



# Renal artery injury during inferior vena cava filter removal with endobronchial forceps

Carlos A Padula , Andrew R Lewis, Gregory T Frey, J Mark McKinney, Ricardo Paz-Fumagalli, Charles A Ritchie, Zlatko Devcic and Beau B Toskich

## Abstract

Retrieval of tip-embedded inferior vena cava filters using endobronchial forceps is a well-described technique. The tip of dorsally tilted filters may be in proximity to the right renal artery, increasing the risk of arterial injury during retrieval. We present one case that illustrates renal artery injury requiring emergent stent graft repair. The three subsequent cases illustrate techniques that avoid renal artery injury using a femoral and jugular approach with the assistance of an arterial fiducial wire. Renal artery injury is a potential complication during retrieval of filters using endobronchial forceps that can be prevented with careful planning.

## Keywords

Arteriovenous fistula, renal artery injury, IVC filter, endobronchial forceps, renal artery fiducial

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## Introduction

Complications associated with inferior vena cava (IVC) filters have been studied extensively<sup>1</sup> and include filter fracture and embolization, caval thrombosis, and penetration of adjacent organs.<sup>2</sup> As retrieval rates for IVC filters continue to improve by utilizing advanced techniques,<sup>3</sup> interventionalists should be aware of potential complications. While the overall IVC filter retrieval complication rate is low (1.7%), there is a significant increase in the rate with advanced techniques over conventional methods (5.3% vs. 0.4%,  $p < 0.05$ ).<sup>4</sup> Serious injuries have been reported including IVC perforation, IVC dissection,<sup>4</sup> and renal artery injury.<sup>5</sup> Complications can be avoided with an understanding of adjacent anatomic risks and modification of approach. As such, four cases are presented to highlight contrasting outcomes with regard to using endobronchial forceps to remove tip-embedded IVC filters in proximity to the renal artery.

## Case series

One patient presented for retrieval of an Argon Option Elite Filter (Argon, Frisco, TX) placed six months

prior. A vena cavogram demonstrated dorsal tilt and mural incorporation at the level of the renal veins. After failed attempts to engage the filter apex using the loop technique, the apex was dissected from the IVC wall with 3 mm shaft diameter endobronchial forceps (Lymol, Woburn, MA). The patient subsequently experienced severe pain, and the procedure was terminated. A computed tomography (CT) arteriogram demonstrated a right renal artery to IVC traumatic fistula. A right renal arteriogram was performed, confirming injury of the proximal right renal artery with fistulous connection to the IVC. The right renal artery injury was crossed, and the fistulous connection to the IVC as well as an inferior pole segmental artery were

Department of Radiology, Division of Interventional Radiology, Mayo Clinic, Jacksonville, FL, USA

### Corresponding author:

Andrew R Lewis, Department of Radiology, Division of Interventional Radiology, Mayo Clinic, 4500 San Pablo Road, Jacksonville, FL 32224, USA.

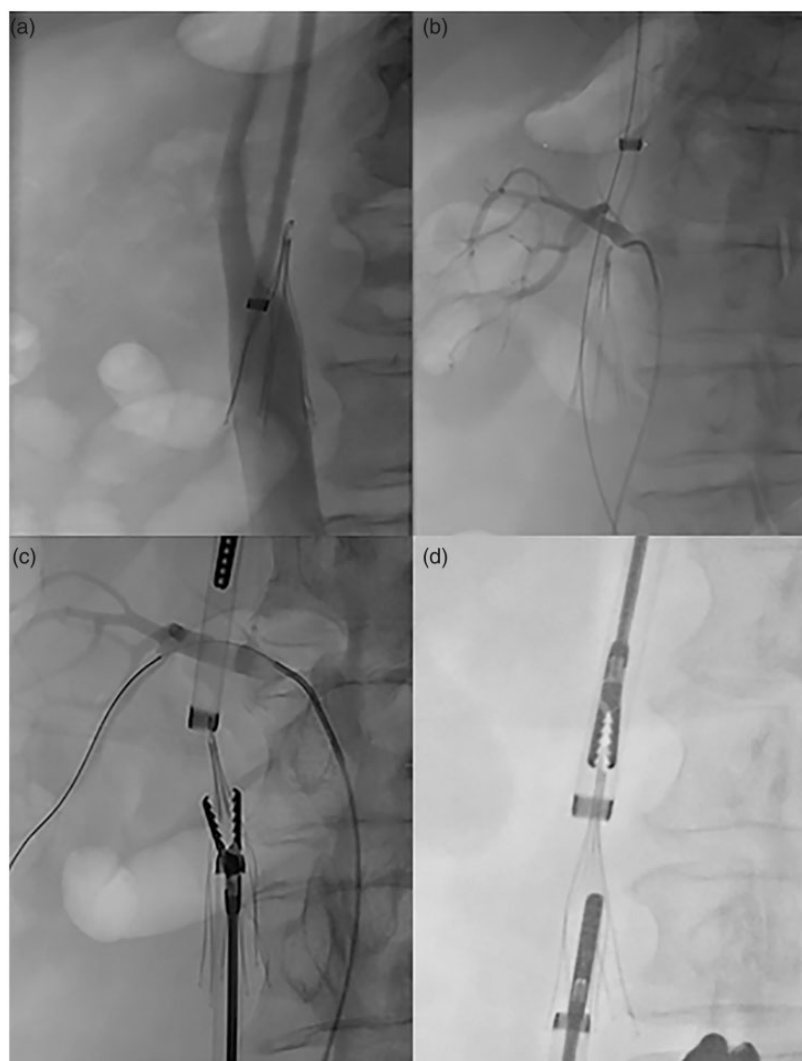
Email: Lewis.Andrew1@mayo.edu



excluded with iCAST covered stents (Atrium, Hudson, NH). Upon consultation with the patient, a second removal was not attempted.

Three patients presented for retrieval of Argon Option Elite Filters (Argon Frisco, TX) with dwell times ranging from 8 to 36 months and imaging demonstrating dorsal transmural incorporation of the filter apex in proximity to the right renal artery (Figure 1(a)). After unsuccessful retrieval with a loop snare, a 5 French forward facing catheter was used to select the right renal artery via a vascular sheath in the right common femoral artery. A right renal artery angiogram was performed, demonstrating less than 2 mm distance from the filter apex to the renal artery lumen (Figure 1(b)). A 0.018 in. nitinol guidewire was placed

in the right renal artery as a real-time fiducial for rotational fluoroscopy. A 14 French vascular sheath was advanced into the inferior vena cava via a right common femoral vein approach. Via the femoral vein sheath, endobronchial forceps grasped and gently retracted the filter inferiorly away from the renal artery to mitigate arterial injury. A second operator advanced a 14 French vascular sheath into the inferior vena cava via a right internal jugular approach. Via the jugular vein sheath, endobronchial forceps dissected free and grasped the filter apex (Figure 1(c)). The filter was captured and removed intact through the jugular sheath (Figure 1(d)). A completion vena cavogram and right renal arteriogram showed no evidence of caval wall or renal artery injury.



**Figure 1.** (a) Inferior vena cavogram showing suspected transmural incorporation of filter apex. (b) Right renal angiogram confirming close proximity of filter apex to right renal artery. (c) Inferior displacement of the filter apex away from the renal artery using endobronchial forceps from a femoral approach. Jugular sheath is advanced to stabilize filter apex to be captured and extracted superiorly by jugular forceps. Renal arteriogram does not show intimal injury to right renal artery. (d) Inferior displacement of filter by femoral forceps to decrease risk of renal artery injury during capture of filter apex by jugular forceps.

Written informed consent for publication of images was obtained. No identifiable patient information was included.

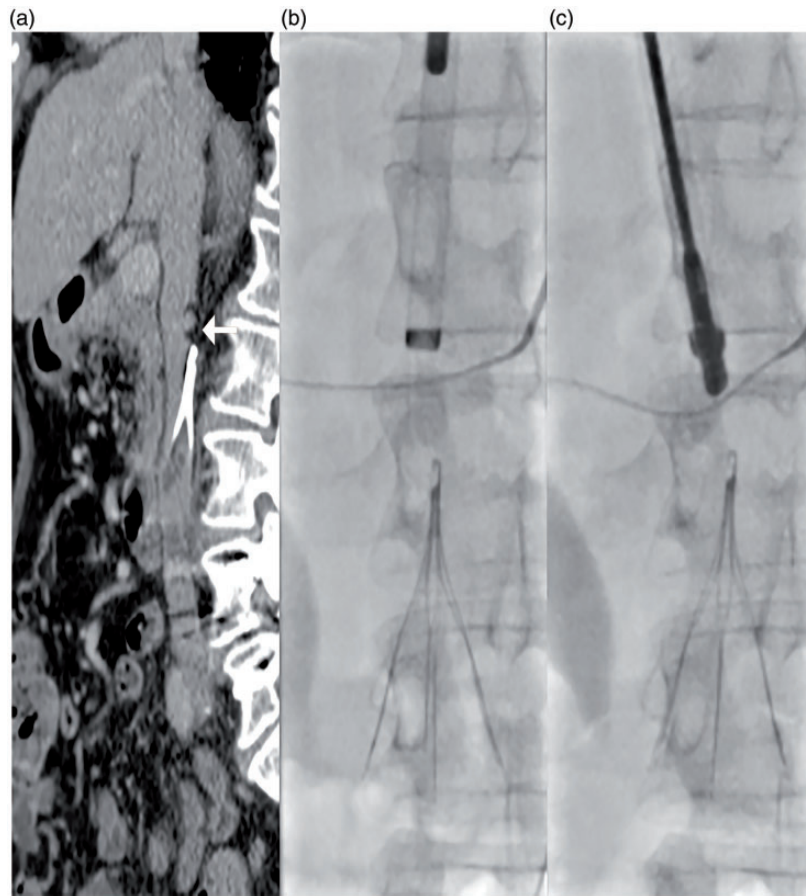
## Discussion

The renal artery injury was most likely incurred during the attempted dissection of the embedded filter apex with forceps. This complication could have been avoided if the anatomy was identified on CT or magnetic resonance imaging, or by obtaining cone-beam CT during the procedure. The right renal artery courses posteriorly to the IVC in the retroperitoneal space and often impresses on the cava creating a 'caval bump', as a jugular approach vascular sheath is advanced in the cava inferiorly at the level of the renal artery (Figure 2 (a) to (c)). Device tilt, observed in up to 12% of cases,<sup>1</sup> can increase the risk of injury to the renal artery during manipulation. Tilting places the filter apex in proximity to the IVC wall and is the most common reason for filter retrieval failure (43%).<sup>6</sup> In our experience,

procedural safety and anatomic tracking were enhanced by catheterization of the renal artery at risk, using a catheter or guidewire as a fiducial. Additionally, repositioning the filter apex into a more favorable location away from the renal artery may reduce the risk of arterial injury.

At seven months, the risk of failure for standard technique removal is 40.9%, with it rising steadily thereafter.<sup>7</sup> Advanced retrieval techniques are necessary in 18% of retrieval cases and have a success rate of 98%.<sup>7</sup> With proper planning, the use of bronchial forceps is a safe and effective technique when filter tilt and mural incorporation negate a conventional retrieval.<sup>8</sup> As presented in Cases 2, 3, and 4, if the filter apex encroaches upon the right renal artery, a bidirectional forceps approach can be attempted (Figure 1(d)).

This report has several limitations. Only three cases utilizing the described technique were performed and for one type of filter (Argon, Frisco, TX). Placing a renal arterial fiducial wire increases procedural time and has a separate risk. In addition, a retrospective



**Figure 2.** (a) Preprocedural contrast-enhanced sagittal CT demonstrating dorsal angulation and caval wall penetration of the filter apex in close proximity to the renal artery (white arrow). Note the intimate course of the right renal artery which ventrally displaces the posterior caval wall resulting in a 'caval bump'. (b, c) Displacement of fiducial guidewire in the right renal artery by jugular forceps highlighting the risk of arterial injury during filter retrieval.

analysis of outcomes for similar filter retrieval cases with similar anatomy was not performed.

## Conclusion

Dorsal mural incorporation of an IVC filter apex at the level of the renal veins poses risk to the right renal artery during forceps filter extraction. Pre-procedural imaging, renal arterial fiducial placement, and caudal filter displacement may prevent injury during forceps retrieval.

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This manuscript expands on the presentation of “Renal arteriocaval fistula following attempted filter retrieval with forceps” by our group at the 2018 ICCIR course in Poertschach, Austria.

## Contributorship

ARL, GTF, CAR, BBT, JM performed the filter removal cases and stenting of renal artery. BBT, ARL conceived the article. CAP conducted research, gathered images, and wrote the article. RP, ZD, BBT, ARL, and CAP edited the article.

## Declaration of conflicting interests

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## Guarantor

ARL.

## ORCID iD

Carlos A Padula  <https://orcid.org/0000-0002-0580-8004>

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