
CASE REPORT

Salvaging Inadvertent Subintimal Stenting with Double-Barrel Subintimal Stenting: A Case Report

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CASE PRESENTATION

A 59-year-old male patient with a history of smoking, metabolic syndrome, ischaemic heart disease, and long-standing peripheral arterial disease presented to our institution in October 2022 with recurrent claudication. He had previously undergone multiple lower limb angioplasties and stenting procedures at various institutions between 2018 and 2021 for recurrent in-stent restenosis. These included an EverFlex stent (Medtronic, Plymouth [MN], US) in the left external iliac artery (EIA), a Protégé stent (Medtronic, Plymouth [MN], US) in the left common iliac artery (CIA), an EverFlex stent in the right EIA, a Supera stent (Abbott, Santa Clara [CA], US) from the right common femoral artery to the proximal superficial femoral artery (CFA-pSFA), a Zilver stent (Cook Medical, Limerick, Ireland) in the

right mid superficial femoral artery (mid-SFA), and a Supera stent from the right distal superficial femoral artery to the popliteal artery (dSFA-pop) [Figure 1].

The patient presented in 2022 with recurrent claudication following placement of a bridging CFA-pSFA stent between the right EIA and mid-SFA stents, with claudication distance reduced to 10 metres. In view of his recurrent symptoms, the authors were consulted for suspected stent occlusion of the previously placed multi-stent system. Computed tomography angiography revealed an in-stent occlusion due to misalignment of the CFA-pSFA and mid-SFA stents (Figure 2), likely resulting from subintimal placement of the CFA-pSFA stent.

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Submitted: 9 July 2025; Accepted: 29 September 2025.

Contributors: ESL, SCW and LFC designed the study. All authors acquired and analysed the data. ESL and SKHW drafted the manuscript. All authors critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of Interest: All authors have disclosed no conflicts of interest.

Funding/Support: This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability: All data generated or analysed during the present study are available from the corresponding author on reasonable request.

Ethics Approval: This study was approved by the Central Institutional Review Board of Hospital Authority, Hong Kong (Ref No.: CIRB-2024-555-4). The patient was treated in accordance with the Declaration of Helsinki and provided written informed consent for all treatments, procedures, and the publication of all clinical images.

Declaration: Part of this study was presented as a poster at the 18th Annual Scientific Meeting of Asia Pacific Society of Cardiovascular and Interventional Radiology, 3-5 May 2024, Bangkok, Thailand.

Supplementary Material: The supplementary material was provided by the authors and some information may not have been peer reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by the Hong Kong College of Radiologists. The Hong Kong College of Radiologists disclaims all liability and responsibility arising from any reliance placed on the content. To view the file, please visit the journal online (<https://doi.org/10.12809/hkjr2518009>).

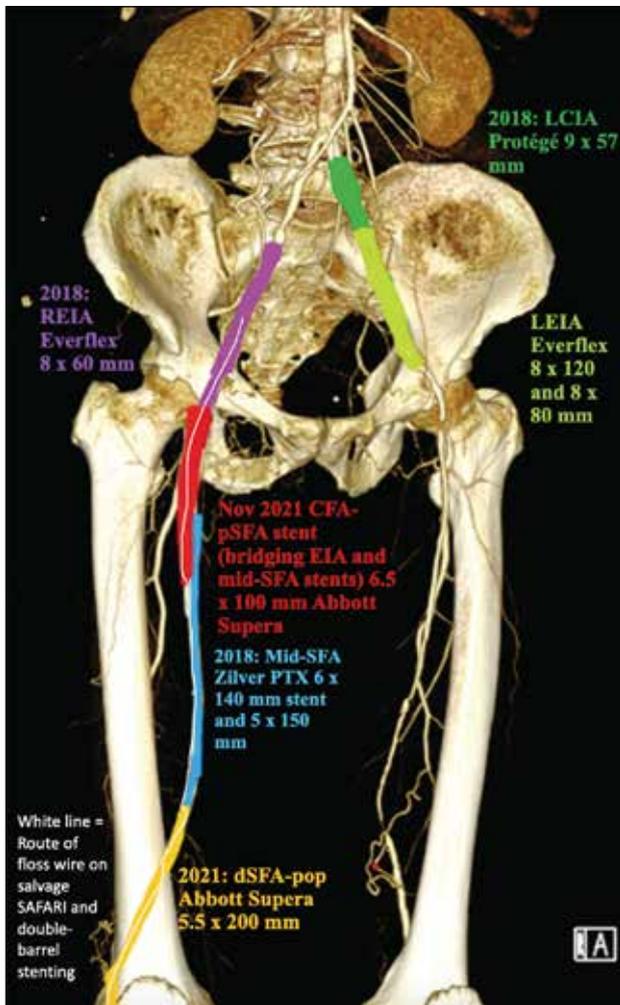


Figure 1. A summary of stents previously placed in the patient between 2018 and 2021 at various institutions. Left common iliac artery (LCIA), left external iliac artery (LEIA), right external iliac artery (REIA), and mid superficial femoral artery (mid-SFA) stents were placed in 2018 for peripheral vascular disease. A distal superficial femoral artery–popliteal artery (dSFA-pop) stent was placed in early 2021. A common femoral artery to proximal superficial femoral artery (CFA-pSFA) stent was placed in November 2021 to bridge the REIA and mid-SFA stents. A thin white line depicts the course of the retrograde guidewire during the 2023 SAFARI (subintimal arterial flossing with antegrade-retrograde intervention) double-barrel stenting procedure. The intraluminal position within the dSFA-pop stent, subintimal position outside the lumen of the mid-SFA stent, and subsequent intraluminal re-entry into the CFA-pSFA stent were confirmed by fluoroscopy and intravascular ultrasound. The retrograde wire was subsequently advanced into a long sheath to establish a floss wire between the right ankle and left groin access.

Digital subtraction angiography images in the anteroposterior projection from the previous procedure in November 2021 revealed apparent alignment of the CFA-pSFA and mid-SFA stents, with improved runoff post-stenting (Figure 3). Lateral views were unavailable.

In view of the recurrent claudication and the in-stent occlusion, repeat angioplasty was performed in October 2023. Left CFA access with crossover was performed. A 6-Fr Destination long sheath (Terumo, Somerset [NJ], US) was placed in the right CIA. A 0.035-inch guidewire (Terumo, Tokyo, Japan) was advanced through the lumen of the occluded right CFA-pSFA stent, encountering resistance (Figure 4a). Inability to negotiate the wire into the right mid-SFA stent led to a decision to obtain retrograde access via the right posterior tibial artery (PTA). With the aid of a 2.6-Fr CXI microcatheter (Cook Medical, Bloomington [IN], US), a 0.018-inch Advantage wire (Terumo, Tokyo, Japan) was advanced retrogradely through the PTA and the dSFA-pop Supera stent intraluminally. The wire was manipulated at the junction of the mid-SFA Zilver stent and dSFA-pop Supera stent, entering the subintimal space. After further subintimal manipulation, re-entry of the retrograde wire into the lumen of the occluded CFA-pSFA stent was achieved. The wire was then advanced into the right EIA/CIA stent lumen (Figures 1 and 4b). Wire position was confirmed by intravascular ultrasound (IVUS) [Visions PV 0.018-inch catheter (Phillips, Rancho Cordova [CA], US)] and angiography. The retrograde wire was externalised through the 6-Fr crossover sheath and retrieved via the left groin access to establish through-and-through access.

Angioplasty was performed along the wire path from the right popliteal artery stent to the left EIA stent with an Armada 6 × 200 mm² balloon (Abbott, Santa Clara [CA], US), expanding the subintimal space for subsequent stenting. Following IVUS sizing, double-barrel subintimal stenting was performed by deploying a Supera 5.5 × 80 mm² stent to bridge the CFA-pSFA and dSFA-pop stents (Figure 4c). Additional angioplasty of the newly deployed stent, as well as the PTA and tibioperoneal trunk, was performed with an Armada 2.5 × 200 mm² balloon. Completion angiography demonstrated re-establishment of flow through the double-barrel subintimal stent, with a patent intraluminal-subintimal-intraluminal channel and crush exclusion of the Zilver mid-SFA stent (Figure 4d and e). Postoperatively, the patient resumed apixaban 5 mg twice daily and aspirin 80 mg daily.

At 1-month follow-up, symptoms improved from claudication after walking 20 steps (Rutherford grade III) to no claudication (Rutherford grade 0). There was no evidence of tissue loss or vascular compromise. At 8 months, follow-up computed tomography showed

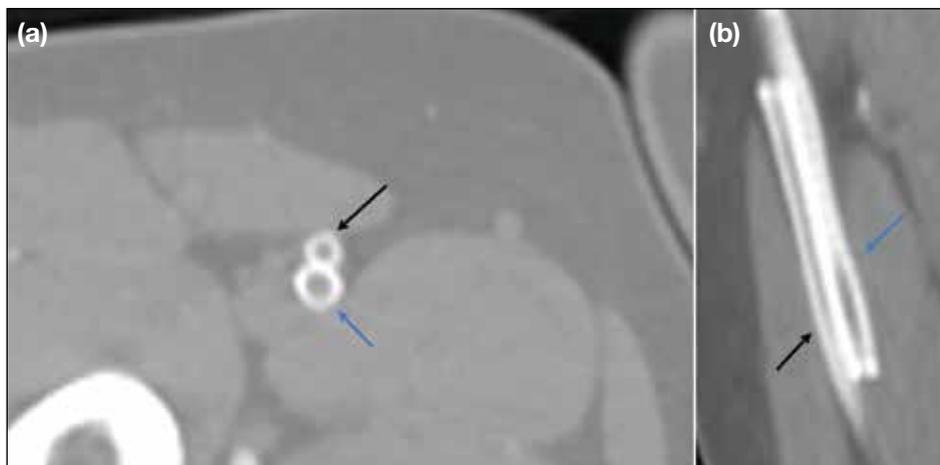


Figure 2. Computed tomography angiogram in 2022 showing stent occlusion, likely resulting from malalignment of the common femoral artery to the Supera stent (blue arrows) of the proximal superficial femoral artery (CFA-pSFA) and the Zilver stent (black arrows) of the mid superficial femoral artery (mid-SFA). The distal margin of the CFA-pSFA stent is seen within the subintimal space, external to the mid-SFA stent. (a) Axial view. (b) Sagittal reconstruction.



Figure 3. Retrospective review of prior common femoral artery to proximal superficial femoral artery bridging stent placement in 2021 showing (a) apparent stent alignment (black arrow) and (b) acceptable runoff on completion angiography.

successful crush exclusion of the mid-SFA Zilver stent (Figure 5). There was complete alignment of the mid-SFA Supera stent with adjacent proximal and distal

stents, with preserved patency and no significant in-stent restenosis (Figure 5). However, mild-to-moderate in-stent restenosis was noted in the previously implanted popliteal and iliac stents. The patient remains under surveillance and is scheduled for repeat angioplasty to preserve the patency of the multi-stent system (online supplementary Figure).

DISCUSSION

Our case highlights several important considerations for interventionists. In retrospect, inadvertent subintimal stent placement could have been avoided through several measures. First, routine biplanar imaging could prevent false assurance from a single anteroposterior projection and detect stent misalignment. Attention should also be paid to contrast pooling around the stent tips and the rate of contrast runoff; delayed clearance may alert the operator to possible distal outflow impairment or subintimal entry. Second, careful observation of the guidewire tip behaviour and mobility may alert interventionists to inadvertent subintimal entry. In cases of initial intimal dissection and subintimal entry, the tip load of the guidewire may be exceeded with the wire tip bending in the reverse direction and a ‘crushing’ sensation commonly reported.¹ Initial entry into the potential subintimal space may restrict free wire rotation. Nonetheless, where manipulation continues and the wire tracks further into an enlarging subintimal space, guidewire rotation may become freer, with loss of resistance. Prolonged manipulation should be avoided if early intraluminal re-entry fails, as this may enlarge the subintimal space and further complicate luminal re-entry. Third, in cases of equivocal wire position,

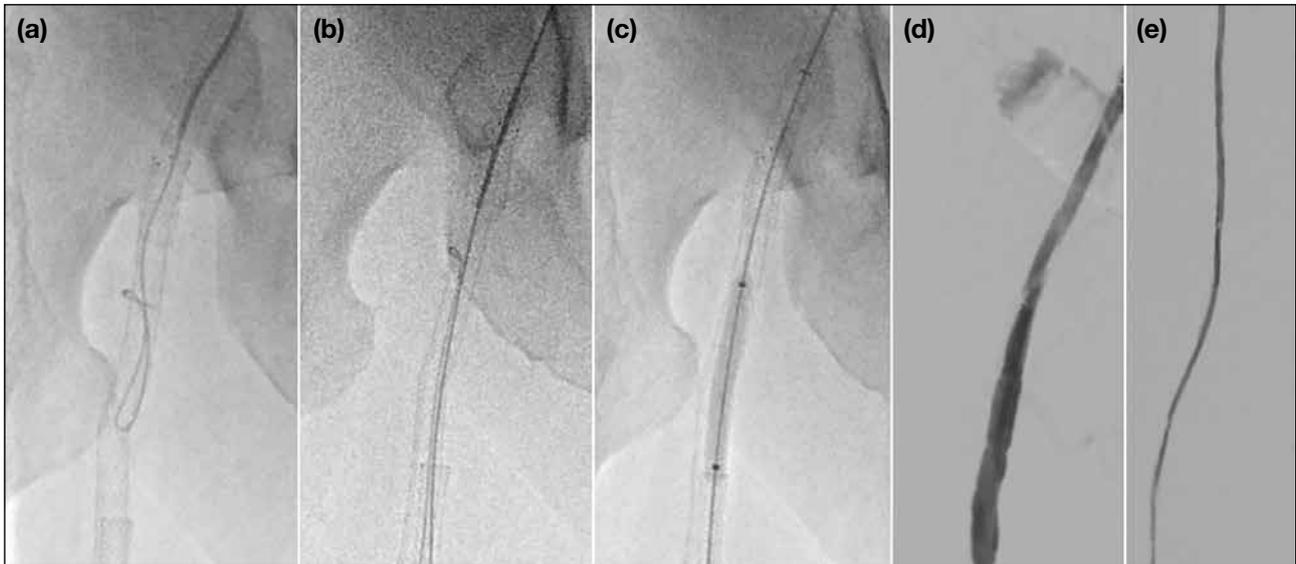


Figure 4. Digital subtraction angiography images of angioplasty and double-barrel stenting performed in November 2023. (a) Crossover wire from left femoral access, with the tip positioned within the right common femoral artery to the proximal superficial femoral artery (CFA-pSFA) stent, encountering resistance due to occlusion. The occlusion was eventually navigated; however, in view of failure to re-enter the mid superficial femoral artery (mid-SFA) stent lumen, a retrograde approach was employed. (b) A 0.018-inch retrograde wire via right posterior tibial artery access was advanced intraluminally through the occluded distal superficial femoral artery popliteal artery stent, with subsequent entry into the subintimal space outside the Zilver SFA stent and re-entry into the intraluminal occluded CFA stent. The long sheath from the left groin access was cannulated by the retrograde wire and subsequently externalised, establishing a through-and-through floss wire. Position was confirmed by intravascular ultrasound (Figure 6). (c) After establishment of the floss wire, angioplasty of the intraluminal-subintimal-intraluminal wire tract was performed. (d, e) Angioplasty of the posterior tibial artery and tibioperoneal trunk was performed, followed by mid-SFA stenting with double-barrel exclusion of the Zilver stent. Completion angiography showed significant restoration of flow between the newly deployed mid-SFA stent and adjacent stents.

familiarity with IVUS may assist operators in accurately stenting within the true lumen. The IVUS images from our salvage procedure are shown (Figure 6). Although resource-intensive and operator-dependent, IVUS enables more accurate visualisation of the vascular and subintimal spaces with applications not only in stent positioning but also in the accurate arterial stent sizing.^{2,3}

In cases of inadvertent subintimal entry or dissection, achieving luminal re-entry remains a major challenge, and familiarity with re-entry techniques is essential for interventionists. If spontaneous re-entry cannot be achieved with a standard wire, specific re-entry devices such as the Outback (Cordis, Miami Lakes [FL], US) may be utilised. Promising data demonstrated technical success and primary stent patency rates of up to 92.3% at 12 months with the Outback, as subintimal angioplasty gains increasing recognition in the treatment of long-segment TransAtlantic Inter-Society Consensus II class C/D lesions.⁴ Where such devices are unavailable, several alternative approaches may be considered, including retrograde access via the distal artery with

establishment of a through-and-through floss wire using the subintimal arterial flossing with antegrade-retrograde intervention (the SAFARI [subintimal arterial flossing with antegrade-retrograde intervention] technique⁵ as in our case), the parallel wire technique,⁶ the wire rendezvous technique with ballooning of subintimal space as seen in CART (controlled antegrade and retrograde subintimal tracking), reverse CART, or the double-balloon technique.^{7,8}

In our experience, SAFARI can be performed in several ways once luminal re-entry has been achieved. First, a nitinol snare system may be deployed via antegrade access to capture the retrograde wire intraluminally and establish a through-and-through access.⁹ Alternatively, retrograde manipulation of the wire tip within the sheath or catheter via groin access may be performed (as in our current case).

To the best of our knowledge, cases of double-barrel subintimal stenting are sparsely reported in the literature and have not been reported locally. Several case reports

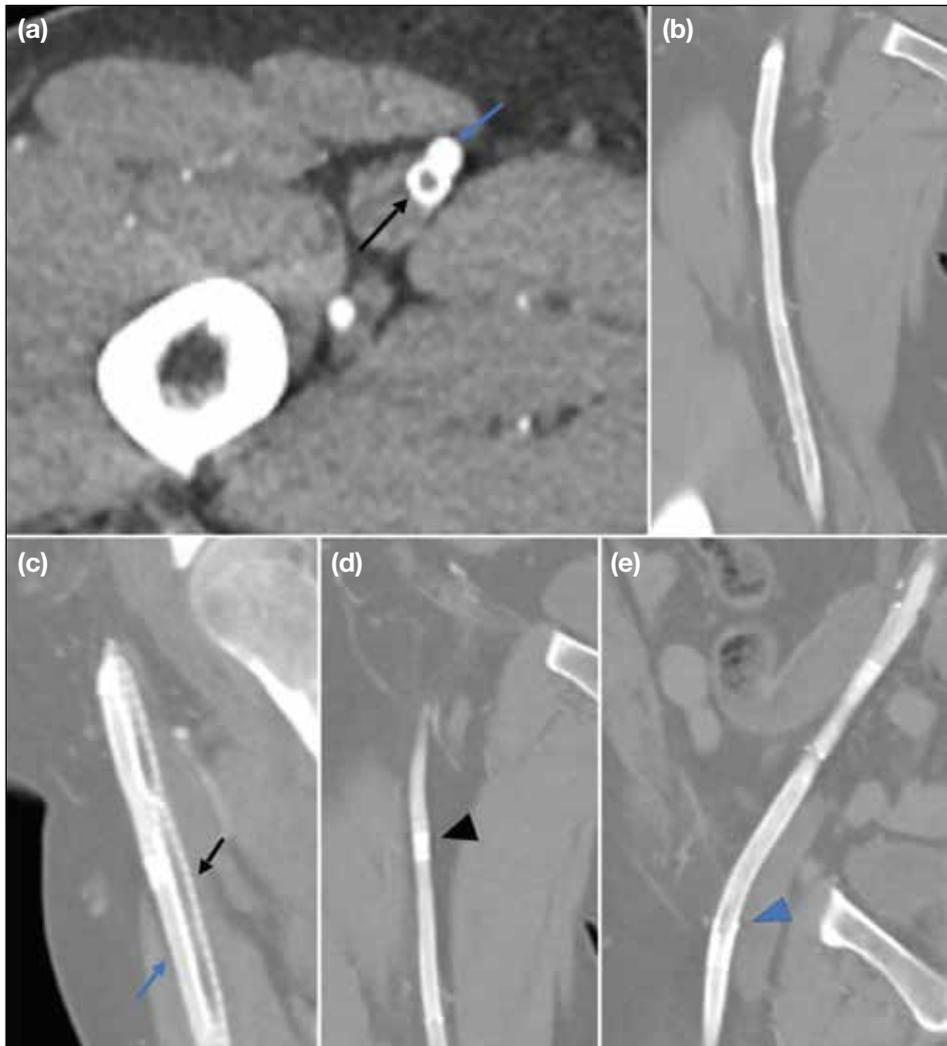


Figure 5. Follow-up computed tomography angiogram at 8 months postprocedure showing successful double-barrel stenting with exclusion of the mid superficial femoral artery (mid-SFA) Zilver stent (black arrows in [a] and [c]) and a patent new Supera mid-SFA stent (blue arrows in [a] and [c]): (a) axial view; (c) oblique sagittal view. Oblique coronal reconstruction showing patency throughout the intraluminal-subintimal-intraluminal multi-stent system (b), including the distal overlapping stent segments (black arrowhead in [d]) and the proximal overlapping stent segments (blue arrowhead in [e]).

describe double-barrel stenting (DBS) for exclusion of occluded stents in salvage procedures for lower limb and coronary arterial occlusions,¹⁰⁻¹² although this remains an uncommonly utilised technique. One case series of three patients with peripheral arterial disease following DBS reported varying degrees of success, with the longest assisted secondary patency of up to 85 months,¹³ supporting its feasibility and long-term patency.

CONCLUSION

We report a case of prior inadvertent subintimal stenting of a bridging CFA-pSFA stent, followed by successful salvage with subintimal DBS using the SAFARI technique within a multi-stent system. Methods to reduce the risk of inadvertent subintimal stenting are discussed. Subintimal manipulation and re-entry techniques with

antegrade-retrograde approaches are also discussed as important tools for interventionists. Although not commonly employed, DBS has been described in several case reports and small case series. Our case affirms the feasibility of this technique where salvage of inadvertent subintimal stenting is necessary.

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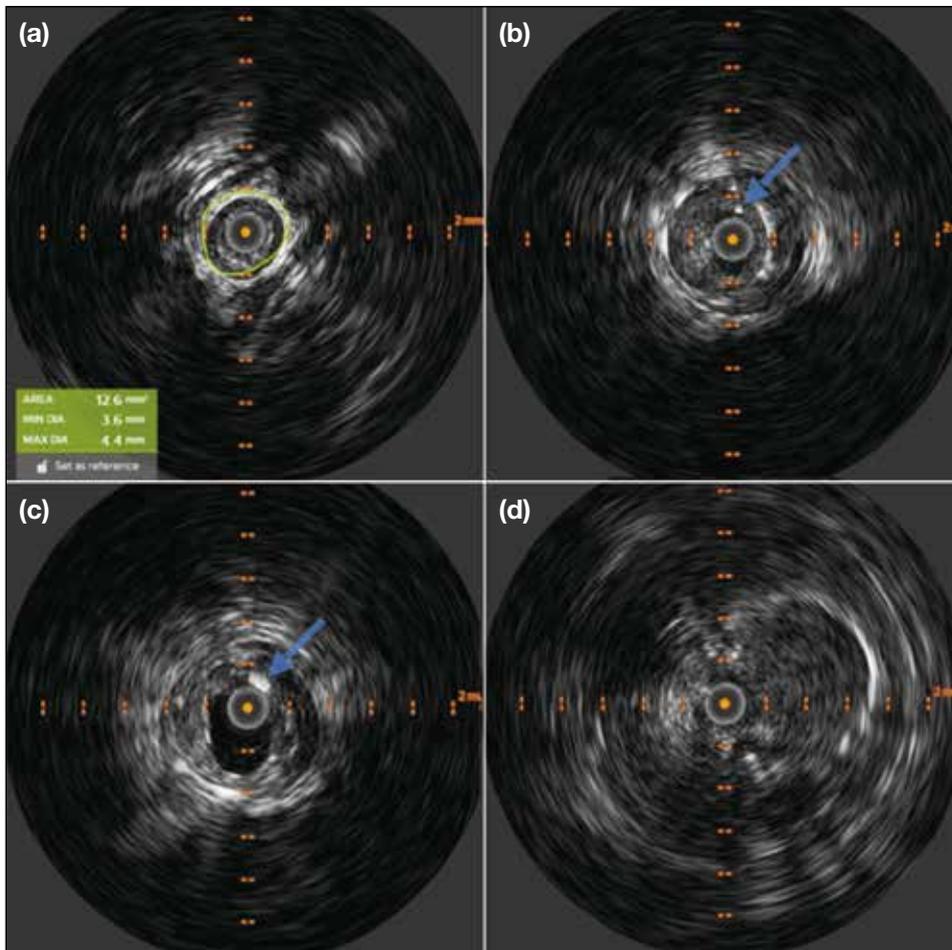


Figure 6. Intravascular ultrasound (IVUS) images confirming wire positioning from the 2023 SAFARI (subintimal arterial flossing with antegrade-retrograde intervention) double-barrel stenting procedure. (a) IVUS enables vessel sizing for selection of appropriate catheters and stents. (b) IVUS image showing the echogenic guidewire in the intraluminal space (arrow). (c) IVUS image showing echogenic guidewire in the subintimal space (arrow). (d) IVUS allows assessment of stent margins to prevent malalignment and inadvertent subintimal entry.

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