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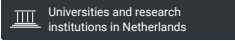
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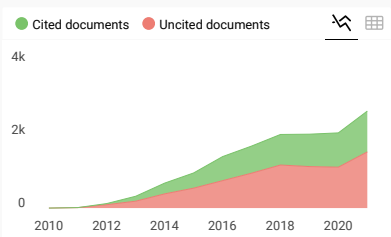
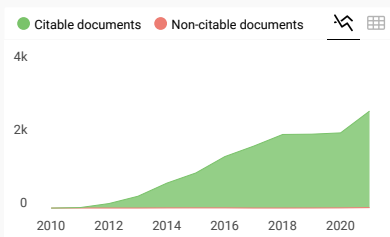
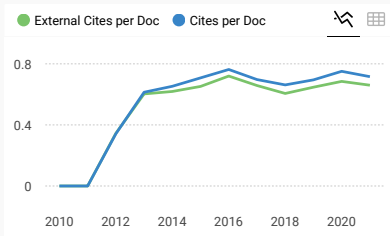
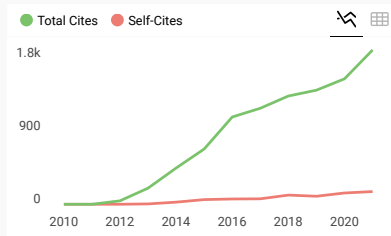
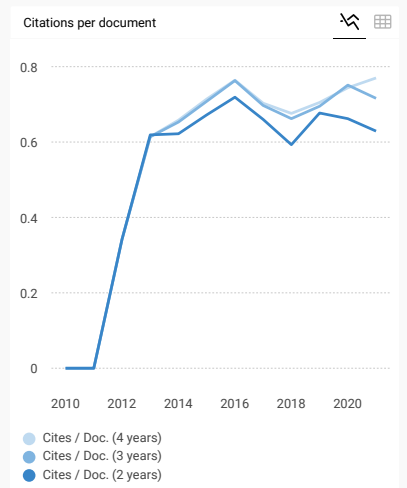
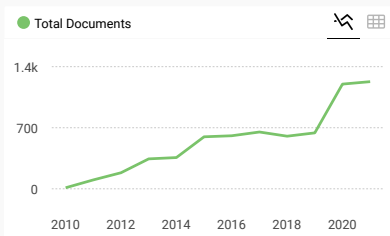
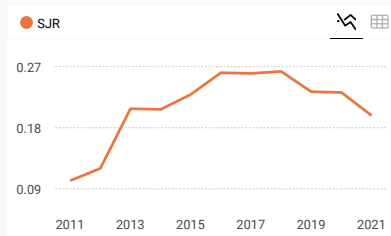
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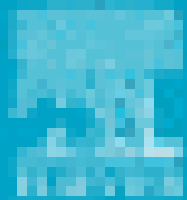


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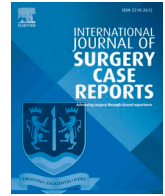
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## Case report

# Recognizing dialysis access steal syndrome with central vein stenosis as arteriovenous fistula complication: A case report

Denny Suwanto<sup>a,\*</sup>, Ivana Purnama Dewi<sup>a,b</sup>, Louisa Fadjri Kusuma Wardhani<sup>a</sup>,  
Yoga Alfian Noor<sup>a</sup>, Johannes Nugroho<sup>a</sup>

<sup>a</sup> Department of Cardiology and Vascular Medicine, Faculty of Medicine, Airlangga University - Dr. Soetomo General Hospital, Surabaya, Indonesia

<sup>b</sup> Faculty of Medicine, Duta Wacana Christian University, Yogyakarta, Indonesia

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## ABSTRACT

**Introduction:** Ischemic consequences of hemodialysis arteriovenous (AV) access are infrequent, yet they can cause substantial limb impairment or even loss. Ischemia can be caused by many factors, but the most common etiology is reduced blood supply to the distal extremities due to blood flow through the AV fistula (AVF) or AV graft. We reported a case of dialysis access steal syndrome (DASS) in a diabetes mellitus patient.

**Case report:** A 69-year-old diabetic man with left brachiocephalic AVF on his left upper arm has main complaint of left-hand pain, swelling, and coldness. There are also trophic darkening changes in the distal first, third, and fourth fingers. A duplex doppler examination revealed a normal functional AV shunt with bidirectional distal retrograde inflow. There was also significant stenosis at axillary vein. So, a diagnosis of DASS with suspicion of distal anastomosis stenosis at axillary vein was made. The patient underwent digital amputation and surgical plication of the AV shunt. He also underwent percutaneous transluminal angioplasty at the level of axillary. After 10 days of care, he was later discharged.

**Clinical discussion:** DASS is life and limb-threatening clinical disorder. Not only does the discomfort make it difficult for the patient to tolerate hemodialysis, but the ischemia can cause tissue necrosis and the eventual loss of fingers and possibly the patient's life. Doppler ultrasonography is a non-invasive technique that provides important information about vascular anatomy and hemodynamics. Aggressive treatment, including limb surgery and intensive blood glucose regulation, will result in favourable results.

**Conclusions:** DASS is a rare condition usually encountered in hemodialysis patients with AVF. Proper diagnosis and management are needed to get an optimal outcome for the patient.

## 1. Introduction

Ischemia induced by an arteriovenous fistula (AVF) or AV graft (AVG) creation as access for hemodialysis is a relatively infrequent but potentially devastating complication. Various factors can cause ischemia, but the most common cause is decreased blood supply to the distal extremities due to blood flow through the AVF or AVG [1]. The prevalence of symptomatic Dialysis Access Steal Syndrome (DASS) is 4–10 % and varies depending on the AV shunt's type and location. DASS may also present several clinical symptoms ranging from minor to severe

[2]. A study by Zanow et al. on 4863 patients showed the incidence of AV shunt related ischemia as follows: snuffbox AVF (0 %), radiocephalic AVF (0.3 %), brachiocephalic AVF (0.9 %), brachiocephalic/basilic AVF (5.2 %), and polytetrafluoroethylene AVG (2.2 %) [3]. This case highlights the relevance of DASS, the complexity of causative factors and management strategy also the potential of duplex sonography in the diagnostic process. This case report has been reported in line with the SCARE Criteria [4].

**Abbreviations:** AVF, arteriovenous fistula; DASS, dialysis access steal syndrome; DRIL, distal revascularization interval ligation; MILLER, minimally invasive limited ligation endoluminal-assisted revision; PAI, proximalization of arterial inflow; PTA, percutaneous transluminal angioplasty; RUDI, revision using distal inflow.

\* Corresponding author at: Department of Cardiology and Vascular Medicine, Faculty of Medicine, Airlangga University - Dr. Soetomo General Hospital, Jl. Mayjen Prof. Dr. Moestopo No.6-8, Surabaya 60286, Indonesia.

E-mail address: [suwantodenny88@gmail.com](mailto:suwantodenny88@gmail.com) (D. Suwanto).

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Fig. 1. Swollen left hand with necrotic fingers.

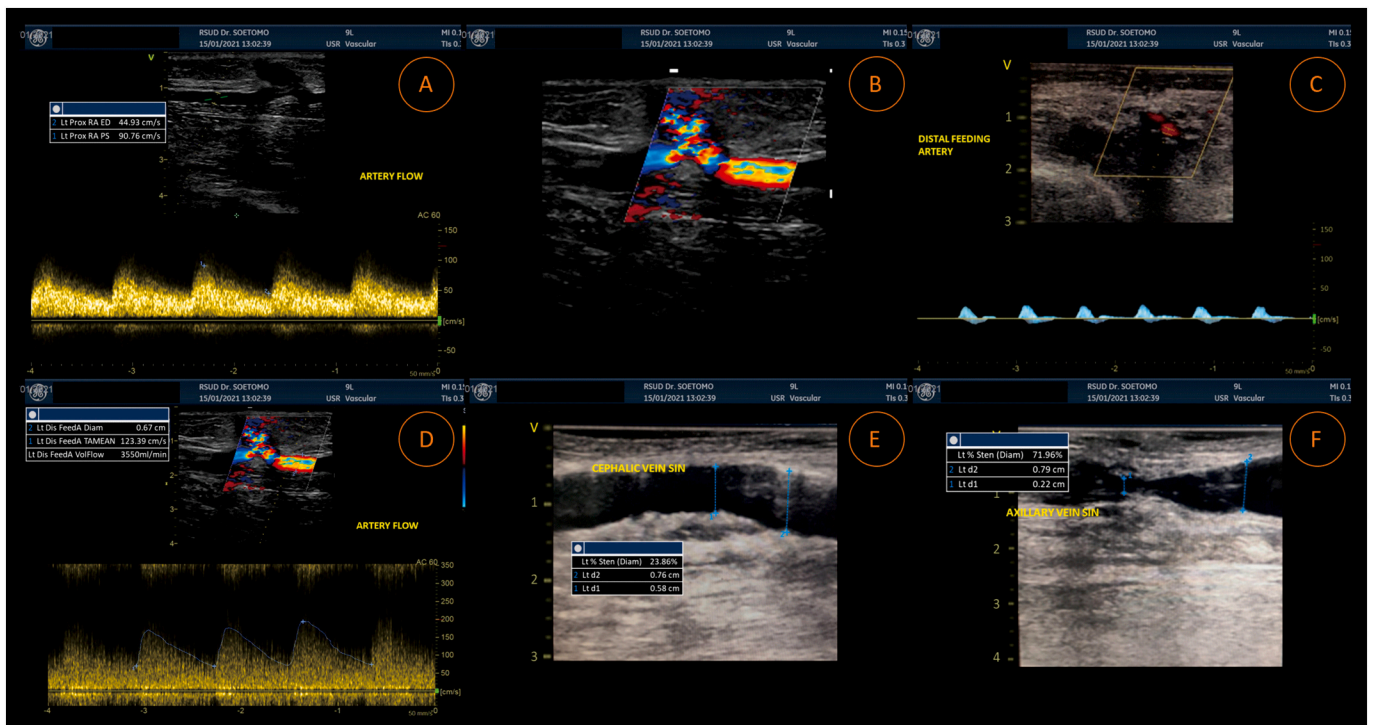


Fig. 2. (A) Normal brachial artery connected to venous segment, (B) flow in AVF with bidirectional shunt predominantly retrograde flow, (C) retrograde flow in the distal radial artery, (D) high flow AVF of 3550 mL/min (normal 600–800 mL/min, (E) normal cephalic vein, (F) significant stenosis at axillary vein.

2. Case report

A 69-year-old man with a left-arm brachiocephalic fistula presented with three months of left-hand pain, swelling, coldness, and trophic darkening changes in the distal aspects of the first, third, and fourth fingers. He was a diabetic male with left brachiocephalic AVF on his left upper arm for the last 6 months. He also had a history of failed right radiocephalic and brachiocephalic AVF abandoned for the past year. There was no history of allergies, smoking, alcohol, or recreational drug

use.

On physical exam, a palpable thrill on his left AVF signified a functional AV shunt. However, distal radial artery pulsation was severely diminished, which persisted even after compression test on the AV shunt. There was also no obtainable peripheral saturation on the 2nd to 5th left finger (Fig. 1). Blood work showed typical findings in diabetic and chronic kidney disease with increased random blood glucose (288 mg/dL), HbA1C (7.6 %), anemia (Hb 8.9 mg/dL), increased serum creatinine (4.1 mg/dL), blood urea nitrogen (BUN 97 mg/dL),

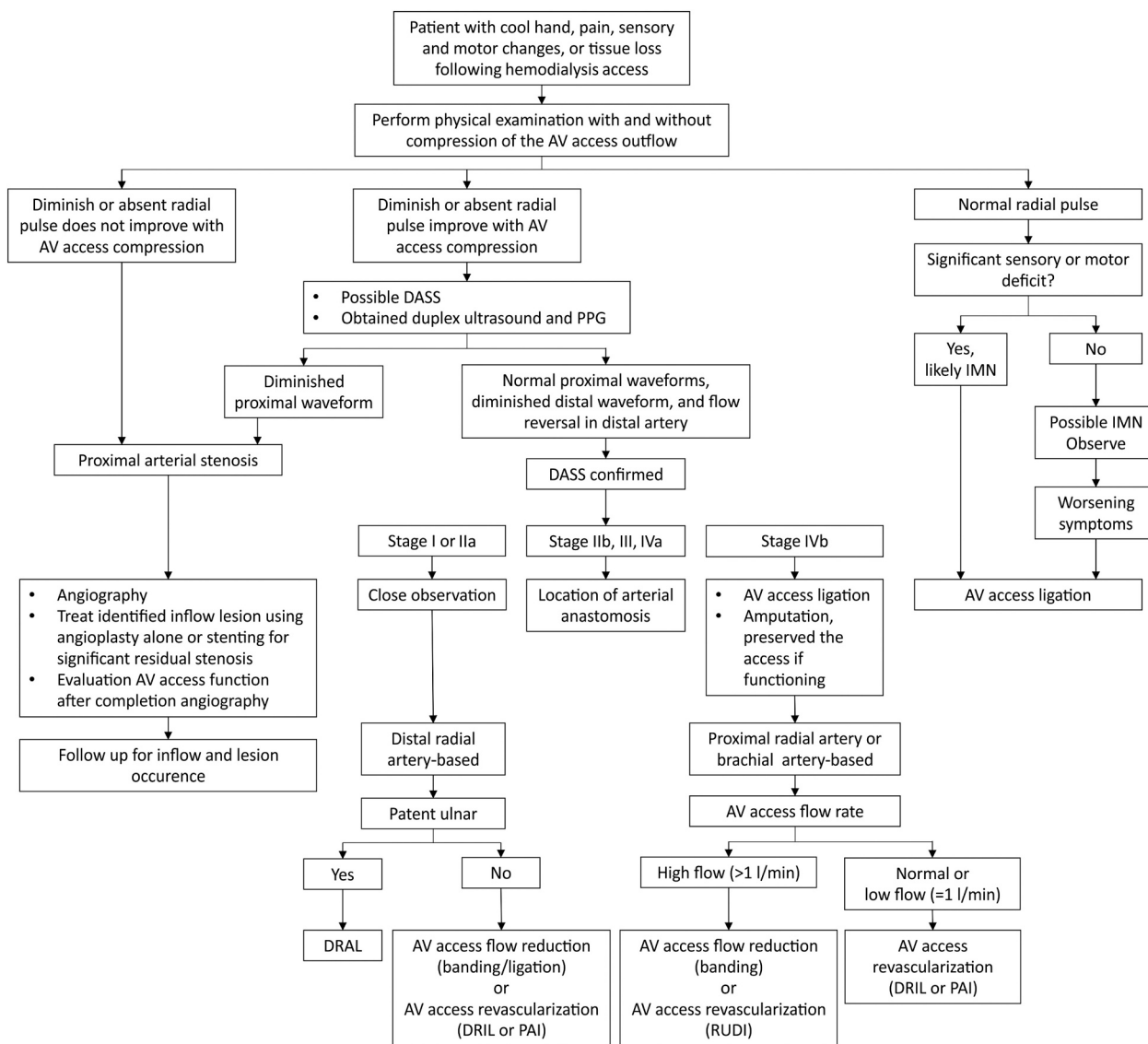


Fig. 3. DASS diagnosis and management algorithm [1].

AV: arteriovenous; DASS: dialysis access-related steal syndrome; PPG: photoplethysmography; IMN: ischemic monomelic neuropathy; DRAL: distal radial artery ligation; DRIL: distal revascularization interval ligation; PAI: proximalization of inflow; RUDI: revision using distal inflow.

hyperkalemia (5.9 mmol/L), and hypoalbuminemia (2.6 ng/L). His ECG showed left ventricular hypertrophy, chest X-ray showed cardiomegaly, echocardiography showed normal ejection fraction (EF) 61 %, grade I diastolic dysfunction, and concentric left ventricle hypertrophy.

Duplex doppler examination revealed a normal functional AV shunt, however, the distal flow was bidirectional with predominantly retrograde inflow. Distal radial artery scanning objectively shows a retrograde flow by doppler tracing. Calculation of flow volume in the fistula showed an excessively high flow volume of 3350 mL/min (normal upper arm AV shunt: 600–800 mL/min) [3]. No perianastomotic venous or arterial stenosis was detected. The brachial artery proximal to the distal anastomosis exhibited low-resistance antegrade flow, typical for a normal functioning fistula artery, while the artery waveform distal to the anastomosis showed high resistance with retrograde flow (Fig. 2). There was also significant stenosis at axillary vein. Based on these findings, a diagnosis of DASS with suspicion of distal to anastomosis stenosis at axillary vein was made.

After consulting with a vascular surgeon, the patient underwent digital amputation and surgical plication of the AV shunt. He also underwent angiography for percutaneous transluminal angioplasty (PTA)

at the level of axillary vein stenosis performed by a vascular interventionist. On the 2nd to 5th day of post-operative, there was poor wound healing at the surgical site, which may have been due to his diabetic comorbidity. However, after prompt treatment and glycemic control, the patient's condition is getting better. The patient was then discharged on the 10th day of hospitalization. The patient feels relieved after the operation because the pain complaints are much reduced. The patient was followed up monthly without any complaints six months after procedure.

### 3. Discussion

Peripheral ischemia is a limb and even life-threatening clinical disorder. It causes discomfort that makes it difficult for the patient to endure hemodialysis. Ischemia can cause tissue necrosis and the eventual loss of fingers or perhaps the entire hand. Some conditions can be related to the development of ischemic symptoms, such as smoking, peripheral vascular disease, and diabetes. DASS can be due to combination of processes that produce peripheral ischemia, such as stenotic lesions, distal arteriopathy, and retrograde flow [5]. For this reason, the



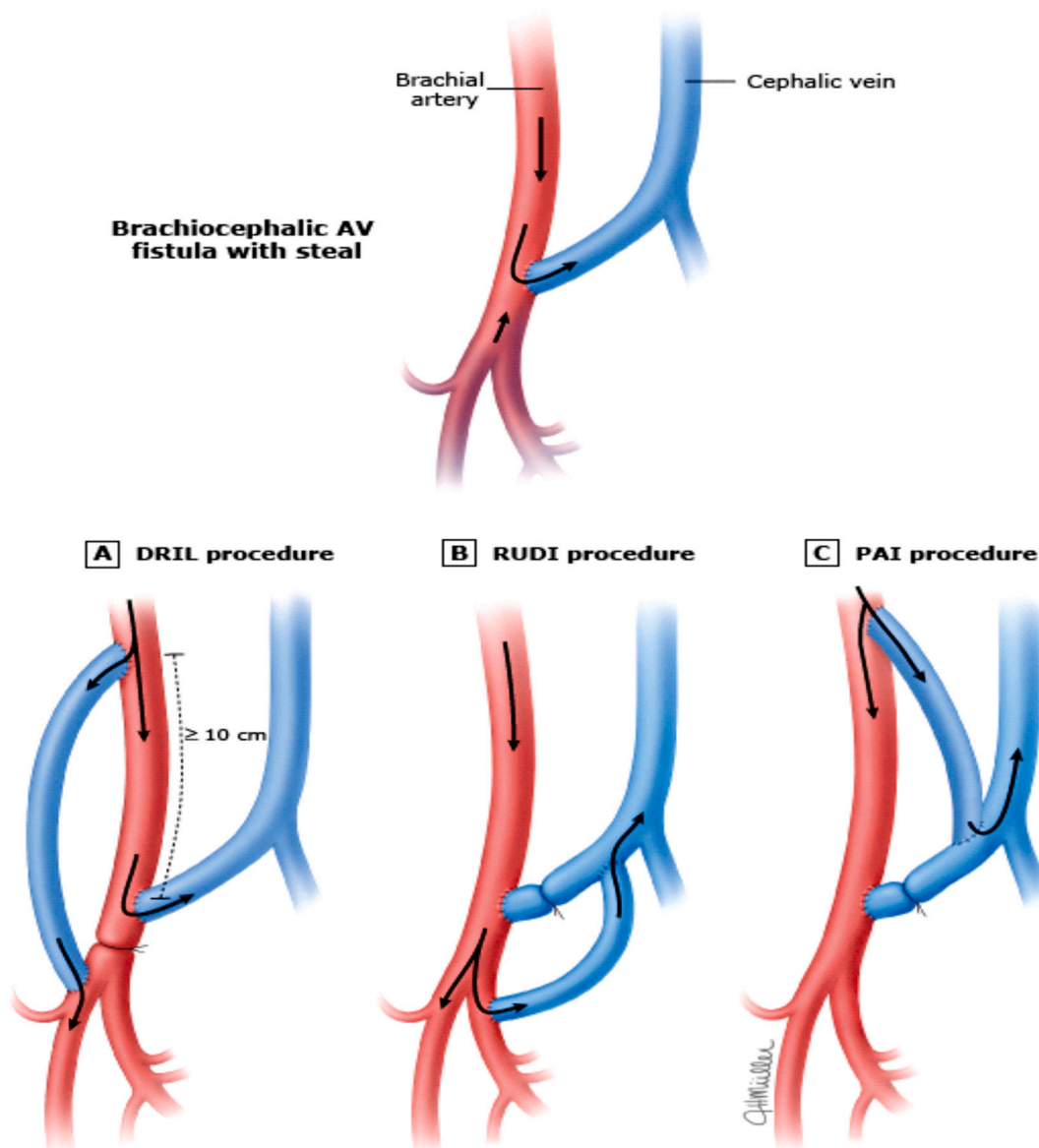


Fig. 4. Surgical revision for brachiocephalic fistula steal.

cause of ischemic symptoms should be investigated using a detailed medical history, physical examination, and careful evaluation of the arterial circulation of the extremity.

Ohm’s law states that fluid flow follows the path of least resistance, and creating AVF/AVG will form a low-resistance vascular circuit [6]. The etiology entities of DASS are (1) Arterial stenosis inducing low arterial inflow, (2) Large AVF producing high fistula flow and “stealing” distal perfusion, and (3) Poor vascular adaptation and collateral formation post fistula/graft placement [7]. As in our cases, a high flow AVF induced distal perfusion stealing and tissue ischemia. Theoretically, all AV shunts induce stealing of blood, however, their clinical significance differs between individuals. DASS can be staged based on clinical condition [1] (Fig. 3):

- I: Pale/livid hand and/or cool hand without pain
- Ia: Tolerable pain during exercise and/or during dialysis
- Ib: Intolerable pain during exercise and/or during dialysis
- III: Rest pain or loss of motor function
- IVa: Limited tissue loss, the potential for preservation of hand function
- IVb: Irreversible tissue loss, significant hand function lost

An AV shunt is categorized as high-flow when the calculated flow volume is over 1500 mL/min [8,9]. High-flow AVF can potentially lead to various AV access-related and cardiovascular problems such as; pseudoaneurysm and aneurysmal of the AV access, accelerated central venous stenosis, cardiac overload, and cardiopulmonary recirculation leading to high output heart failure, and pulmonary hypertension [9,10].

Second pathology found in our case was central vein stenosis at the level of the axillary vein. This stenosis was accelerated by long-term exposure to shear stress from high AVF flow [11]. This stenosis limits the outflow drainage into the systemic vein and cardiac chamber. The imbalance of inflow/outflow may manifest as upper arm swelling. Percutaneous precision banding could be done using the Minimally Invasive Limited Ligation Endoluminal-assisted Revision (MILLER) banding procedure, which has been tested on 22 patients with excellent outcomes [12,13]. Surgical revascularization with high priority in preserving AV fistula could be done using distal revascularization interval ligation (DRIL) procedure, proximalization of arterial inflow (PAI), or revision using distal inflow (RUDI) [5,14] (Fig. 4). A bypass is established from the brachial artery at least 10 cm proximal to the distal brachial or proximal radial artery for the DRIL technique. The brachial

artery is then ligated just distal to the anastomosis, ensuring that flow into the ulnar and radial arteries from the bypass is preserved. The distal circulation depends on the new bypass's patency, putting the extremity at risk if it fails. In the RUDI technique, the fistula inflow is shifted to more distant arterial source (radial or ulnar artery) and the original fistula vein is ligated slightly above the anastomosis [1,15]. Unlike the DRIL operation, the RUDI preserves native arterial circulation, which puts the fistula at risk rather than the extremities. A bypass from the proximal brachial or axillary artery to the outflow vein distal to the original anastomosis is established for PAI [1,16]. Just above the anastomosis, the original fistula outflow vein is ligated. PAI, like the RUDI operation, puts the fistula at risk rather than the extremities [1].

Based on the clinical data above, our patient presented with DASS stage IV with necrotic fingers. He was suggested to undergo precision banding on the AVF by surgical or percutaneous method concurrent with digital amputation for the necrotic segment. When there are dual lesions (high-flow AV shunt and axillary vein stenosis), it is recommended to undergo banding on AVF initially and PTA on central vein stenosis later because management of central vein stenosis as the initial procedure will diminish its protective effect and induce excessive venous return leading to cardiac decongestion and high output heart failure [14].

#### 4. Conclusion

DASS is a rare condition usually encountered in hemodialysis patients with AVF. Doppler ultrasonography is non-invasive modality that provides important information about vascular anatomy and hemodynamics. Proper diagnosis and management are needed to get an optimal outcome for the patient.

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#### Ethical approval

Our institution exempted ethical approval.

#### Consent

Written informed consent was obtained from the patient for publication of the details of their medical case and any accompanying images. Identifiable patient information has been removed.

#### Author contribution

DS and JN conceived the idea and mainly designed the report. DS was contributed in patient management of this case and a major contributor to writing the manuscript. IPD and YAN have edited the manuscript for publication. IPD and LFKW contributed to artwork editing and grammar correction. JN reviewed the article before submission. All authors read and approved the final manuscript.

#### Availability of data and materials

The datasets used are available from the corresponding author on reasonable request.

#### Registration of research studies

Not applicable.

#### Guarantor

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Johanes Nugroho.

#### Declaration of competing interest

The authors declare that there is no conflict of interest.

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