Ultrasonographically-guided stent placement at the vertebral artery origin without contrast medium: A case report

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(Citation)
Journal of Clinical Ultrasound,48(6):362-366

(Issue Date)
2020-07

(Resource Type)
journal article

(Version)
Accepted Manuscript

Abstract

Although ultrasound-guided carotid interventions without contrast medium have been reported in the literature, no reports regarding vertebral artery origin stenosis (VAOS) were found. We report an iodine allergic patient with VAOS successfully treated with ultrasound-guided stent placement without contrast medium. During the procedure, a real-time B-mode longitudinal image was useful for each step, including the insertion of an embolic protection device, positioning of the stent, and the evaluation of the stent opening. This technique can be an alternative treatment option for those allergic to the contrast medium and should be considered in selected patients.

Keywords

ultrasound-guided stenting, vertebral artery, contrast medium

1 | INTRODUCTION

Approximately one-fifth of ischemic strokes affect the vertebrobasilar territory, and atherosclerotic stenosis mostly occur at the origin of the vertebral artery (VA).[1] Patients with recently symptomatic vertebrobasilar stenosis are associated with a high risk of recurrent stroke with the highest risk in the first month. Endovascular treatment has been introduced as a promising option.[1] Very low complication rates have been reported for stenting of extracranial vertebral artery origin stenosis (VAOS), while higher stroke rates preclude conclusions on the benefit of stenting intracranial stenosis.[2] When stenting these lesions, the administration of contrast medium is essential; however, there is a significant risk of adverse reactions in patients with chronic kidney disease (CKD) or an allergy to contrast medium.

Ultrasound imaging of the carotid artery is widely used as a noninvasive diagnostic tool for extracranial vascular disease. This technique can also be applicable for real-time monitoring during carotid intervention. Several studies focused on ultrasound-guided carotid artery stenting (CAS) without contrast medium.[3-5] However, ultrasound VAOS imaging is difficult to visualize because it is located deep in the chest. Based on our experiences with ultrasound-guided CAS,[4] we applied this technique to VAOS stent placement. Although there was one report of contrast-less stent placement for VAOS assisted with intravascular ultrasound (IVUS),[6] no studies have chronicled ultrasound image-guided stent placement of VAOS without contrast medium. The objective of this report was to demonstrate the safety and feasibility of this technique.

2 | CASE REPORT

A 65-year-old man was referred to our hospital for the evaluation and treatment of multiple carotid and vertebral artery stenosis. The patient was diagnosed with chronic myelogenous leukemia at age 40 because of the abnormal elevation of his white blood cell count at a regular medical examination and was in complete remission after several cycles of chemotherapy. CAS on the left side was performed at another hospital because of the progression of the carotid stenotic lesion. At that time, multiple rashes associated with erythema and pruritus appeared throughout his body just after the procedure. Then, the patient was suspected the allergy for iodine. A clinical followed-up was performed according to a scheduled ultrasound examination and magnetic resonance angiography (MRA) for the evaluation of the right carotid artery stenosis and bilateral VAOS. The ultrasound examination at this time showed the peak systolic velocity (PSV) of the VA on the right and left side were 1.0 m/s and 0.9 m/s, respectively. Three years later, the progression of carotid artery and vertebral artery stenosis was observed in MRA; therefore, further examination was planned. A computed tomography angiography (CTA) was conducted with an infusion of steroids; however, edema of his face and extremities appeared, and the patient was definitively diagnosed with iodine allergy. The CTA showed bilateral severe VAOS (Figure 1A-B). Despite treatment with dual antiplatelet therapy with aspirin and clopidogrel for three years, the patient had several episodes of vertigo, nausea, dysarthria, dysmetria, and gait ataxia lasting for a few hours. According to these clinical manifestations, the patient was diagnosed with an ischemic attack in the vertebrobasilar circulation due to VAOS. When he was referred to our hospital, there was no neurological deficit. We planned two sessions to treat both the carotid and vertebral artery stenosis without contrast medium. Non-enhanced MRA of the aortic arch and iliac-femoral artery was performed preoperatively to evaluate the access route, as previously reported.[4] First, we performed our previously reported ultrasound-guided CAS[4] on the patient's right side without any complications. Bilateral severe VAOS was diagnosed without bilateral posterior communicating arteries (Figure 1C). The PSV of the VA on the both right and left side had increased to 4.4 m/s and 3.3 m/s respectively. After the patient gave informed consent, we planned the angioplasty and stent placement of the dominant right VAOS one month after the right CAS. The procedure was performed under local anesthesia with systemic heparinization via a right transfemoral approach. Intraoperative ultrasound monitoring of VAOS was performed by one author (T.I.) using an ultrasound system (Xario 200, Canon Medical systems, Tochigi, Japan) with a 7 MHz microconvex probe. During the procedure, the patient's posture was supine, and the probe was positioned in the supraclavicular fossa and angled posterolateral to detect the VAOS. The longitudinal plane of the VA of B-mode (Figure 1D) and color Doppler (Figure 1E) was used for real-time monitoring. A color Doppler image was used to evaluate the peak systolic velocity (PSV) and waveform monitoring during the procedure. In this case, the measured preoperative PSV was 440 cm/s. As both inflation and deflation of the balloon were detectable on ultrasound imaging, no contrast medium was used for the aim of balloon inflation and deflation. A 7Fr ultralong sheath was advanced from the right femoral artery to the right subclavian artery under fluoroscopic guidance without contrast medium. After introducing the 7Fr ultralong sheath into the right subclavian artery supported by a 0.014 inch guidewire deeply advanced into the right brachial artery, an embolic protection device (EPD) (Carotid Guardwire PS, Medtronic, Santa Rosa, CA, USA) was slowly moved across the stenotic lesion under ultrasound monitoring (Figures 2A). The EPD was inflated and flow arrest was confirmed by both waveform changes and color Doppler images. After angioplasty using a 4 mm diameter predilatation balloon, a 6 mm x 18 mm balloon expandable Palmaz Genesis stent (Cordis, Miami, FL, USA) was navigated along the EPD and final positioning was decided by ultrasound monitoring (Figures 2B and 2C). Both the predilatation balloon size and stent size were decided according to the preoperative ultrasound examination, and the predilatation balloon was inflated slowly to a nominal pressure (8 atm). The balloon expandable stent was navigated into the right VA. Both the proximal and distal ends of the stent were confirmed with long axis image of the ultrasound. The stent was applied a few millimeters of the proximal end of the stent into the subclavian artery. Then, the balloon expandable stent was deployed across the stenosis at 10 atm. The stent was navigated and deployed as usual with ultrasound monitoring instead of DSA monitoring. After confirming the precise positioning of the stent (Figures 3A and 3B) and aspirating the blood (about 100 ml) to disappear the debris, the balloon and EPD were retracted under ultrasound monitoring. B-mode (Figure 3C) and color Doppler (Figure 3D) images obtained immediately after the procedure showed a good stent opening and an apparent decrease in the PSV (180 cm/s). There were no procedure-related complications and the postoperative course was uneventful. The patient was followed-up via regular ultrasound imaging at the outpatient clinic. No restenosis was detected at a one-year follow-up examination (PSV 70 cm/s). Double antiplatelet therapy was continued for 6 months after stent placement, then single therapy with clopidogrel was continued lifelong.

All of the procedures in this report were conducted in accordance with the Declaration of Helsinki and International Council for Harmonisation/Good Clinical Practice guidelines approved by the institutional review board and informed written consent was obtained from the patient before his inclusion in this study.

3 | DISCUSSION

In this report, we presented an iodine allergic patient with VAOS treated with ultrasound-guided stent placement without contrast medium throughout the process from the insertion of the EPD until the withdrawal of the balloon system. During the procedure, real-time B-mode longitudinal plane monitoring of the VA and its origin from the subclavian artery made it possible to perform successful VAOS stent placement without periprocedural complications. No restenosis was observed at a one-year follow-up ultrasound examination.

To date, there have been no reports regarding the ultrasound-guided VAOS stent placement without contrast medium, while there were several reports regarding ultrasound-guided CAS in the literature.[3-5]

Although there was only one report of contrast-less VAOS stent placement assisted with IVUS placed in the subclavian artery,[6] our technique has the following advantages over the previous method. In the previous report, an IVUS was placed in the subclavian artery near the VAOS to assist the procedure, mainly to detect the proximal edge of the stent. The IVUS images were transverse planes of the subclavian artery and showed the origin of the VA. However, both the origin and the distal site, including the stenotic lesion, could not be depicted at the same time with IVUS. On the other hand, our technique showed the clear longitudinal plane of the VA including the stenotic lesion using a microconvex probe positioned in the supraclavicular fossa. The superiority of our procedure is that the entire length of the stenotic lesion is detected in one plane, so the images are useful for each step such as the insertion of the EPD, the appropriate positioning of the balloon and stent, and the evaluation of the stent opening immediately after the procedure. The most important factor related to the success of this procedure is obtaining the clear longitudinal plane of the VA and its origin from the subclavian artery. Ultrasound evaluation of the vertebral artery origin is often difficult due to anatomical reasons.[7] Moreover, thoracic respiratory motion and calcification at the narrowing can make it difficult to visualize the clear longitudinal plane of the VA. Thus, the preoperative evaluation and selection of patients is necessary to exclude those where there is difficulty in visualizing the VA.

There is no evidence that prophylactic treatment cannot prevent an allergic reaction to contrast medium,[8] so the possibility of leakage of the contrast medium from the balloon should be excluded. We prepared the balloons outside the body by flushing the normal saline and attached an inflation syringe filled only with normal saline. When the balloon was advanced to the target lesion, it was insufflated by the normal saline. In this situation, both the inflation and deflation of the balloon could not be detected by conventional fluoroscopic imaging. During insufflation of the balloon, however, a real-time ultrasound image of the longitudinal plane clearly showed both the inflation and deflation of the balloon, which is difficult to observe using fluoroscopic images.

For the patients with iodine allergy, gadolinium has been reported to be a useful alternate contrast medium.[9] In order to prevent nephrotoxicity, the maximum dose of gadolinium is 0.3 mmol/kg, which is approximately 36 mL for a 60-kg man.[9] However, this amount is considered to be too small to accomplish angioplasty for VAOS.

An experienced ultrasound technician collaborating with the angiography suite is essential and there is a learning curve for this procedure for both the operator and technician. Radiation exposure to the duplex operator is also an issue. In our previous report on our experiences with ultrasound-guided CAS, the level of radiation exposure for the duplex operator reached 0.246mSv,[4] which was within the acceptable range recommended by the International Commission on Radiological Protection (ICRP).[10] In cases of VAOS stent placement, the level of radiation exposure seemed to be lower because radiation exposure was limited to obtaining several unsubtracted images when the duplex operator is not present. Based on our initial experiences with carotid intervention, this technique can be applied to VAOS stent placement in patients with iodine allergy; however, further prospective studies are warranted to validate our results.

4 | CONCLUSION

We reported a case of ultrasound-guided VAOS stent placement without contrast medium and no adverse events were observed perioperatively. For patients with allergic reactions to the contrast medium, this technique can be an alternative treatment option.

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Figure Legends

FIGURE 1 A-B, Antero-posterior view of the computed tomography angiography (CTA) showing both vertebral artery origin stenosis (VAOS) (A, right side; B, left side). C, Cranio-caudal view of the magnetic resonance angiography (MRA) indicating absence of posterior communicating arteries on the both sides. D, Longitudinal grayscale view of the right vertebral artery (arrowheads) showing severe VAOS (arrow). This plane also shows the transverse view of the right subclavian artery (black arrowheads). E, Longitudinal color Doppler image of the right vertebral artery clearly showing high-velocity flow in the VAOS (peak systolic velocity at origin, 440 cm/s).

FIGURE 2 Intraoperative longitudinal grayscale image of the right vertebral artery obtained after advancement of the distal protection device (A, arrows). Note the 0.014 inch guidewire placed in the vertebral artery clearly depicted in these images. B, Longitudinal grayscale view during positioning of a Palmaz genesis stent (arrows). Accurate stent positioning is confirmed by this image. C, Unsubtracted fluoroscopic image showing that the stent (arrows) is advanced and positioned accurately along the distal protection device.

FIGURE 3 A, Longitudinal grayscale view obtained just after placement of the stent (arrows). Note the deflated balloon (black arrowheads) in the stent. B, Unsubtracted fluoroscopic image obtained after the deflation of the balloon showing proper opening of the stent (arrows). Longitudinal grayscale (C) and color Doppler (D) images of the right vertebral artery obtained at the end of the intervention showing VAOS improvement and the disappearance of turbulent flow.

Figure 1A

Figure 1B

Figure 1C

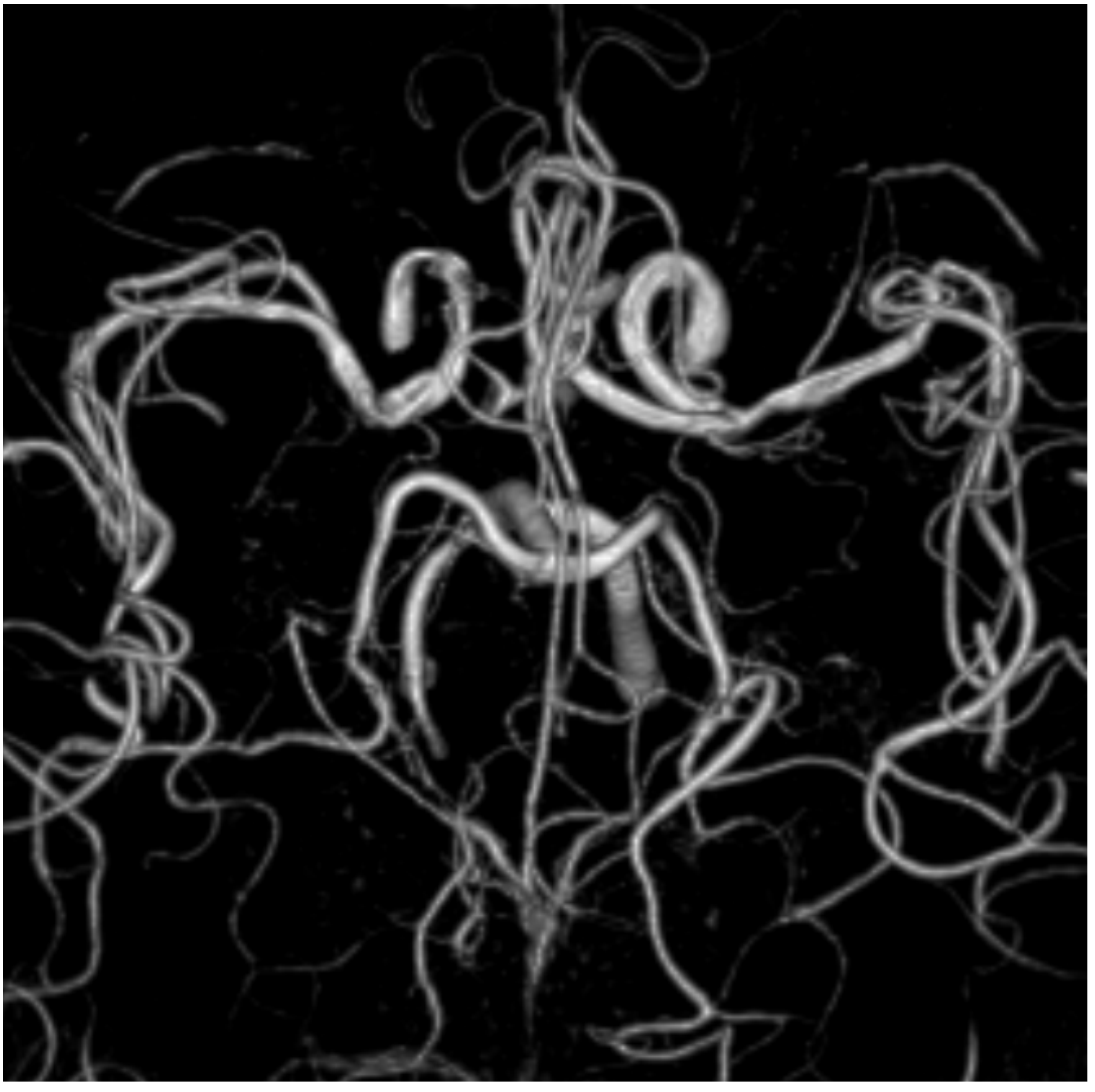
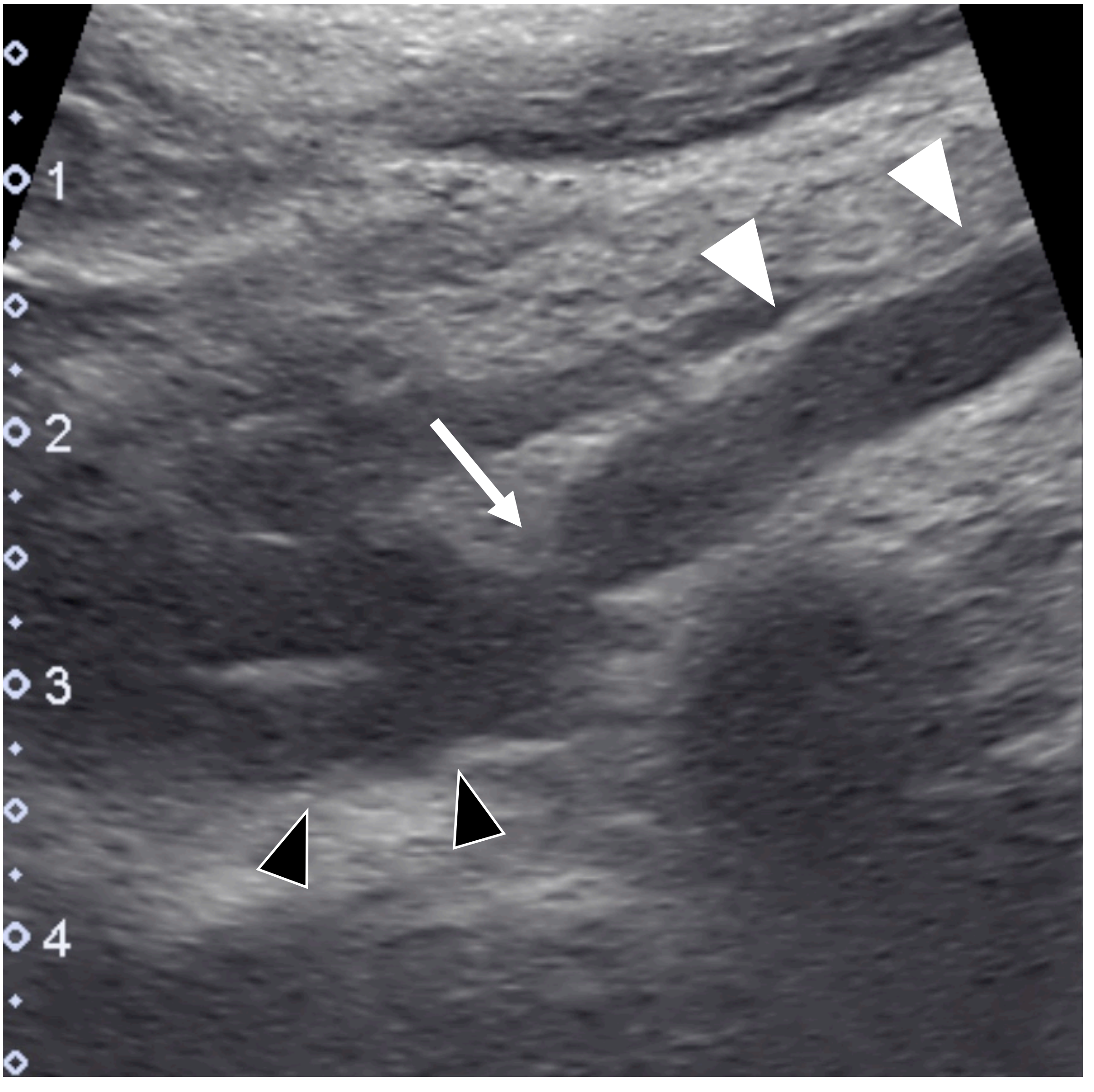


Figure 1D



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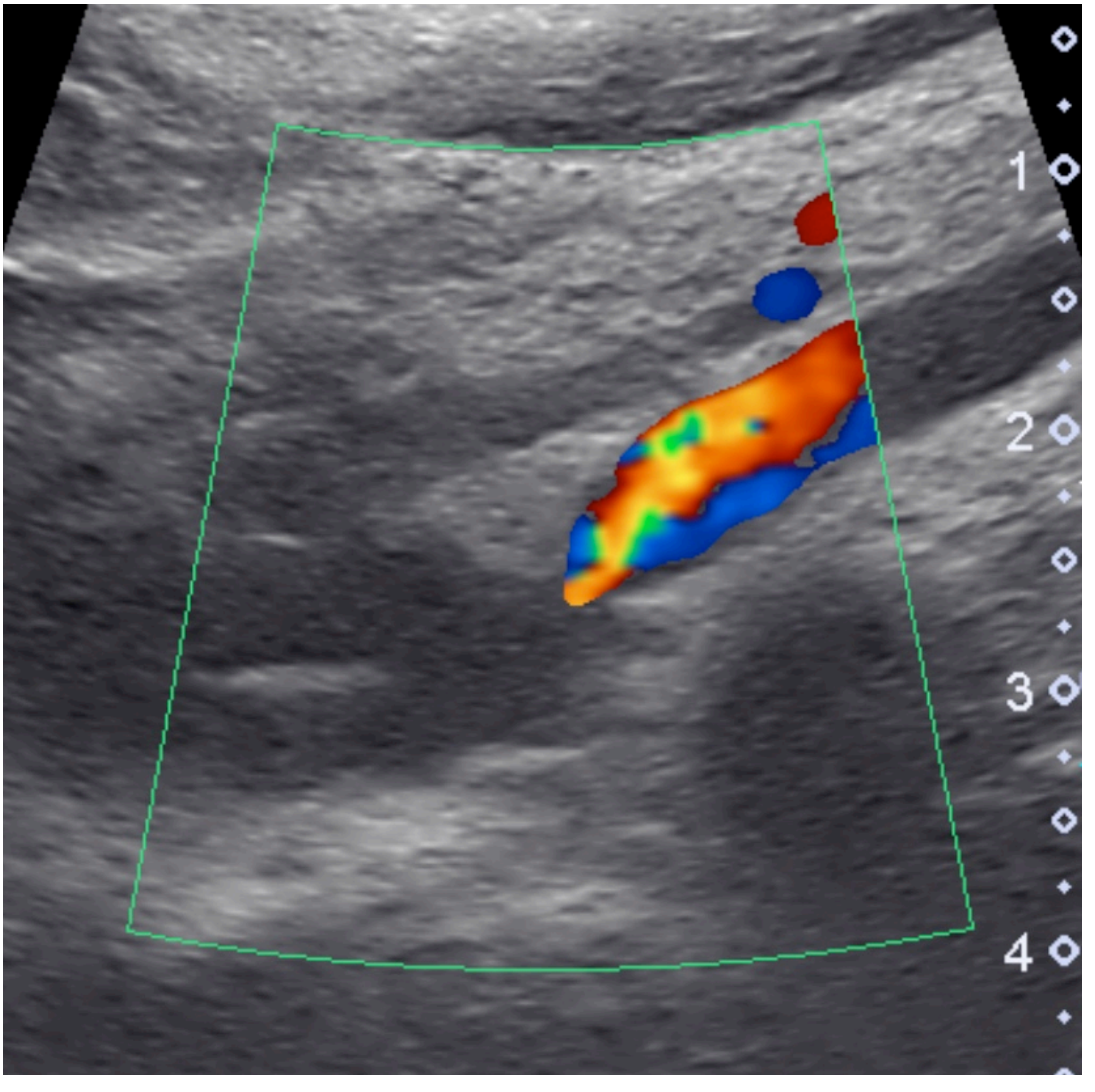

Figure 2A

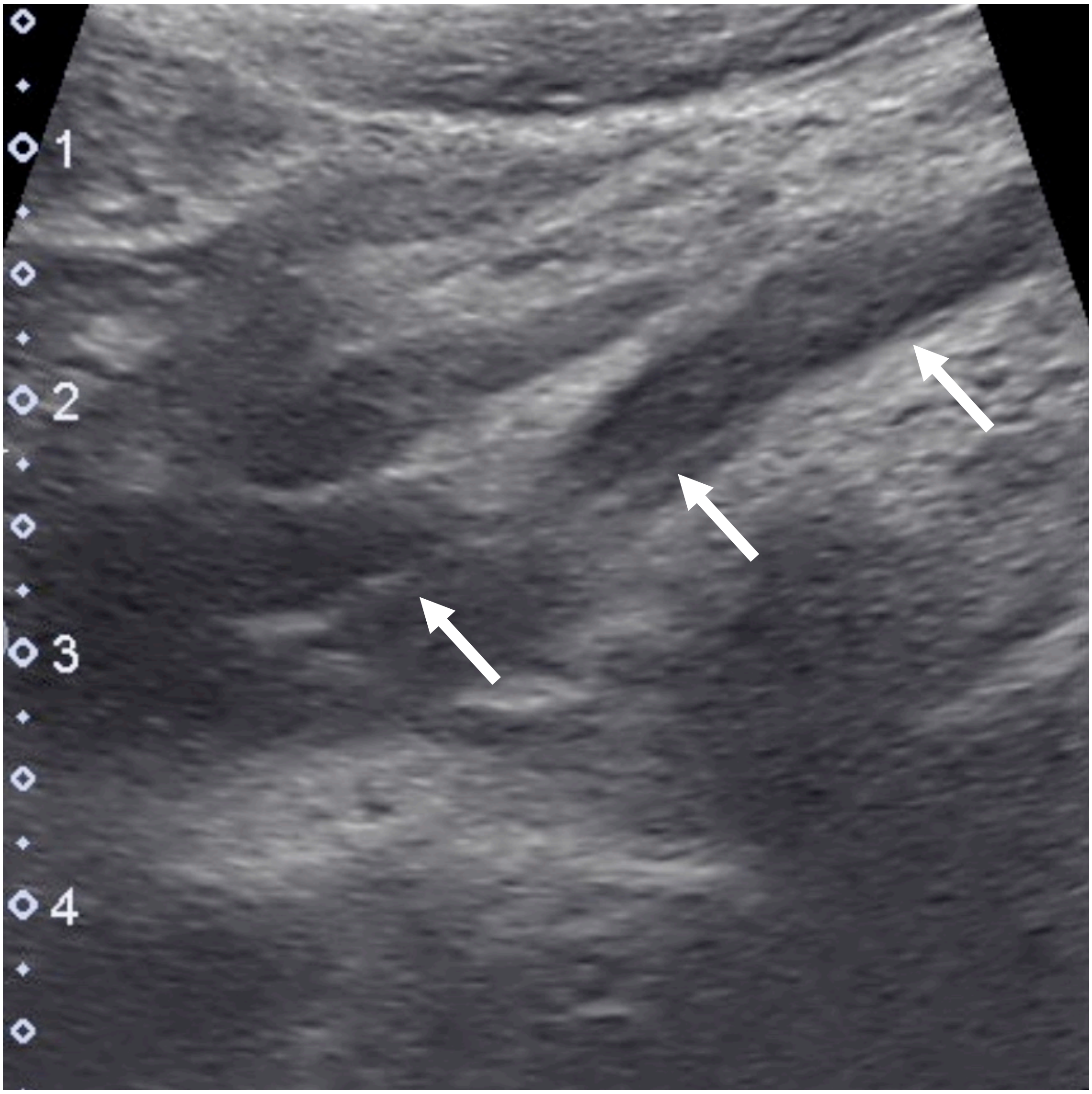

Figure 2B

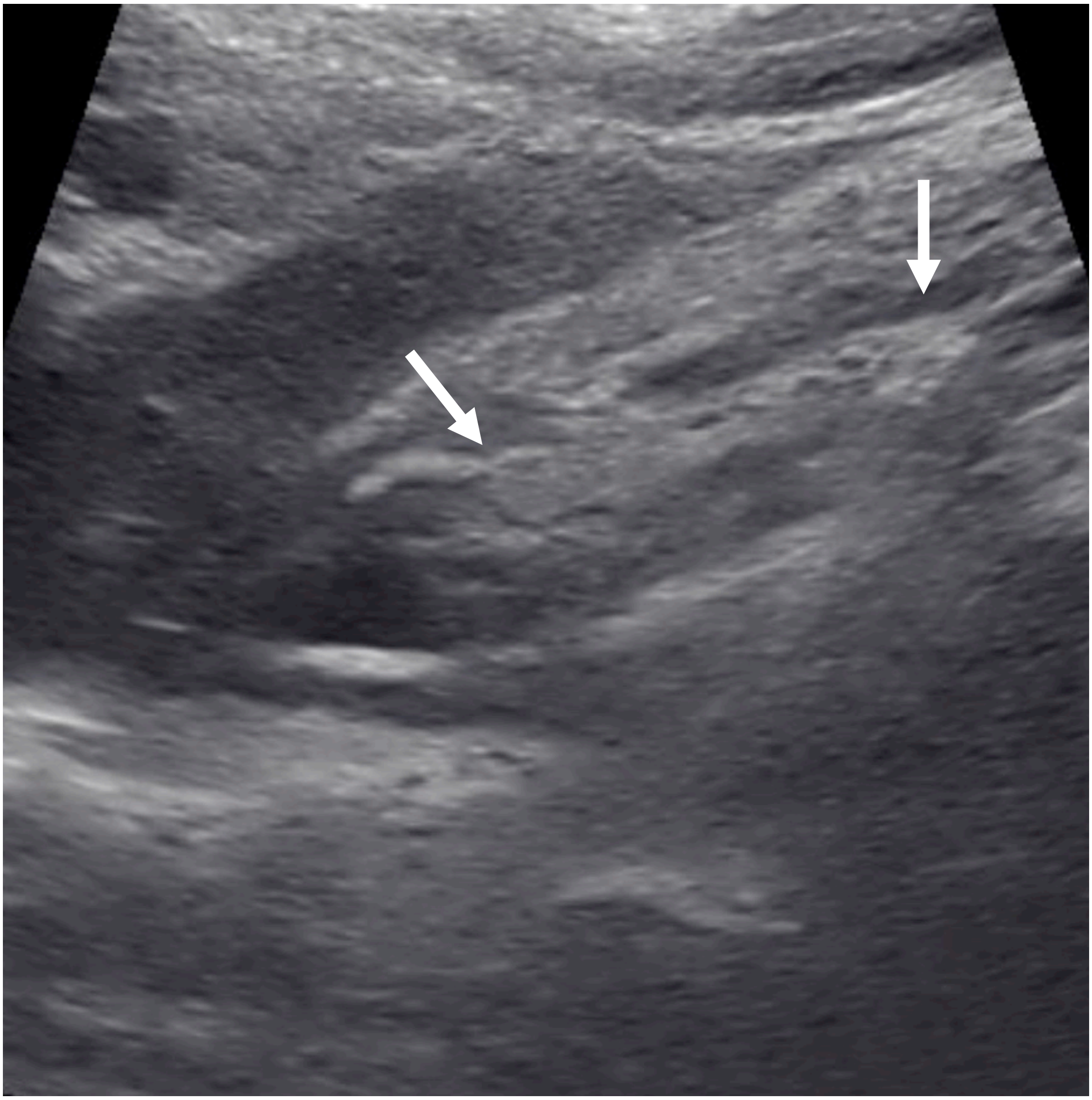

Figure 2C

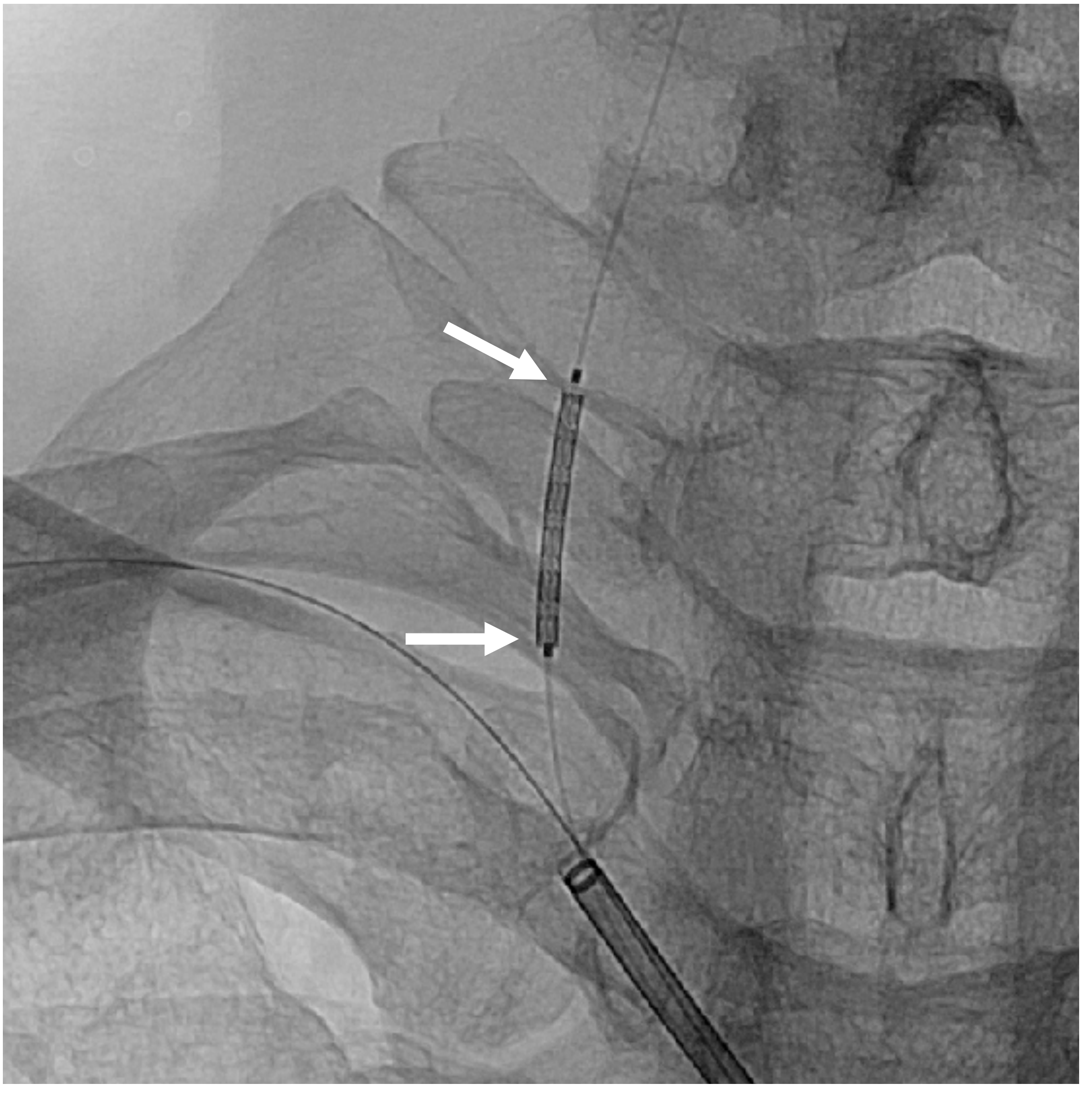

Figure 3A

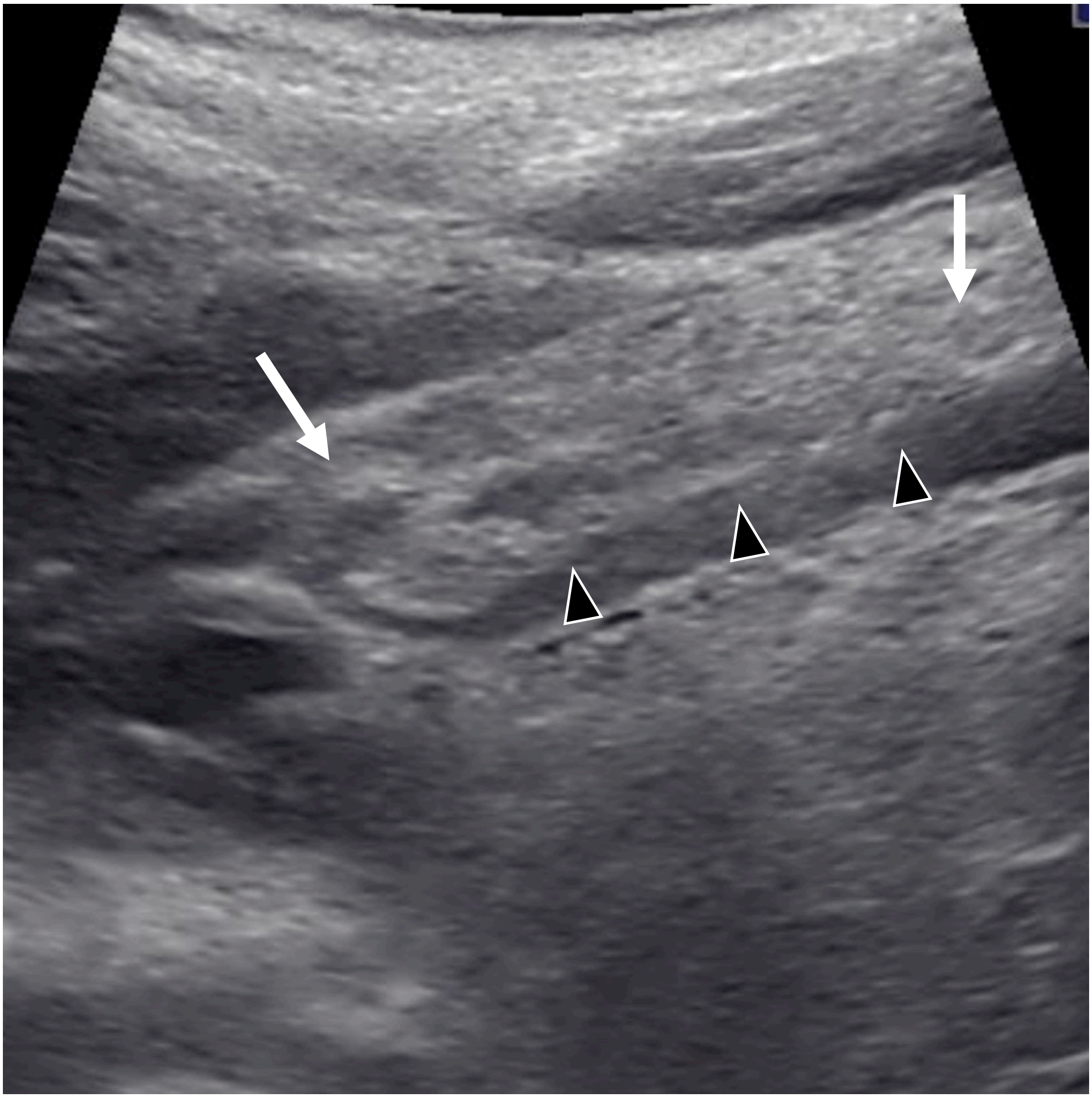

Figure 3B

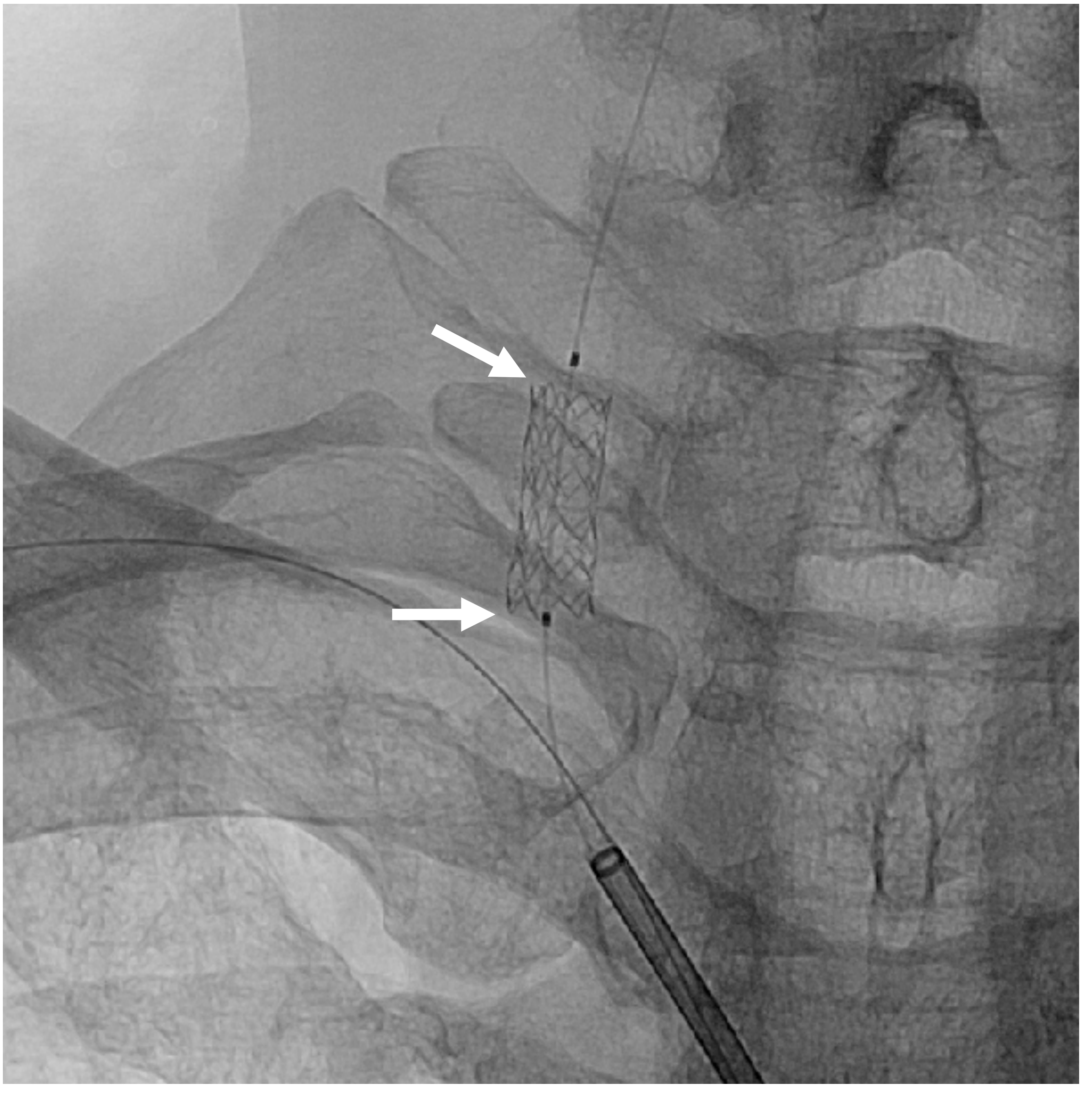

Figure 3C

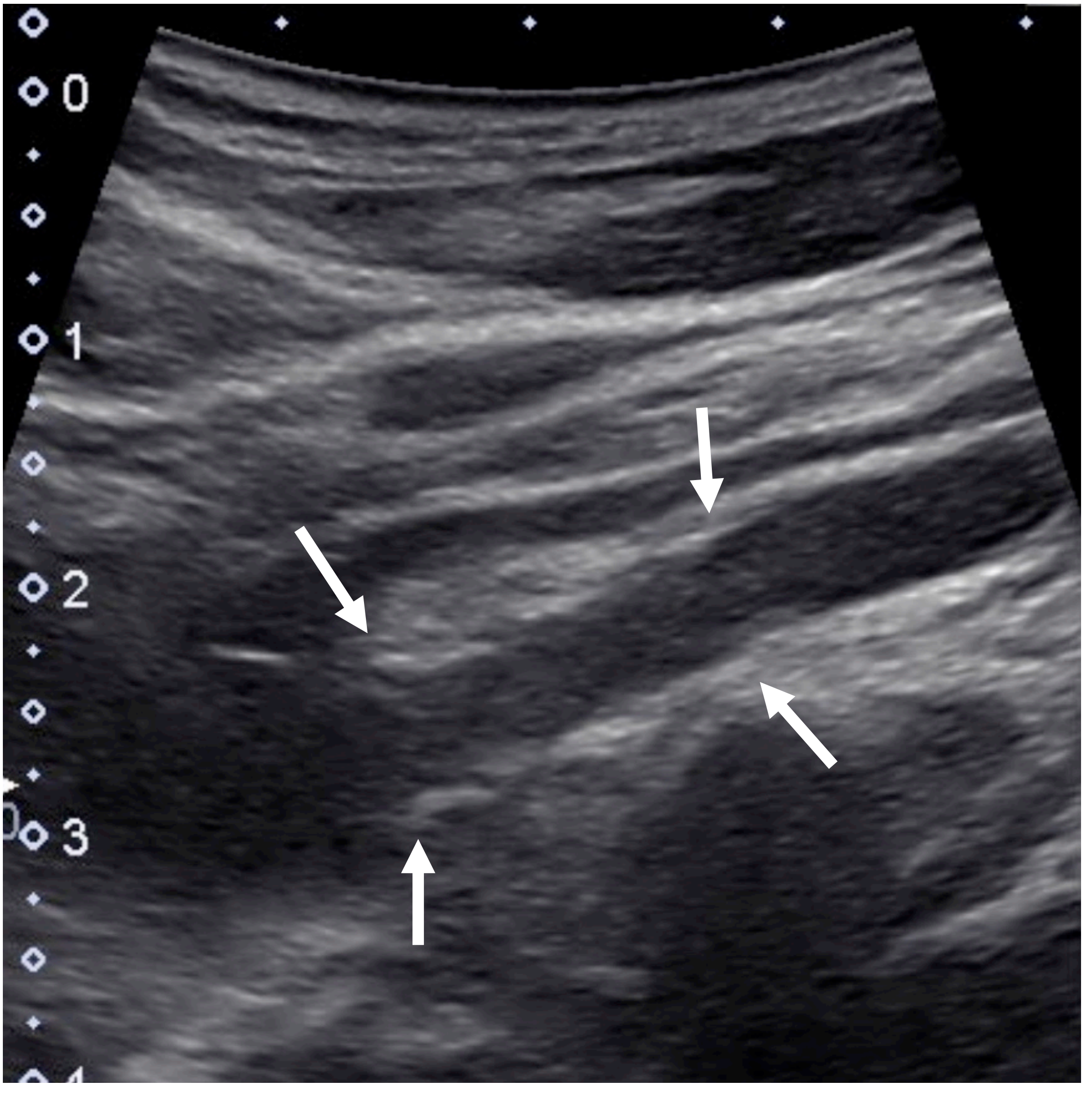

Figure 3D