High-Output Heart Failure Secondary to Post-Traumatic Arteriovenous Fistula

Cruz Castillo Yessenia Magaly Docente de Medicina[1],Fejioó Amaya Diana Elizabeth Cirujana Vascular[2], Solís Serrano María Augusta[3], Vasco Martínez Armando Juvenal[4], Telenchana Sulqui Rosa Elizabeth[5], Pombosa Manobanda Luis Daniel[6]

[1]Universidad Técnica de Ambato ym.cruz@uta.Edu.Ec ORCID: 0000-0002-4642-885X,
[2]Universidad Central del Ecuador dra.feijoo@hotmail.com ORCID: 0000-0002-1849-9554,
[3]Universidad Técnica de Ambato magus_649@hotmail.com ORCID: 0000-0002-5959-7935
[4]Universidad Técnica de Ambato luispombosa@hotmail.com ORCID: 0009-0008-6717-1783
[5]Escuela Superior Politécnica de Chimborazo eli_telenchana@hotmail.com ORCID: 0009-0002-7560-9040
[6]Universidad Regional Autónoma de los Andes armandovasco36@gmail.com ORCID: 0000-0003-3862-1374

KEYWORDS

No Keywords

ABSTRACT

Introduction: Arteriovenous fistulas are abnormal connections between the arterial and venous systems that bypass normal anatomical capillary beds. Any device, implement, or projectile that passes through an artery and vein has the potential to lead to one, thereby preventing normal blood flow through the capillary bed. Late complications of untreated arteriovenous fistulas include proximal arterial dilation, venous congestion, congestive heart failure, and distal ischemia. Objective: Describe the clinical manifestations, diagnostic, therapeutic, prognostic complexities and complications present in post-traumatic arteriovenous fistula and its association with heart failure. Material and methods: Retrospective study presentation of a clinical case. Results: The case of a 55-year-old female patient is presented, with a 2-year history of ischemic heart disease and a gunshot wound 20 years ago. Who was admitted for bypass and coronary angiography + cardiac angiography in whom no etiology of his dilated ischemic heart disease was found until Doppler ultrasound and tomography angiography was performed due to recurrence of pain in the lower limbs and changes in skin color, which revealed presence of arteriovenous fistula. The same one that was resolved with distal ligation of the popliteal vein + exclusion of aneurysm. Conclusions: Risk factors for the development of this pathology are difficult to establish. Therefore, the shotgun trauma to the left leg 20 years ago, in addition to her obesity and female sex, led to the formation of an arteriovenous fistula that would gradually produce high-grade heart failure. Endovascular AVF repair is a treatment alternative for those patients considered high risk from anesthesia, those who have a hostile groin due to excessive scar tissue, or who cannot tolerate the consequences of bleeding that can occur with surgical control. of the FAV.

1. Introduction

Arteriovenous fistulas (AVFs) are abnormal connections between the arterial and venous systems that bypass normal anatomical capillary beds. Any device, implement or projectile that passes through an artery and vein has the potential to lead to AVF formation (1); The direction can be from artery to vein or from vein to artery. During a percutaneous access, lateral or medial deviation of the needle or placement of the needle through the concomitant vein or venous tributary can lead to a combined artery and vein puncture. In most cases, the communication between the artery and vein will seal spontaneously. However, given certain risk factors, the communication between the artery and vein may not seal and an AVF will occur. In the lower extremity, AVF is often iatrogenic, primarily due to arterial access in the groin for percutaneous cardiovascular procedures. Penetrating trauma can cause AVF to any part of the extremity, depending on the trajectory of the missile or implement, they can also result from a penetrating injury to the lower extremity, including stab, gunshot, and shotgun wounds.Long-term AVFs can cause edema of the extremities, high-output heart failure, or aneurysmal degeneration of the artery(4). Large common AVFs can cause hemodynamic changes due to shunting of blood from the high-resistance arterial circulation to the low-resistance venous circuit. Shunting increases venous volume and pressure and decreases peripheral vascular resistance, consequently the consequent increase in stroke volume and heart rate can lead to a dramatic increase in cardiac output. Another consequence of high-flow AVF is the reduction of blood flow to the lower extremity, which in the face of pre-existing peripheral arterial disease (PAD), can cause the appearance or worsening of ischemic symptoms of the lower extremity. (1) Among the systemic effects, secondary to the increase in cardiac output, there is an increase in cardiac function, with secondary hypertrophy according to the diameter of the fistula and its proximity to the heart. It is common to find AVF accompanied by aneurysms or pseudoaneurysms. (1)Risk factors for iatrogenic arteriovenous fistula include female gender, hypertension, anticoagulation or

antifibrinolytic therapy, single or multiple punctures, increased body mass index, and advanced age. Symptoms suggestive of AVF include abnormal sensation (eg, vibration) in the groin and fatigue, and new onset or worsening lower extremity ischemia. (1) The clinical diagnosis of AVF is made by palpation and auscultation of the affected vessel, which may demonstrate a murmur, dilation and prominent pulsations visible in the artery proximal to the fistula, as well as in the surrounding venous structures, hematoma, in addition the patient may present edema of the lower extremities (23) Clinical conditions related to lower extremity AVF include deep vein thrombosis, symptoms of nerve compression, and appearance of new chronic varicose veins. (1) The most important AVF-related condition is high-output heart failure, which is estimated to occur after 0.01 to 0.02 percent of cardiac catheterizations(1).For diagnosis, a Doppler ultrasound, magnetic resonance imaging, angiotomography and arteriography can be performed to demonstrate the abnormal. Most small asymptomatic AVFs spontaneously thrombose and should therefore be observed.Treatment is generally indicated for patients who develop symptoms. Surgical repair is the first approach, but ultrasound-guided compression and percutaneous techniques are alternative treatments if anatomically feasible, especially for patients who have bleeding disorders, have a hostile groin due to excess scar tissue, or who have a prohibitive risk for anesthesia. (1)(24).

AVF repair is indicated for patients with:

- Clinical symptoms related to AVF
- Steal syndrome causing claudication or ischemia of the distal limb.
- Heart failure due to high flow fistula.
- Progressive enlargement under ultrasound surveillance.
- Large AVF after a stab, gunshot, or other projectile injury
- Iatrogenic AVFs that do not seal spontaneously
- Significant edema or venous insufficiency due to venous hypertension.

The procedure can be performed under general or neuraxial anesthesia or peripheral nerve block, depending on patient and surgeon preference and underlying anesthetic risk. Just before the procedure, a duplex ultrasound should be performed to confirm that the AVF is still patent and to mark its position on the skin. (1) Typically, an incision is made over the fistula site as identified by ultrasound or another imaging modality. It is important to note that the superficial veins of the skin and subcutaneous tissues are pressurized, and care must be taken to avoid uncontrolled transection. Superficial veins should be grasped with two forceps and carefully divided and ligated to minimize the possibility of blood loss. The artery and vein proximal to the site are dissected free of surrounding tissue, and vascular control is obtained with hemostatic loops. The artery is dissected from proximal to distal until the fistula is identified. The presence of localized inflammation usually identifies the site of the fistula. (1) During fistula dissection, care must be taken to avoid removing the adventitia of the artery, which weakens the arterial wall and complicates repair. Once the arteriovenous connection is divided, direct pressure is usually all that is needed to control bleeding from the venous wall defect. The arterial wall defect can be controlled with pressure, or with arterial clamps or hemostats. Each defect is closed with permanent suture; often only one suture is needed in each. Once the repair is complete, control of the artery is released and the pulse distal to the repair site is evaluated with Doppler ultrasound. (1) El pronóstico para la fístula AV después de la reparación es excelente. Los trastornos fisiológicos se revierten inmediatamente después de cerrar la fístula. De hecho, se ha reportado que el gasto cardíaco medio disminuyó de 12.2 L / min a 5.4 L / min después de la reparación quirúrgica de las FAV (1) It is necessary to have a high degree of suspicion to establish an adequate diagnosis and request the indicated complementary tests and that is why injury to the vessels should be suspected in any wound close to the course of the vessels. Generally, most AVFs are asymptomatic and are detected clinically by palpation of a thrill or auscultation of a murmur. Heart failure should also be suspected when a patient with HF experiences persistent severe symptoms despite optimal evidence-based treatment (drug therapy plus cardiac resynchronization therapy, as indicated).

OBJECTIVE: To describe the clinical manifestations, diagnostic, therapeutic, prognostic complexities and complications present in post-traumatic arteriovenous fistula and its association with heart failure.

2. **Material and Methods**: Retrospective study presentation of a clinical case.

3. **Results and Discussion**

This was a 55-year-old female patient with a clinical history of ischemic heart disease, leg osteosynthesis 7 years ago with complication (osteomyelitis) and gunshot trauma 20 years ago; who was admitted for coronary artery + cardiac angiography with a 2-year history of mild cough, mild lower limb edema, functional class I and II dyspnea on exertion. On physical examination, a heart with rhythmic heart sounds, tricuspid murmurs III/VI. Extremities with edema ++/++++. In the paraclinic without pathological alteration.Subsequently, the patient was transferred to the center where she underwent cardiac catheterization procedure, finding: Left coronary artery trunk, anterior descending artery, circumflex artery, right coronary artery without significant angiographic lesions. Echocardiographic mapping: dilated left ventricle with kinesis disorder, severely depressed systolic function, binaural dilation. Conduction disorder and electrical rhythm disorder.The electrocardiogram reported a QRS complex greater than 0.12 seconds. v5 and v6, which concludes in a complete left bundle branch block. A dilated left ventricle and binaural dilation were found. The patient was subsequently discharged with the diagnoses of dilated heart disease and congestive heart failure.

After 4 months, he presented with a clinical picture of 15 days of evolution characterized by moderate to high intensity pain in the left ankle accompanied by changes in skin color and mild edema.The physical examination revealed left lower limb: femoral and popliteal pulse 2/2, anterior and posterior tibial 1/2, distal coldness, capillary refill for 4 seconds, preserved mobility and sensitivity, wound in the internal malleolus 2 cm, no infection, healed wound on the anterior surface of the leg. 2 cm. Thrill is palpable in the posterior region of the leg. Ecografía doppler reportó una vena poplítea dilatada con diámetro mayor de 3,6 x 2,37cm hacia distal aumento de diámetro de 4,46 cm, vena femoral: 1.24 cm x 2.79 cm en su interior se evidencia flujo de patrón fistular, arteria tibial anterior con un diámetrode 0.38 cm patrón de flujo fistular y una arteria tibial posterior con un diámetro de 0.23cm, ondas de flujo bifásico. VPS de32.23 cm/S Therefore, its surgical resolution was decided with closure of the arteriovenous fistula + distal ligation of the popliteal vein + exclusion of aneurysm. After 10 days she was discharged in good condition with a favorable prognosis.

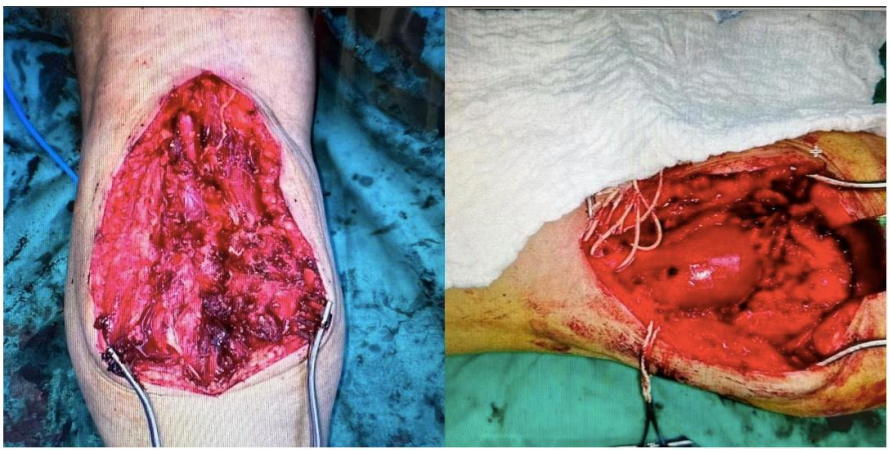

Image: Surgical repair of arteriovenous fistula.

Source: Clinical History of the patient-Ambato General Teaching Hospital.

The patient went to the consultation to delve into the cause of what was initially assumed to be chronic ischemic heart disease, where she then underwent tests, without finding a cause for it, being relevant in the coronary angiography as in the electrocardiogram a blockage of complete left branch. After 4 months with more abundant symptoms, it would end in the correct diagnosis of a high-flow

fistula. Thus, giving a retrospective diagnosis of high-flow heart failure due to a post-traumatic arteriovenous fistula in the left leg.

Discussion

This case shows the diagnosis and management of heart failure (HF) that presents with high output after trauma. It is an uncommon presentation of HF, related to the decrease in systemic vascular resistance and the increase in metabolic demand. In various observational studies it has been shown that patients present a hyperdynamic state that is characterized by: elevation of natriuretic peptides, elevation of filling pressures, expansion of plasma volume, and pulmonary arterial hypertension (1, 2).Within the etiologies of AVFs they can also be the result of penetrating injuries to the lower extremity, including stab, gunshot and shotgun wounds. Although there are no large studies on the prevalence of traumatic AVFs, the incidence may be increasing due to the increasing number of firearm injuries in the last 30 years. (25) Treatment is indicated for patients who develop symptoms. Surgical repair is the standard approach, but ultrasound-guided compression and percutaneous techniques are alternative treatments. (1)The prognosis for AV fistula after repair is excellent. Physiological disorders are reversed immediately after closure of the fistula. In fact, it has been reported that the mean cardiac output decreased from 12.2 L/min to 5.4 L/min after surgical repair of AVFs. (1)Given the patient's history of shotgun trauma, she presented 4 months later, reaching a correct diagnosis with a high-flow fistula where the case was resolved by means of distal popliteal vein ligation surgery + aneurysm exclusion. Following adequate multidisciplinary management, she is discharged in good condition.

In this case, after correction of the AVF the patient presents significant clinical and hemodynamic improvement, with decreased use of drugs and subsequent normalization of cardiac output.

Conclusion

Risk factors for iatrogenic arteriovenous fistula include female gender, hypertension, anticoagulation or antifibrinolytic therapy, punctures, punctures, or multiple punctures, increased body mass index, and advanced age. AVFs can also result from penetrating injuries to the lower extremity, including stab, gunshot, and shotgun wounds. Although there are no large epidemiological studies on the prevalence of traumatic AVFs, the incidence may be increasing due to the increasing number of firearm injuries in the last 30 years. Long-standing AVFs can cause edema of the extremities, high-output heart failure, or aneurysmal degeneration of the artery since shunting increases venous volume and pressure and decreases peripheral vascular resistance. High-output heart failure is a rare presentation of heart failure. The appropriate treatment depends on the correct etiological diagnosis. The clinical examination and history are crucial in the initial diagnostic approach. In the case we present, the history of lumbar intervention together with the continuous murmur (more prominent at the lumbar level) alerted the clinician to the possibility of the existence of iatrogenic arteriovenous fistula, confirming it with non-invasive techniques.

Reference

[1] Clement D, Joseph M. Acquired arteriovenous fistula of the lower extremity. In: UpToDate [Internet]. 2018. Disponible en: https://www.uptodate.com/contents/acquired-arteriovenous-fistula-of-the-lower- extremity
[2] Baril DT, Denoya PI, Ellozy SH, Carroccio A, Marin ML. Endovascular repair of a traumatic arteriovenous fistula 34 years after the injury: report of a case. Surg Today. 2007;37(1):78–81.
[3] Altin RS, Flicker S, Naidech HJ. Pseudoaneurysm and arteriovenous fistula after femoral artery catheterization: association with low femoral punctures. AJR Am J Roentgenol. 1989 Mar;152(3):629–31.
[4] Kotelis D, Klemm K, von Tengg-Kobligk H, Allenberg JR, Bockler D. Intermittent claudication secondary to a traumatic arteriovenous fistula. Vasa. 2007 Nov;36(4):285–7.
[5] Pagnotta P, Briguori C, Presbitero P. Arteriovenous fistula complicating directional atherectomy of the popliteal artery. J Cardiovasc Med (Hagerstown). 2009 Oct;10(10):798–800.
[6] Kearney M. Chronic Heart Failure [Internet]. Oxford, UNITED KINGDOM: Oxford University Press; 2008. Disponible en: http://ebookcentral.proquest.com/lib/uta-ebooks/detail.action?docID=975581
[7] Ramachandran V. Epidemiology and causes of heart failure. In: UpToDate [Internet]. 2018. Disponible en: https://www.uptodate.com/contents/epidemiology-and-causes-of-heart-failure

[8] Roger VL. The heart failure epidemic. Int J Environ Res Public Health. 2010 Apr;7(4):1807–30.
[9] Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics--2013 update: a report from the American Heart Association. Circulation. 2013 Jan;127(1):e6–245
[10] Doughty RN, White HD. Epidemiology of Heart Failure BT - Management of Heart Failure: Volume 1: Medical. In: Baliga RR, Haas GJ, editors. London: Springer London; 2015. p. 1–12. Disponible en: https://doi.org/10.1007/978-1- 4471-6657-3_1
[11] Katz S, Baliga R. Heart Failure : A Practical Guide for Diagnosis and Management [Internet]. Oxford, UNITED STATES: Oxford University Press, Incorporated; 2013. Disponible en: http://ebookcentral.proquest.com/lib/uta-ebooks/detail.action?docID=1630624
[12] Katz SD. Mechanisms of Heart Failure BT - Management of Heart Failure: Volume 1: Medical. In: Baliga RR, Haas GJ, editors. London: Springer London; 2015. p. 13–30. Disponible en: https://doi.org/10.1007/978-1-4471-6657-3_2
[13] Wamique S. Chronic congestive heart failure. In: British Medicla Journal [Internet]. 2019. Disponible en: https://bestpractice.bmj.com/topics/en-gb/61
[14] Colucci W. Clinical manifestations and diagnosis of advanced heart failure. In: UpToDate [Internet]. 2018. Disponible en: https://www.uptodate.com/contents/clinical-manifestations-and-diagnosis-of- advanced-heart-failure
[15] Setoguchi S, Stevenson LW, Schneeweiss S. Repeated hospitalizations predict mortality in the community population with heart failure. Am Heart J. 2007 Aug;154(2):260–6.
[16] Smart N. Exercise Training for Heart Failure Patients with and without Systolic Dysfunction: An Evidence-Based Analysis of How Patients Benefit. Butler J, editor. Cardiol Res Pract [Internet]. 2011;2011:837238. Disponible en: https://doi.org/10.4061/2011/837238
[17] Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Drazner MH, et al. 2013 ACCF/AHA Guideline for the Management of Heart Failure. J Am Coll Cardiol [Internet]. 2013 Oct 15;62(16):e147 LP-e239. Disponible en: http://www.onlinejacc.org/content/62/16/e147.abstract
[18] Taylor AL, Ziesche S, Yancy C, Carson P, D'Agostino R, Ferdinand K, et al. Combination of Isosorbide Dinitrate and Hydralazine in Blacks with Heart Failure. N Engl J Med [Internet]. 2004 Nov 11;351(20):2049–57. Disponible en:
[19] https://doi.org/10.1056/NEJMoa042934
[20] E S. Anticoagulation versus placebo for heart failure in sinus rhythm. Cochrane Database Syst Rev. 2014;3.
[21] Roy D, Talajic M, Nattel S, Wyse DG, Dorian P, Lee KL, et al. Rhythm Control versus Rate Control for Atrial Fibrillation and Heart Failure. N Engl J Med [Internet]. 2008 Jun 19;358(25):2667–77. Disponible en: https://doi.org/10.1056/NEJMoa0708789
[22] Jaff MR, Mintz BL, Mintz J. Atlas of Clinical Vascular Medicine [Internet]. Somerset, UNITED KINGDOM: John Wiley & Sons, Incorporated; 2013. Disponible en: http://ebookcentral.proquest.com/lib/uta-ebooks/detail.action?docID=1179728
[23] Thompson PC, Ullery BW, Fleischmann D, Chandra V. Novel Approach to a Giant External Iliac Vein Aneurysm Secondary to Posttraumatic Femoral Arteriovenous Fistula. Vasc Endovascular Surg. 2015;49(5–6):148–51.
[24] Topuz M, Cosgun M, Sen O, Cayli M. Coil embolization of a traumatic arteriovenous fistula of the lower extremity. Turk Kardiyol Dern Ars. 2015 Dec;43(8):724–6.
[25] Lebreton G, Uzel A-P, Celerien J, Roques F, Deneuville M. Popliteal arteriovenous fistula due to a gunshot injury. Ann Vasc Surg. 2010 Oct;24(7):952.e17-21.
[26] Arakama S, Soriano M, Padilla M, Fernández J, Viladés D. Insuficiencia cardíaca de alto gasto por fístula arteriovenosa tras artrodesis lumbar. RETIC. 2022 (Diciembre); 5 (3): 26-30. doi: 10.37615/retic.v5n3a6.