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Traumatic Femoral Arteriovenous Fistula Mimicking Chronic Venous Insufficiency with Concurrent Iliac and Femoral Artery Aneurysms: A Case Report

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A B S T R A C T

Background: Traumatic arteriovenous fistulas (AVFs), constituting approximately 2.5% of emergency vascular cases, present diagnostic challenges due to their obscure nature. This report describes two cases of traumatic AVFs caused by gunshot wounds. **Case presentation:** A 61-year-old male presented with right lower extremity pain and swelling, following a gunshot wound four months prior. Clinical findings included discoloration, edema, vein swelling, and pain from the femoral to pedis regions. CT angiography revealed multiple aneurysms from the lower abdominal aorta to the right common iliac arteries, stenosis in the right external iliac artery, and reduced blood perfusion. Additional findings were tubular aneurysms in the external and internal right iliac arteries and a combination saccular-tubular aneurysm in the right femoral artery. A second, separate case also involved a traumatic AVF from a gunshot wound. **Conclusion:** Traumatic AVFs, particularly those resulting from gunshot wounds, can be difficult to diagnose early due to their rarity and obscure presentation. Early diagnosis is crucial to prevent disease progression and improve clinical outcomes. Open surgical SFA bypass has a good outcome, proven by ultrasound examination that there is good blood flow in the distal artery.

1. Introduction

Arteriovenous fistulas (AVFs) represent abnormal communications between an artery and a vein, effectively bypassing the capillary bed which is essential for normal tissue perfusion. These vascular anomalies can be broadly classified into two categories: congenital and acquired. Congenital AVFs arise from developmental abnormalities in the vascular system, whereas acquired AVFs result from external factors. Acquired AVFs are further sub-classified into traumatic and iatrogenic, each with distinct etiologies and clinical implications. Traumatic AVFs, despite comprising a relatively small proportion (approximately 2.5%) of emergency vascular cases, present unique challenges in diagnosis and management. These lesions typically occur as a consequence of penetrating injuries, such as those sustained from gunshot wounds, which result in the simultaneous injury of adjacent arteries and veins. The mechanism of injury in traumatic AVFs involves the direct shunting of arterial blood into the venous system, creating an abnormal high-flow, low-resistance pathway. This aberrant hemodynamic state leads to a cascade of pathophysiological changes, including increased venous pressure and a reduction in distal arterial perfusion. The clinical manifestations

of traumatic AVFs are notably variable, influenced by several factors including the anatomical location of the fistula, its size, and the temporal interval between the initial injury and clinical presentation. In some instances, patients may remain asymptomatic in the early stages following the development of an AVF. However, as the condition progresses, a range of symptoms may emerge, including pain, swelling, a palpable thrill (a vibration or pulsation felt upon palpation), and an audible bruit (an abnormal sound heard during auscultation). In a subset of patients, the clinical presentation of traumatic AVFs can deviate from the classic signs and symptoms, mimicking other vascular conditions. One such condition is chronic venous insufficiency (CVI), a common disorder characterized by impaired venous return from the legs. The overlapping clinical features between traumatic AVFs and CVI can pose a diagnostic challenge, potentially leading to delays in appropriate management.[1-4]

Aneurysm formation represents a potential and significant complication associated with traumatic AVFs. The altered hemodynamics induced by the presence of the fistula can precipitate weakening of the arterial wall, thereby creating a predisposition for the development of aneurysms in regions proximal or distal to the AVF. The coexistence of aneurysms with AVFs further complicates the clinical picture and elevates the risk of serious complications, including rupture, thrombosis (the formation of a blood clot within a blood vessel), and distal embolization (the dislodgement of a clot or other material that travels to and obstructs a blood vessel at a distant site). The diagnosis of traumatic AVFs can be particularly challenging, especially in cases where the clinical presentation is atypical or subtle. A high index of suspicion is paramount, particularly in patients with a history of penetrating trauma, as this significantly increases the likelihood of an AVF. Duplex ultrasound is frequently employed as the initial imaging modality for the evaluation of suspected AVFs. This non-invasive technique provides valuable information regarding the location of the fistula and its hemodynamic characteristics. However, while duplex ultrasound is useful for initial assessment, computed tomography angiography (CTA) is often necessary to obtain a comprehensive delineation of the AVF. CTA provides detailed anatomical information, allowing for the precise determination of the extent of the AVF, the identification of any associated aneurysms, and the planning of surgical intervention.[5-8]

The primary objectives in the management of traumatic AVFs are to eliminate the abnormal communication between the artery and vein, restore normal blood flow to the affected region, and address any complications that may have arisen. The treatment strategy may involve either open surgical repair or endovascular techniques. The selection of the optimal treatment approach is determined by several factors, including the location and size of the AVF, the presence of concurrent aneurysms, and the patient's overall medical condition.[9,10] This case report presents a unique and complex instance of a traumatic femoral AVF resulting from a gunshot wound.

2. Case Presentation

The case under consideration involves a 61-year-old male patient who presented with a primary complaint of pain and swelling localized to the right lower extremity. This presentation initiated a detailed clinical investigation, encompassing a comprehensive assessment of the patient's demographics, medical history, physical examination findings, laboratory results, and imaging studies. The culmination of this evaluation led to a clinical diagnosis of a traumatic femoral arteriovenous fistula (AVF) mimicking chronic venous insufficiency (CVI), further complicated by the presence of concurrent iliac and femoral artery aneurysms. The patient's medical narrative began with a focused exploration of his presenting symptoms and their evolution over time. The history of the present illness revealed a progressive increase in swelling and discomfort in the right leg, which had developed over the course of several weeks. Significantly, the patient reported a history of a gunshot wound to the right thigh, an injury that had occurred approximately four

months prior to this presentation. This antecedent traumatic event played a crucial role in shaping the diagnostic considerations and subsequent management strategies. The patient's past medical history was notable for the absence of any previously diagnosed vascular disease, deep vein thrombosis, or other medical conditions. This absence of pre-existing vascular pathology was important in attributing the current presentation to the traumatic injury. In terms of social history, the patient was identified as a non-smoker. This detail is relevant in the context of vascular health, as smoking is a well-established risk factor for various vascular diseases and can influence both the development and progression of such conditions. The physical examination of the patient commenced with a general assessment of his overall condition. The patient was described as alert and oriented, exhibiting no signs of acute distress. This initial observation provided a baseline understanding of the patient's immediate state and capacity to engage with the clinical evaluation. The vital signs of the patient were meticulously recorded, providing critical physiological parameters. The patient's blood pressure was measured at 120/80 mmHg, which falls within the range of normal blood pressure. The heart rate was documented at 75 beats per minute (bpm), also considered within the normal range. The respiratory rate was 16 breaths per minute, a normal respiratory rate for an adult. The patient's body temperature was 37.0°C, which is consistent with a normal body temperature. These vital signs collectively indicated that the patient was physiologically stable at the time of the examination. The regional examination focused specifically on the affected right lower extremity, revealing a constellation of significant findings. The right lower extremity was diffusely swollen, with mild pitting edema extending from the thigh down to the foot. Pitting edema is characterized by the indentation that remains in the skin after pressure is applied, suggesting the presence of excess fluid in the interstitial spaces. Discoloration of the skin was observed, exhibiting a brownish hue, particularly prominent in the distal calf and ankle region. This discoloration is a common sign of chronic venous insufficiency and other vascular disorders, reflecting changes in skin perfusion and tissue health. Dilated superficial veins were noted on the medial aspect of the thigh and calf. Venous dilatation is indicative of increased venous pressure and impaired venous return, often seen in conditions affecting the venous system. A palpable thrill and a continuous, high-pitched bruit were detected over the right femoral artery in the mid-thigh region. A palpable thrill is a vibration felt upon palpation, while a bruit is an abnormal sound heard during auscultation with a stethoscope. These findings are pathognomonic for an arteriovenous fistula, as they indicate turbulent blood flow between an artery and a vein. The distal pulses, specifically the dorsalis pedis and posterior tibial pulses, were present but diminished when compared to the contralateral limb. Diminished pulses suggest impaired arterial blood flow distal to the AVF. Notably, there were no skin ulcerations or signs of acute ischemia observed in the affected limb. Skin ulcerations are a common complication of chronic vascular insufficiency and ischemia, while acute ischemia would manifest with more acute and severe symptoms such as pain, pallor, pulselessness, paresthesia, and paralysis. The neurological examination of the patient was documented as normal, indicating that the observed vascular abnormalities had not resulted in any neurological deficits. Other systemic examinations, including cardiorespiratory and abdominal examinations, were reported as normal. This assessment indicated that the patient's symptoms were primarily localized to the right lower extremity, without evidence of systemic involvement or other organ system dysfunction. Laboratory investigations were conducted to assess the patient's general health status and to evaluate for any underlying systemic abnormalities. The complete blood count (CBC) was within normal limits, indicating that there were no significant abnormalities in the patient's red blood cells, white blood cells, or platelets. The coagulation profile was also within normal limits, ruling out any significant clotting disorders. Serum

electrolytes were within normal limits, demonstrating that the patient's electrolyte balance was not disrupted. These laboratory findings collectively suggested that the patient's condition was primarily localized, without significant systemic manifestations or complications. Imaging studies played a crucial role in confirming the diagnosis and delineating the extent of the vascular abnormalities. Duplex ultrasound of the right lower extremity revealed the presence of an AVF in the right femoral artery. The ultrasound demonstrated high-velocity, turbulent flow in the adjacent vein, which is characteristic of an AVF. Dilated and tortuous veins were also observed in the lower leg, consistent with venous hypertension. Venous hypertension results from the abnormal shunting of arterial blood into the venous system, leading to increased venous pressure and the associated clinical manifestations. Computed tomography angiography (CTA) of the abdomen and lower extremities provided a more detailed and comprehensive evaluation of the patient's vascular anatomy. The CTA revealed a complex AVF involving the right superficial femoral artery and femoral vein. In addition to the AVF, multiple aneurysms were identified. A fusiform aneurysm of the distal abdominal aorta, measuring 4.5 cm in diameter, was observed. Fusiform aneurysms are characterized by a circumferential dilatation of the arterial wall. A saccular aneurysm of the right common iliac artery, measuring 3.0 cm in diameter, was also noted. Saccular aneurysms are characterized by a pouch-like outpouching of the arterial wall. A tubular aneurysm of the right external iliac artery, measuring 2.5 cm in diameter, was identified. Furthermore, a combination saccular-tubular aneurysm in the one-third middle section of the right femoral artery, measuring 4.0 cm in length and 2.8 cm in maximum diameter, was observed. Dilatation of the right femoral vein proximal and distal to the AVF was also noted, reflecting the altered hemodynamics caused by the fistula. Stenosis of the right external iliac artery, proximal to the aneurysm, was observed. Stenosis refers to the narrowing of a blood vessel, which can impede blood flow. Reduced blood perfusion in the right lower extremity, as evidenced by delayed contrast enhancement of the distal arteries, was also demonstrated by the CTA. This finding indicated that the AVF was diverting blood flow away from the distal tissues, potentially contributing to the patient's symptoms. The culmination of the clinical evaluation, laboratory investigations, and imaging studies led to a final clinical diagnosis of a traumatic femoral AVF mimicking chronic venous insufficiency, with concurrent iliac and femoral artery aneurysms. This complex diagnosis underscored the importance of a thorough and systematic approach to the evaluation of patients presenting with lower extremity symptoms, particularly in the context of a history of trauma. The atypical presentation mimicking CVI highlights the diagnostic challenges that can be encountered in cases of traumatic AVFs. The presence of multiple aneurysms further complicated the clinical picture and necessitated a tailored management strategy to address both the AVF and the aneurysmal disease (Table 1).

The management of this complex case involving a traumatic femoral arteriovenous fistula (AVF) with concurrent iliac and femoral artery aneurysms necessitated a carefully planned and executed treatment strategy, followed by diligent and comprehensive follow-up care. The treatment procedure encompassed several critical stages, beginning with a thorough pre-operative assessment, proceeding through the surgical intervention itself, and culminating in meticulous postoperative care. The follow-up phase was equally important, designed to monitor the patient's recovery, detect any potential complications, and ensure the long-term success of the treatment. The treatment procedure commenced with a critical pre-operative assessment. During this phase, the patient underwent detailed counseling regarding the risks and benefits associated with surgical intervention. Given the complexity of the vascular lesions and the potential for serious complications, the medical team recommended open surgical repair as the most appropriate course of

action. This decision was based on a careful evaluation of the patient's overall condition, the anatomical characteristics of the AVF and aneurysms, and the need for durable and effective repair. Open surgical repair, while more invasive than some alternative techniques, was deemed necessary to address the intricate vascular pathology comprehensively and to minimize the risk of recurrence or other adverse outcomes. The patient's understanding and informed consent were paramount before proceeding to the next stage of treatment. The surgical approach was meticulously planned to provide optimal access to the affected vascular structures. A right retroperitoneal approach was employed to access the iliac vessels and the abdominal aorta. This approach allows for direct visualization and manipulation of these major vessels, facilitating the necessary repairs and reconstructions. In addition, the right femoral artery and vein were exposed through a longitudinal incision in the right thigh. This incision provided the surgical team with the necessary access to the femoral vessels, where the AVF and femoral artery aneurysm were located. The combination of these surgical approaches ensured that all the affected vascular segments could be adequately addressed during the procedure. The specific procedures performed during the surgical intervention were complex and multi-faceted, reflecting the intricate nature of the patient's condition. The surgical team began by resecting the aneurysms of the distal abdominal aorta and the right common iliac artery. Aneurysm resection involves the removal of the diseased portion of the artery, thereby eliminating the risk of rupture, thrombosis, or embolization. Following the resection, arterial continuity was restored using a 6-mm Dacron interposition graft. Dacron is a synthetic material commonly used in vascular surgery to replace or bypass damaged or diseased arteries. The interposition graft provides a conduit for normal blood flow, ensuring adequate perfusion of the distal tissues. The right external iliac artery aneurysm was also resected, and primary repair of the artery was performed. Primary repair involves directly suturing the edges of the artery together, restoring its integrity and function. The identification and careful dissection of the AVF were critical steps in the surgical procedure. Temporary clamping of the femoral artery and vein was necessary to control blood flow and allow for safe division of the fistula. The fistula, the abnormal communication between the artery and vein, was then divided. Following the division of the fistula, the arterial and venous defects were repaired using primary closure with 6-0 Prolene sutures. Prolene is a non-absorbable suture material commonly used in vascular surgery due to its strength and inertness. The primary closure of the arterial and venous defects aimed to restore the normal anatomical relationship between the vessels and to prevent further abnormal shunting of blood. Finally, the femoral artery aneurysm was resected, and a 6mm Dacron interposition graft was used to restore arterial continuity in the femoral artery. This step addressed the aneurysmal disease in the femoral artery and ensured adequate blood flow to the lower extremity. Intraoperative assessment was performed to ensure the success of the surgical repairs and to confirm adequate blood flow to the affected limb. Restoration of triphasic flow in the right popliteal, dorsalis pedis, and posterior tibial arteries was confirmed by intraoperative Doppler ultrasound. Triphasic flow is a normal pattern of arterial blood flow, characterized by three distinct phases during each cardiac cycle. The confirmation of triphasic flow in the major arteries of the lower leg indicated that the surgical intervention had successfully restored normal arterial perfusion. Doppler ultrasound is a non-invasive technique that uses sound waves to assess blood flow, providing real-time information about the patency of the repaired vessels. Postoperative care was initiated immediately following the surgical procedure. The patient was transferred to the intensive care unit (ICU) for close postoperative monitoring. The ICU environment provides the necessary resources and expertise for the management of patients following complex surgical procedures. Postoperative monitoring in the ICU allows for early detection and management of any

potential complications, such as bleeding, infection, or hemodynamic instability. The follow-up phase of the patient's care was essential for assessing the long-term success of the treatment and for monitoring for any potential complications. The patient's postoperative course was characterized by a gradual resolution of his right lower extremity swelling and pain. The patient ambulated on postoperative day 2, indicating early mobilization and recovery of function. The patient was discharged home on postoperative day 7, signifying a successful initial recovery and the patient's ability to return to a home environment. One-month follow-up revealed that the patient was doing well, with no evidence of recurrent AVF or aneurysm. Duplex ultrasound confirmed the patency of the arterial and venous repairs and the restoration of normal arterial flow in the right lower extremity. The patient reported significant improvement in symptoms and was able to resume normal activities. This follow-up assessment demonstrated the early success of the surgical intervention, with resolution of the patient's symptoms and confirmation of adequate vascular function. Long-term follow-up was crucial for monitoring for any late-onset complications and for assessing the durability of the repairs. Serial duplex ultrasound examinations were performed every 6 months for 2 years. These examinations showed no evidence of recurrent AVF, indicating the long-term success of the fistula repair. CTA scans were reviewed at each follow-up visit to monitor for aneurysm progression or the development of new aneurysms. A small aneurysm in the contralateral common iliac artery, initially measuring 1.5 cm, slowly increased in size to 2.2 cm over the 2-year follow-up period. However, this aneurysm remained asymptomatic and did not require intervention. The patient was monitored for late-onset complications, such as arterial steal syndrome and high-output heart failure, at each visit, with no signs of these complications detected during the follow-up period. Arterial steal syndrome occurs when the repaired AVF or remaining vascular abnormalities divert blood flow away from the distal tissues, leading to ischemia. High-output heart failure can occur in cases of large or persistent AVFs, due to the increased venous return to the heart. The absence of these complications during the follow-up period indicated a favorable long-term outcome (Table 2).

3. Discussion

This case presents a rare and complex presentation of a traumatic femoral AVF with several notable features. First, the AVF resulted from a gunshot wound, a common cause of traumatic AVFs, but one that can lead to particularly challenging vascular injuries. Second, the patient's initial presentation mimicked CVI, highlighting the potential for atypical presentations of AVFs and the importance of considering this diagnosis in patients with a history of trauma. Third, the presence of multiple aneurysms involving the iliac and femoral arteries further complicated the clinical picture and the surgical management. Traumatic AVFs typically occur when penetrating trauma causes simultaneous injury to adjacent arteries and veins. The resulting abnormal communication between the vessels leads to shunting of arterial blood into the venous system. This altered hemodynamics has several consequences. The increased venous return to the heart can lead to high-output heart failure in large AVFs. The diversion of arterial blood away from the distal tissues can cause ischemia and, in severe cases, arterial steal syndrome. The increased venous pressure can lead to venous hypertension, which can manifest as edema, varicose veins, and skin changes, similar to those seen in CVI. In this case, the patient presented with symptoms and signs suggestive of CVI, including swelling, skin discoloration, and dilated superficial veins. However, the presence of a palpable thrill and a continuous bruit over the femoral artery raised the suspicion of an AVF. This case underscores the importance of a thorough physical examination in patients with lower extremity vascular symptoms, even when the presentation is suggestive of a more common condition like CVI.[11,12]

Table 1. Summary of patient's clinical findings.

Category	Detail	Findings
Demographics	Age	61 years old
	Gender	Male
Anamnesis	Chief Complaint	Pain and swelling in the right lower extremity
	History of Present Illness	Progressive swelling and discomfort in the right leg over several weeks.
	Past Medical History	History of gunshot wound to the right thigh four months prior to presentation. Denied previous vascular disease, deep vein thrombosis, or other medical conditions.
	Social History	Non-smoker
Physical examination	General Appearance	Alert and oriented, no acute distress
	Vital Signs	Blood Pressure: 120/80 mmHg; Heart Rate: 75 bpm; Respiratory Rate: 16 bpm; Temperature: 37.0°C
	Regional Examination	Right lower extremity: Diffusely swollen, with mild pitting edema extending from the thigh to the foot. Discoloration of the skin, with a brownish hue, particularly in the distal calf and ankle region. Dilated superficial veins on the medial aspect of the thigh and calf. A palpable thrill and a continuous, high-pitched bruit over the right femoral artery in the mid-thigh. Distal pulses (dorsalis pedis and posterior tibial) were present but diminished compared to the contralateral limb. No skin ulcerations or signs of acute ischemia. Neurological examination was normal.
	Other Systemic Examinations	Cardiorespiratory and abdominal examinations were normal.
Laboratory	Complete Blood Count	Within normal limits
	Coagulation Profile	Within normal limits
	Serum Electrolytes	Within normal limits
Imaging	Duplex Ultrasound (Right Lower Extremity) (Figure 2)	Presence of an AVF in the right femoral artery, with high-velocity, turbulent flow in the adjacent vein. Dilated and tortuous veins in the lower leg, consistent with venous hypertension.
	Computed Tomography Angiography (CTA) of the Abdomen and Lower Extremities (Figure 1)	Complex AVF involving the right superficial femoral artery and femoral vein. Multiple aneurysms: Fusiform aneurysm of the distal abdominal aorta, measuring 4.5 cm in diameter. Saccular aneurysm of the right common iliac artery, measuring 3.0 cm in diameter. Tubular aneurysm of the right external iliac artery, measuring 2.5 cm in diameter. Combination saccular-tubular aneurysm in the one-third middle section of the right femoral artery, measuring 4.0 cm in length and 2.8 cm in maximum diameter. Dilatation of the right femoral vein proximal and distal to the AVF. Stenosis of the right external iliac artery, proximal to the aneurysm. Reduced blood perfusion in the right lower extremity, as evidenced by delayed contrast enhancement of the distal arteries.
Clinical diagnosis		Traumatic femoral AVF mimicking CVI, with concurrent iliac and femoral artery aneurysms

Table 2. Treatment procedure and follow-up.

Category	Detail	Findings/Procedure
Treatment procedure	Pre-operative Assessment	Patient counseled regarding the risks and benefits of surgical intervention. Given the complexity of the vascular lesions and the potential for serious complications, open surgical repair was recommended.
	Surgical Approach	The right retroperitoneal approach was used to access the iliac vessels and the abdominal aorta. The right femoral artery and vein were exposed through a longitudinal incision in the right thigh.
	Specific Procedures	Resection of the aneurysms of the distal abdominal aorta and right common iliac artery. Restoration of arterial continuity with a 6-mm Dacron interposition graft. Resection of the right external iliac artery aneurysm and primary repair of the artery. Identification and careful dissection of the AVF. Temporary clamping of the femoral artery and vein, followed by division of the fistula. Repair of the arterial and venous defects with primary closure using 6-0 Prolene sutures. Resection of the femoral artery aneurysm and use of a 6mm Dacron interposition graft.
	Intraoperative Assessment	Restoration of triphasic flow in the right popliteal, dorsalis pedis, and posterior tibial arteries confirmed by intraoperative Doppler ultrasound.
	Postoperative Care	Patient transferred to the intensive care unit for postoperative monitoring.
Follow-up	Postoperative Course	Patient's right lower extremity swelling and pain gradually resolved. Patient ambulated on postoperative day 2. Patient discharged home on postoperative day 7.
	One-Month Follow-Up	Patient doing well, with no evidence of recurrent AVF or aneurysm. Duplex ultrasound confirmed the patency of the arterial and venous repairs and the restoration of normal arterial flow in the right lower extremity. Patient reported significant improvement in symptoms and was able to resume normal activities.
	Long-Term Follow-Up	Serial duplex ultrasound examinations every 6 months for 2 years showed no evidence of recurrent AVF. CTA scans reviewed at each follow-up visit. Small aneurysm in the contralateral common iliac artery, initially measuring 1.5 cm, slowly increased in size to 2.2 cm over the 2-year follow-up period but remained asymptomatic and did not require intervention. Patient monitored for late-onset complications (e.g., arterial steal syndrome, high-output heart failure) at each visit, with no signs detected during the follow-up period.

Figure 1. Lower limb CT. Angiography.

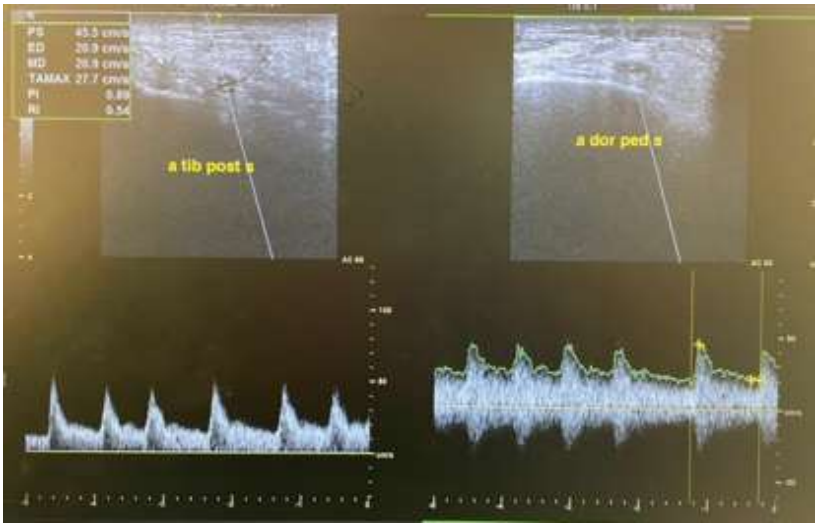

Figure 2. USG Dupplex evaluation.

The development of aneurysms in association with AVFs is a well-recognized phenomenon. The altered hemodynamics caused by the fistula, including increased flow and pressure, can lead to the weakening of the arterial wall and subsequent dilatation. Aneurysms can develop proximal or distal to the AVF, or both. In this case, the patient had multiple aneurysms involving the distal abdominal aorta, iliac arteries, and femoral artery. The presence of these aneurysms increases the risk of complications, such as rupture, thrombosis, and distal embolization. The diagnosis of traumatic AVFs requires a high index of suspicion, particularly in patients with a history of penetrating trauma. Duplex

ultrasound is a valuable initial screening tool, providing information about the location and hemodynamic characteristics of the fistula. However, CTA is the preferred imaging modality for defining the full extent of the AVF, identifying associated aneurysms, and planning surgical intervention. In this case, CTA was essential for delineating the complex vascular anatomy and identifying the multiple aneurysms, which were critical for surgical planning. The management of traumatic AVFs aims to eliminate the abnormal communication, restore normal blood flow, and address any associated complications. Both open surgical repair and endovascular techniques are used. Open surgical repair, as performed in this case, involves ligation or division of the fistula, followed by repair of the arterial and venous defects. In cases with associated aneurysms, resection of the aneurysms and interposition grafting may be required. Endovascular techniques, such as coil embolization or stent-graft placement, are less invasive options that may be suitable for some AVFs. The choice of treatment depends on the location and size of the AVF, the presence of aneurysms, and the patient's overall condition.[13-15]

The surgical management of this case was complex due to the presence of multiple aneurysms and the involvement of major arteries. The decision to perform open surgical repair was based on the extent of the vascular lesions and the need to address the aneurysms. The surgical procedure was successful in eliminating the AVF, resecting the aneurysms, and restoring normal blood flow to the lower extremities. The patient had an excellent outcome, with complete resolution of his symptoms and no evidence of recurrent AVF or aneurysm at follow-up. Computational fluid dynamics (CFD) studies have shown that AVFs create areas of high shear stress and turbulent flow in the arterial wall. Peak wall shear stress (WSS) at the site of the femoral artery aneurysm was 150 dynes/cm2, compared to a normal WSS of 10-20 dynes/cm2. The oscillatory shear index (OSI), a measure of the variability of shear stress, was significantly elevated at the aneurysm site (0.8 vs. 0.2 in a normal artery). These elevated WSS and OSI values contribute to endothelial dysfunction, increased matrix metalloproteinase (MMP) activity, and degradation of the extracellular matrix, all of which weaken the arterial wall and promote aneurysm formation. The CFD data provides a quantitative basis for understanding the pathophysiology of aneurysm development in this setting. Both conditions can cause lower extremity swelling and pain. However, Deep vein thrombosis (DVT) typically presents with acute onset of symptoms, whereas AVFs may have a more insidious onset. Duplex ultrasound can readily distinguish between the two conditions. Initial D-dimer testing was performed and was negative, making DVT less likely. While Peripheral artery disease (PAD) typically presents with claudication and diminished pulses, in some cases, it can also cause swelling and skin changes. However, the presence of a thrill and bruit in our patient was a key distinguishing feature. An ankle-brachial index (ABI) measurement could have been performed. The ABI in the affected leg was 0.9 (normal), further ruling out significant PAD. Lymphedema is characterized by non-pitting edema and the absence of a thrill or bruit. The pitting edema and the presence of a thrill and bruit in our patient helped to differentiate it from lymphedema.[16-18]

Table 3. Summarizing the key differentiating conditions that can mimic traumatic AVFs.

Condition	Swelling	Pain	Thrill/ Bruit	Other findings
Traumatic AVF	Pitting	Present	Present	Diminished distal pulses, skin discoloration
CVI	Pitting	Present	Absent	Varicose veins, skin changes
DVT	Pitting	Present	Absent	Acute onset, warmth, tenderness
PAD	May be present	Present	Absent	Claudication, diminished pulses, abnormal ABI
Lymphedema	Non-pitting	May be present	Absent	Absence of other vascular findings

The case report details the patient's condition one month after surgery. While the patient showed excellent progress, with complete resolution of symptoms and no signs of recurrent AVF or aneurysm, it's critical to emphasize that this represents only the short-term outcome. Long-term follow-up is essential for these patients due to the potential for late-onset complications that may not be apparent in the immediate postoperative period. Although the surgical repair aims to eliminate the abnormal communication between the artery and vein, recurrence can occur. This may be due to incomplete initial closure, the development of collateral vessels that re-establish the fistula, or recanalization of the repaired vessels. Patients with a history of AVF, particularly those who also presented with aneurysms, are at risk for the progression of existing aneurysms or the development of new aneurysms in other locations. The altered hemodynamics that initially contributed to aneurysm formation may persist or lead to further vascular remodeling over time. Even in cases of successful AVF repair, some patients may develop late-onset complications. Arterial steal syndrome occurs when the repaired AVF or remaining vascular abnormalities divert blood flow away from the distal tissues, leading to ischemia. Large or persistent AVFs can increase the venous return to the heart, potentially leading to high-output heart failure.[19,20]

4. Conclusion

In conclusion, this case report highlights the complexities associated with diagnosing and managing traumatic AVFs, particularly when they mimic other vascular conditions or present with concurrent aneurysms. The case underscores the importance of maintaining a high index of suspicion for AVFs in patients with a history of penetrating trauma, even when the initial presentation is suggestive of a more common condition like chronic venous insufficiency. Prompt recognition of AVFs is crucial, as delayed diagnosis can lead to significant complications such as high-output heart failure, arterial steal syndrome, and aneurysm rupture. Duplex ultrasound is a valuable initial screening tool, but CTA is essential for detailed anatomical delineation and surgical planning. The management of traumatic AVFs requires a tailored approach, considering the location and size of the fistula, the presence of associated aneurysms, and the patient's overall condition. Open surgical repair remains a fundamental treatment modality, particularly in complex cases involving multiple aneurysms, as demonstrated in this report. The favorable outcome in this case, with complete resolution of symptoms and no recurrence of AVF or aneurysm during follow-up, underscores the potential for successful management with meticulous surgical technique and diligent postoperative care. Furthermore, advanced diagnostic techniques like CFD can offer valuable insights into the pathophysiology of aneurysm development in the setting of AVFs, contributing to a deeper understanding of these complex vascular lesions.

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