in which arterial vessels are not adequate[23,24].

CONCLUSION

Transcatheter aortic valve implantation is a reality in our country. However, it is necessary to have follow-up data in the medium and long term to compare the results with large international series, evaluate what needs to be improved, and prepare the hospital environment to treat aortic valve lesions with all the treatment options available, as well as detect, treat, and resolve possible associated eventualities.

Declarations

The authors declare no conflict of interest.

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