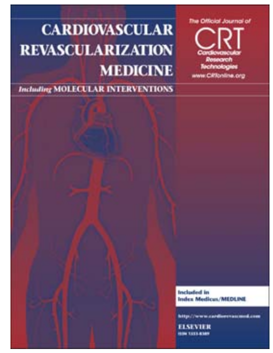
Accepted Manuscript



Percutaneous coronary intervention of chronically occluded saphenous vein grafts using excimer laser atherectomy as an adjuvant therapy.

Mohsen Mohandes, Sergio Rojas, Mauricio Torres, Cristina Moreno, Francisco Fernández, Jordi Guarinos, Alfredo Bardají

PII: S1553-8389(16)30378-5
DOI: doi: 10.1016/j.carrev.2016.12.016
Reference: CARREV 968

To appear in: *Cardiovascular Revascularization Medicine*

Received date: 29 October 2016
Revised date: 15 December 2016
Accepted date: 22 December 2016

Full title:

Percutaneous coronary intervention of chronically occluded saphenous vein grafts using excimer laser atherectomy as an adjuvant therapy.

Short title:

EXCIMER in saphenous vein graft chronic total occlusion

Authors:

1 (Corresponding author): Mohsen Mohandes, MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007 Tarragona, Spain. TEL: 0034-977295817; Email: mohandesmohsen@hotmail.com

2. Sergio Rojas MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: serchmed7@hotmail.com

3. Mauricio Torres MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: maoto11@gmail.com

4. Cristina Moreno MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: crystynama@hotmail.com

5. Francisco Fernández MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: pacofdezmex@gmail.com

6. Jordi Guarinos MD, Interventional Cardiology Unit, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: jguarinos@gmail.com

7. Alfredo Bardají MD, PhD, FESC, Cardiology Division, Joan XXIII university hospital, Universitat Rovira Virgili, Calle Dr Mallafré Guasch 4, 43007. Email: abardaji.hj23.ics@gencat.cat

Authors

Mohsen Mohandes, Sergio Rojas, Mauricio Torres, Cristina Moreno, Francisco Fernández, Jordi Guarinos, Alfredo Bardají

Title

Percutaneous coronary intervention of chronically occluded saphenous vein grafts using excimer laser atherectomy as an adjuvant therapy

Abstract

We present two cases with chronic total occlusion of the saphenous vein graft in two patients with a history of previous bypass surgery with unfavourable anatomic features for recanalization of the native coronary artery. In the first case, two dedicated attempts for recanalization of chronic total occlusion of the native artery failed and in the second case there was not an adequate visualization of the native vessel beyond the occlusion point, not even by contralateral injection. Excimer laser atherectomy was used in both cases as an adjuvant therapy during recanalization of the saphenous vein graft in combination with a distal protection device in order to reduce distal embolization. The procedures proved successful after stent implantation in the whole length of the saphenous vein grafts and the patients suffered no remarkable events during hospitalization.

Keywords

ELCA: excimer laser coronary atherectomy; **PCI**: percutaneous coronary intervention; **CTO**: chronic total occlusion.

Introduction

Excimer laser coronary atherectomy (ELCA) consists of the application of electromagnetic energy with the capability of debulking atherosclerotic plaques in different kinds of lesions [1]. The first generation of cardiac laser used continuous wave and subsequently generated tissue temperature higher than 160ºC, resulting in significant damage to the coronary wall as a consequence [2]. The new generation of cardiac laser utilizes pulse-wave modality combining brief pulse duration alternated with long pause interval, which prevents adverse effects driven from thermal injury on the vascular wall [3].

ELCA is potentially effective for the percutaneous treatment of a variety of complex lesions including chronic total occlusion (CTO), calcified lesions, stents restenosis, balloon-crossing failures, thrombus vaporization in acute coronary syndrome and eventually saphenous vein graft (SVG) debulking [4]. Percutaneous coronary intervention (PCI) of a SVG in the setting of acute coronary syndrome is technically feasible although attention should be paid to distal embolization due to high thrombus burden. In the case of SVG chronically occluded the recommended strategy is to recanalize the native artery if technically possible. In the event that the recanalization of the occluded native artery is not possible and the patient's symptoms persist, a PCI over SVG can be reserved as a last option. The two cases presented here both have unfavourable anatomic features for PCI of the CTO native artery. The use of dedicated techniques for CTO-PCI combined with an adjuvant debulking device such as ELCA for recanalization of a totally occluded SVG make the procedures technically interesting and challenging.

Case 1: a 67-year-old man was admitted to our hospital due to a non-ST elevation acute coronary syndrome (NSTEACS). Coronary risk factors were a smoking habit, hypertension and dyslipidemia. The patient suffered from chronic kidney disease and was undertaking a hemodialysis program. One year before the last coronary event he was diagnosed with a type-B aortic dissection below the left subclavian artery which was conservatively managed. From a cardiologic point of view, the patient had a history of chronic ischaemic cardiomyopathy and he was operated with a coronary artery bypass graft (CABG) in 1988 with left internal mammary artery (LIMA) to left anterior descending artery (LAD), and SVG to first obtuse marginal (OM) and to right coronary artery (RCA). In January 2015, the patient presented with NSTEACS and underwent a coronary angiogram which showed all three bypasses patent. In September and December 2015, he presented two consecutive NSTEACS and both were conservatively managed. The current episode happened in June 2016, six months after the last coronary event and on this occasion the patient presented a troponin I elevation up to 14 ng/ml. A coronary angiogram revealed total occlusion of SVG supplying OM from the ostial segment. The native artery was totally occluded without adequate collateralization to its distal bed (Figure 1). SVG to RCA and LIMA to LAD both were patent. There was no Q wave in the electrocardiogram registry and an echocardiographic examination showed hypokinetic motion in the inferolateral wall with a normal left ventricular ejection fraction. As the patient presented with recurrent chest pain and taking into account the unfavourable anatomic features for PCI to the native OM, an angioplasty on the SVG was planned.

The procedure was performed by radial approach using a long sheath introducer (90 cm) and a 6F AL2 guiding catheter for a proper SVG engagement, occluded from the ostial segment (figure 2; video 1). The angiogram of the previous patent SVG was used during the procedure for the step-by-step advancement of the guidewires. With a Pilot 50 guidewire through a Finecross microcatheter (Terumo medical corporation, Japan) we were able to traverse the proximal segment of the SVG and afterwards a Pilot 200 was used to advance up to the native vessel. After blood aspiration, a cautious dye injection through the microcatheter confirmed the true lumen position (figure 3; video 2).

In this step, an ELCA 0.9 mm catheter (Spectranetics, Colorado Springs, Co.) was used at 25 mJ/mm2 (fluences) and pulse repetition rates (frequency) of 40 Hertz throughout the entire SVG (figure 4 and 5) with the patient's tolerance. After positioning an embolization protection device Spider FX 3 mm (ev3 inc. Plymouth, MN, USA) in the distal part of the SVG, predilatation with 2.5x25 mm balloon at low atmosphere was performed (figure 6). Three drug eluting stents (DES), Xience 3x48 mm (Abbott Vascular, Santa Clara, USA), CRE 8: 3x46 mm (CID, Alvimedica; Saluggia VC, Italy) and Xience 3x23 mm were successfully implanted although a significant residual lesion in the distal segment persisted (figure 7). Two additional DES (Onyx: 3x18 mm and Onyx: 3x38 mm (Medtronic, Inc. MN, USA)) were implanted without a distal protection device in the SVG distal segment achieving an excellent angiographic final result (figure 8; video 3). Troponin determination after the procedure did not show any re-elevation and the patient was discharged without any remarkable events during hospitalisation.

Case 2. A 72-year-old man with coronary risk factors being a former smoker, hypertension and dyslipidemia was admitted to our hospital. He had a history of chronic ischaemic cardiomyopathy from 2000, the time when he underwent triple bypasses, LIMA to LAD, SVG to RCA and to first OM. In 2008, a PCI with bare-metal stent into the SVG proximal segment was performed. In January 2016, the patient was hospitalized due to unstable angina and underwent a coronary angiogram which revealed three vessel coronary artery disease with total occlusion of the SVG to RCA and a CTO of RCA. An attempt to recanalize the SVG in the same procedure failed. The patient was discharged under optimal medical treatment but symptoms persisted with evidence of ischaemia in the inferior wall in a myocardial perfusion SPECT performed externally. Therefore, a PCI on RCA-CTO was planned six months after the last procedure. Despite a dedicated attempt using the antegrade approach the procedure was unsuccessful (figure 9 and 10). A retrograde approach was not attempted because of the absence of proper collaterals filling distally the CTO. The patient continued with symptoms of effort angina, and therefore we scheduled a new attempt to recanalize the RCA which failed again. As a last strategy we proceeded to recanalize the SVG which was occluded proximally where a bare metal stent had been previously implanted (figure 11). A Pilot 200 supported by a Finecross microcatheter was used and after crossing in-stent total occlusion segment (video 4) we successfully reached the RCA-posterolateral (PL) branch. A gentle dye injection through the microcatheter after blood extraction confirmed the guidewire position into true lumen (figure 12; video 5). After positioning a distal protection system (Spider FX 4 mm) before distal anastomosis, ELCA 0.9 mm catheter at 25 mJ/mm2 (fluences) and pulse repetition rates (frequency) of 40 Hertz was applied (figure 13). 4 DES (Synergy: 3x38 mm (Boston Scientific Corporation, Marlborough, MA, USA), CRE 8: 3x38 mm, Xience: 3x33 mm Xience:

3x33 mm) after balloon predilation were implanted from the distal to ostial saphenous segment. A control angiographic injection showed a residual lesion in the distal segment of the SVG extending to the native artery, so a new DES (Onyx: 2.75x22 mm) was implanted from the saphenous distal segment to the RCA-PL branch, without a distal protection device. The procedure was well tolerated and no electrocardiographic changes were registered. A successful angiographic result with TIMI III flow was achieved (figure 14, video 6) and the patient had no remarkable in-hospital course.

Discussion

The cases presented here reveal the recanalization of two SVGs chronically occluded as a last strategy with dedicated techniques and instrumentation for CTO-PCI in conjunction with coronary laser debulking.

SVG are often diffusely diseased and contain a great amount of friable atherosclerotic material. In this scenario, ELCA has the potential benefit of debulking the underlying plaque with a reduction in the risk of distal embolization [5].

40% to 50% SVGs will be diseased or occluded in the first 10 years after CABG [6]. The current practise in post-CABG patients with chronic total occlusion of the SVG is to recanalize the native artery. The potential embolization and high rate restenosis in this scenario do not make it recommendable as a first strategy.

Both patent and occluded SVGs have been used as a conduct to access a native coronary artery in order to recanalize retrogradely a CTO with high final technical success [7,8].

Al-Lamee R et al. [9] in a series of 34 SVG-CTO achieved 68% of successful recanalization after stent implantation and they did not register any major in-hospital adverse cardiac events in the successful PCI group, although in-stent restenosis was 68.4% of which 76.9% were focal resulting in successful revascularization in all restenotic lesions. In the latter study, in 78% of all cases the operators used an embolic protection device.

In our first case we had a very poor visualization of the native CTO beyond the occluded segment due to the absence of adequate collaterals. It is worth noting that this patient had had a coronary angiogram one year and a half before the last coronary event and on this occasion the SVG to OM was patent. Between that event and the current NSTEACS the patient had suffered two additional NSTEACS, the second being 6 months earlier, therefore we assumed that SVG was likely chronically occluded at the time of PCI.

There are isolated cases of SVG-CTO undergoing PCI using the coronary laser adjuvant therapy for plaque debulking [10]. We decided to perform a PCI on the SVG with all technical considerations for CTO-PCI and we do believe that the combination of coronary laser debulking and distal protection device increased the possibility of a successful final angiographic result.

In the second case we performed two dedicated PCI for the recanalization of the native RCA but both attempts were unsuccessful. As the patient continued with symptoms we decided to recanalize the SVG-CTO using laser atherectomy and a distal protection device to ensure the reduction of distal debris embolization achieving a successful angiographic final result.

There are several technical aspects which should be taken into consideration during SVG-CTO-PCI. Firstly, the step-by-step wire advancement using the trajectory of the previously open SVG is mandatory in order to ensure the guidewire intralumen navigation. Secondly, although a saphenous perforation may not cause cardiac tamponade but continuous leakage can provoke hemodynamic instability, then attention should be paid to this aspect. Thirdly, in an ideal scenario distal wire positioning into true lumen should be contralaterally verified and in its absence the operator can confirm the position of the wire into true lumen by extraction of blood and in the next step by a very gentle supraselective dye injection through a microcatheter. Finally, although coronary laser can contribute to the reduction of distal embolization, its utilization in conjunction with distal protection device is probably more recommendable to diminish the risk of microcirculation damage.

Conclusion:

The recanalization of a SVG-CTO as a last strategy in symptomatic patients is feasible and the use of ELCA in combination with distal protection device can reduce the distal embolization and ensure an optimal angiographic result.

Source of funding: The authors received no financial support for the treatment of the patients or for the preparation of this manuscript.

Conflict of interest: Nothing to declare.

Acknowledgment: The authors would like to personally thank all members of interventional cardiology unit.

Bibliography

[1] Litvack F, Eigler N, Margolis J,et al. Percutaneous excimer laser coronary angioplasty: results in the first consecutive 3,000 patients. The ELCA Investigators. J Am Coll Cardiol 1994;23: 323-9.

[2] Litvack F, Grundfest WS, Papaioannou T, Mohr FW, Jakubowski AT, Forrester JS. Role of laser and thermal ablation devices in the treatment of vascular diseases. Am J Cardiol 1988;61:81G-6G. Review.

[3] Topaz O. Plaque removal and thrombus dissolution with the photoacoustic energy of pulsed-wave lasers-biotissue interactions and their clinical manifestations. Cardiology 1996;87:384-91. Review.

[4] Topaz O, Das T, Dahm J, Madyhoon H, Perin E, Ebersole D. Excimer laser revascularisation: current indications, applications and techniques. Lasers Med Sci 2001;16:72-7. Review.

[5] Ebersole DG. Excimer laser for revascularisation of saphenous vein grafts. Lasers Med Sci 2001;16:78-83.

[6] Tatoulis J, Buxton BF, Fuller JA. Patencies of 2127 arterial to coronary conduits over 15 years. Ann Thorac Surg 2004;77: 93-10.

[7] Dautov R, Manh Nguyen C, Altisent O, Gibrat C, Rinfret S. Recanalization of Chronic Total Occlusions in Patients With Previous Coronary Bypass Surgery and Consideration of Retrograde Access via Saphenous Vein Grafts. Circ Cardiovasc Interv 2016; 9. pii: e003515. doi: 10.1161/CIRCINTERVENTIONS.115.003515.

[8] Karmpaliotis D, Michael TT, Brilakis ES, et al. Retrograde coronary chronic total occlusion revascularization: procedural and in-hospital outcomes from a multicenter registry in the United States. JACC Cardiovasc Interv 2012; 5:1273-9.

[9] Al-Lamee R, Ielasi A, Latib A, et al. Clinical and angiographic outcomes after percutaneous recanalization of chronic total saphenous vein graft occlusion using modern techniques. Am J Cardiol 2010;106:1721-7. doi: 10.1016/j.amjcard.2010.08.013. Epub 2010 Oct 26.

[10] George JC. A Percutaneous Intervention Strategy for Chronic Total Occlusions of Saphenous Veins Grafts with Absence of Native Artery Revascularization Options. Cath Lab Digest 2011; 19 (10).

Figures and videos legends

Figure 1. Coronary angiogram shows total occlusion of OM branch where SVG had been anastomosed.

OM: obtuse marginal, SVG: saphenous vein graft.

Figure 2. Total occlusion of SVG from its ostial segment engaged by guiding catheter through radial approach.

SVG: saphenous vein graft.

Figure 3. Supraselective contrast injection through microcatheter confirmed true lumen position in OM branch.

OM: obtuse marginal.

Figure 4. ELCA application throughout SVG.

ELCA: excimer laser coronary atherectomy. SVG: saphenous vein graft.

Figure 5. Mild flow restoration after laser application.

Figure 6. Distal protection device (Spider 3 mm) positioning before distal anastomosis of SVG to OM. Predilatation with 2.5 mm balloon is being performed.

OM: obtuse marginal. SVG: saphenous vein graft

Figure 7. Persistence of a significant lesion in SVG distal segment after implantation of three DES in proximal and mid segment.

DES: drug eluting stent. SVG: saphenous vein graft.

Figure 8. Final angiographic result after implantation of 5 DES in SVG.

SVG: saphenous vein graft.

Figure 9. Total occlusion of RCA from its ostial segment.

RCA: right coronary artery.

Figure 10. Unsuccessful antegrade guidewiring into true lumen. Contralateral injection through LIMA showed poor visualization of RCA distal branches.

LIMA: left internal mammary artery. RCA: right coronary artery.

Figure 11. In-stent proximal occlusion of SVG to RCA.

RCA: right coronary artery. SVG: saphenous vein graft.

Figure 12. Supraselective dye injection through microcatheter confirms true lumen position in RCA-PL branch.

PL: posterolateral. RCA: right coronary artery.

Figure 13. unbroken arrow shows ELCA catheter and dashed arrow the position of distal protection device

ELCA: excimer laser coronary atherectomy.

Figure 14. Successful angiographic result after implantation of 5 DES from SVG ostial segment to RCA-PL branch.

DES: drug eluting stent. PL: posterolateral. RCA: right coronary artery. SVG: saphenous vein graft.

Video 1: SVG ostial total occlusion engaged by a guiding catheter through a long sheath introducer inserted by radial approach.

SVG: saphenous vein graft.

Video2: supraselective dye injection through microcatheter shows correct position in true lumen beyond distal anastomosis.

Video 3: final angiographic result after multiple stents implantation.

Video 4: Pilot 200 guidewire supported by Finecross microcatheter could successfully cross in-stent total occlusion.

Video 5: dye injection through microcatheter confirms the adequate guidewire advancement into true lumen native coronary artery beyond SVG anastomosis.

SVG: saphenous vein graft.

Video 6: final angiographic result after multiple stents implantation.

Highlights:

- Percutaneous coronary intervention of chronically occluded saphenous vein graft in cases with unfavorable anatomic features of native coronary artery

- Use of excimer laser atherectomy as adjuvant therapy in order to reduce distal debris embolization

- Simultaneous use of distal protection device in combination with laser coronary to increase the safety of the procedure.

Figure 1

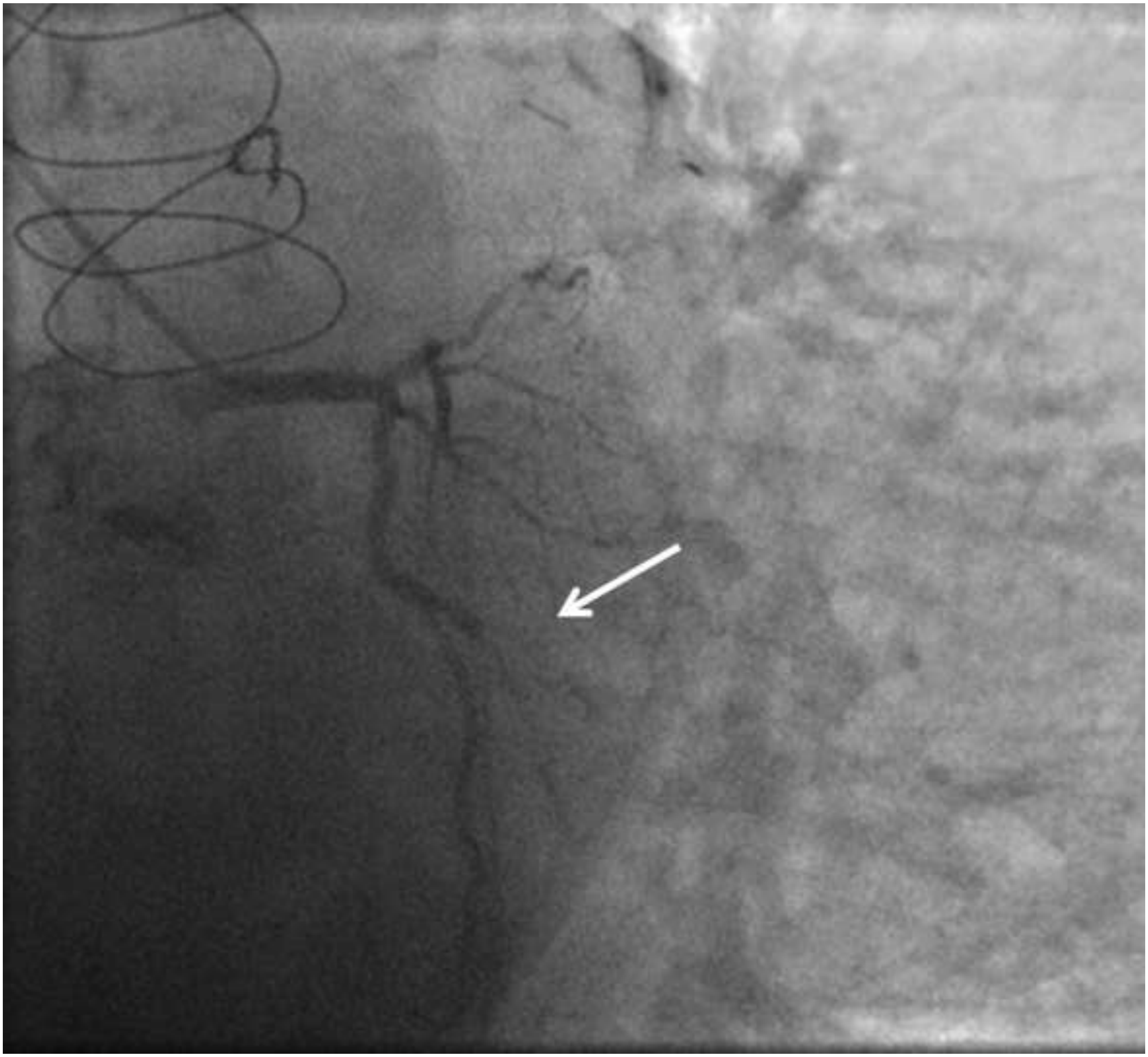


Figure 2

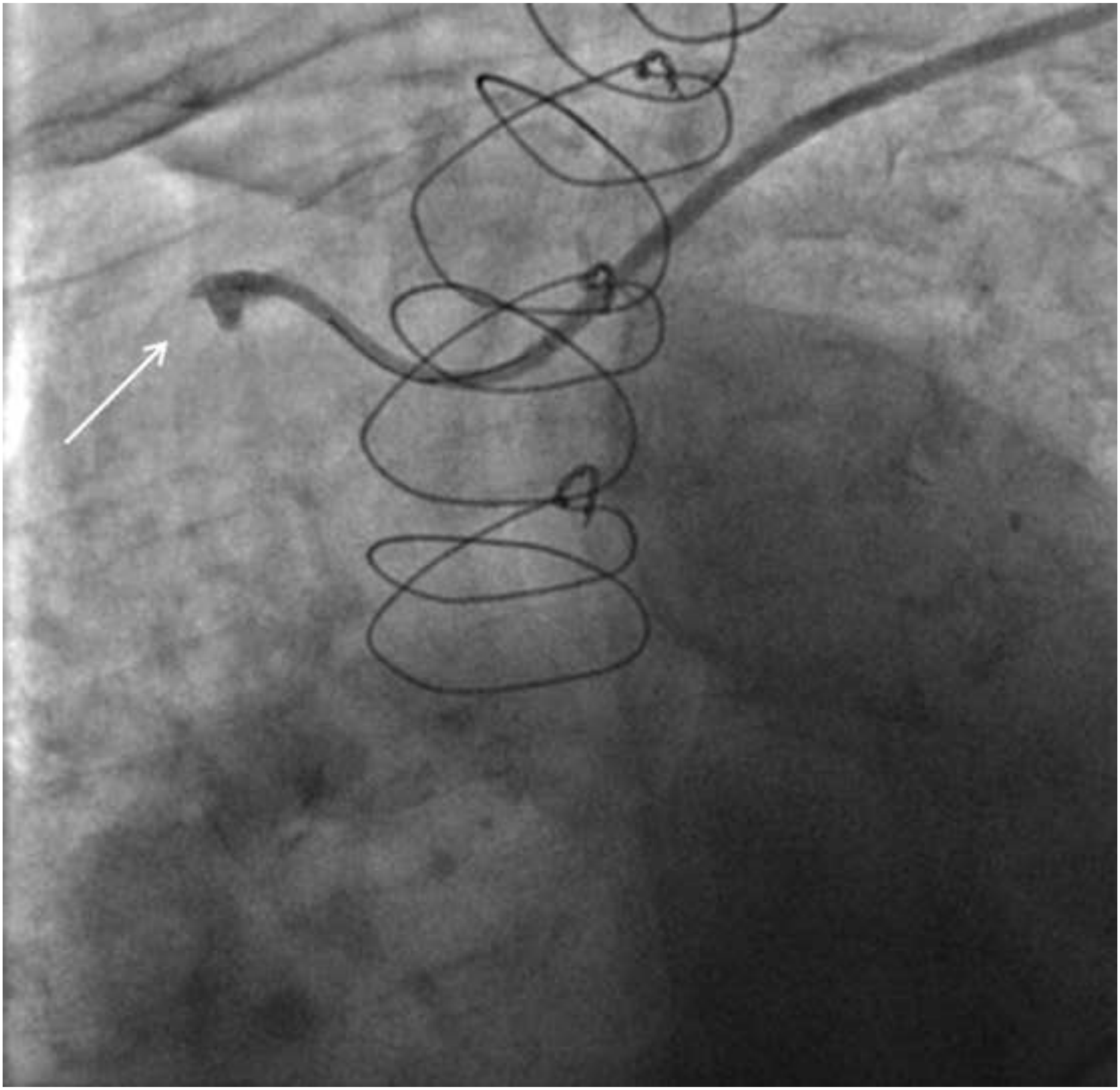


Figure 3

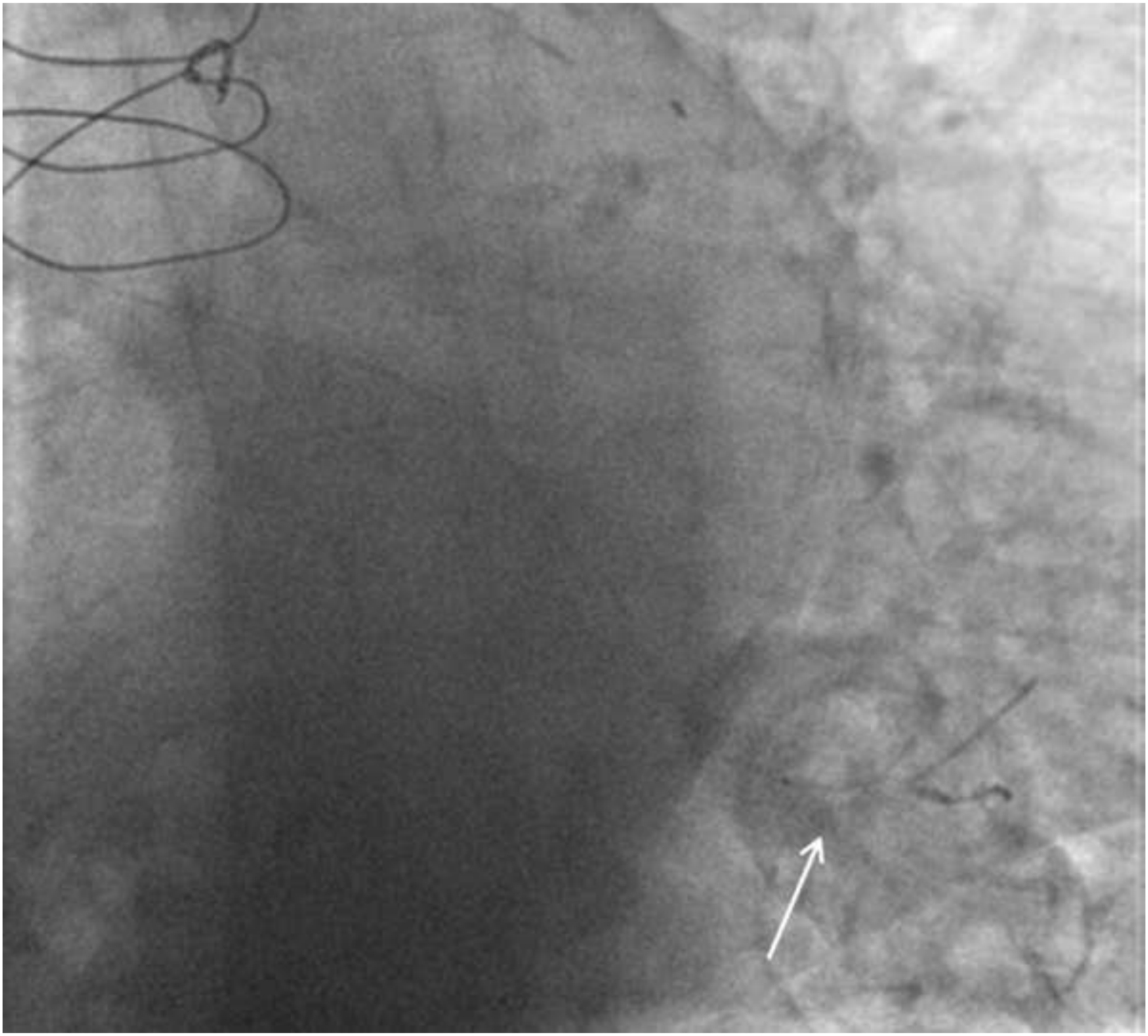


Figure 4

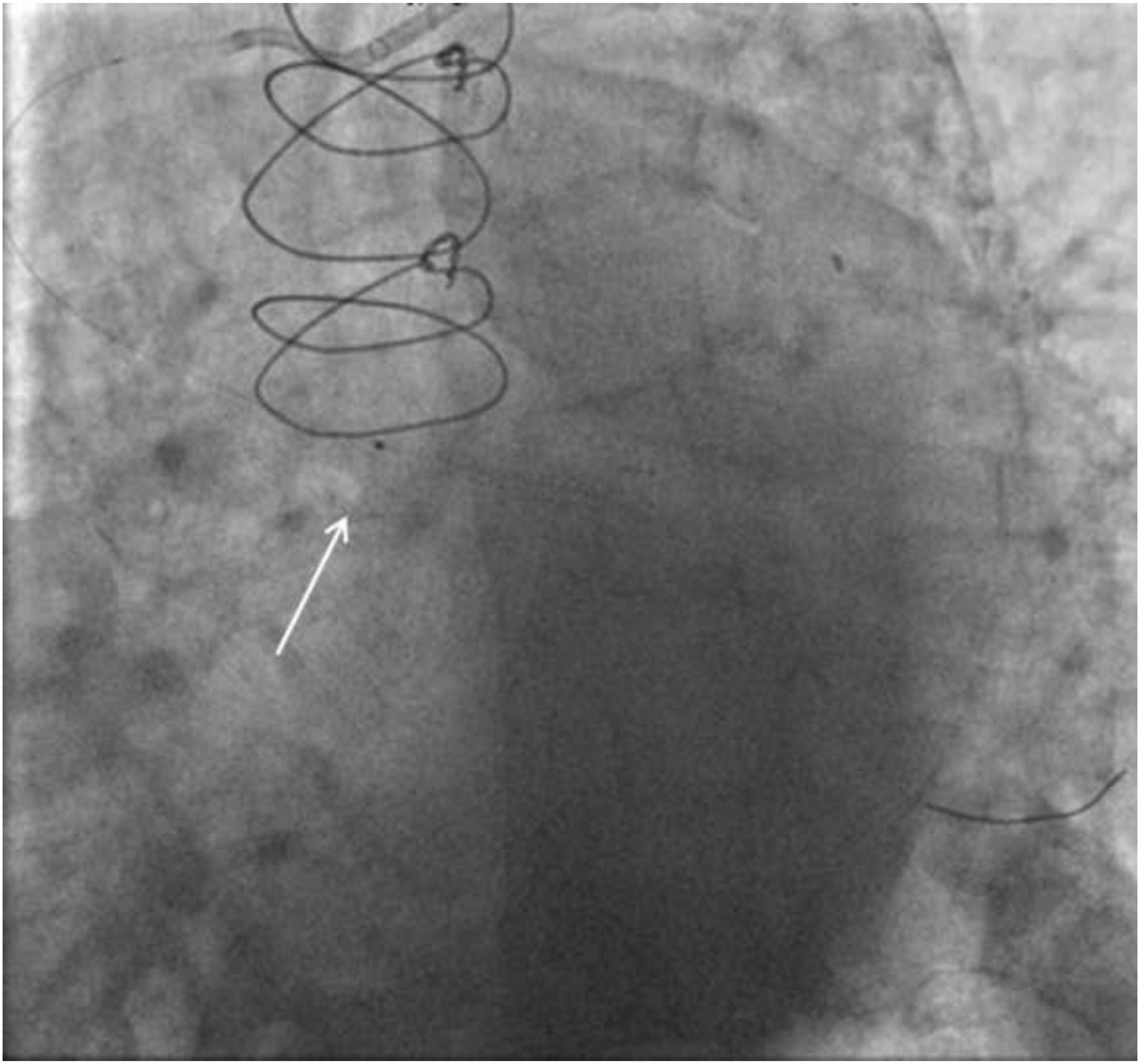


Figure 5

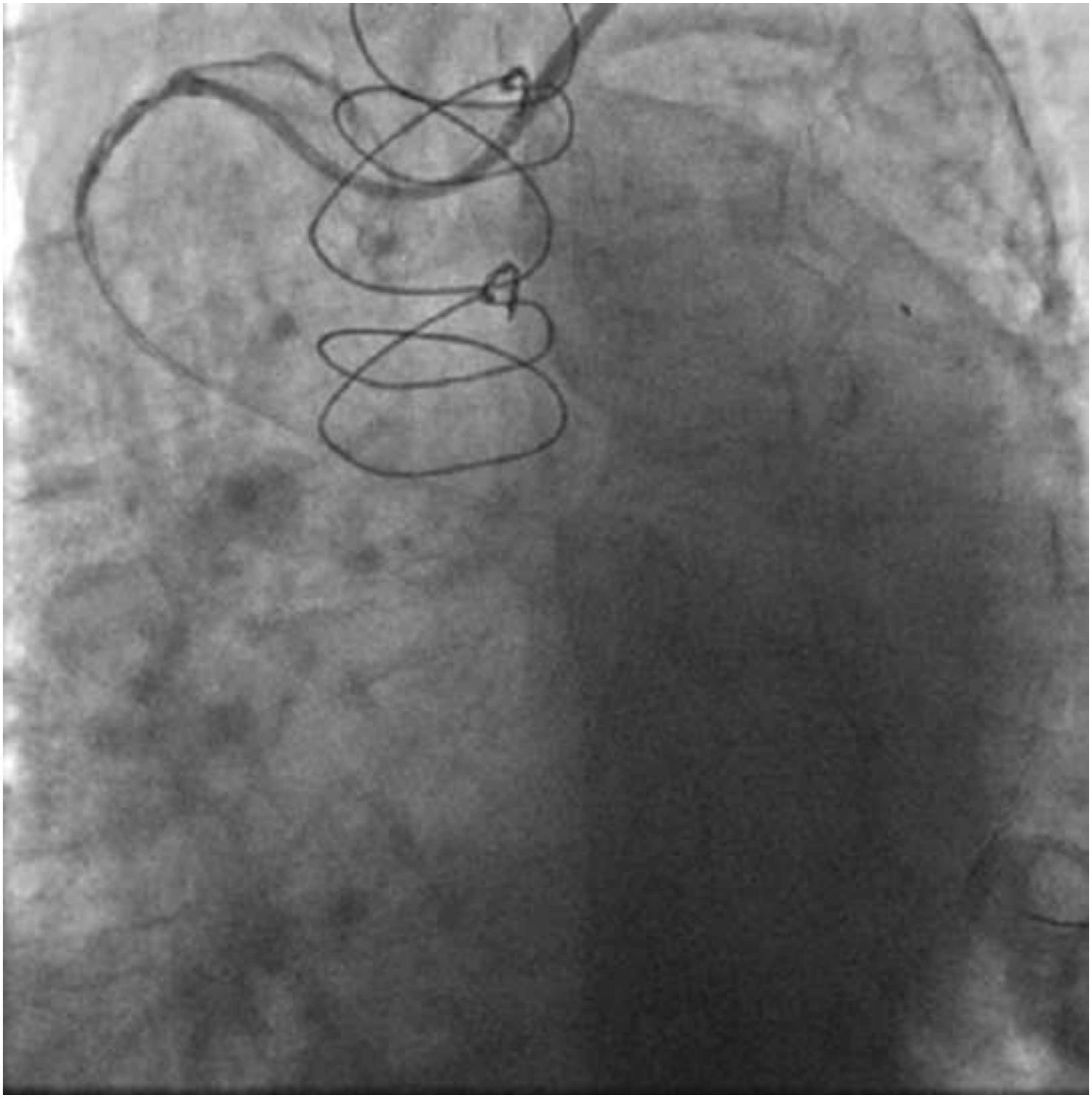


Figure 6

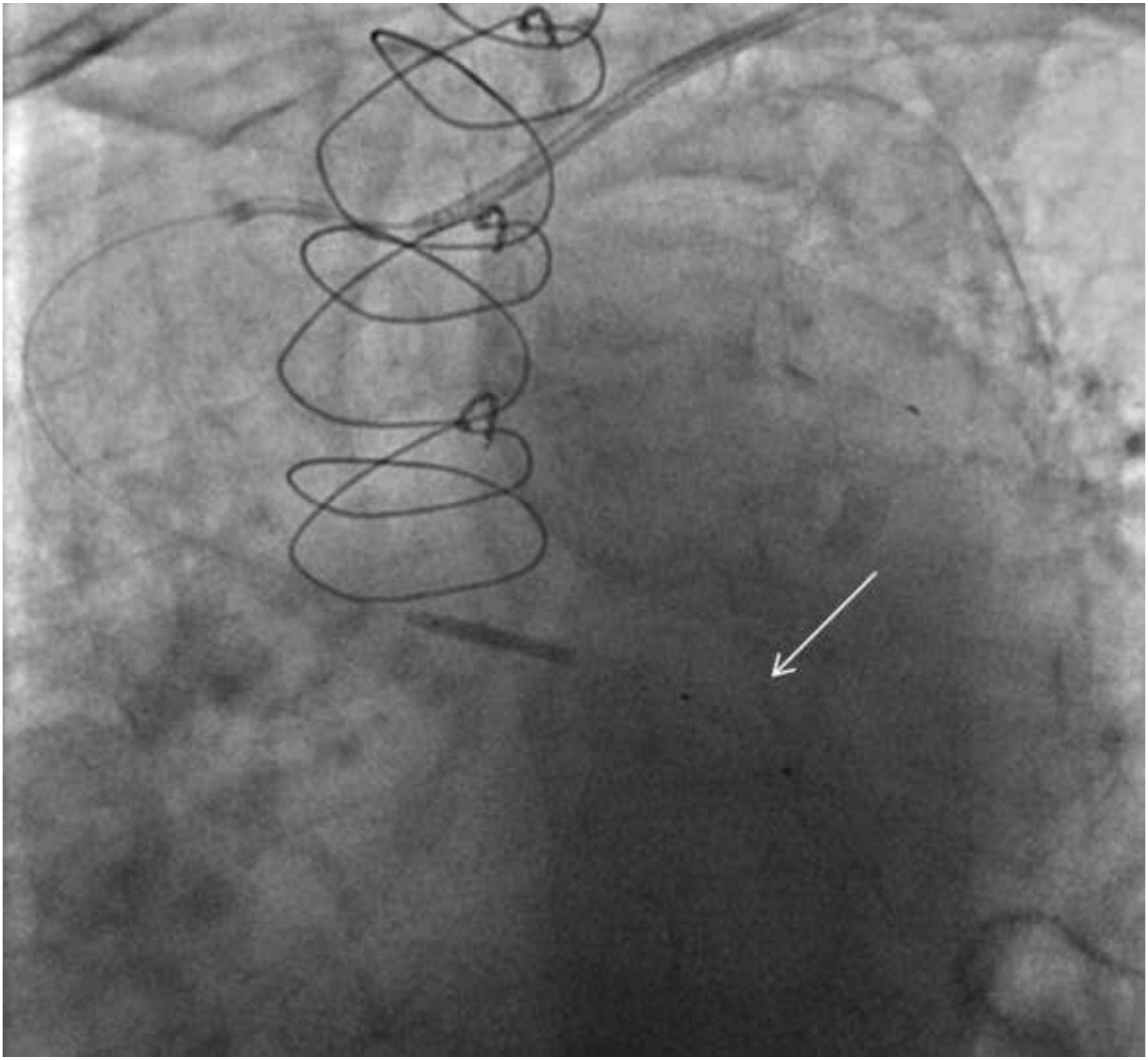


Figure 7

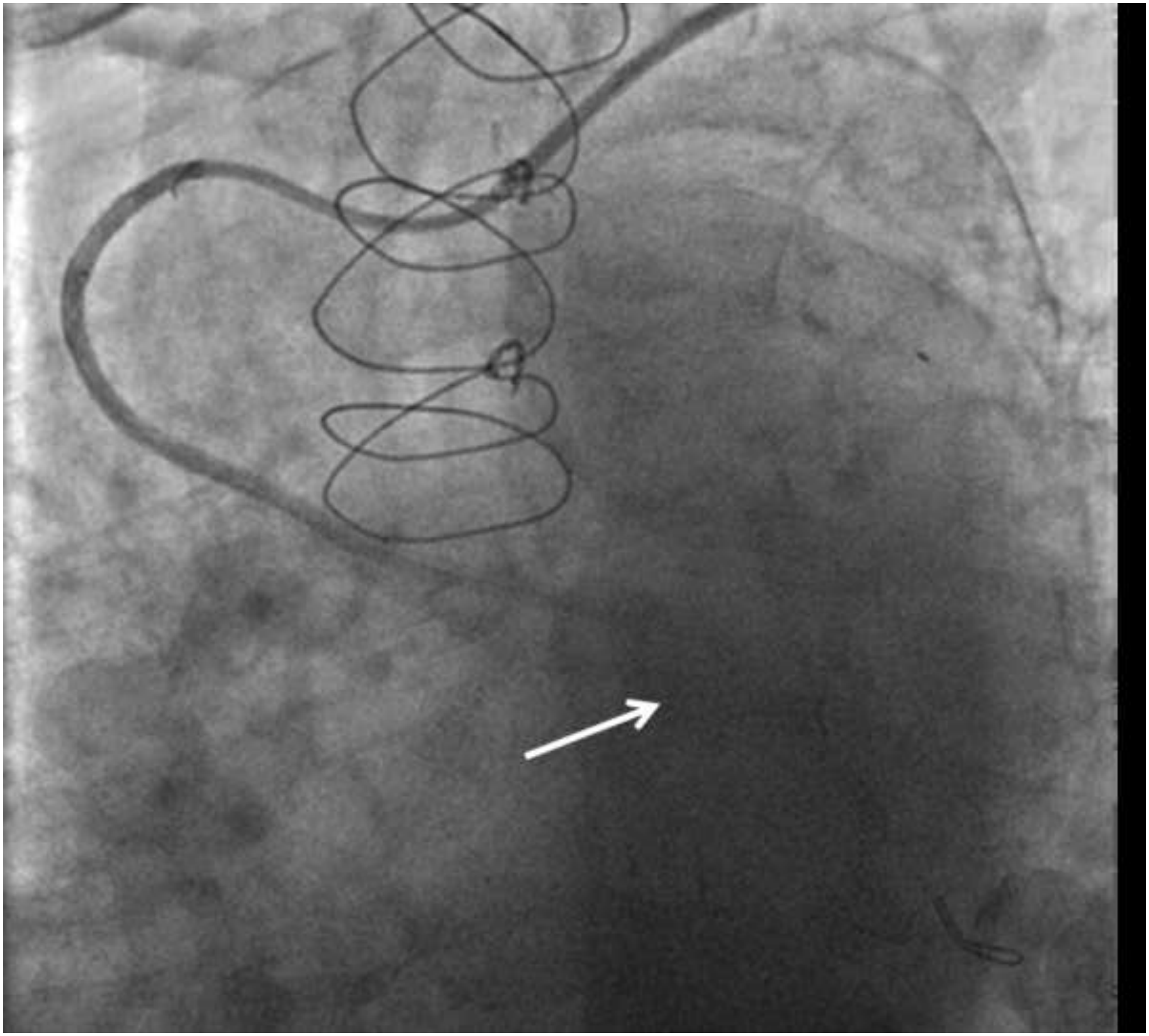


Figure 8

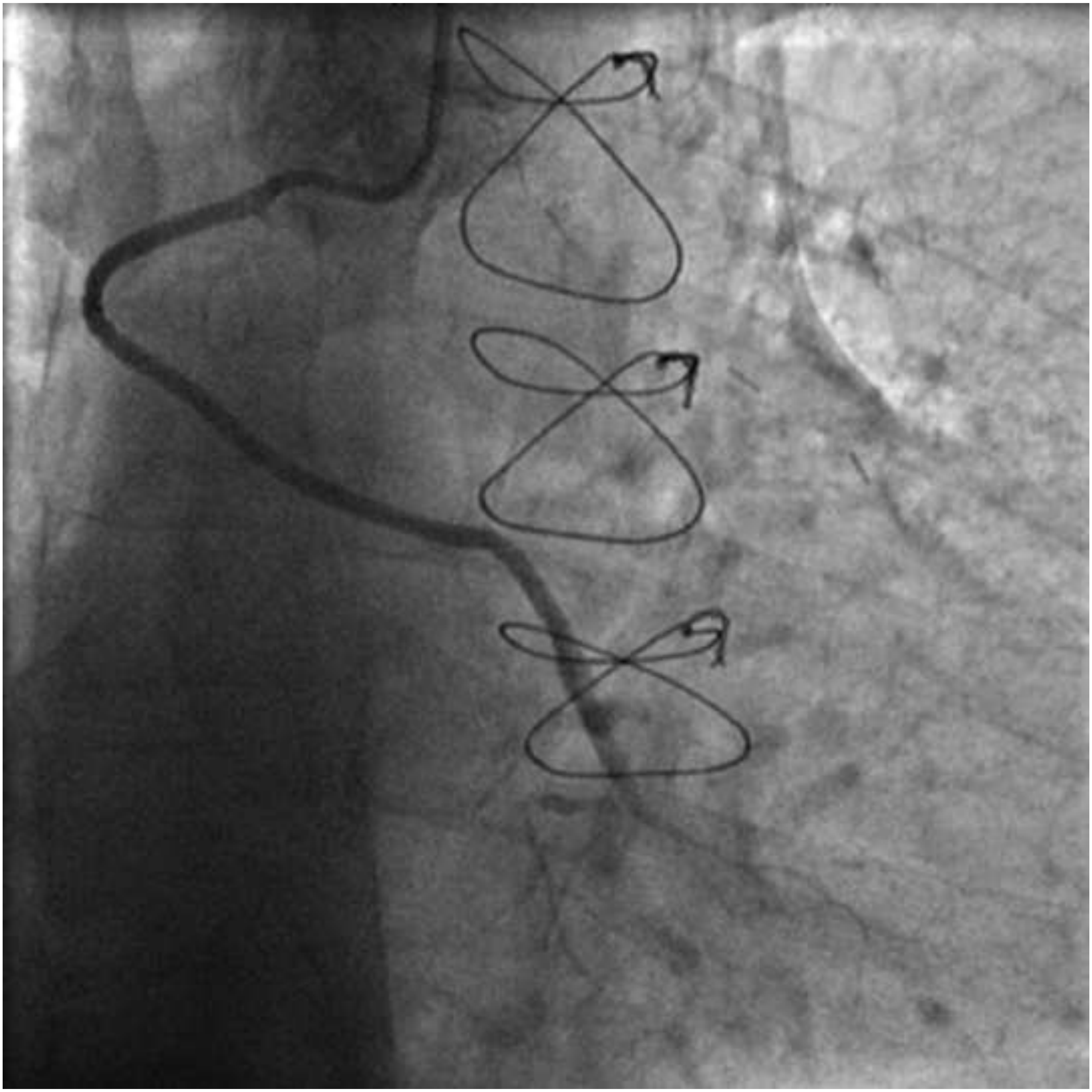


Figure 9

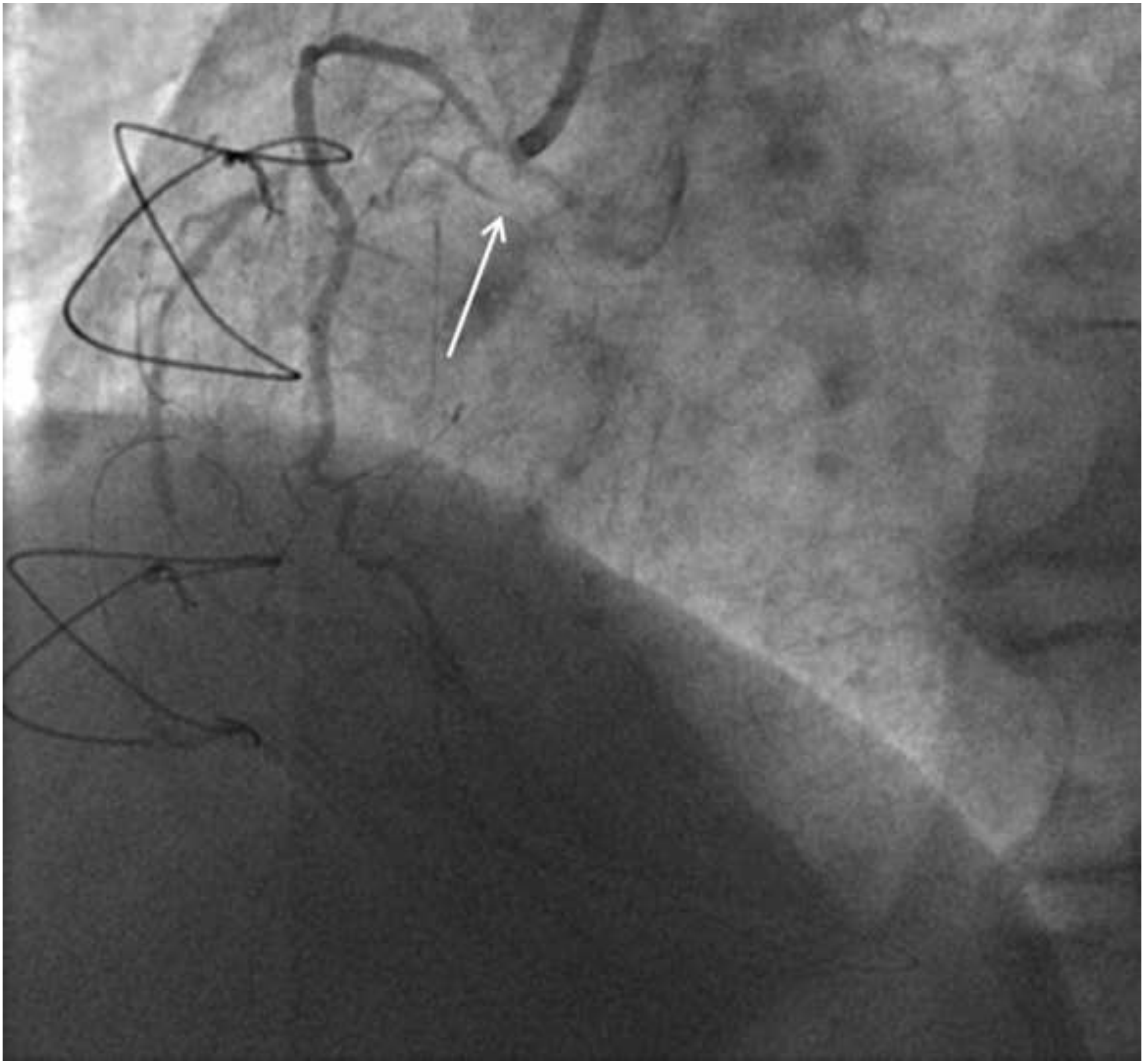


Figure 10

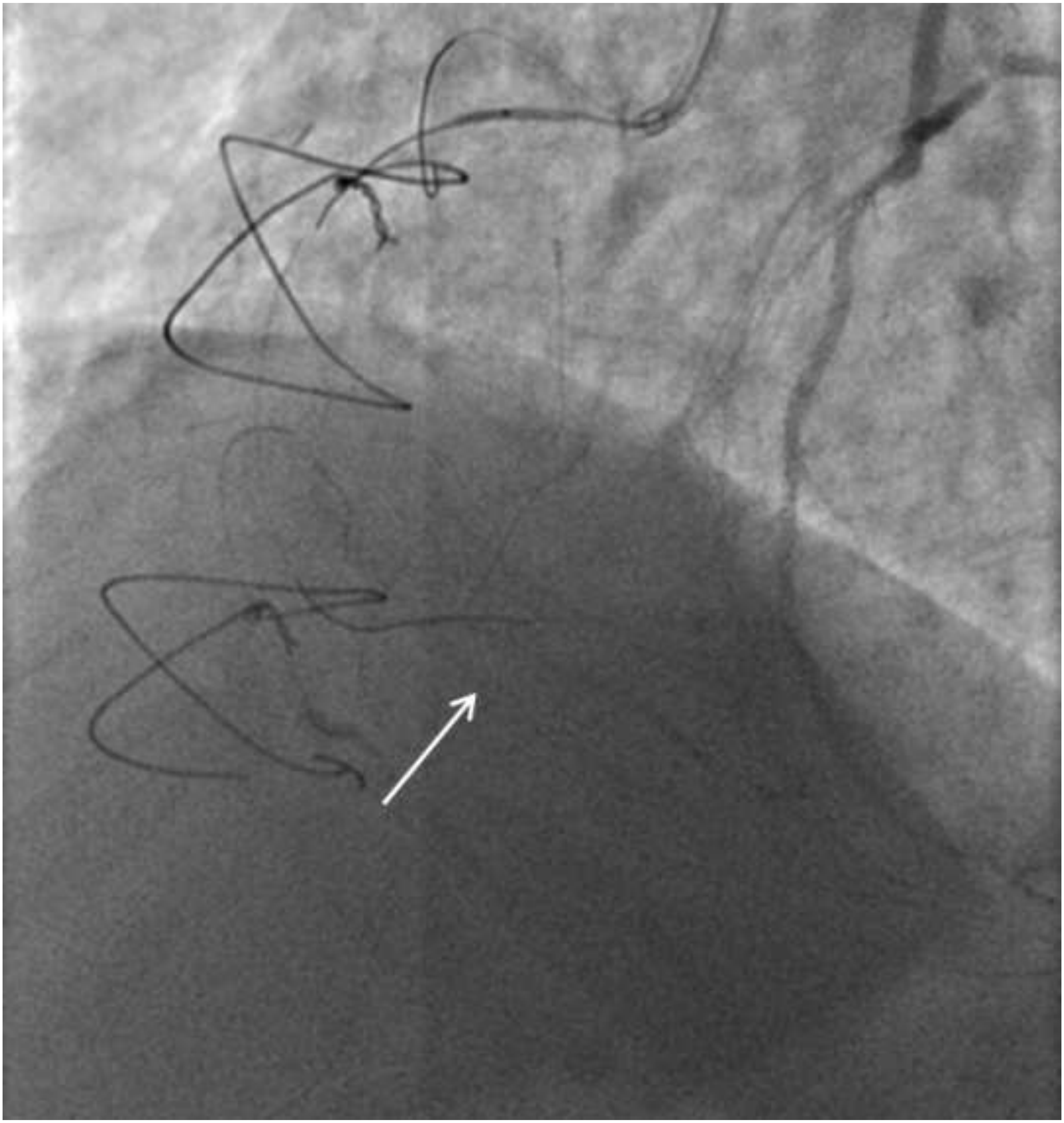


Figure 11

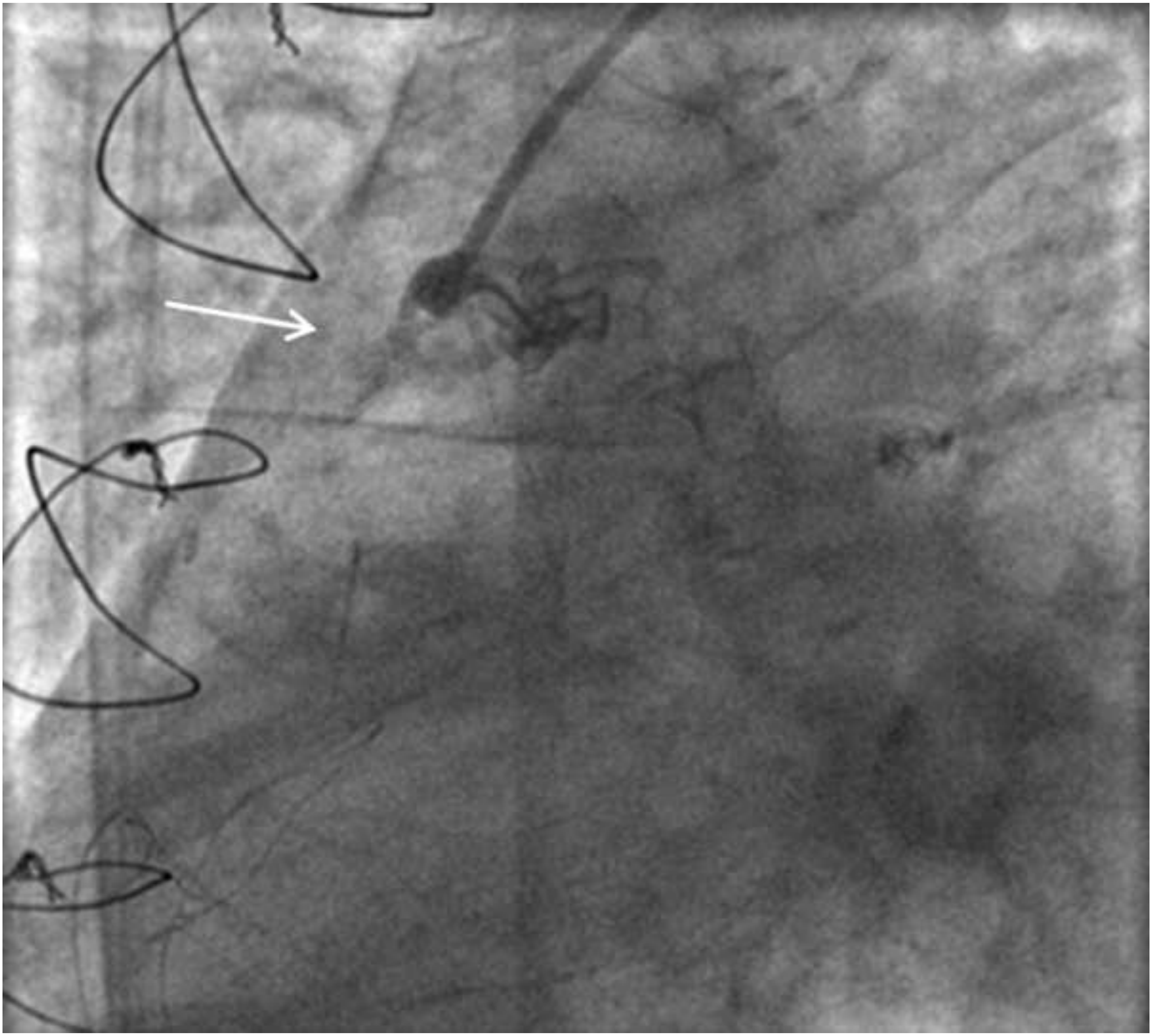


Figure 12

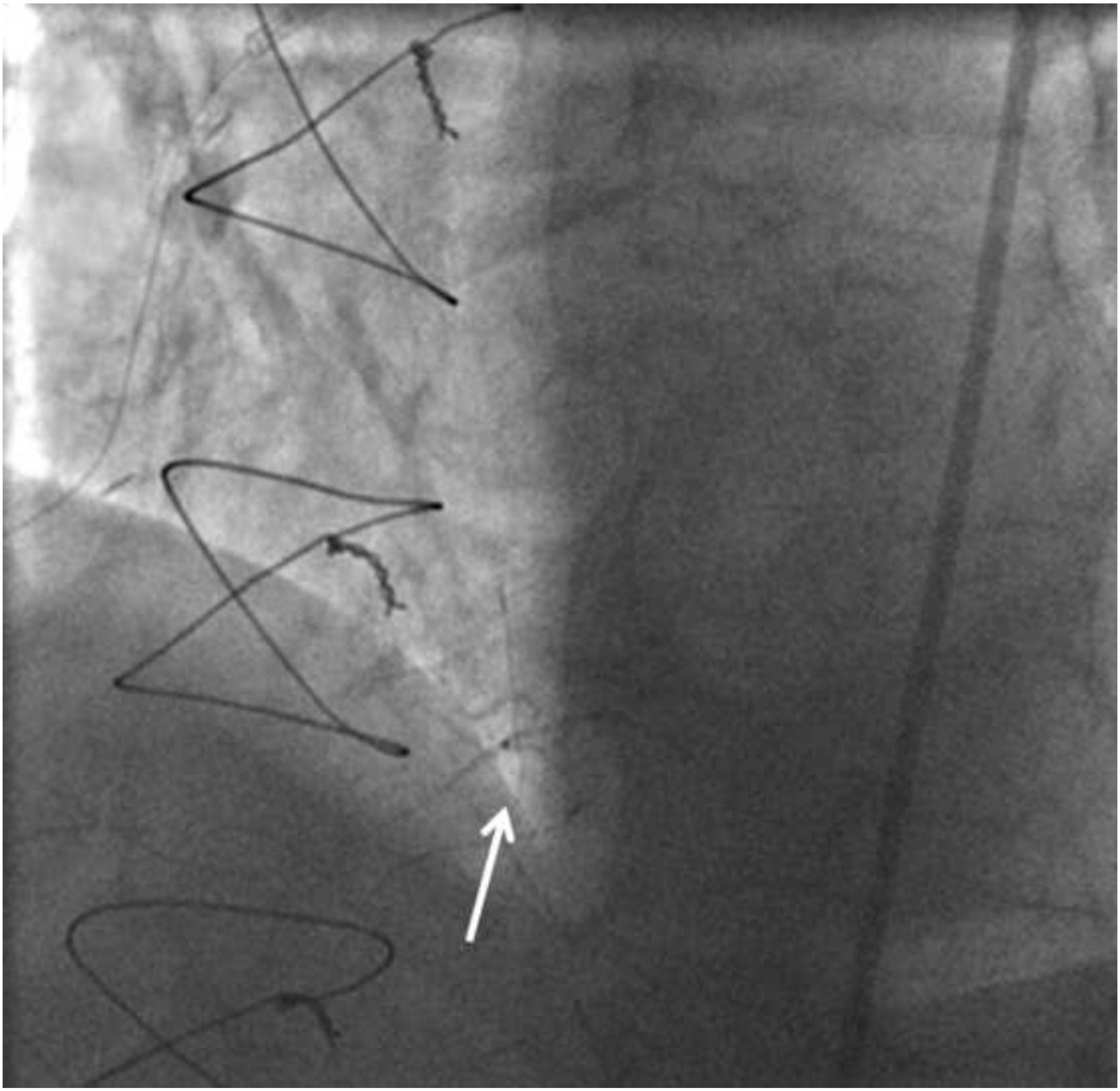


Figure 13

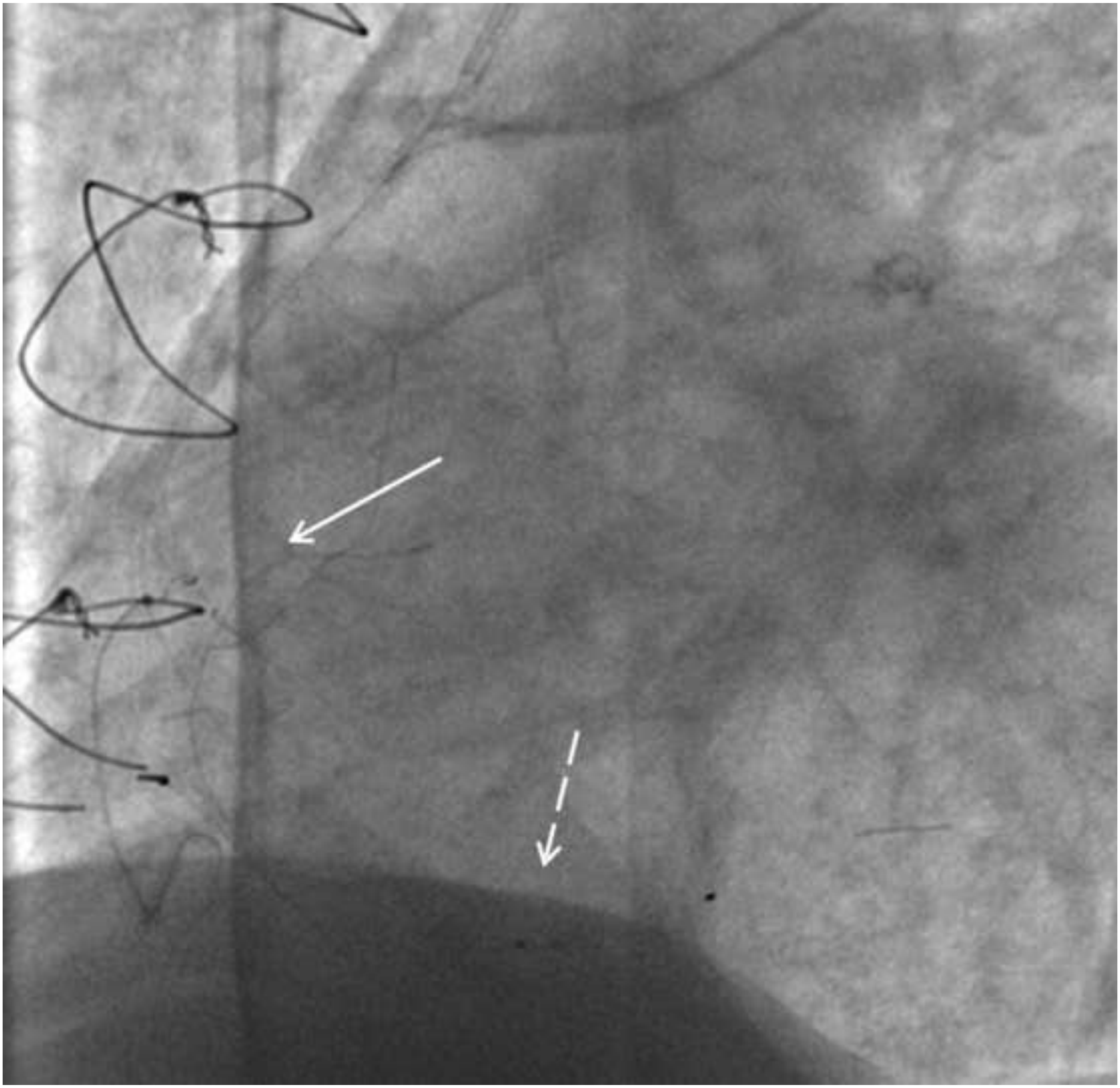


Figure 14