CASE REPORT

An inadvertently created arteriovenous fistula in the radial artery benefitting the patient for future haemodialysis

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Abstract

Radial artery puncture is a routine procedure in clinical practice for both diagnostic and therapeutic purposes. Although generally considered safe, rare complications, such as the development of arteriovenous fistula (AVF), can occur. This case report describes the case of a 57-year-old male with stage 5 chronic kidney disease (CKD) who developed an AVF following percutaneous coronary intervention (PCI). Ultrasound evaluation revealed that the AVF had matured sufficiently and was likely to provide adequate blood flow for future haemodialysis. Notably, this inadvertent AVF obviated the need for additional surgical intervention to establish dialysis access. This case highlights the rare but beneficial outcome of AVF formation following radial artery puncture, emphasising the importance of considering anatomical variations and procedural factors during the radial artery puncture.

Keywords: Arteriovenous fistula, Radial artery puncture, Haemodialysis, Chronic kidney disease, Percutaneous coronary intervention.

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Introduction

Radial artery puncture is a widely adopted technique in clinical practice for diagnostic and therapeutic interventions, including arterial blood gas analysis and percutaneous coronary intervention (PCI).[1] Its increasing preference is due to several advantages: the radial artery's superficial location, smaller diameter, ease of compression, and lower risk of severe complications as compared to femoral artery access. These factors make radial artery access a safer and more convenient option for many medical procedures.[2]

Despite these benefits, radial artery puncture is not without risks, and complications can occur. These complications are typically categorised into vascular and non-vascular types. Vascular complications include haematoma, pseudoaneurysm, arterial spasm, occlusion, and arteriovenous fistula (AVF).[3] Among these, haematoma and occlusion are relatively common, while pseudoaneurysm and AVF, though rare, can be serious.[4,5] Non-vascular complications, such as local infection, nerve injury, and skin necrosis, are less frequent but can still significantly affect patient outcomes.

AVF, a particularly concerning vascular complication, occurs when both the radial artery and an adjacent vein are injured, leading to the formation of an abnormal connection that disrupts normal blood flow.[6] Other rare complications, like pseudoaneurysm, may result from improper closure of the puncture site, leading to localised blood pooling that might require surgical intervention.[7]

This study reports a rare and notable case of a patient who developed an AVF near the wrist following a radial artery puncture. Remarkably, in this patient with stage 5 chronic kidney disease (CKD), the AVF was not only asymptomatic but also provided a beneficial outcome. The fistula negated the need for corrective treatment and eliminated the requirement for additional AVF surgery for future renal replacement therapy. This unexpected, positive result makes this case particularly noteworthy.

Case Report

A 57-year-old male was admitted to the Department of Nephrology, Jinhua Municipal Central Hospital, Zhejiang, China on September 10, 2024, for the evaluation of renal replacement therapy due to elevated serum creatinine levels observed over the past three years. Upon admission, a comprehensive diagnostic workup revealed a long-standing history of polycystic kidney disease (over 30 years). Additionally, the patient's son had been on haemodialysis for more than three years due to the same disease. The patient is currently in stage 5 CKD. After a thorough discussion of the risks and benefits of the three available renal replacement modalities, the patient chose haemodialysis as his preferred option. Consequently, a preocedure to create an AVF was scheduled.

During the pre-operative evaluation, a prominent bulging venous structure was observed near the patient's right

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Figure-1: Notable dilation of superficial veins on the surface of the right forearm, observed even when the patient was seated with the forearm resting horizontally. The dilation was particularly pronounced near the cephalic vein (indicated by the blue arrow) and the radial artery puncture site (indicated by the red arrow). A prominent thrill was detected over the radial artery puncture site (indicated by the red arrow).

wrist, accompanied by a palpable thrill and an audible continuous blowing murmur. This raised concern and prompted a detailed review of the patient's medical history. The patient disclosed that five years earlier, he had undergone PCI for an acute myocardial infarction. At that time, no abnormalities were observed around the right wrist. However, approximately one year after the PCI, he began noticing a visibly dilated venous vessel at the same site, with progressive prominence of the cephalic vein along the right forearm (Figure 1). The patient also reported the ability to palpate distinct vibrations and hear a continuous sound emanating from the area. Despite this, he did not seek further medical evaluation or treatment.

To further assess the maturation of the AVF, an experienced vascular ultrasound specialist was consulted. The primary surgical team also conducted an ultrasound examination to evaluate the fistula's patency and maturation. The results revealed a brachial artery flow rate of approximately 479mL/min (within the acceptable range of ≤500mL/min), a cephalic vein diameter of 6mm (≥5mm), and a skin-to-vessel depth of 2mm (<5mm). Typically, on full maturation of an AVF in Chinese individuals, the ultrasound reveals a brachial artery flow >500mL/min, a venous diameter ≥5mm, and a vein depth <5mm from the skin surface (this differs from the 'Rule of 6', which requires flow >600 mL/min, vein diameter >6 mm, and vein depth <6 mm.).[8] Additionally, two ultrasound images of the anastomotic site were captured (Figure 2). Following detailed discussions with the ultrasound specialist, it was concluded that while the brachial artery flow was slightly suboptimal, the AVF in the patient's right forearm had matured sufficiently. As

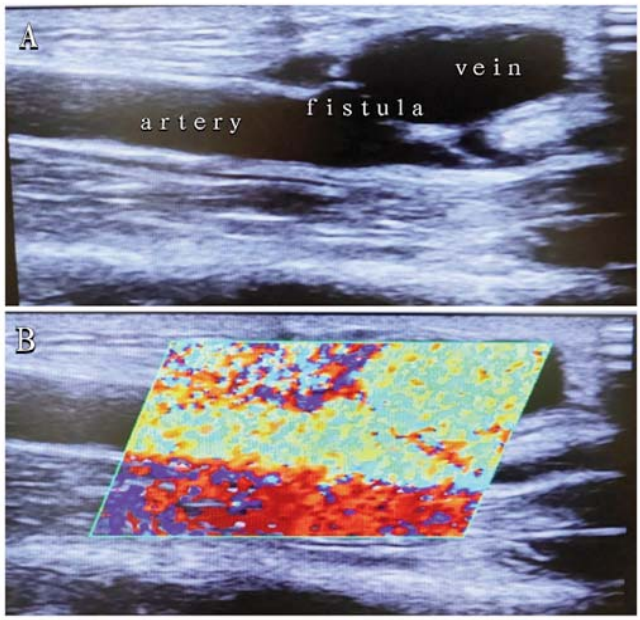

Figure-2: Image A clearly illustrated the anatomical structure of the arteriovenous fistula with high clarity. Image B: Doppler ultrasonography was performed at the level of Image A, revealing a mosaic pattern of multicoloured blood flow signals, further confirming the presence of the arteriovenous fistula over the radial artery puncture site

such, there was no immediate indication for further surgical intervention.

On follow-up phone call, on September 30, the patient reported a serum creatinine level of 6.7 mg/dl (normal range: 0.6–1.2 mg/dl) but denied experiencing hyperkalaemia, significant acid-base imbalance, or typical uraemic symptoms, such as dyspnoea, chest tightness, loss of appetite, or lower limb oedema. At that time, the patient had not yet started haemodialysis. Subsequently, on November 30, 2024, another telephone follow-up was conducted. The patient informed that he had been using the AVF for routine haemodialysis for approximately two weeks. The dialysis sessions had been uneventful, and the AVF had consistently provided adequate blood flow to meet the requirements of haemodialysis.

Informed consent was obtained from the patient, for publishing his case report, and the case study received approval from the hospital's ethics committee.

Discussion

AVF formation following radial artery puncture is a rare but significant complication, typically linked to mechanical injury. The close proximity of the radial artery to veins, such as the cephalic vein, increases the likelihood of simultaneous arterial and venous trauma during the procedure. When both the vessels are punctured, direct communication can form between the high-pressure

arterial system and the low-pressure venous system, leading to turbulent blood flow. This abnormal shunt is clinically characterised by a palpable thrill or an audible bruit.

Several procedural factors contribute to the development of AVF, including multiple puncture attempts, improper needle placement, and the use of large-bore needles. Additionally, inadequate compression following the procedure may leave the arterial and venous puncture sites in close proximity, facilitating fistula formation. Prolonged catheterisation can further damage the vessels, increasing the risk of AVF[1].

Patient-specific factors, such as CKD and anatomical variations, also play a crucial role in the formation of AVFs. Patients with CKD often have fragile vasculature and require frequent vascular access, making them particularly susceptible to such complications. In this case, the AVF might be both an unintended complication and an incidental benefit, especially if future dialysis access was needed.

The clinical impact of an AVF largely depends on its size and blood flow. Small, asymptomatic AVFs often resolve spontaneously without intervention. However, larger AVFs can lead to serious complications, such as venous hypertension, distal ischaemia, or even high-output heart failure if left untreated. The abnormal blood shunting decreases arterial perfusion to distal tissues while increasing venous pressure, which can cause vessel dilation. When symptomatic or large AVFs are detected, intervention becomes necessary.[9] Treatment options include ultrasound-guided compression, surgical ligation, or endovascular embolisation. Early detection and timely management are essential to prevent long-term complications.[10]

In this case, the development of right-sided AVF in the patient can be attributed to several factors: (1) the cephalic vein branches run in close proximity to the radial artery at the puncture site; (2) the patient had undergone multiple PCIs and coronary angiographies via the right radial artery; and (3) ultrasound examination indicated that the patient's right radial artery had a diameter of 4.7mm, which is larger than the average. This larger diameter likely played a key role in the maturation of the beneficial AVF that provided adequate blood flow to meet the requirements of haemodialysis, which distinguished this case from previous reports[4-7] that identified the AVF as a negative complication.

This case offers valuable insights, particularly regarding the importance of considering anatomical variations during radial artery puncture. It also underscores the necessity of minimising the number of puncture attempts to reduce the risk of complications associated with radial artery access.[1]

Conclusion

This case report highlights an AVF that, while technically a complication of the procedure, did not necessitate further intervention for the patient. In fact, the formation of the AVF proved beneficial, as it eliminated the need for additional fistula surgery in preparation for renal replacement therapy. Thus, this case represents a unique and clinically significant example, offering valuable insights into the potential outcomes of radial artery puncture.

Consent: Informed written consent was obtained from the patient for the publication of this case.

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AUTHOR'S CONTRIBUTION:

FH: Concept, design, data acquisition, analysis, interpretation, drafting, critical revision, final approval and agreement to be accountable for all aspects of the work.

XZ: Data acquisition, analysis, interpretation, drafting, critical revision, final approval and agreement to be accountable for all aspects of the work.

XL & SL: Data analysis, interpretation, drafting, critical revision, final approval and agreement to be accountable for all aspects of the work.

JH: Concept, design, analysis, interpretation, drafting, critical revision, final approval and agreement to be accountable for all aspects of the work.