CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CLINICAL CASE

Innovative Closure of an Iatrogenic Arteriovenous Radial Fistula Via the Distal Radial "Snuffbox" Access

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ABSTRACT

BACKGROUND Iatrogenic radial arteriovenous fistula (AVF) is a rare but serious complication of transradial interventions, with no standardized management approach.

CASE SUMMARY We report a case of iatrogenic radial AVF after a complex transradial percutaneous coronary intervention (PCI). Five months after PCI, the patient presented with right forearm swelling. Clinical examination revealed an audible bruit, suggestive for an AVF, which was confirmed by duplex ultrasound. The AVF was successfully treated by means of distal radial artery access (dTRA) via the "snuffbox" approach and deployment of a coronary stent-graft.

DISCUSSION Management of radial AVFs remains nonstandardized, ranging from conservative strategies to surgical and endovascular interventions. To our knowledge, this is the first case using a coronary graft-stent via dTRA for radial AVF closure, introducing a novel treatment option.

TAKE-HOME MESSAGE This case highlights dTRA as a viable approach for iatrogenic radial AVF repair. Familiarity with this technique may enhance interventionalists' ability to manage such complications effectively. (JACC Case Rep. 2025;30:104000) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Percutaneous radial interventions have become highly popular owing to their limited access site and bleeding complications. These interventions also enhance patients' comfort and reduce the time to ambulation. Arteriovenous radial fistula (AVF) is an extremely rare complication of cardiac coronary percutaneous catheterizations via radial access.[1] Large registries have identified the incidence of AVF as an iatrogenic complication to be as low as 0.08%-0.04% making it one of the rarest complications associated with radial access.[2,3] Because of its rarity, there is no general consensus on the optimal management of iatrogenic AVFs after radial access. Most reported cases have been treated either conservatively, percutaneously, or surgically.[4] Here, we report a case of AVF as a complication of transradial coronary percutaneous intervention treated percutaneously using the right distal transradial access (dTRA-"snuffbox"). To our knowledge, this is the first case of successful AVF closure by

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ABBREVIATIONS AND ACRONYMS

AVF = arteriovenous fistula

dTRA = distal transradial access

GS = graft-stent

PCI = percutaneous coronary intervention

implanting a coronary graft-stent (GS), via the distal radial access, ipsilateral to the complication site.

HISTORY OF PRESENTATION

A 74-year-old man presented for elective percutaneous coronary angiography because of atypical chest pain, and coronary computed tomography angiography revealed severe 3-vessel coronary artery disease. Diagnostic coronary angiography was performed via the right dTRA which confirmed the presence of severe stenosis in the proximal left anterior descending artery (LAD), intermediate artery (IM), and proximal circumflex artery (LCx), and occlusion of the posterolateral branch of the right coronary artery (RCA) (Figure 1). After discussion with the patient, an endovascular approach with percutaneous coronary intervention (PCI) in the LAD, IM, and LCx was decided. Twenty days later, the patient underwent a scheduled, successful, and uncomplicated intravascular ultrasound-guided PCI, with stents implanted in the "unprotected" left main, proximal LAD, and mid-IM, and a drug-coated balloon angioplasty performed in the proximal LCx without stent (provisional stenting with proximal optimization technique, the POT-kiss-POT technique) (Figure 2). The right transradial artery was used as access site, where a 7-F radial sheath was placed to accommodate a 7-F XB3.5 Cordis Vista BriteTip guiding catheter. Radial compression with a dual-balloon compression device was applied for 6 hours, with gradual pressure degradation, to achieve radial hemostasis. The patient was discharged the next day on dual antiplatelet therapy (aspirin and

TAKE-HOME MESSAGES

- Interventionalists must remain vigilant in identifying and managing even the rarest complications, such as radial arteriovenous fistulas.
- Distal radial access has gained significant popularity owing to its potential for reducing radial occlusion rates.
- Familiarity with this technique offers a unique opportunity to effectively address iatrogenic radial complications with safety, efficiency, and comfort for the patient.
- In certain cases, distal radial access may serve as a safer alternative to brachial or femoral access, particularly in patients who require continuous, uninterrupted antithrombotic therapy

VISUAL SUMMARY Timeline of the Events From Initial PCI Procedure to the Diagnosis and Management of the Complication (Iatrogenic AVF)

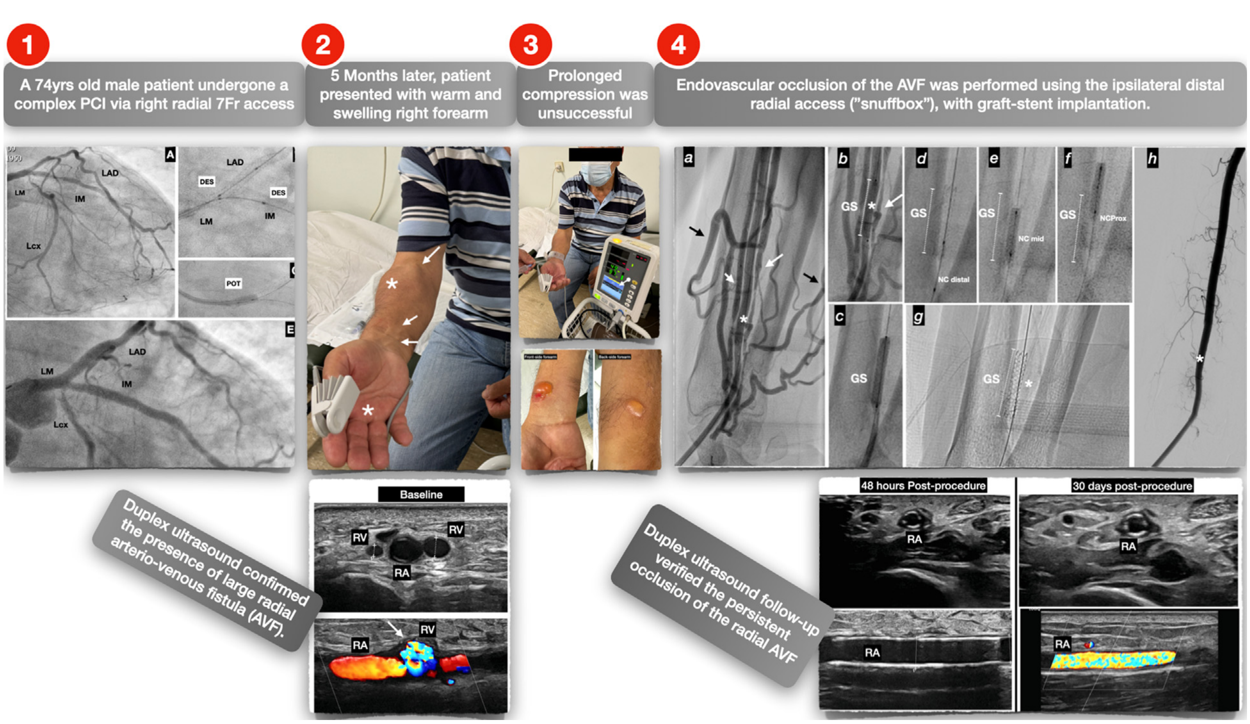
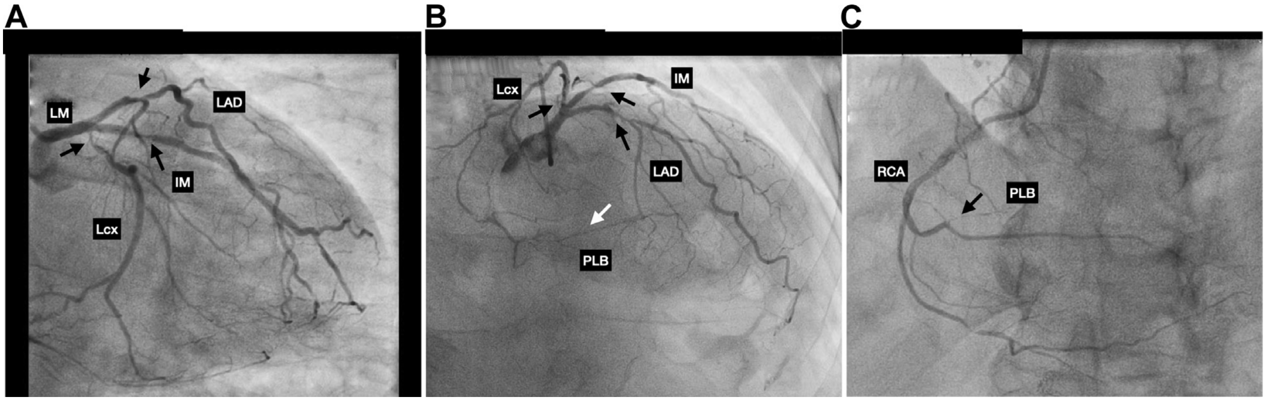
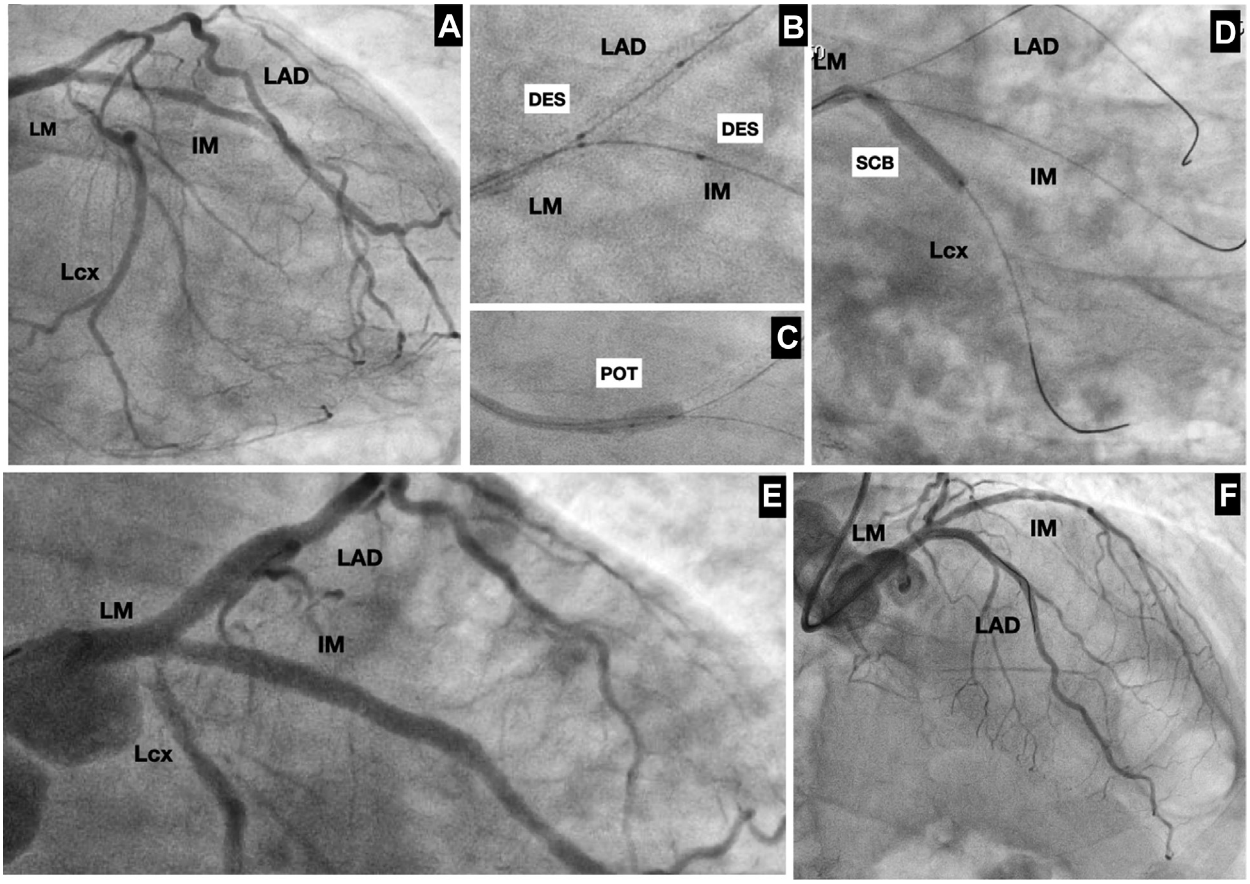


FIGURE 1 **Baseline Coronary Angiography Revealed 3-Vessel Disease**



(A) LAO-caudal projection and (B) AP-cranial projection: severe multiple stenoses in proximal LAD, mid-IM, and ostium LCx (arrows); distal PLB can be visualized via collaterals from the left coronary system (white arrow). (C) Total occlusion (100%) in the origin of PLB (arrow). AP = anteroposterior; IM = intermediate branch; LAD = left anterior descending artery; LAO = left anterior oblique; LM = left main; PLB = posterolateral branch; RCA = right coronary artery.

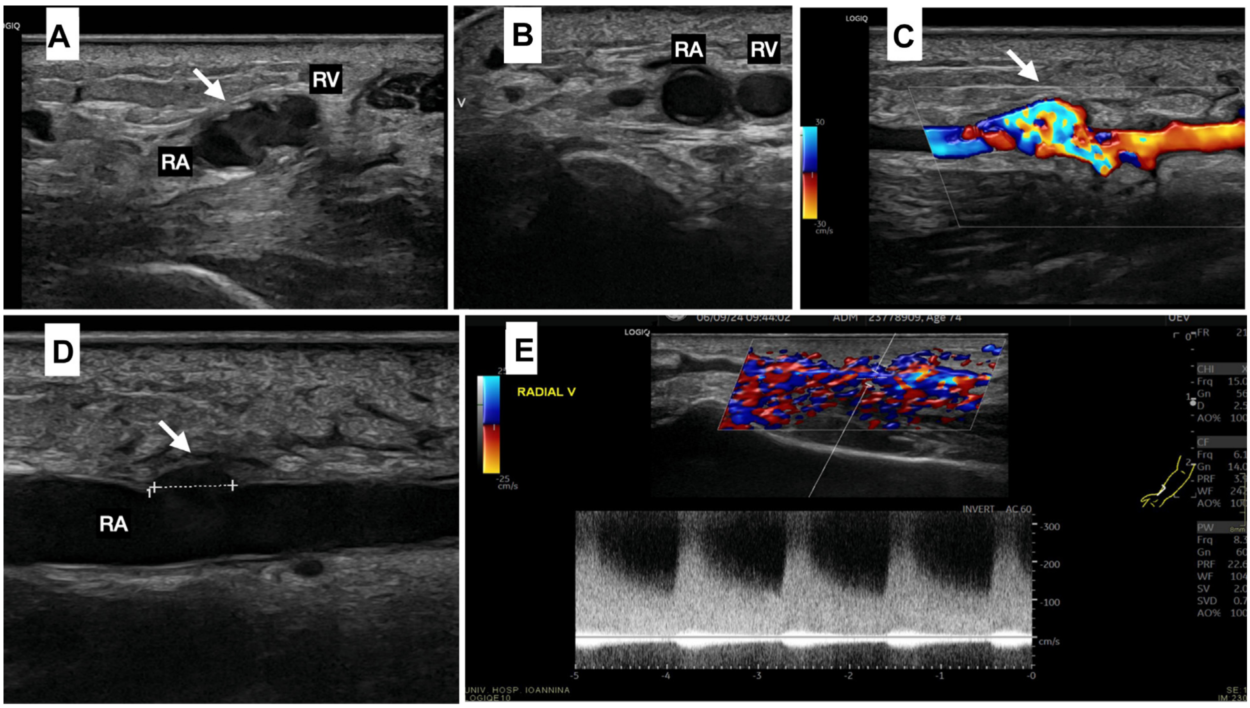
FIGURE 2 **Angiographic Images From PCI Procedure**



(A) Baseline AP-caudal projection. (B) Implantation of 3.0 × 32 mm and 3.5 × 24 mm DES up to the ostium of LAD-LM, kissing balloon inflation, and (C) proximal optimization technique with a 4.0 × 8 mm NC balloon. (D) LCx ostium lesion was treated with 3.0 × 20 mm SCB. (E) Final result in AP-caudal projection. (F) Final result in AP-cranial projection. DES = drug-eluting stent; LCx = left circumflex artery; NC = noncompliant; SCB = sirolimus-coated balloon; other abbreviations as in Figure 1.

JACC: CASE REPORTS, VOL. 30, NO. 13, 2025
JUNE 4, 2025:104000

FIGURE 3 **Baseline Ultrasound Images of the Radial Arteriovenous Fistula**



(A) Site of communication (arrow) between radial artery (RA) and vein (RV); (B) cross-sectional duplex ultrasound image of the RA and RV; (C) flow turbulence at the site of communication; (D) communication point at the site of RA; (E) "arterialization" of the flow in the radial vein and color bruit artifact.

clopidogrel) without any complications. Routine predischarge palpation of the radial artery showed nicely palpable radial pulse without presence of thrill or obvious signs of local complications.

Five months later, the patient presented with a warm and significantly swollen right forearm. No other symptoms were reported apart from severe discomfort of the right forearm. At physical examination, the forearm was warm and erythematous, with palpable (thrill) and loudly audible bruit.

PAST MEDICAL HISTORY

The patient had no previous cardiac events. He was a former smoker and had a history of hypertension and hyperlipidemia, both well controlled with appropriate medications.

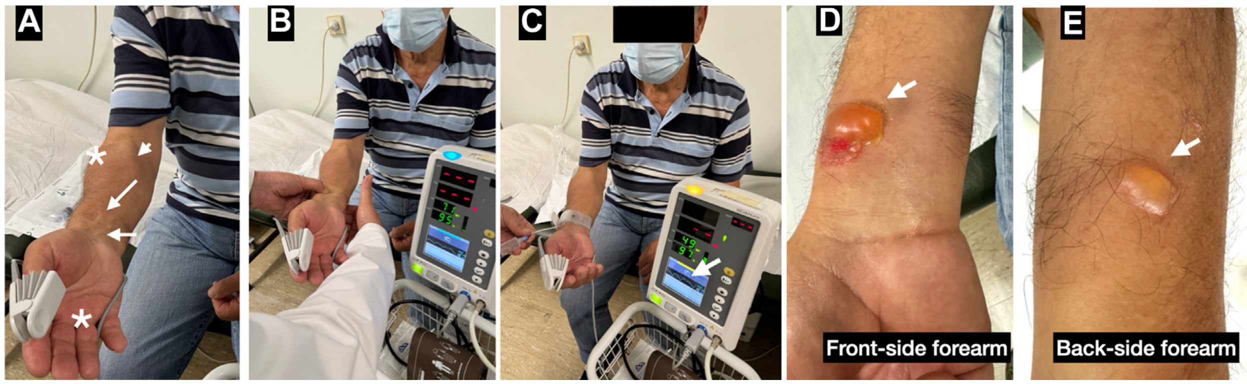
DIFFERENTIAL DIAGNOSIS AND INVESTIGATIONS

An AVF was clinically suspected, with other possible diagnostic differentials including pseudoaneurysm and radial artery dissection. Duplex ultrasound of the forearm (Figure 3) promptly confirmed the diagnosis of AVF.

MANAGEMENT

To alleviate the patient's discomfort, an initial attempt to close the AVF by means of prolonged radial compression for 24 hours with a standard hemostasis band was attempted. After 12 hours of continuous compression, the patient returned complaining for increasing discomfort of the arm. Unfortunately, no signs of successful fistula closure were evident; warm forearm and loud audible bruit were still present. Moreover, a large local skin ulcer with extensive blisters complicated the compression site, making a second attempt of prolonged compression unfeasible (Figure 4, Video 1). The patient was put on antibiotics and local skin therapy for 20 days, and an invasive approach to close the AVF was scheduled. After thorough discussion with the vascular surgeons, an endovascular percutaneous approach was decided, using the dTRA to access the AVF point of communication and close it with a GS.

FIGURE 4 **Unsuccessful Attempt to Close the AVF With Long Compression**



After 12 hours, premature removal of the prolonged radial compression device was needed owing to the presence of a fluid-filled cyst and a pressure ulcer at the site of the hemostasis band. A loud bruit was still palpable and auscultated with the stethoscope, indicate unsuccessful fistula closure. (A) Patient at presentation, with obvious enlargement of the veins of the forearm (white arrows) and swelling of the hand and the fingers (asterisks). (B) Barbeau test applied to evaluate ulnar patency and sufficient collateral perfusion of the hand, in order to safely proceed to a 24-h radial compression. (C) Radial hemostasis device was applied, maintaining perfusion in the thumb, as proved by means of plethysmography method: visual pulse waveform (white arrow) and clear indication for sufficient O_2 saturation (97%). (D, E) Prolonged compression complicated with skin ulcer and blisters.

The right distal artery ("snuffbox") was selected to access the site of radial fistula. Successful puncture of the distal radial artery was performed using a 20-G bare needle and a 0.025-inch wire were inserted, followed by a 6-F radial sheath 12 cm in length (Engage TR, St Jude/Abbott). The 0.025-inch wire was removed, and a workhorse 0.014-inch coronary angioplasty guidewire (Choice Floppy; Boston Scientific) was easily advanced to the proximal part of the brachial artery; 5,000 IU of heparin was introduced intravenously. Baseline angiography revealed a patent radial artery along with enlarged and dilated deep radial veins communicating with the superficial cephalic and basilic veins (Figure 5). After intra-arterial injection of nitroglycerin to achieve maximal vasodilation, multiple angiograms were obtained to evaluate the appropriate size of the radial artery and reveal the exact site of AVF communication. According to initial ultrasound measurements, a coronary GS was selected (3.5 × 21 mm, BeGraft with expanded polytetrafluoroethylene [ePTFE] membrane; Bentley InnoMed). Size and length of the stent was confirmed according to automated reference obstruction analysis (Philips Allura X-Prep 20FD). The GS was placed at the site of the fistula and inflated in the nominal pressure (11 atm) with immediate sealing. Additional dilatations with a noncompliant balloon 3.5 × 15 mm (Quantum Apex, Boston Scientific) were performed, especially at the stent edges, to ensure complete sealing. A final angiogram showed full radial patency without the presence of venous circulation, indicating successful AVF closure (Figure 6). dTRA ("snuffbox") site hemostasis was achieved using a routine radial balloon compression hemostasis device applied for 4 hours.

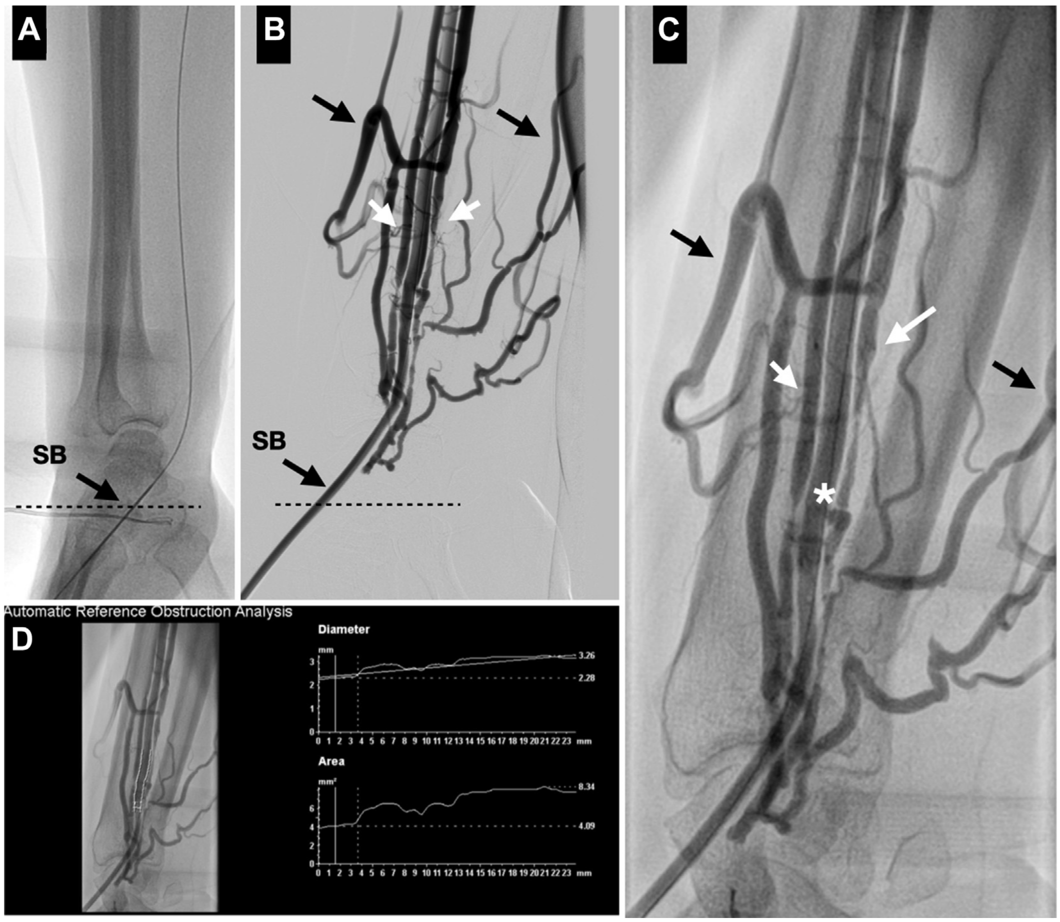
OUTCOME AND FOLLOW-UP

The following day, the patient reported complete resolution of his symptoms. The forearm appeared normal, with no signs of warmth, and the bruit was no longer audible. At 48 hours, a new duplex ultrasound confirmed closure of AVF with thrombotic occlusion of one of the accompanying radial veins (Figure 7). The patient was discharged on dual antiplatelet therapy with no interruption before, during or after the procedure.

At 1 month after the procedure, there were no signs of warmth or swelling in the right forearm. A follow-up duplex ultrasound confirmed radial patency, with no signs of re-stenosis, thrombosis, or AVF relapse. A series of ultrasound images at baseline, 48 hours, and 30 days after the procedure are provided in Figure 8. At 4 months, the patient remained clinically stable, asymptomatic, and free of dyspnea or angina (NYHA functional class I, Canadian Cardiovascular Society class 0), without any clinical signs of AVF relapse.

JACC: CASE REPORTS, VOL. 30, NO. 13, 2025
JUNE 4, 2025:104000

FIGURE 5 **Baseline Angiography via the Right Distal Radial Artery (dTRA-"Snuffbox")**



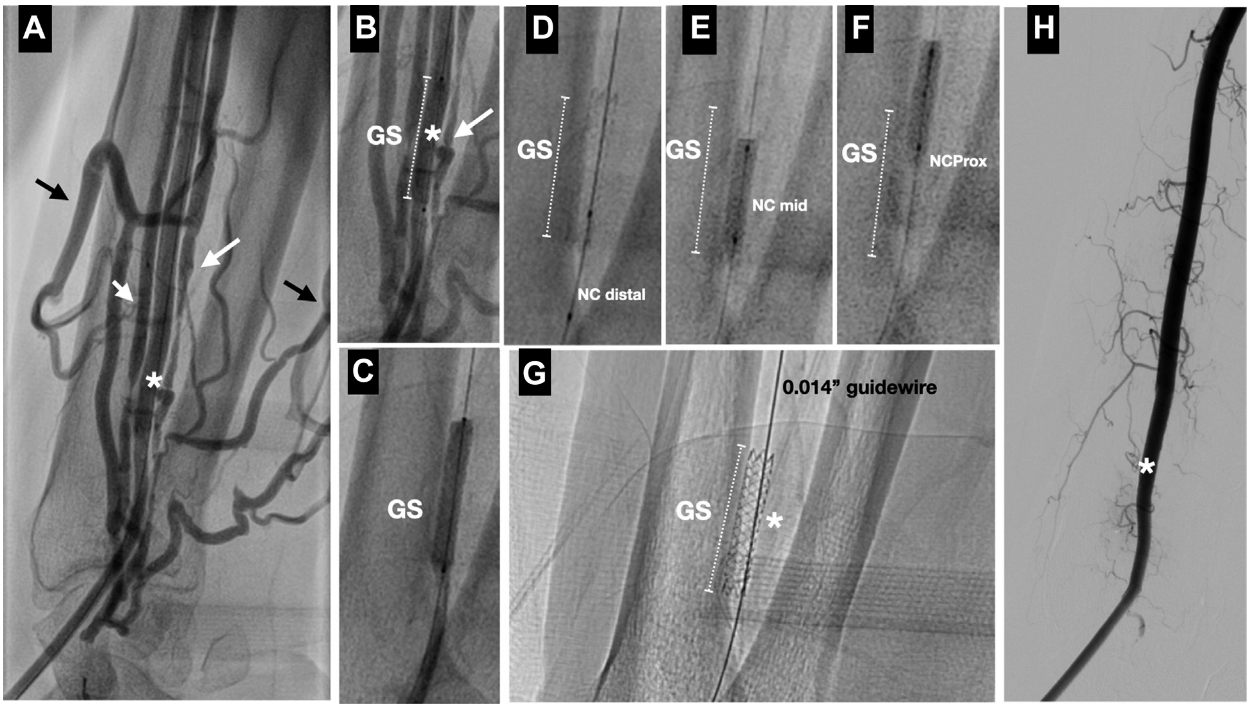
(A) Through a bare 20-G needle, a 0.025-in wire was inserted to achieve support for an Engager TR 6-F radial introducer sheath (Abbott Medical). (B, C) Baseline angiography revealed significant opacification of the venous system, with enlarged proximate venous circulation providing communication between the deep radial veins (white arrows) and the superficial vein system (cephalic and basilic vein; black arrows. (D) After intra-arterial nitroglycerin injection, automatic reference obstruction analysis was used to verify the exact diameter of the radial artery in order to select the appropriate size and length of the graft-stent (min diameter 2.3 mm, max diameter 3.2 mm). Asterisk indicates point of arteriovenous communication.

DISCUSSION

Iatrogenic radial AVF is an extremely rare complication of radial PCI procedures. Such AVFs may run undiagnosed for a long time and, in most of the cases, may be asymptomatic. In rare cases, large communications can be developed, which may lead to symptoms, particularly affecting the forearm. As in the present case, patients typically complain of forearm swelling and warmth. In the absence of symptoms and in case of hemodynamically insignificant shunt, radial AVF can be managed conservatively. However, when symptoms are persistent, accumulating, or increasing patient discomfort, closure of AVF should be considered.

Three basic techniques have been described so far to close a radial AVF: prolonged radial compression, surgical repair, and endovascular closure with a GS. Hashimoto et al reported complete occlusion of a left radial AVF by means of continuous compression of the left radial puncture site with a hemostatic band for 24 hours.[5] That is the only noninvasive report of successful radial AVF occlusion. In our case, however, the same technique had failed: The patient returned earlier, at 12 hours, owing to significant forearm discomfort and skin ulcer, without any signs of

FIGURE 6 **AVF Closure Procedure Step-by-Step**



(A) Baseline image. Black arrows indicate enlarged and dilated superficial forearm veins, cephalic, and basilic veins. (B) Placement of the graft-stent (GS) at the point of communication (white arrow). (C) GS inflated at 12 atm. (D to F) Further dilatation with a noncompliant (NC) balloon, especially at the edges of the GS to ensure complete GS apposition. (G) Enhanced radiographic image of the deployed GS. (H) Final angiographic image demonstrates complete sealing of the atreriovenous fistula communication.

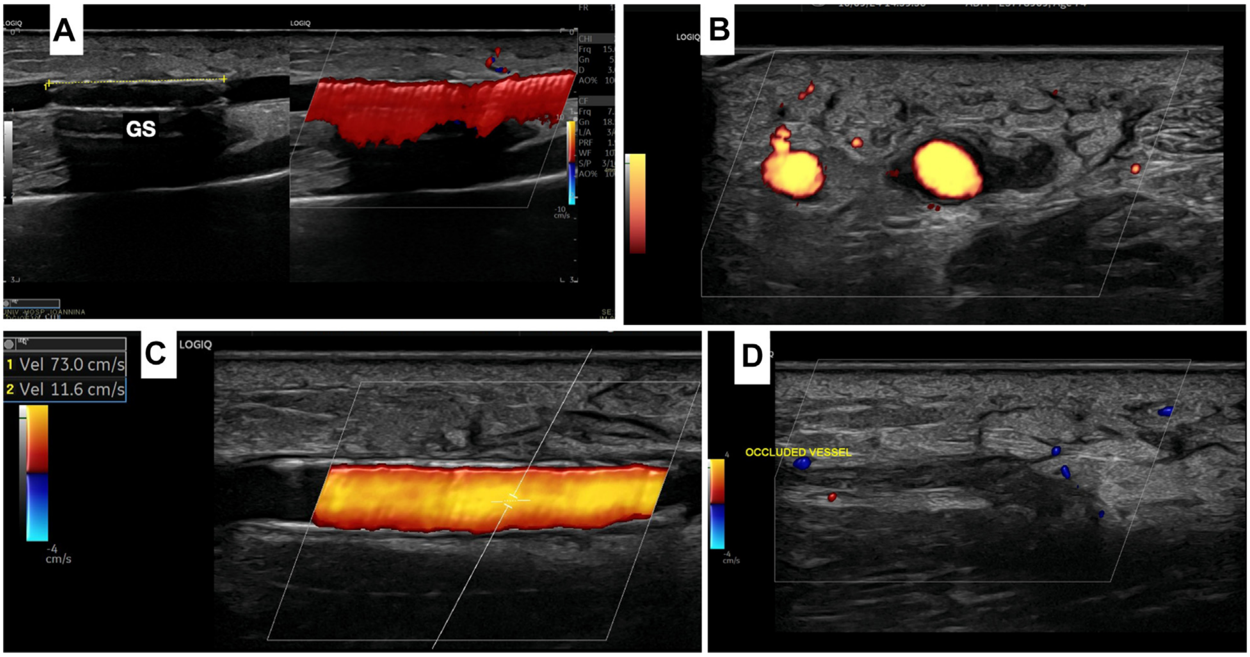
successful AVF closure. Several factors may have contributed to this failure. Both the shorter duration of compression (12 hours in this case, instead of the recommended 24 hours) and the significantly longer interval between the procedure and the diagnosis of the AVF may be among them. Hashimoto et al reported that the AVF became apparent on the 20th day after the procedure, suggesting that the AV system may not have fully developed at that time, making prolonged radial band compression potentially successful. However, our patient developed symptoms much later, indicating that the AVF may have matured sufficiently, making prolonged compression ineffective. In addition, the size of the sheath—7 F in our case compared with 6-F in the Hashimoto et al[5] report—may have played a role. The larger sheath caliber could have created a wider communication, leading to a larger AVF that was less amenable to closure with prolonged compression.

Previous reports have successfully treated AVFs mostly surgically by means of ligation of the site of AVF and repair of the radial artery when needed.[1,4] In one case, balloon-assisted embolization with N-butyl cyanoacrylate (NBCA) was used successfully to close radial AVF. However, after the initial procedure, another draining vein developed and a second procedure was deemed necessary to achieve complete resolution of AVF.[6] It should be noted that a potential risk for NBCA adhering to the balloon or distal NBCA embolization, leading to severe peripheral ischemia, has been recognized. In the present case, we considered that this technique may carry significant risk, mostly due to the peripheral location of the AVF and the potential risk of distal embolization that could lead to severe hand ischemia or even possible finger necrosis. Therefore, we considered the percutaneous GS technique as more appropriate for our patient.

There are several reports where a GS was used to close the AVF. Reguiro et al used a technique similar to ours to seal a late-presented iatrogenic radial AVF, after conservative measures, such as external compression, had failed.[7] In contrast to our case, they used transbrachial access to approach the site of AVF. They also had to use an additional GS, because the

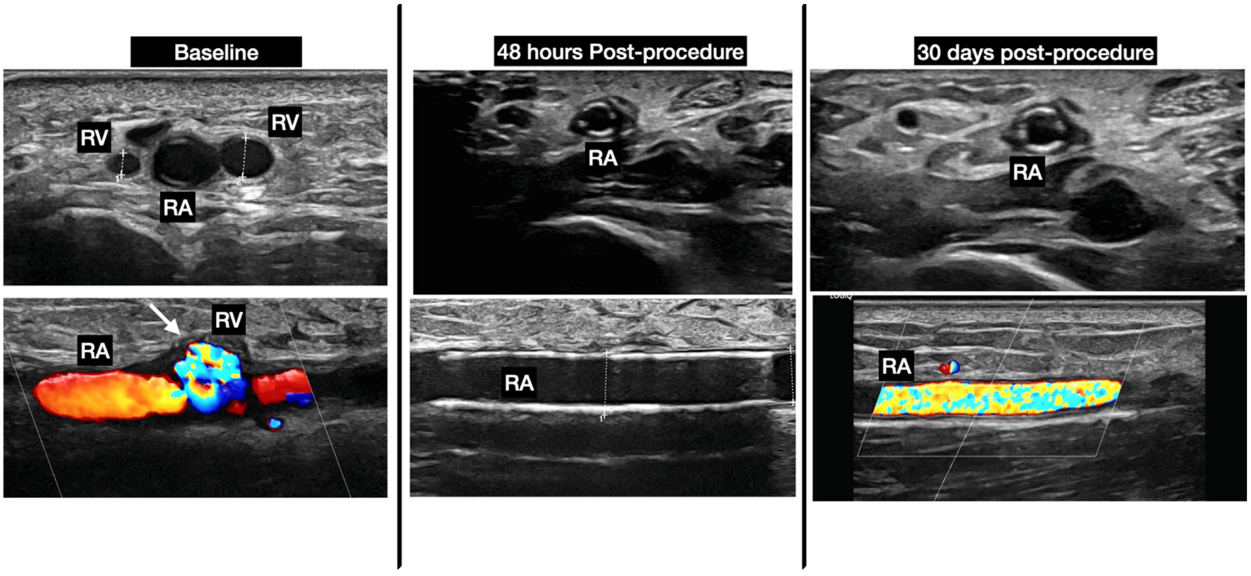
JACC: CASE REPORTS, VOL. 30, NO. 13, 2025
JUNE 4, 2025:104000

FIGURE 7 Duplex Ultrasound Images 48 Hours After Procedure



(A) Presence of the nicely expanded graft-stent (GS). (B, C) Patency of the radial artery. (D) Thrombotic occlusion of one of the radial veins.

FIGURE 8 Series of Duplex Ultrasound Follow-Up Comparison Images



Baseline, 48 hours, and 30 days after procedure. The graft-stent is clearly visible without any leakage. RA = radial artery; RV = radial vein.

first one proved to be small for the size of the radial artery and a second, larger, GS was required to successfully close the AVF. This underscores the importance of precise and careful measurement of the radial artery dimensions, both during the preprocedural duplex ultrasound, and peri-procedurally after intra-arterial nitroglycerin administration. These measurements are crucial to achieving the maximal radial artery diameter and selecting the appropriate GS size. Moreover, the use of transbrachial puncture may be associated with relatively higher risk of complications. In a large study by Petrov et al, which included 847 patients with transbrachial access, 7.3% of the patients suffered minor complications and 2.2% had severe complications requiring surgical intervention, such as pseudoaneurysm or thrombosis.[8] Hypothetically, in rare circumstances of "high," more proximal radial puncture, a more distal, yet not in the "snuffbox," radial approach could also be used.

Because of limited data, concerns have been raised regarding the long-term patency of GS in the radial artery position. Data from the application of different types of GS in the coronary arteries indicate that there is higher risk for thrombogenicity, and eventually stent thrombosis and stent closure, due to possible delayed endothelialzation.[9] Obviously, there are no data about the long-term patency of GS in the radial artery position. However, experimental data from canine iliofemoral arteries have indicated nearly complete endothelialization for ePTFE GS—like the one in our case—by 6 months.[10] Therefore, in such cases, extended dual antiplatelet therapy is generally recommended to mitigate the risk of late GS thrombosis. Nonetheless, the complexity of the PCI in our patient warranted prolonged dual antiplatelet therapy, limiting the risk of future GS failure. We further think that the precise calculations regarding the size, length, and stent-to-artery ratio, together with the meticulous deployment technique, will also contribute to the long-term patency of the GS.

Surgical repair is the standard of care in cases like the one presented here. However, our unique approach via the "snuffbox" site may offer an alternative, with lower rates of bleeding complications compared with surgery and other percutaneous access sites, particularly in patients requiring uninterrupted dual antiplatelet therapy, as in this case, after a complex unprotected left main PCI. In addition to bleeding concerns, the presence of extensive local skin infection, which required prolonged antibiotic therapy, compelled our surgeons to opt for an endovascular rather than local surgical intervention. In light of previous reports that used dTRA to treat occlusions of radial AVF mostly for renal hemodialysis, we selected the percutaneous treatment approach.[11]

Our technique may have an important limitation, mostly regarding the need for future reinterventions. The presence of SG at this particular site may prohibit possible future access. However, alternative access sites, such as contralateral radial access or ipsilateral "snuffbox" access, could overcome this problem.

AVFs have been reported as a rare complication of dTRA as well. However, none of those cases required intervention, and all of them were treated either with prolonged compression or conservatively.[12] In our center, we have adopted dTRA as the first option for the majority of diagnostic procedures and some of the interventional ones, accounting for 38.7% in total (448/1,157, both diagnostic and interventional procedures), without noticing any clinical sign of important AVF (unpublished data, Dimitrios N. Nikas, Andreas P. Eustathopoulos, February 2025). However, because no routine ultrasound examination was performed, we cannot exclude the occurrence of such a complication.

CONCLUSIONS

To the best of our knowledge, this is the first reported use of the ispilateral dTRA to approach and treat an iatrogenic radial AVF, 5 months after the insertion of a 7-F sheath for a complex PCI. dTRA offers several key advantages in managing radial AVF. It is associated with an enhanced safety profile because the access site is closer to the AVF, enabling a more targeted and efficient procedure. Additionally, dTRA reduces contrast requirements and significantly shortens hemostasis times compared with transfemoral or transbrachial access. Furthermore, it provides improved patient comfort, similarly to other transradial interventions, making it a preferred approach in such clinical scenarios.

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KEY WORDS complication, percutaneous coronary intervention, vascular disease

APPENDIX For a supplemental video, please see the online version of this paper.