Combination of Quadruple Antegrade and Retrograde In Situ Stent-Graft Laser Fenestration in the Management of a Complex Abdominal Aortic Aneurysm

Peter Salib, Marek Majewski, Joseph Touma, Vania Tacher, Hicham Kobeiter, Pascal Desgranges

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Peter SALIB [1] MBBCH , Marek MAJEWSKI [1] MD , Joseph TOUMA [1] MD , Vania TACHER [2] MD Hicham KOBEITER [2] PhD , Pascal DESGRANGES [1] PhD

1 Department of Vascular Surgery, Henri Mondor
University Hospital, 51 Avenue Mare´chal de Lattre de Tassigny,
94000 Creteil, France
2 Department of Interventional Radiology, Henri Mondor
University Hospital, Creteil, France

- **Peter SALIB [1], MBBCH**
  ORCID ID : peterbahgat90@gmail.com

- **Marek MAJEWSKI[1] ,MD**
  majewski2003@yahoo.fr

- **Joseph TOUMA[1], MD**
  Josephtouma.md@gmail.com

- **Vania TACHER [2] ,MD**
  Vania.tacher@aphp.fr

- **Hicham KOBEITER [2] , PhD**
  hicham.kobeiter@aphp.fr

- **Pascal DESGRANGES [1] , PhD** (corresponding author)
  - pascal.desgranges@aphp.fr
  - ORCID ID : pascal.desgranges@aphp.fr
  - Department of Vascular Surgery, Henri Mondor University Hospital, 51 Avenue Marechal de Lattre de Tassigny, 94010 CRETEIL CEDEX, France
    Tél : +33.1.49.81.24.05

COMBINATION OF QUADRUPLE ANTEGRADE AND RETROGRADE IN-SITU STENT GRAFT LASER FENESTRATION IN THE MANAGEMENT OF A COMPLEX ABDOMINAL AORTIC ANEURYSM

Abstract

Purpose: We report a case of juxta-renal abdominal aortic aneurysm - anatomically unsuitable for conventional endovascular repair because of narrow distal aorta - successfully treated by endovascular repair facilitated by in situ laser fenestration.

Case report: An aortic stent graft was inserted to exclude a juxta renal aneurysm: under image fusion guidance, antegrade in situ laser fenestration allowed to perfuse superior mesenteric artery and both renal arteries. After complementary insertion of an extended aorto-uni-iliac stent graft, retrograde in situ laser fenestration was performed to perfuse the contralateral left iliac artery, in order to overcome a narrow distal aorta.

Conclusion: In situ laser fenestration seems to be an effective solution for endovascular therapy of complex juxta renal aneurysms. In this case of narrow distal aorta it was a suitable alternative to overcome EVAR anatomical restrictions and to prevent other additional open surgical interventions.

Keywords: Juxta renal aneurysm, EVAR, narrow distal aorta, in situ laser fenestration.

Introduction

Open surgical aneurysm repair was the gold standard management for juxta renal aneurysm (JRA) until Fenestrated / Branched – endovascular aneurysm repair (F/B-EVAR) was proposed with a lesser mortality and morbidity rate upon short- and intermediate- term follow-up.[1]

Many limiting anatomical criteria must be considered before F/B-EVAR, in order to prevent post-operative complications such as endoleak, aortic rupture or graft thrombosis. Thus, alternative endovascular techniques, such as chimney techniques, home-made fenestrations, and in situ fenestration were developed to overcome these anatomical restrictions.

According to the European Society of Vascular Surgery, one of these criteria, i.e. aortic bifurcation diameter less than 20 mm – known as narrow distal aorta (NDA) -, is considered as a contraindication for conventional EVAR with bifurcated grafts, as it could lead to graft kinking or thrombosis.[2,3] Usually, surgeons rely on conventional EVAR using an aorto-uni-iliac (AUI) stent graft followed by a cross over femoro-femoral bypass. More recently, new techniques, such as AFX unibody bifurcated graft and "paving and cracking" technique were proposed to avoid additional open surgery. Over the last decade, in situ fenestration (ISF) provided another alternative for complex JRA, opening a new endovascular way to overcome aortic anatomical restrictions.

We describe total endovascular repair of a case with JRA and NDA treated successfully by combination of quadruple antegrade and retrograde in-situ laser fenestration (ISLF) of an aorto-uni-iliac (AUI) stent-graft under image fusion guidance.

Case report

A 69 years-old male patient, smoker with a past medical history of chronic obstructive lung disease, asthma, Klinefelter syndrome under hormonal therapy and type A hemophilia, was followed for asymptomatic abdominal aortic aneurysm.

Thoraco-abdominal aortic CTA showed a JRA with an increasing diameter of 51-52 mm. Preoperative sizing showed a 4 mm short infra renal aortic neck length , a 14.8 mm proximal healthy landing zone involving superior mesenteric artery (SMA) and both renal arteries and a 12 mm circumferential calcified NDA diameter (Fig 1).

Conventional open surgery was refused by the patient for two reasons an increased risk of hemorrhage because of hemophilia, and a risk of renal impairment because of suprarenal aortic clamping.

FEVAR with bifurcated stent-graft was declined owing to NDA which could lead to graft kinking or thrombosis. Even if “paving and cracking” technique could facilitate introduction and deployment of the aortic stent-graft through the NDA, it was deemed at risk of aortic rupture. Hybrid surgery consisting FEVAR with AUI model followed by crossover femoro-femoral bypass was also declined because of the increased risk of wound/graft infection and hemorrhagic complication as above mentioned .Chimney technique was not preferred because we had had to use 3 chimneys stents for the superior mesenteric artery and both renal arteries, thus increasing the risk of type 1A endoleak due to multiple gutters. Finally, we could not use the AFX unibody bifurcated graft for the NDA because is not reimbursed in France and is not available a fenestrated custom-made model of it.

The patient was thus considered for total endovascular repair using ISLF. Under general anesthesia, We loaded pre-intervention CTA images with intraoperative unenhanced cone-beam computed tomography (CBCT) images without contrast, in order to create a 3D road map overlay on 2D fluoroscopy, providing landmark rings for each targeted artery.(Fig. 2).

After bilateral femoral and right brachial percutaneous access, we catheterized the superior mesenteric artery via the brachial access as a rescue procedure in case of failure of SMA fenestration. Catheterization of the abdominal aorta via the right femoral artery allowed placement of a Lunderquist guidewire up to the thoracic aorta.

We then deployed a 30/100/30 Valiant Captivia aortic stent graft (Medtronic, Santa Rosa, CA, USA) at the level of the celiac trunk, thus covering the superior mesenteric artery and both renal arteries.

Via the right femoral access, we inserted a long steerable Aptus catheter (Medtronic, Santa Rosa, CA, USA) to carry the Turbo Elite excimer laser catheter (Spectranetics, Colorado Springs, CO, USA) at a precise point to perforate the stent graft opposite to the SMA, guided by landmark rings previously created. We passed the guide wire into the SMA through the opening after two attempts of fenestration (10 minutes). Then, we used a 1.5x2.5 mm cutting balloon followed by a 5x20 mm semi-compliant balloon to enlarge the perforated opening. Next, we inserted a balloon expandable Bentley covered stent 7x27 (Bentley Innomed, GMBH, DE). Maximum ischemia time was 21 mins. We used the same protocol for right and left renal arteries: maximum ischemia time 50 and 72mins respectively.

Finally, we deployed an Endurant 32/104/14 aorto-uni-iliac (AUI) stent graft (Medtronic, Santa Rosa, CA, USA) to the right iliac artery with 25 mm overlapping length with the Valiant stent graft. Via the left femoral artery, we inserted the APTUS steerable catheter (Medtronic, Santa Rosa, CA, USA) opposite to the AUI stent graft. We directly perforated it using the same laser fiber as previously. After only one attempt of laser perforation , we were able to pass the 0.014 wire smoothly through the laser catheter and the opening .Then, we enlarged the opening with the same protocol as mentioned before and we inserted a 10x59 mm Advanta V12 balloon expandable covered stent (Atrium Medical Corporation, Hudson, NH). Maximum ischemia time for the left lower limb was 30 mins. (Fig 3)

Additional covered iliac stent was necessary to fix a dissection of the homolateral right external iliac artery. Final angiogram was satisfactory and showed patency of all stents without evidence of endoleak. Total operating time was 150mins, amount of contrast 60 cc, fluoroscopy exposure time 68 min, DAP 167138 $mGycm^2$.

Post-operative course was uneventful, and the patient was discharged at day 7 after a post-operative CT scan showing good exclusion of the aneurysm. Stable baseline of creatinine level was at 74 µmol/L and lactate level was at 1.8 mmol/L.

6 months follow up CTA showed patency of the aortic stent graft and of all inserted stents and stable aneurysmal sac diameter at 52 mm. No endoleak was detected. (Fig 4).

Discussion

Open surgical aneurysm repair was the gold standard management for juxta renal aneurysm (JRA) until Fenestrated / Branched – endovascular aneurysm repair (F/B-EVAR) was proposed with a lesser mortality and morbidity rate upon short- and intermediate- term follow-up.[1]

The main challenge face surgeons during conventional EVAR for complex aneurysms is anatomical restrictions. Other off-label endovascular techniques were developed to overcome these anatomical restrictions such as chimneys techniques, home-made fenestration, and in situ fenestration.

In the present case, we describe the first application of retrograde ISLF to preserve the contra lateral common iliac artery following an antegrade ISLF of SMA and both renal arteries in the management of JRA with a NDA .

First ISF was reported by McWilliams in the management of saccular thoracic aortic aneurysm to maintain the left subclavian artery revascularization by retrograde way during thoracic EVAR. Since then, many ISF cases were reported to perfuse the aortic branches by two main methods; mechanical and physical fenestration and two main approaches; retrograde and antegrade way. [4,5]

Excimer Laser device, one of physical methods, was initially used by cardiologist to revascularize atherosclerotic coronary arteries. Then, it was proposed as an alternative technique instead of mechanical ISF to fenestrate the aortic stent graft by retrograde way for aortic arch reconstruction.

Also, ISLF was developed to be used by ante grade way in the management of JRA to perfuse reno-visceral arteries. Indication of the exact point of perforation during antegrade

ISLF is the corner stone of the procedure.[6]Therefore, preliminary stenting of target vessels is used to guide surgeons before laser fenestration until image fusion technique offered the creation of landmarks rings to simplify perforation procedure without preliminary stenting of target vessels as reported before by our team.[7,8]

The retrograde ISF through the common iliac artery was previously reported by coscas et al to convert an AUI to bifurcated endograft in the management of infra renal aortic aneurysm and a NDA by using in situ mechanical fenestration by the Ross modified Colapinto needle from the transjugular intrahepatic access set with satisfactory results. .[9]

In the present case, using a retrograde ISLF through a calcified NDA had two main challenges. On the one hand, the implantation of an iliac stent through a small laser fenestration and a narrow circumferential calcified aorta may lead to stent stenosis and inadequate perfusion to contra lateral limb. On the other hand, the damage made by the laser fiber on the aortic stent graft fabric and the unreinforced fenestration could cause fenestration instability, weakness, and sealing long term issue. In our case, we fenestrated a woven Dacron stent graft by the laser fiber. Dacron stent graft showed more stability with laser fenestration compared to polytetrafluoroethylene covered endografts which seems to be unsuitable for laser fenestration.[10] Furthermore, physical in situ Laser fenestration showed a clean fenestration and less fabric fraying of the stent graft compared to mechanical needle fenestration according to in vitro benchtop evaluations.[11] Finally, the enlargement performed with the cutting balloon and semi-compliant balloon before stent insertion helped us to easily expand the iliac balloon expandable covered stent which reinforced the fenestration and prevent iliac limb stenosis or kinking due to the NDA.

By using this technique under image fusion guidance, we avoided any surgical intervention and we consumed less amount of contrast and less time of fluoroscopy exposure.

Conclusion

In situ laser fenestration offers an effective solution for endovascular therapy of complex juxta renal aneurysms. In this case of narrow distal aorta, ISLF was a suitable advance to overcome EVAR anatomical restrictions and to prevent other additional open surgical interventions providing safe and rapid total endovascular reconstruction of abdominal aortic branches and its bifurcation.

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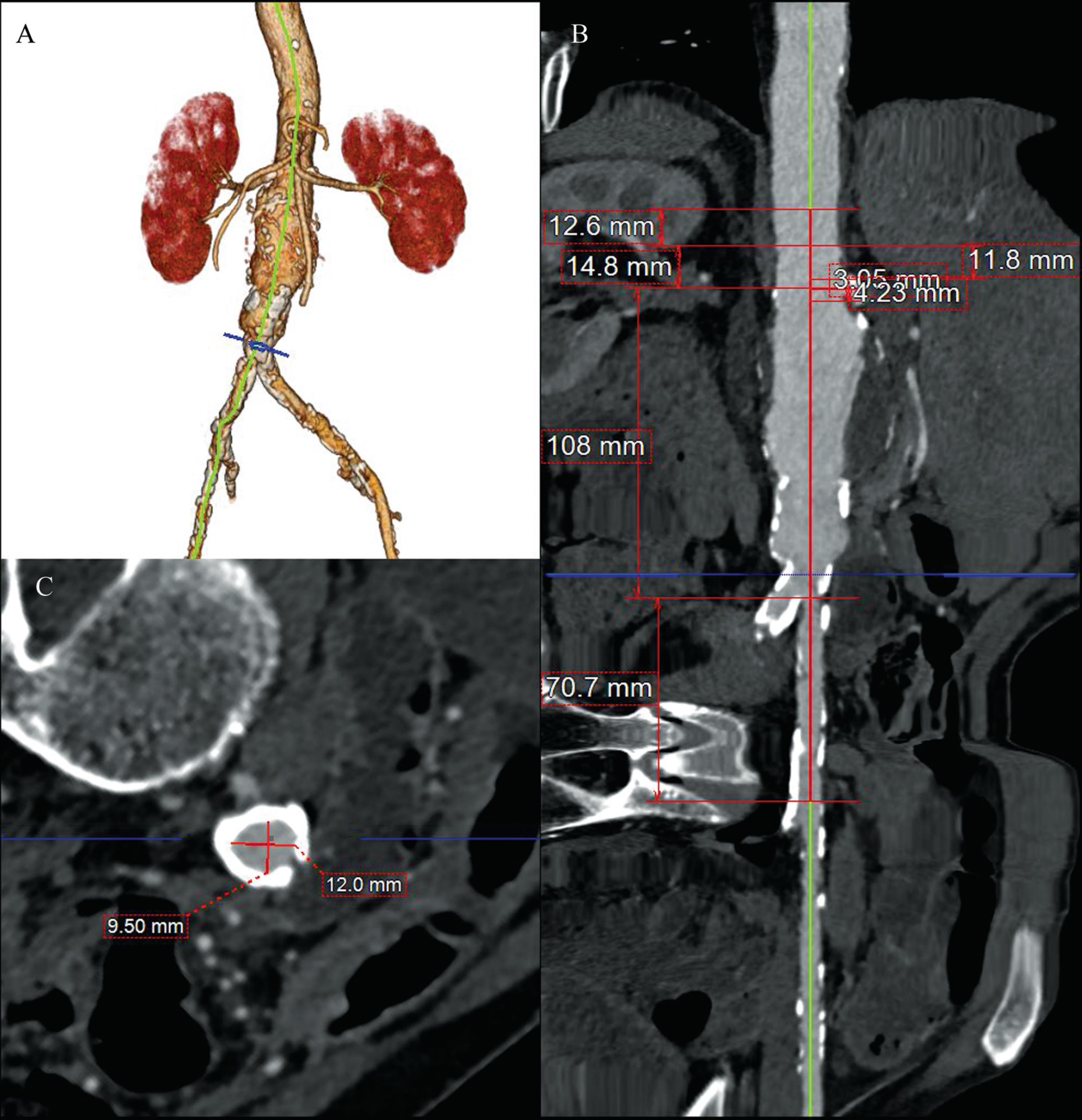
Figures quotations

Fig 1 : pre-operative of Computed tomographic angiography (CTA) sizing. (A) 3D reconstruction of 52 mm juxta renal aneurysm. (B) short infra renal landing zone measuring 4 mm, proximal healthy 14.8 mm landing zone involving superior mesenteric artery and both renal arteries. (C) 12 mm Circumferential calcified narrow distal aorta

Fig 2 : 3D road map created by image fusion technique (A)created landmark rings of each targeted vessels , superior mesenteric artery (SMA) and both renal arteries before the antegrade laser fenestration (ISLF). (B) (SMA) catheterization with a guidewire after ISLF. (C) created left contralateral common iliac artery landmark ring before retrograde laser fenestration.

Fig 3: retrograde in situ laser fenestration technical steps. (A) Fabric hole enlargement using a 2.5 x 1.5 cutting balloon after in situ laser fenestration was performed through the Aptus steerable catheter using the Turbo Elite excimer laser catheter.(B) completion of the enlargement procedure using a 5 x 2 mm semi compliant balloon. (C)Insertion of V12 balloon expandable covered stent (D) intra operative angiography showed intact stent without stenosis or endoleak.

Fig 4: 6 months post-operative follow up. (A) 3D reconstruction CTA shows intact aortic stent graft. (B)patent SMA stent. (C) patent both renal arteries stents. (D) Stable aneurysmal sac diameter at 52 mm (E) patent common left iliac artery stent with no stenosis or compression.



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B
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3.05 mm
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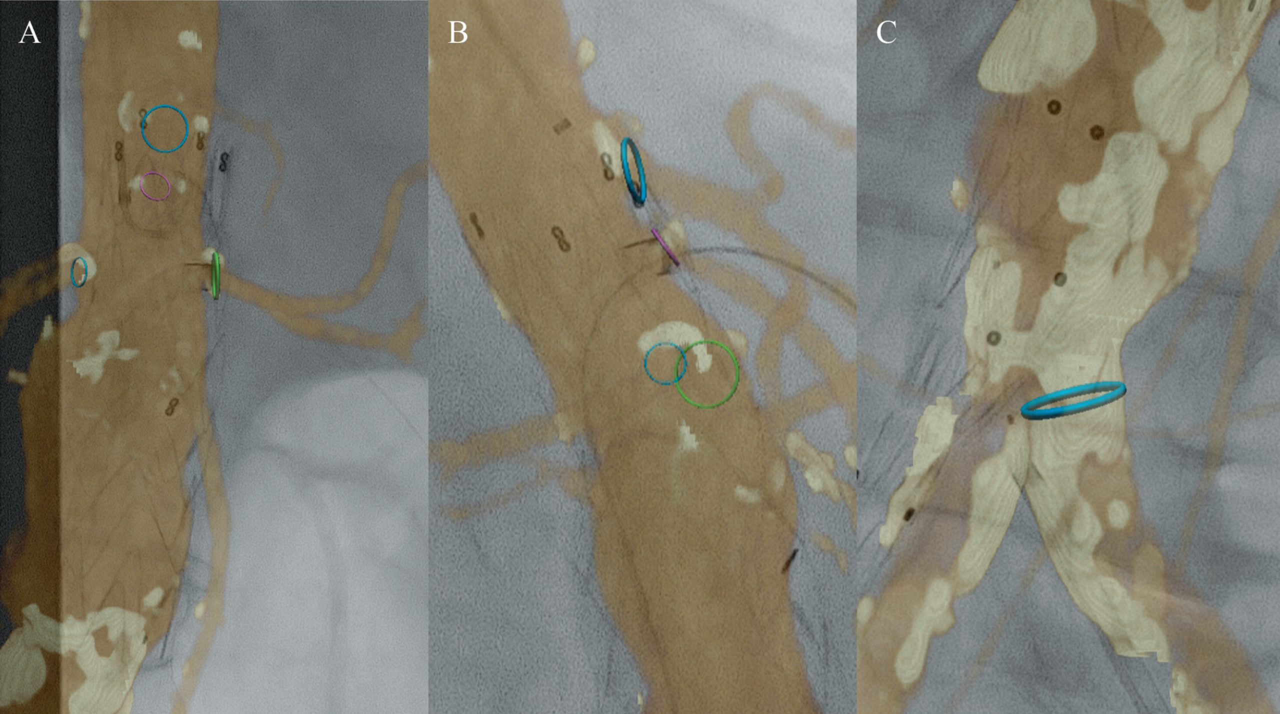
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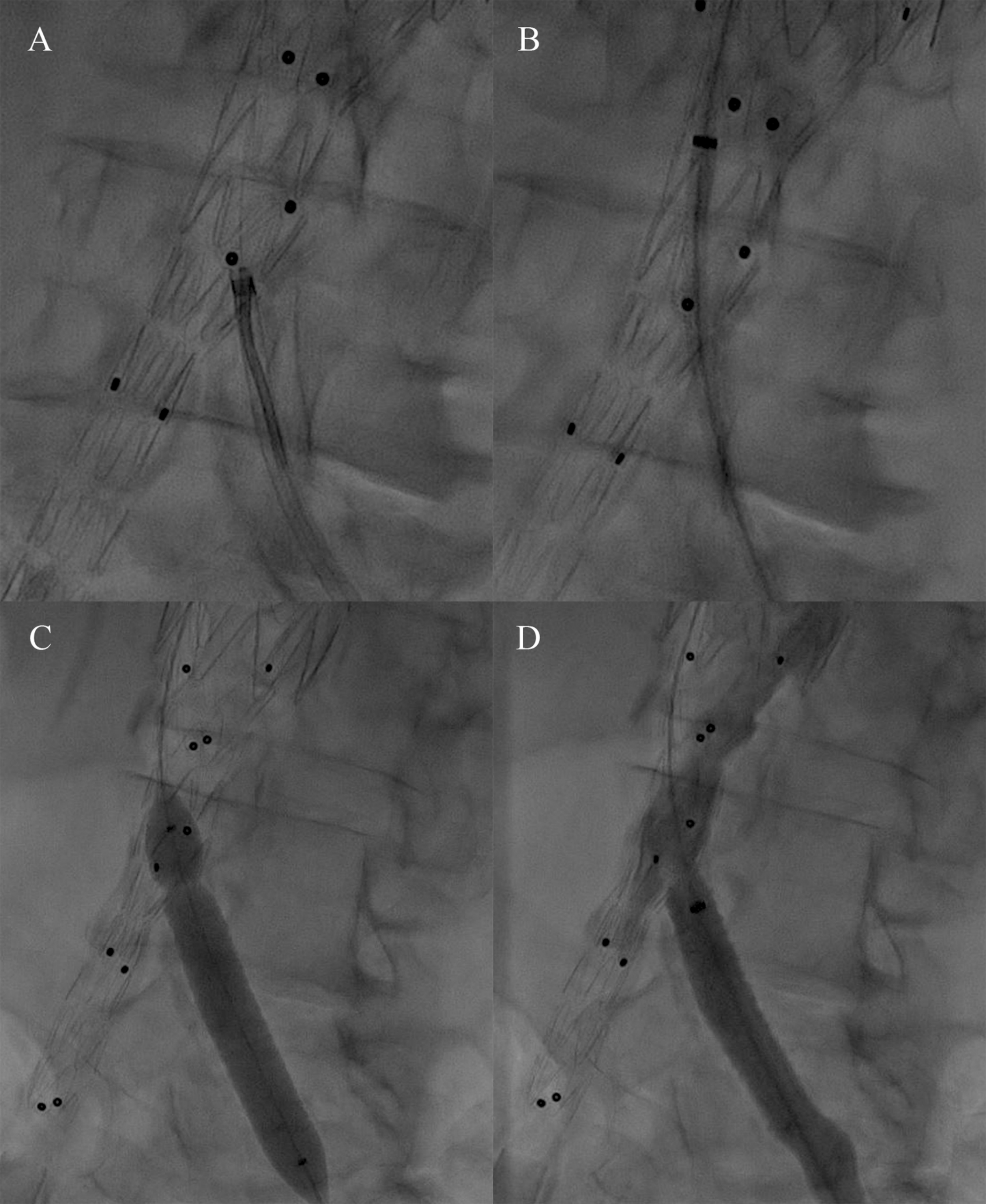
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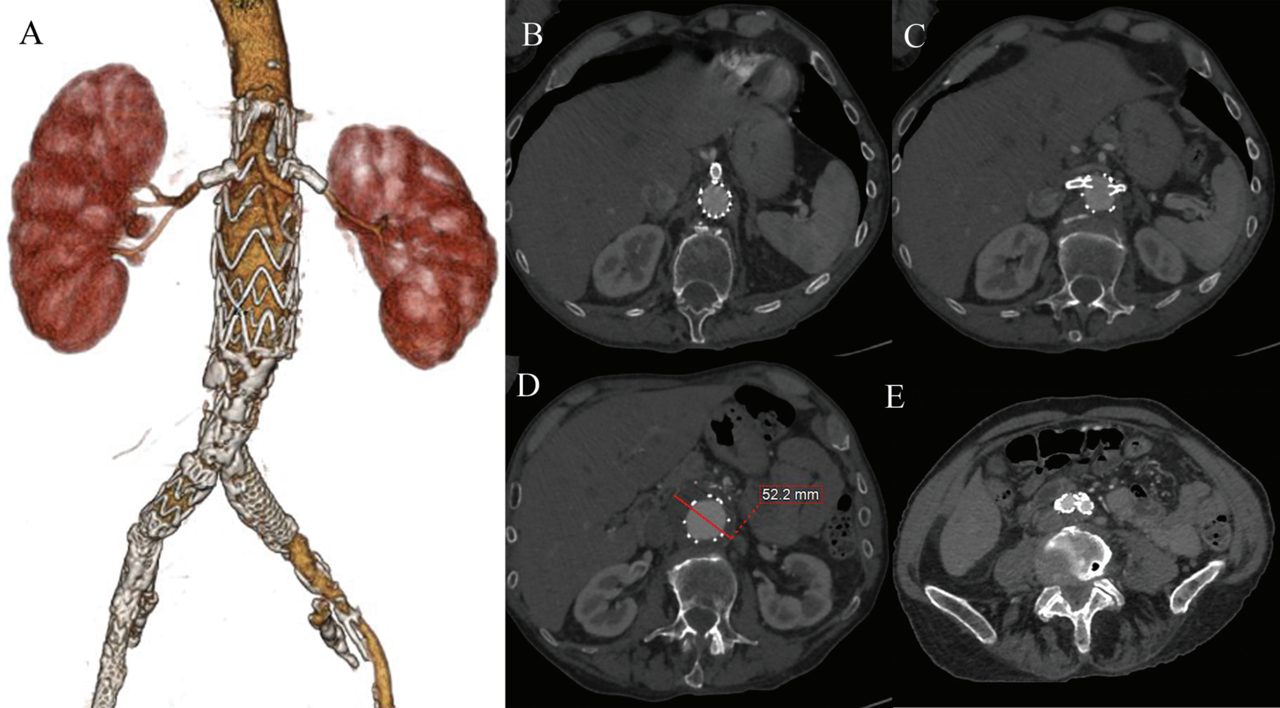
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52.2 mm
E