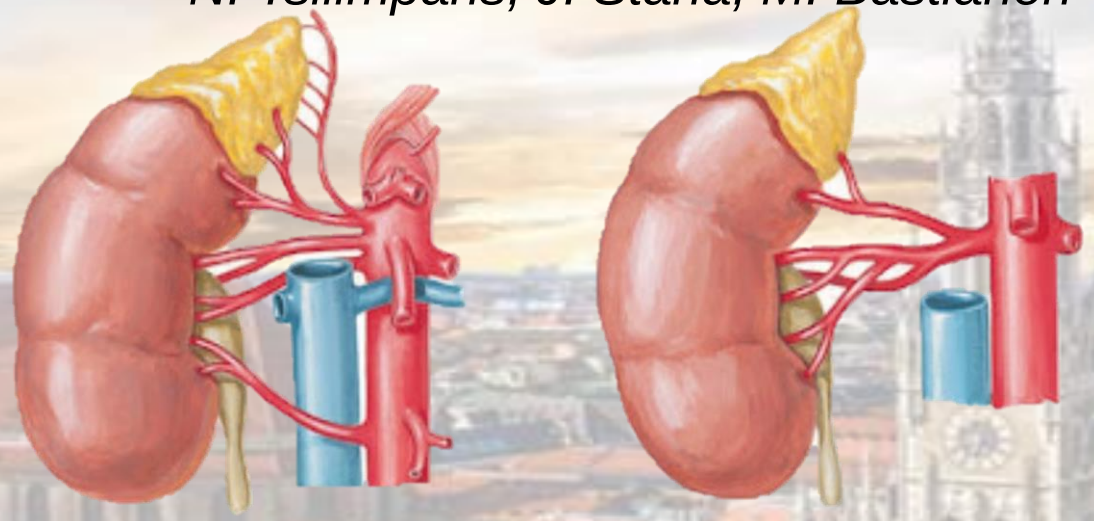
Approaches to aberrant target vessel anatomy - double barrel stenting, bibranches, double branches and more

N. Tsilimparis, J. Stana, M. Bastianon



Univ. Prof. Dr. med. Nikolaos Tsilimparis
Direktor der Abteilung für Gefäßchirurgie –
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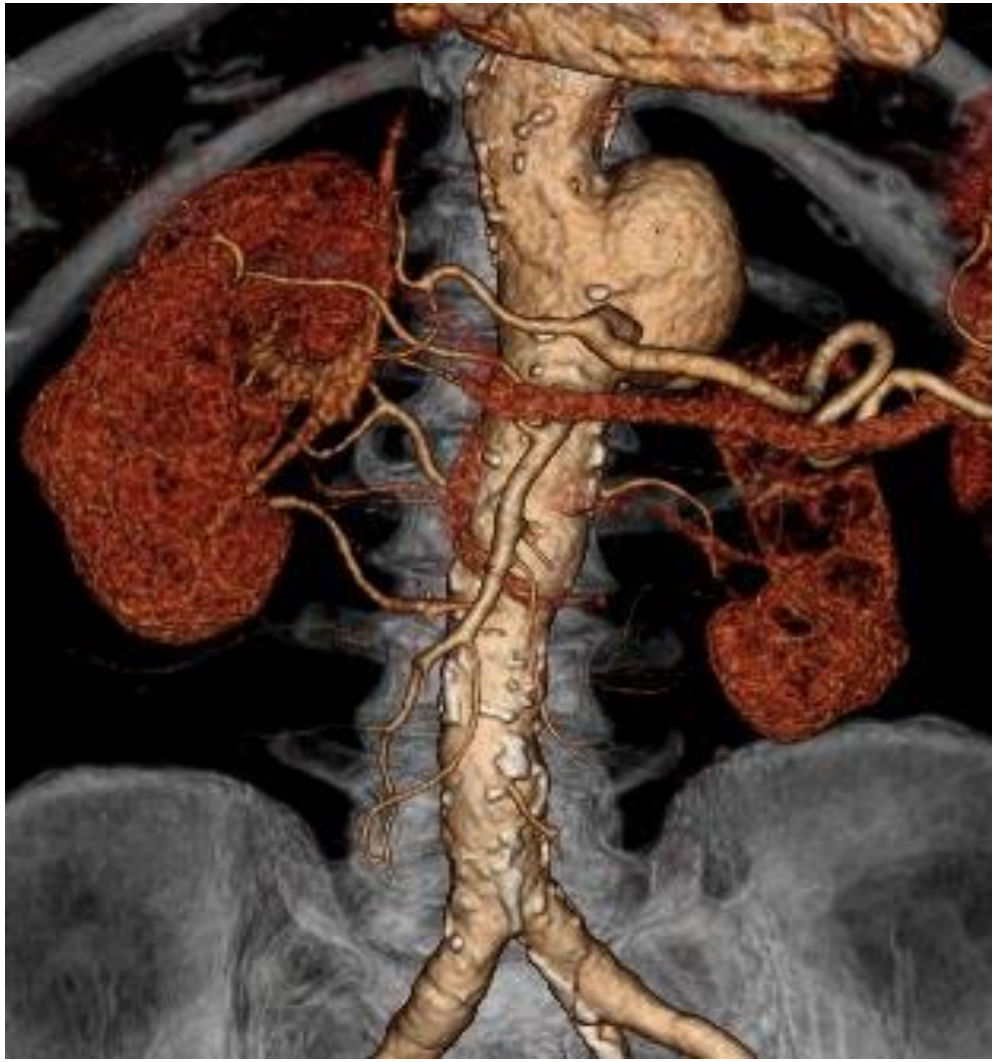
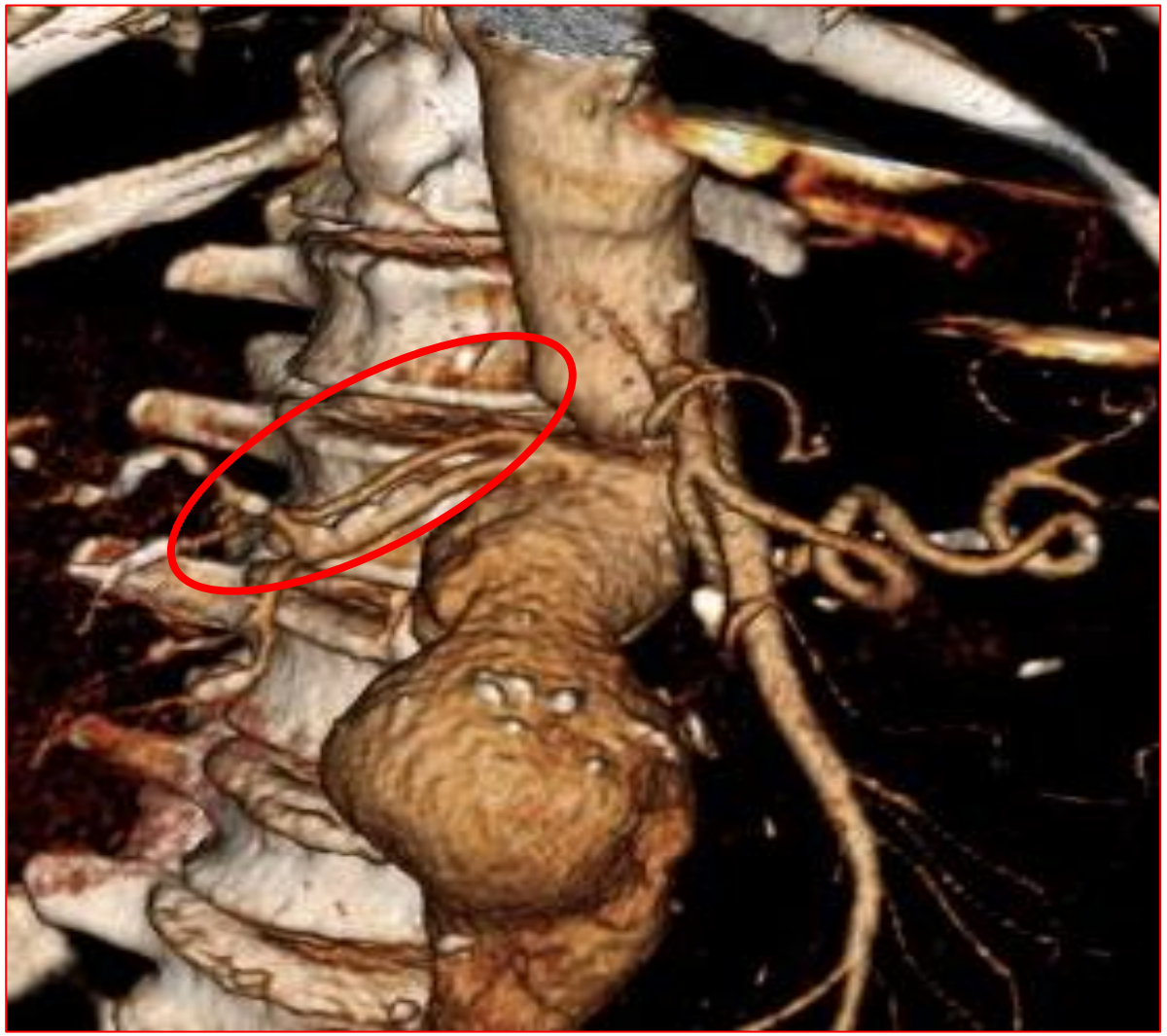
Klinikum der Ludwig-Maximilians-Universität (LMU) München

550 Jahre LMU MEDIZIN Exzellenz seit 1472

Abberant target vessel anatomies - Renals





Classification of extra renal arteries

IJAE
Vol. 124, n. 2: 153-163, 2019
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Circulatory system

Renal artery variations: a 20.782 kidneys review

Caryn Recto[1,2], Antonino Marcello Pilia[1], Riccardo Campi[3], Jacopo J.V. Branca, Alessandra Pacini[1], Ferdinando Paternostro[1,*]

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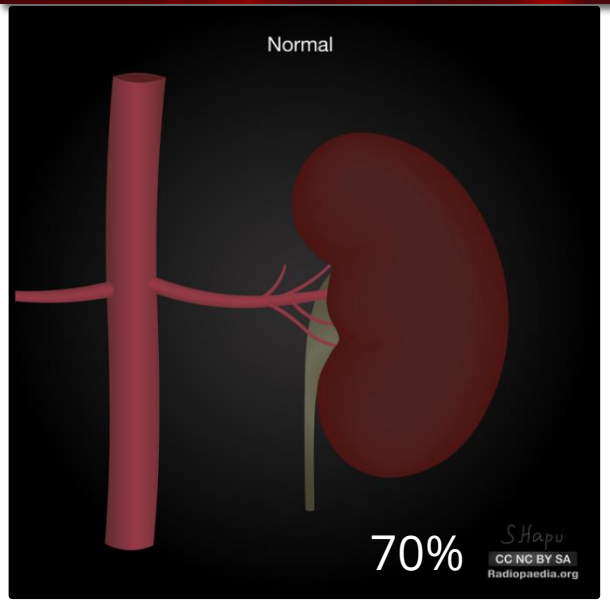

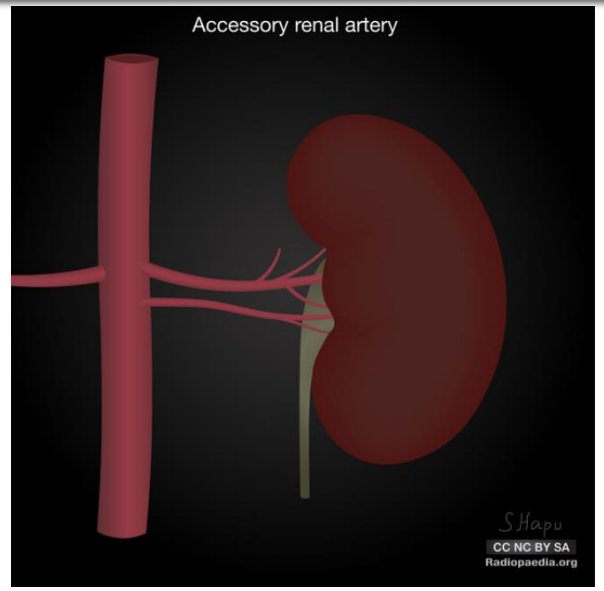

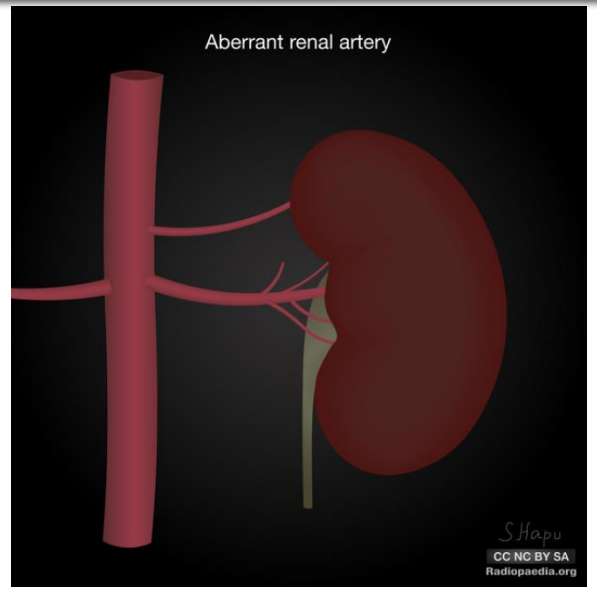

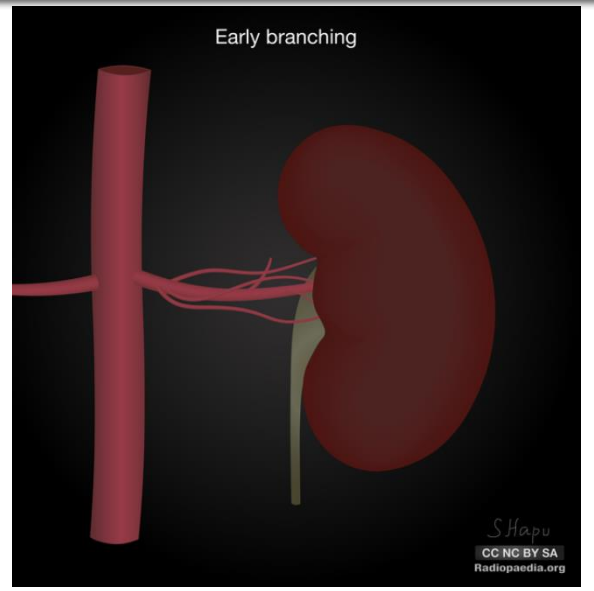

Extra renal arteries

~25% (range 20-30%) of the population

Subclassification of extra renal artery :

- aberrant renal artery: supplying the superior and/or inferior pole of the kidney
- accessory renal artery: supplying the renal hilum

Bilateral accessory renal arteries: 10-15% of cases:

- single renal artery arising from the abdominal aorta: 70%
- double renal arteries: ~20% (range 14-23%)
- triple renal arteries: ~2.5% (range 1-4%)
- quadruple renal arteries: <1%

Clinical effect of accessory renal artery coverage after endovascular repair of aneurysms in abdominal and thoracoabdominal aorta

Konstantinos Spanos, MD, MSc, PhD,[a,b] Petroula Nana, MD,[a] Alexandros G. Brotis, MD, MSc, PhD,[c] George Kouvelos, MD, MSc, PhD,[a] Christian-Alexander Behrendt, MD Dr,[b] Nikos Tsilimparis, MD, PhD,[d] Tilo Kölbel, MD. PhD,[b] Miltiadis Matsagkas, MD, PhD, FEBVS,[a] *and* Athanasios Giannoukas, MD, MSc, PhD, FEBVS,[a] *Larissa, Greece; and Hamburg and Munich, Germany*

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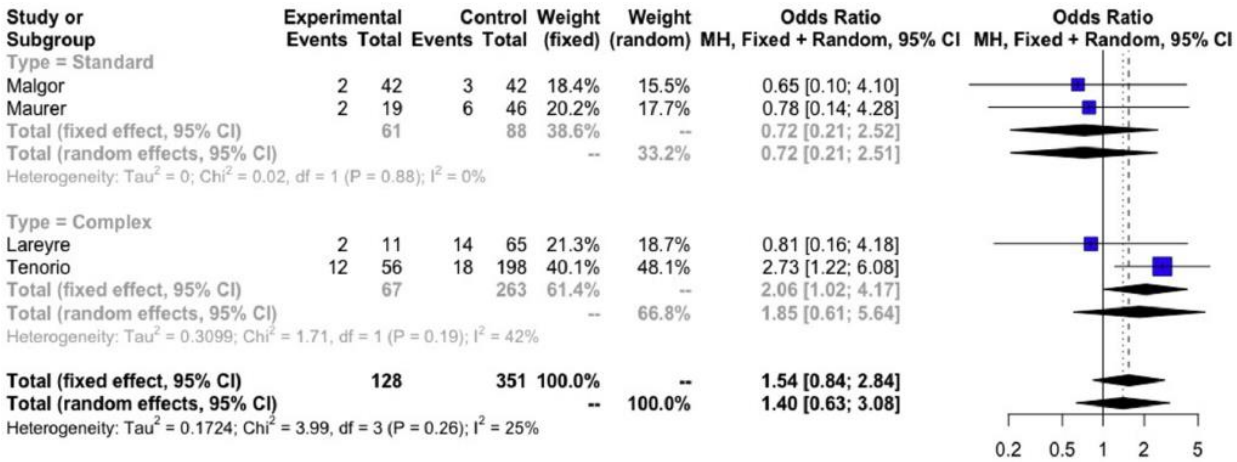
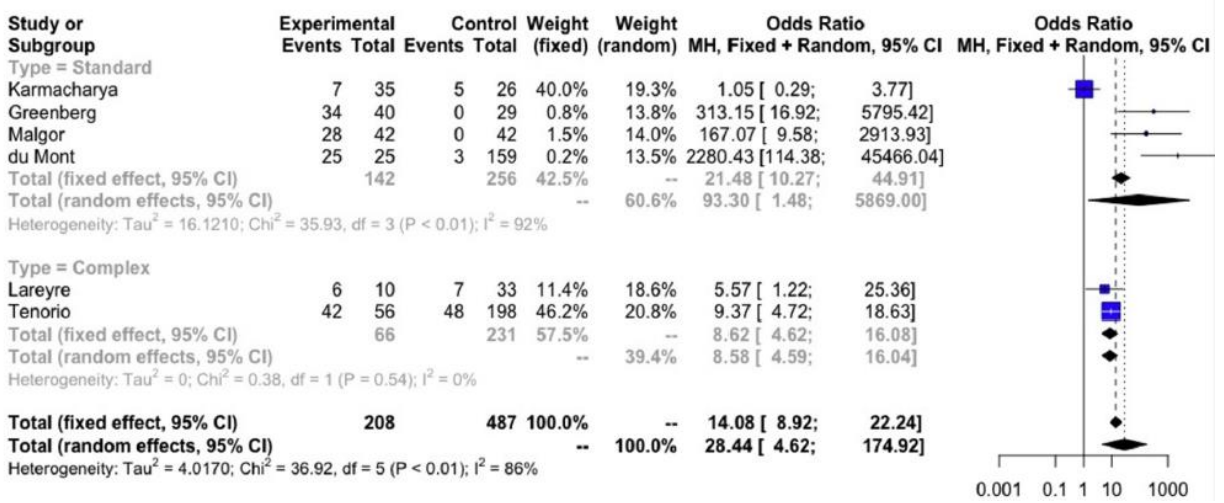
Meta-analyses of acute kidney injury (AKI) incidence



Meta-analyses of renal infarction rate

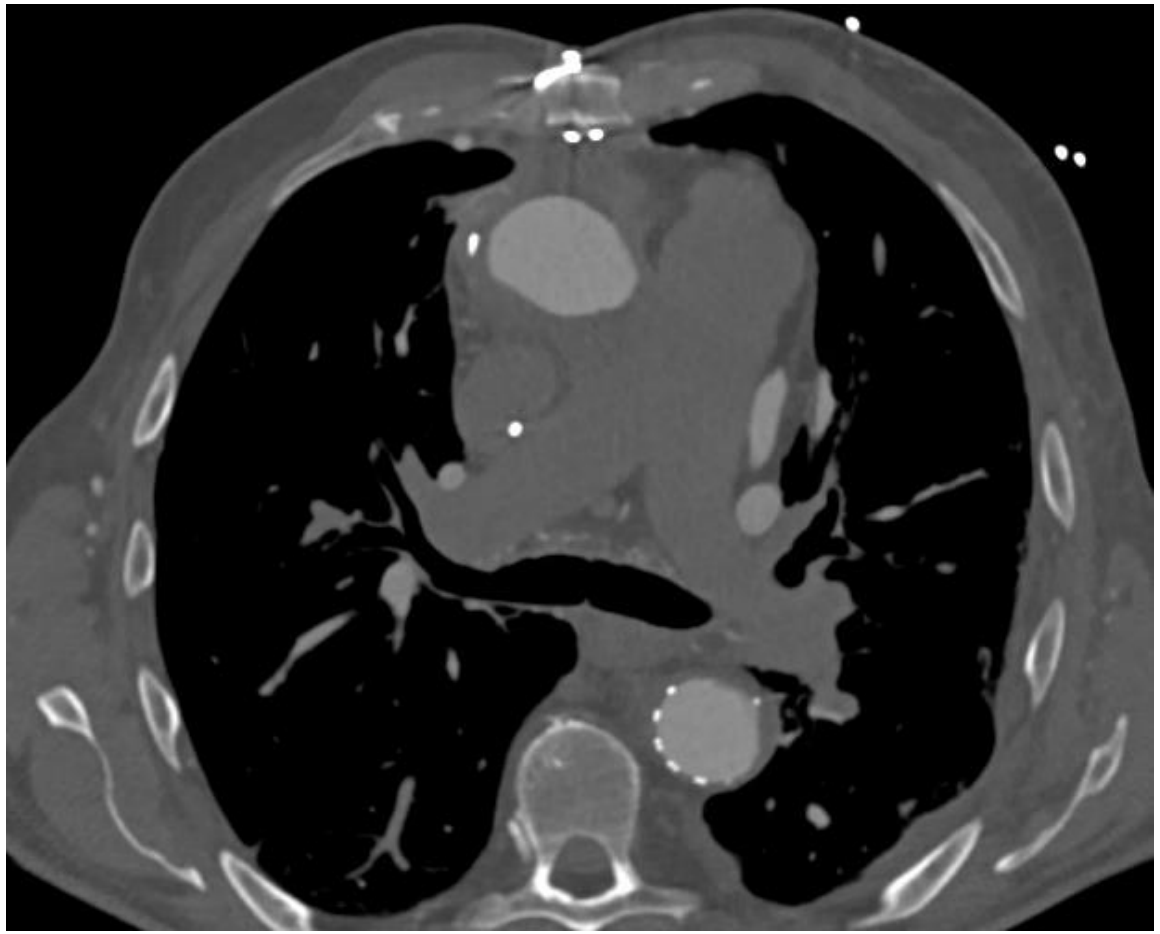


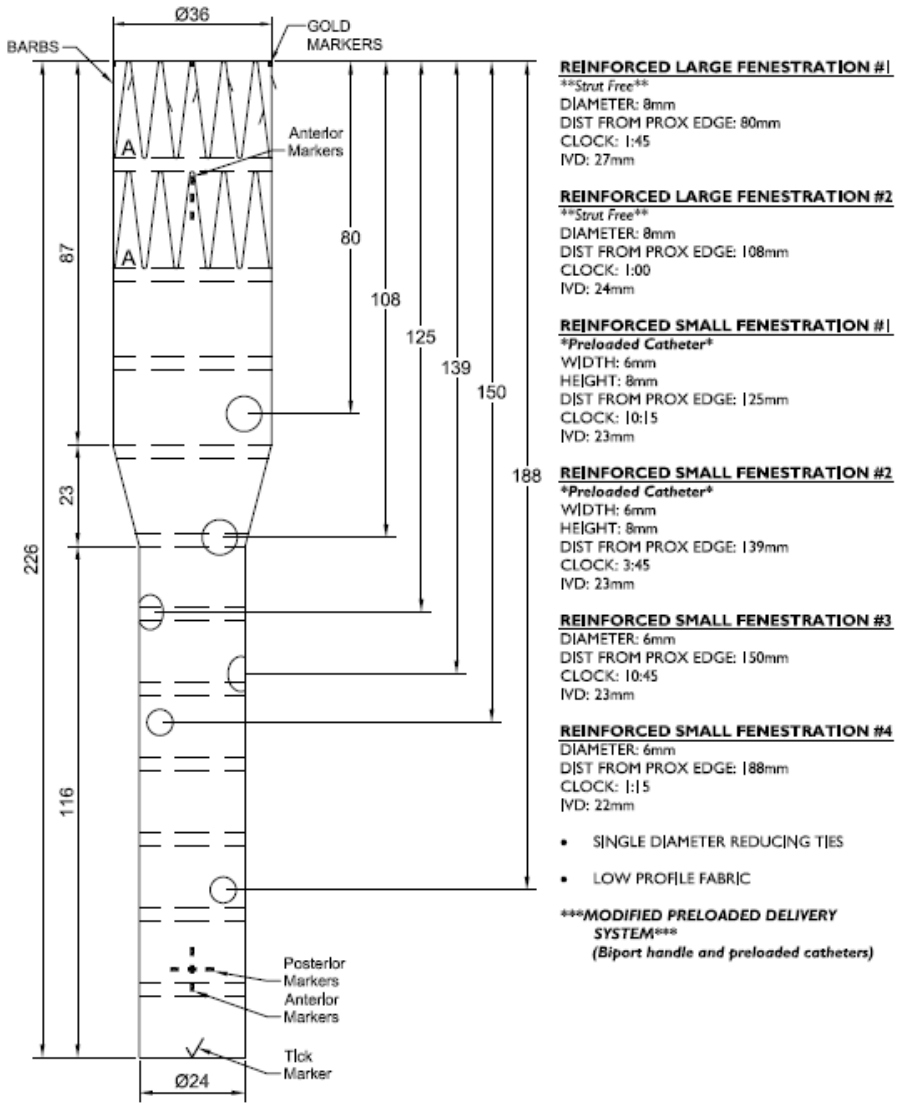
ARA (<4 mm) coverage in patients undergoing standard EVAR or endovascular repair of complex aneurysms is associated with an increased risk of renal infarction. However, we found no clinical effects of ARA coverage on renal function or mortality in early postoperative and follow-up period. **Preservation of an ARA >4 mm should be considered.**

J Vasc Surg 2021

Incorporation of multiple renals

6 vessel fenestrated
with staged TEVAR





REINFORCED LARGE FENESTRATION #1
Strut Free
DIAMETER: 8mm
DIST FROM PROX EDGE: 80mm
CLOCK: 1:45
IVD: 27mm

REINFORCED LARGE FENESTRATION #2
Strut Free
DIAMETER: 8mm
DIST FROM PROX EDGE: 108mm
CLOCK: 1:00
IVD: 24mm

REINFORCED SMALL FENESTRATION #1
Preloaded Catheter
WIDTH: 6mm
HEIGHT: 8mm
DIST FROM PROX EDGE: 125mm
CLOCK: 10:15
IVD: 23mm

REINFORCED SMALL FENESTRATION #2
Preloaded Catheter
WIDTH: 6mm
HEIGHT: 8mm
DIST FROM PROX EDGE: 139mm
CLOCK: 3:45
IVD: 23mm

REINFORCED SMALL FENESTRATION #3
DIAMETER: 6mm
DIST FROM PROX EDGE: 150mm
CLOCK: 10:45
IVD: 23mm

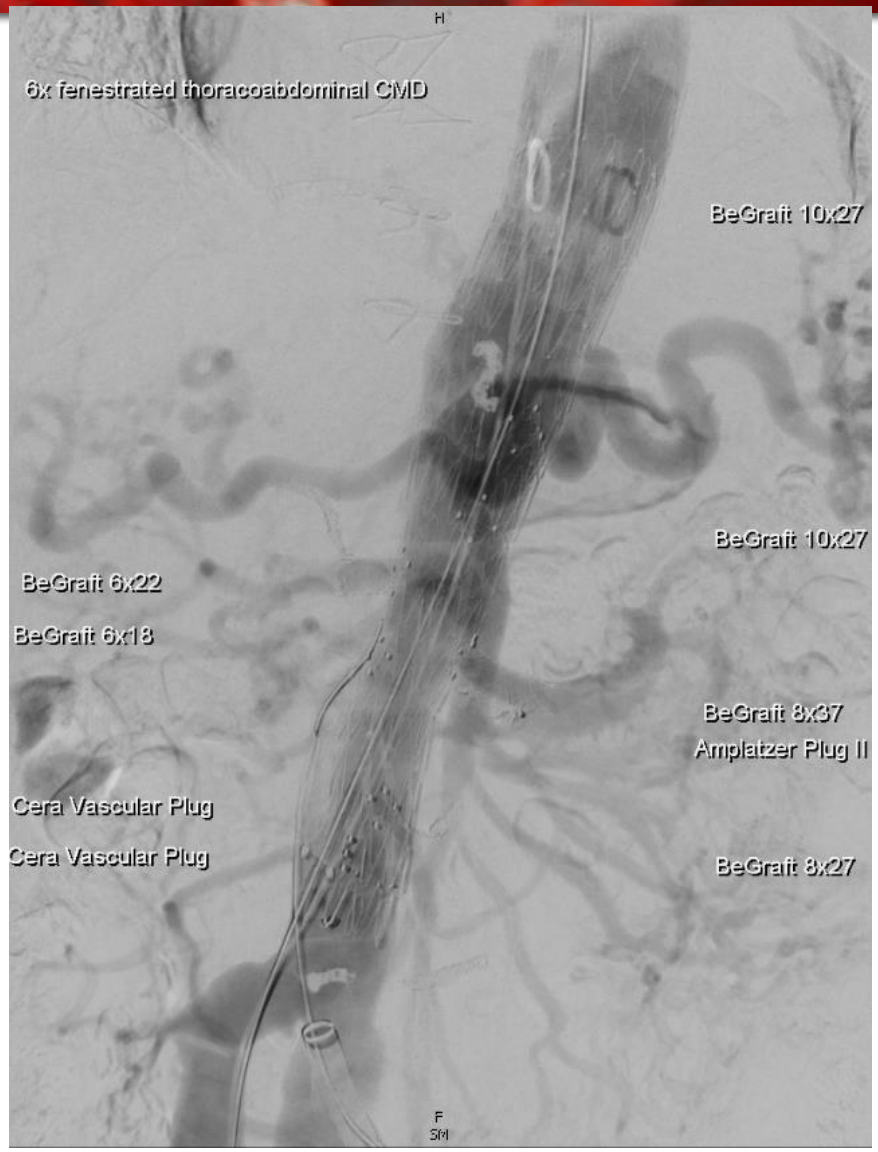
REINFORCED SMALL FENESTRATION #4
DIAMETER: 6mm
DIST FROM PROX EDGE: 188mm
CLOCK: 1:15
IVD: 22mm

- SINGLE DIAMETER REDUCING TIES
- LOW PROFILE FABRIC

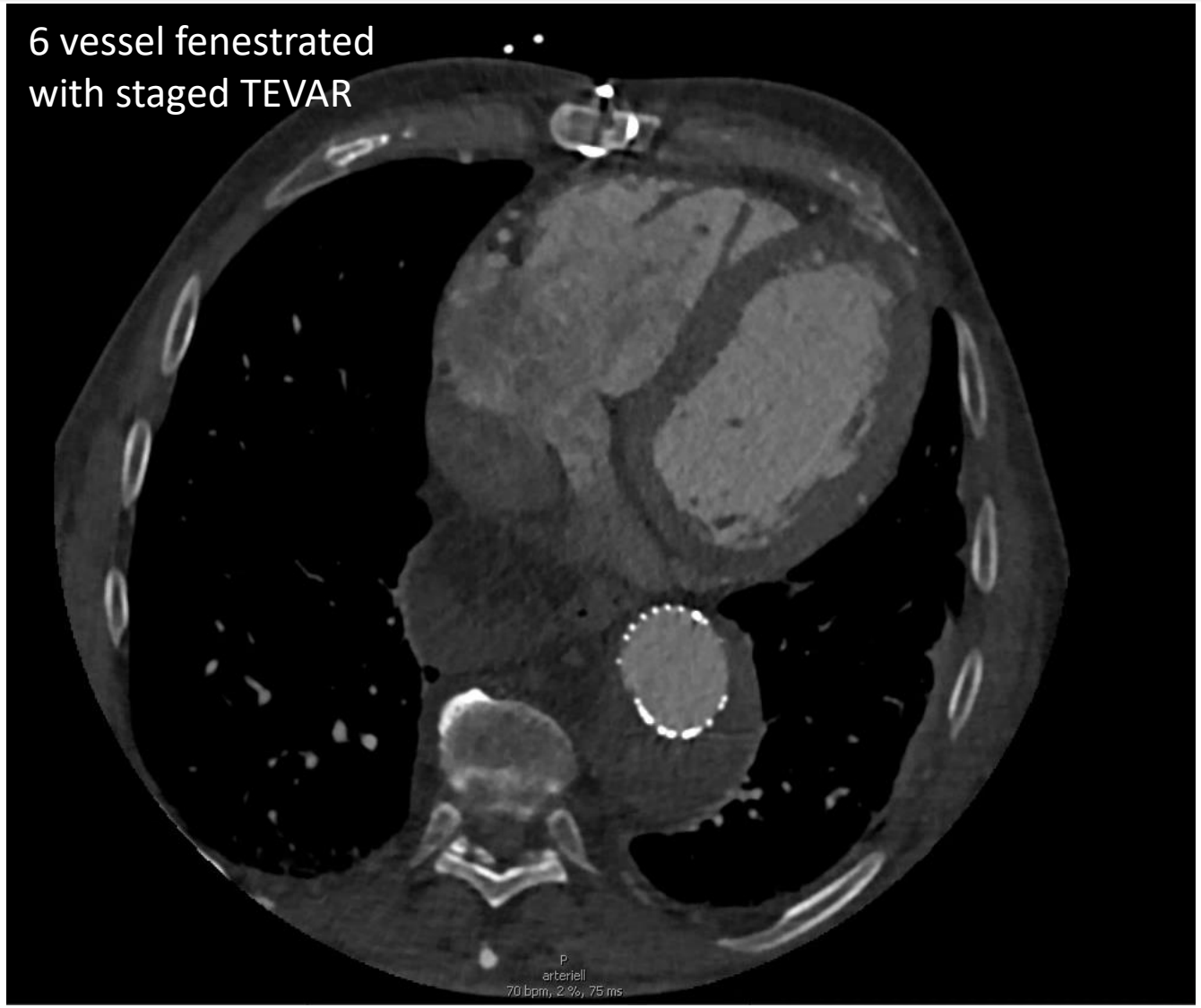
MODIFIED PRELOADED DELIVERY SYSTEM
(Biport handle and preloaded catheters)

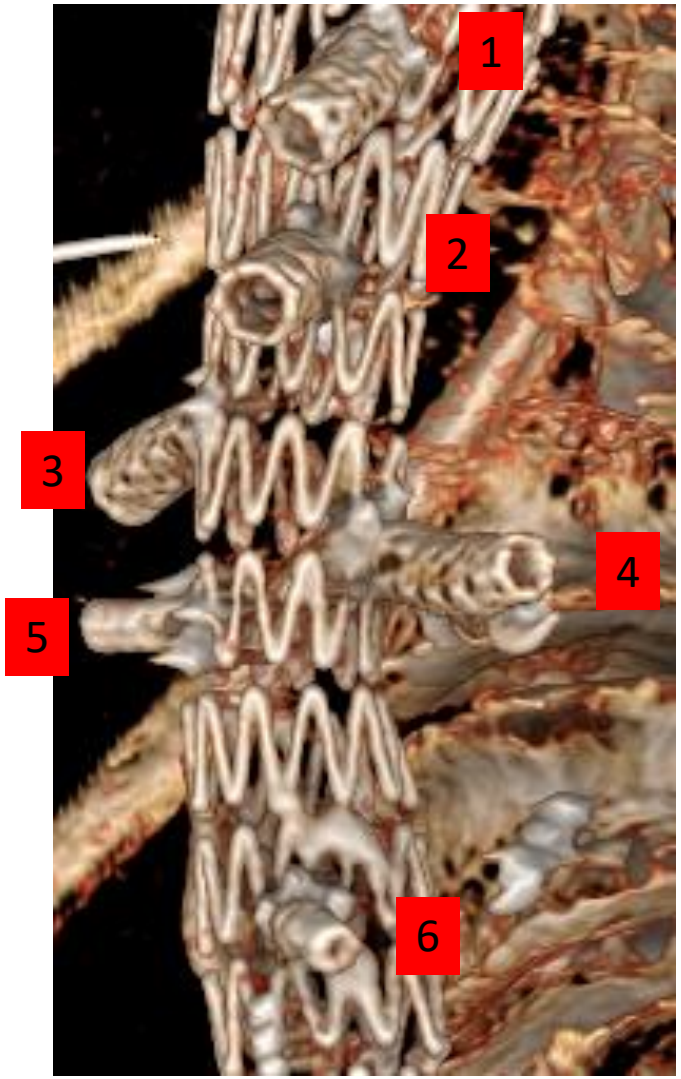
Incorporation of multiple renals

6 vessel fenestrated with staged TEVAR



Incorporation of multiple renals





The preservation of accessory renal arteries should be considered the treatment of choice in complex endovascular aortic repair

Jose I. Torrealba, MD,[a,b] Tilo Kölbel, MD, PhD,[b] Fiona Rohlffs, MD, PhD,[b] Franziska Heidemann, MD,[b] Kostas Spanos, MD, PhD,[b,c] *and* Giuseppe Panuccio, MD, PhD,[b] *Santiago, Chile; Hamburg, Germany; and Larissa, Greece*

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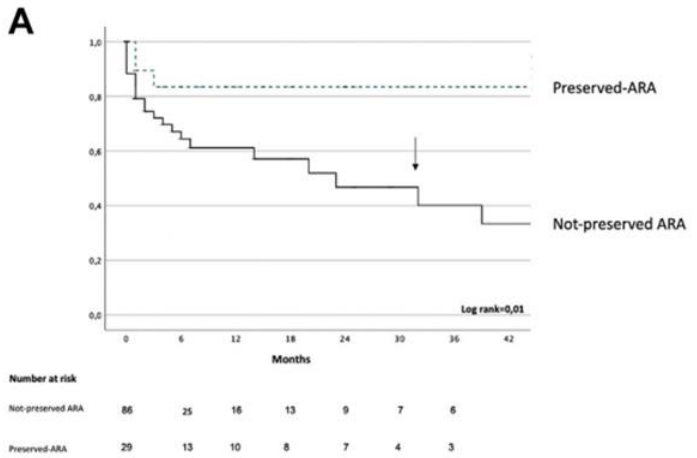
ARAs	Preserved (n = 33)	Not preserved (n = 99)	P
Total number of ARAs identified	57	125	
Total number of ARAs incorporated	39	0	
Total number of ARAs embolized	0 (0)	11 (11)	
ARAs per patient	2 (1-2)	1 (1-1)	.01
Patients with 1 ARA	48	77	.003
Patients with 2 ARAs	40	20	.03
Patients with 3 or more ARAs	12	3	.06
Patients with bilateral ARAs	48	20	.002
Size, mm			
Diameter ARA	4 (3.6-5)	3 (2-3.7)	.001
ARAs between 3 and <4	33	38	ns
ARAs ≥4	67	22	.001
Localization			
Origin from neck	52	65	.01
Origin form sac	42	25	.01
Origin from TL/FL in aortic dissection	6	10	ns

FL, False lumen; *TL*, true lumen.
Data are presented as median (interquartile range), number (percentage), or percentage.

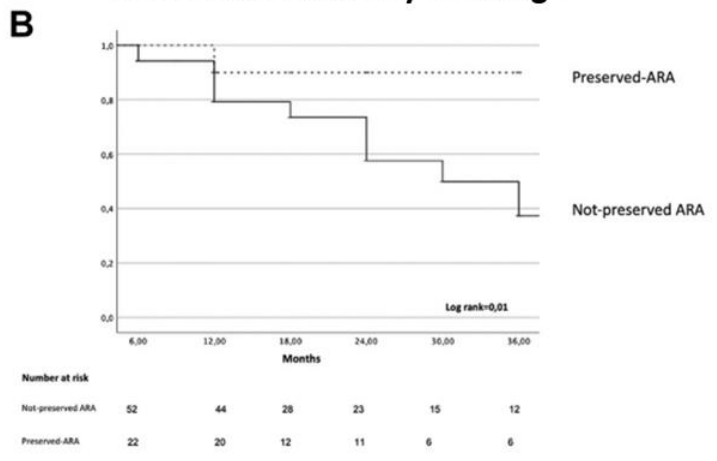
Renal outcomes	Preserved ARA	Not-preserved ARA	P
Baseline GFR, mL/min	62 (49-77)	65 (54-78)	ns
Postoperative decrease of GFR, mL/min	3 (−8 to 16)	−8 (−20 to 7)	.01
Worsening of GFR >30%	6	23	.03
Postoperative dialysis	0	3	ns
Postoperative kidney infarction	6	57	.001
ARA-related EL	0	20	.01

Complex aortic repair incorporation of ARA is feasible, with low complications and good primary assisted patency at 2 years. It leads to less postoperative early renal dysfunction as well as higher freedom for mid-term renal disfunction and kidney shrinkage.

Freedom from GFR decrease over 30%



Freedom from kidney shrinkage



CLINICAL PRACTICE GUIDELINE DOCUMENT

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Editor's Choice – European Society for Vascular Surgery (ESVS) 2024 Clinical Practice Guidelines on the Management of Abdominal Aorto-Iliac Artery Aneurysms☆

Anders Wanhainen [a,*], Isabelle Van Herzeele [a], Frederico Bastos Goncalves [a], Sergi Bellmunt Montoya [a], Xavier Berard [a], Jonathan R. Boyle [a], Mario D'Oria [a], Carlota F. Prendes [a], Christos D. Karkos [a], Arkadiusz Kazimierczak [a], Mark J.W. Koelemay [a], Tilo Kölbel [a], Kevin Mani [a], Germano Melissano [a], Janet T. Powell [a], Santi Trimarchi [a], Nikolaos Tsilimparis [a]

Recommendation 62 — **Changed**

For patients undergoing endovascular abdominal aortic aneurysm repair, preservation of large accessory renal arteries (≥ 4 mm) or those that supply a significant portion of the kidney (> 1/3) should be considered, however without compromising adequate sealing.

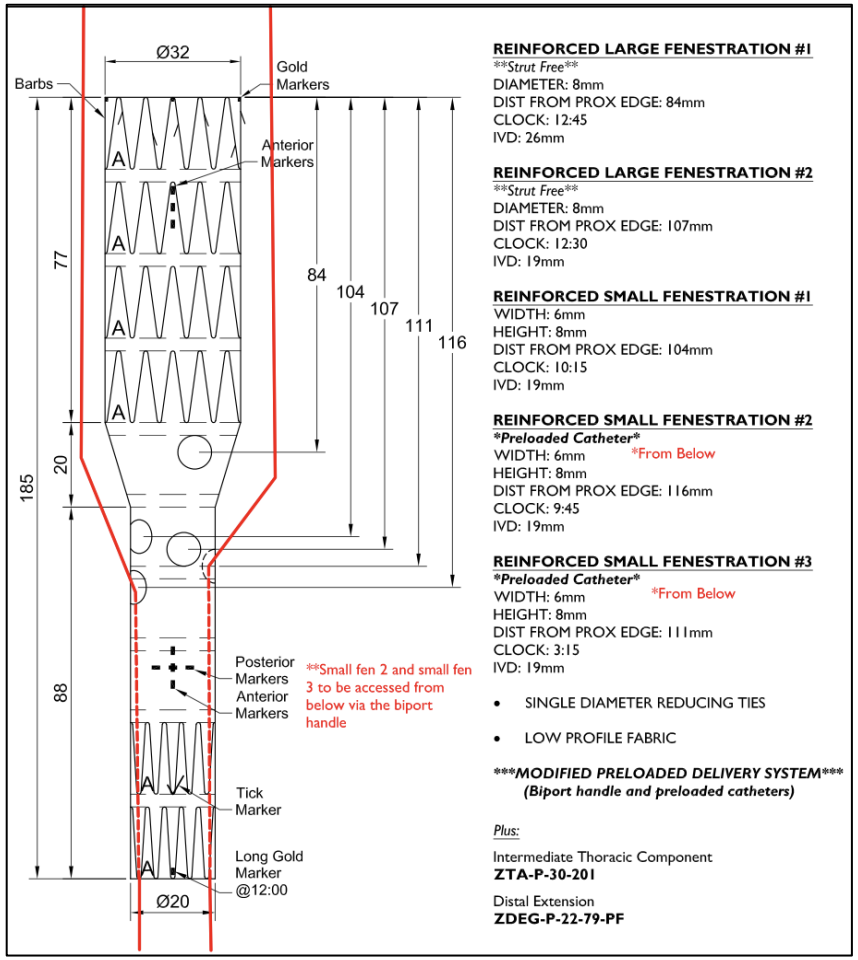
Class	Level	References	ToE
IIa	C	Lareyre *et al.* (2019),[446] Spanos *et al.* (2014)[448]	

Recommendation 127 — **New**

For endovascular repair of a complex abdominal aortic aneurysm, preservation of large accessory renal arteries (≥ 4 mm) should be considered.

Class	Level	References	ToE
IIa	C	Spanos *et al.* (2021),[448] Torrealba *et al.* (2022)[1036]	

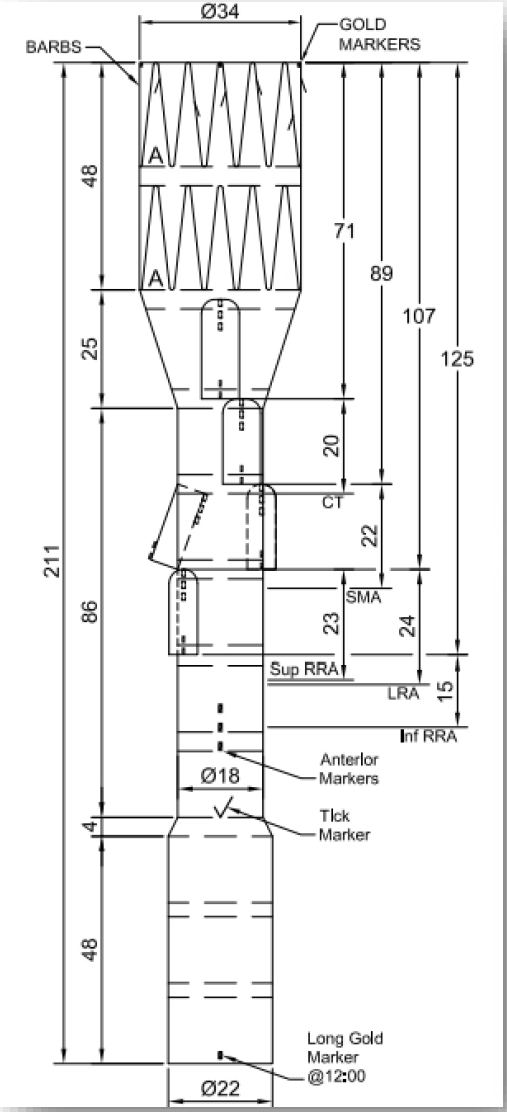
Preloaded fenestrated with biport handle – additional vessels

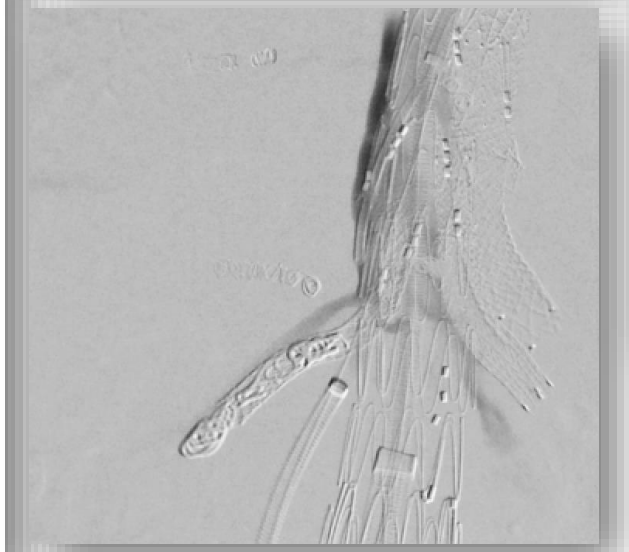


Preloaded fenestrated with ipsilateral biport handle allows for up to 6 target vessels to be targeted for below

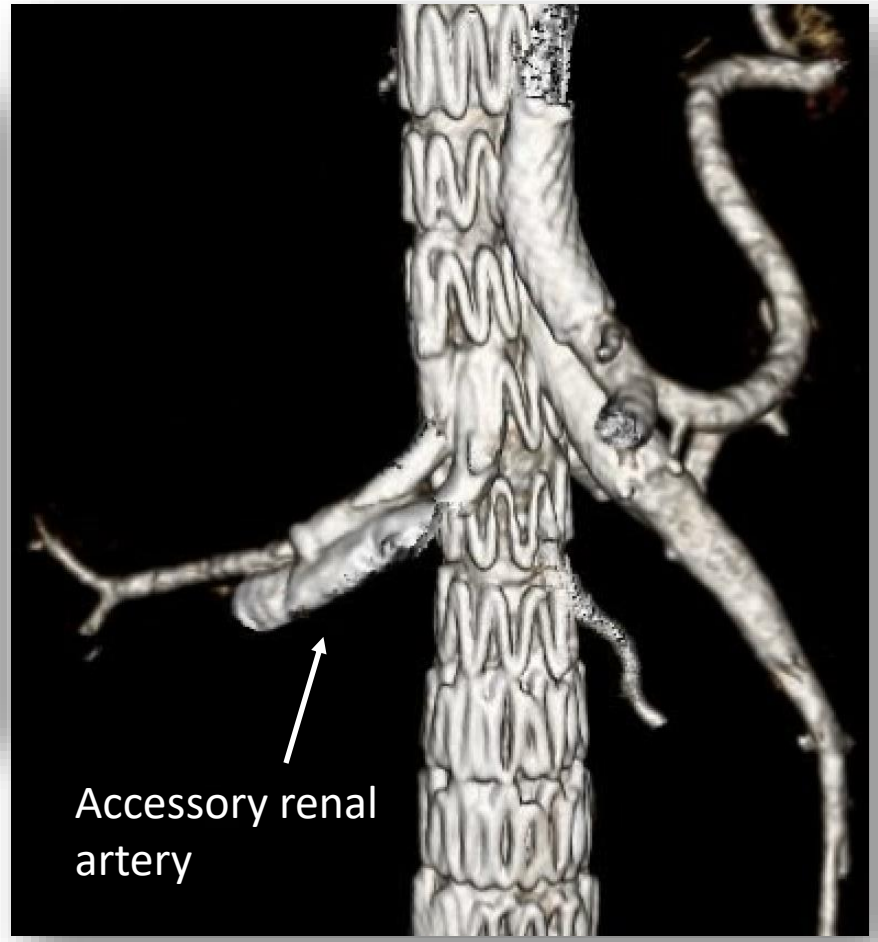
Maurel B et al. JVS. 2017 Apr;65(4):972-980.

>4 target vessels Branched device

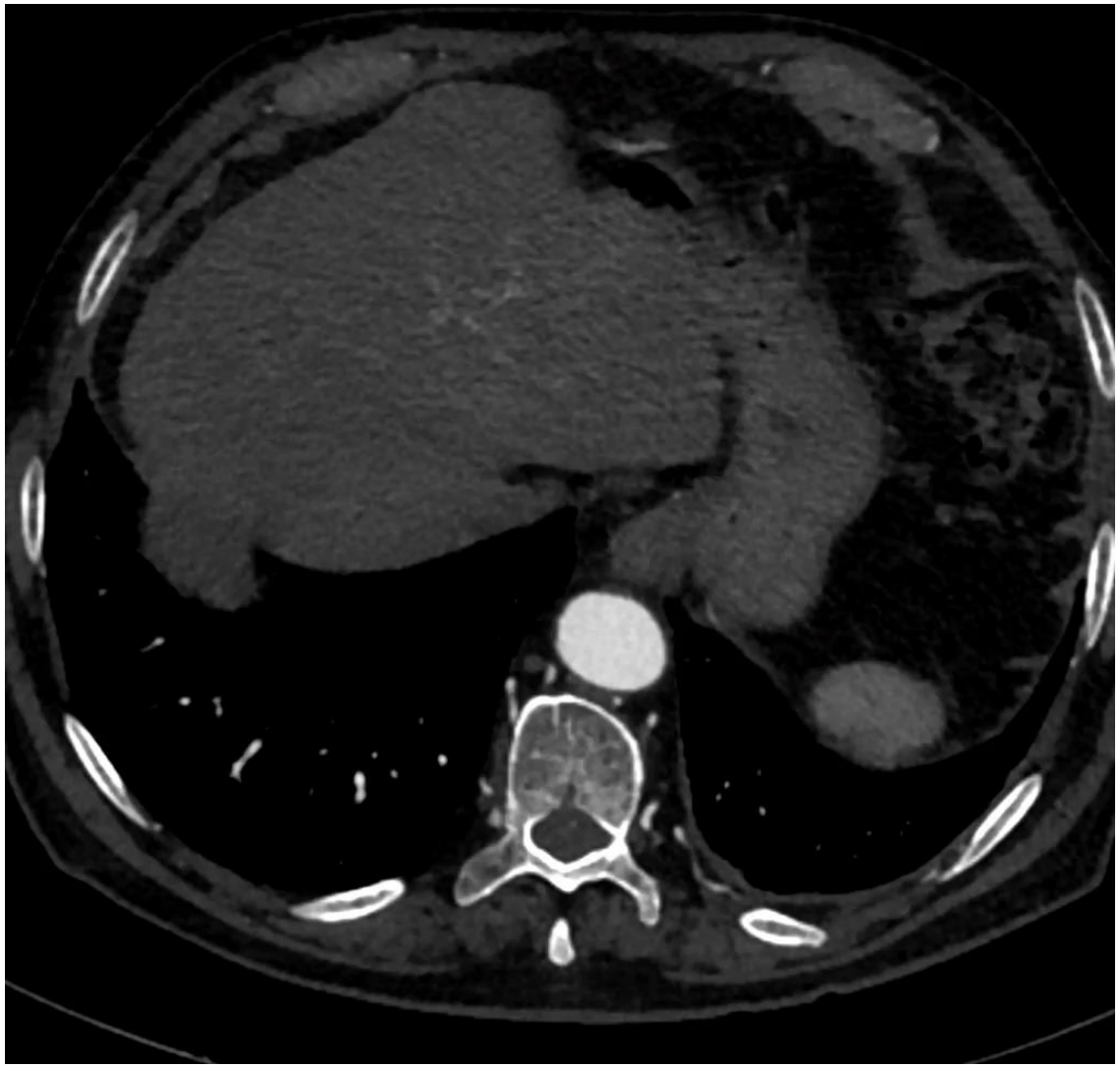


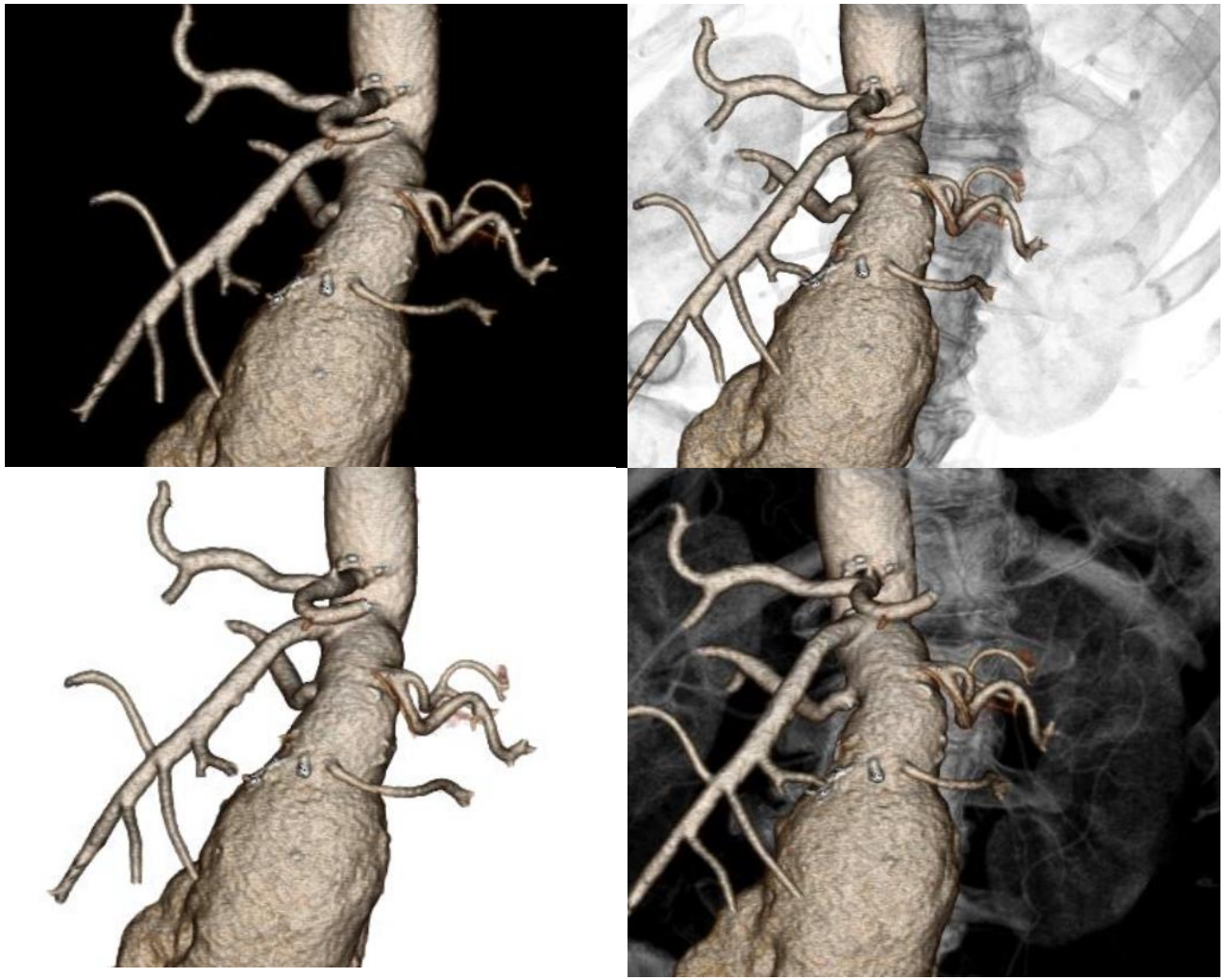


Caution Accessory Renals are small in caliber and sensitive



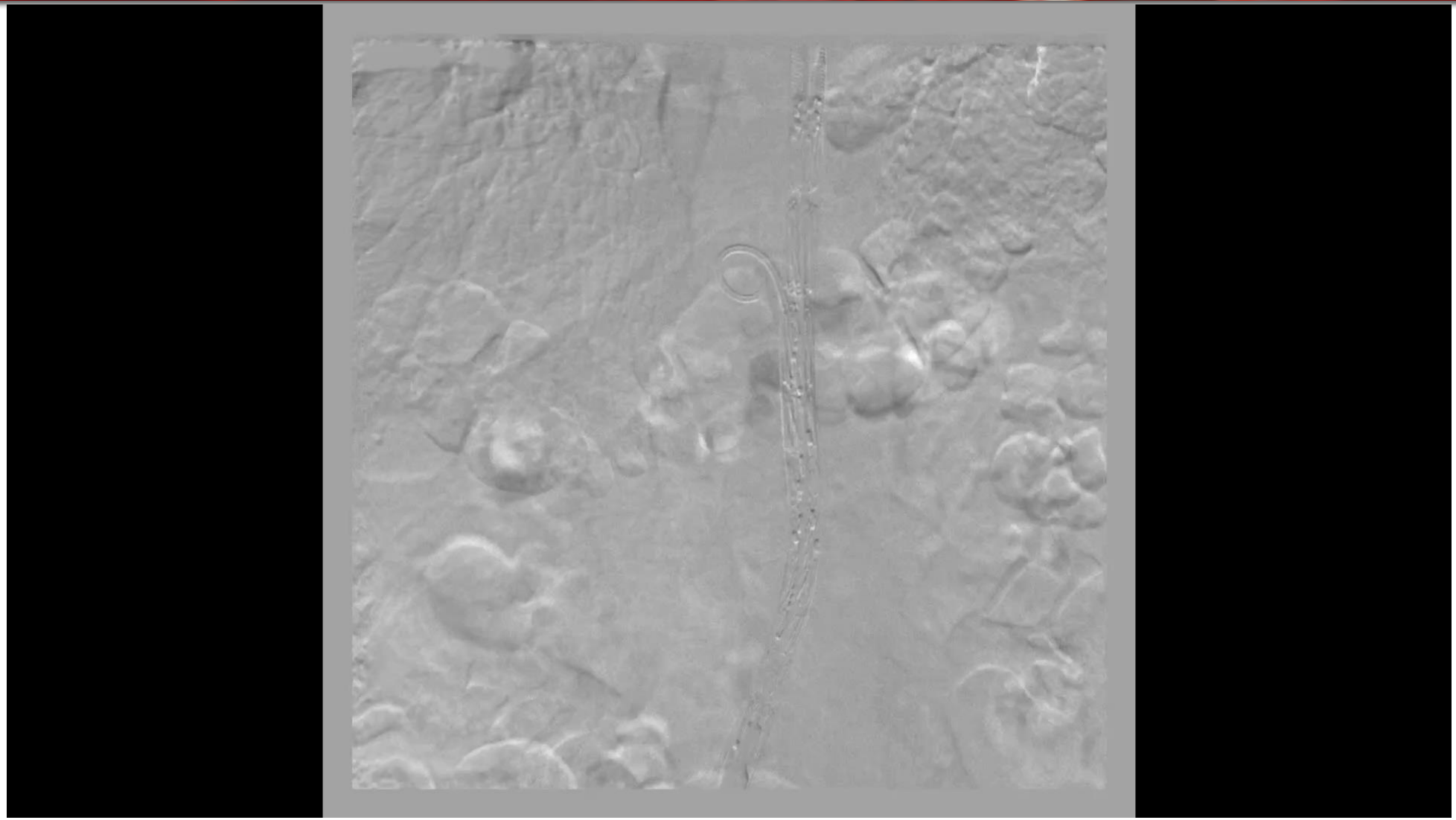
Early renal division - Rule Nr. 1: keep it simple if possible



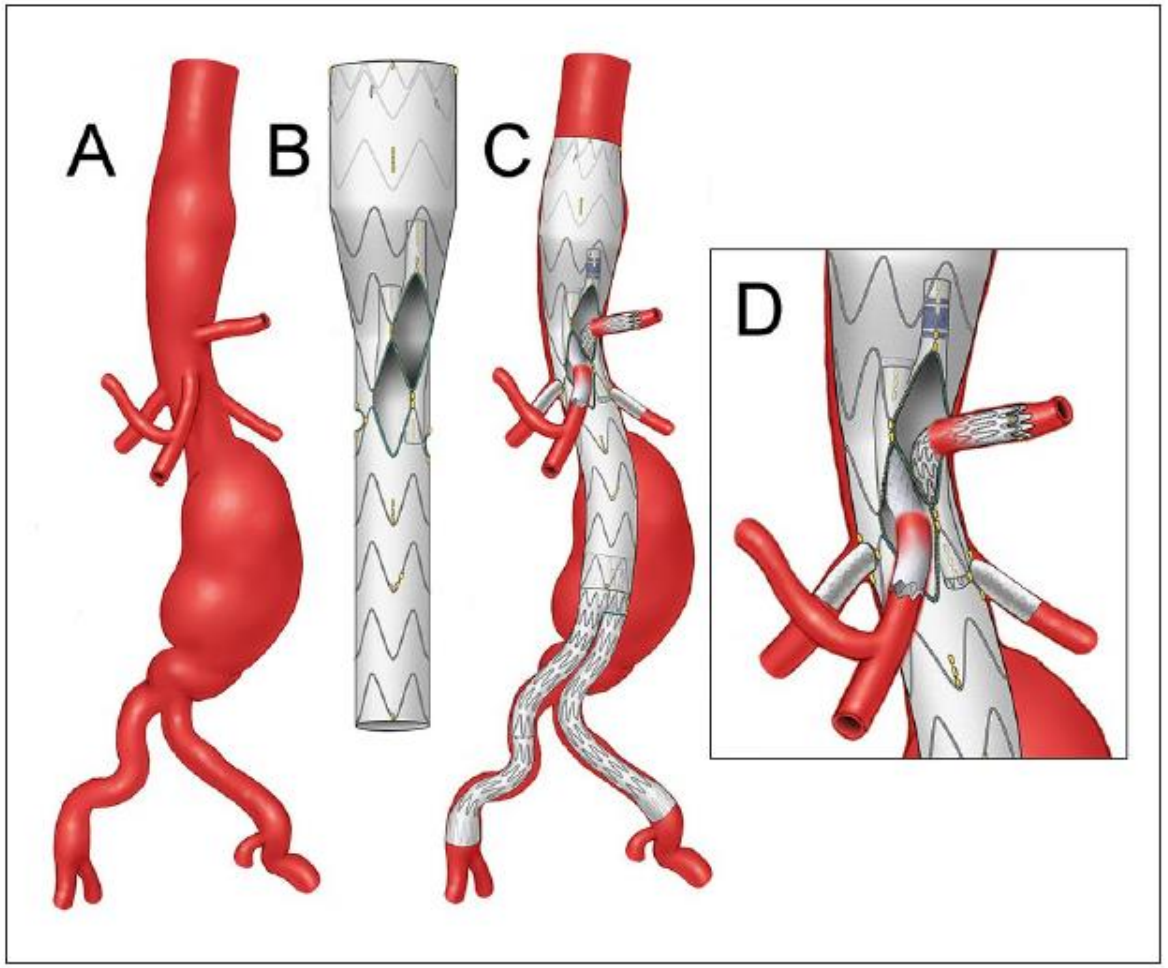


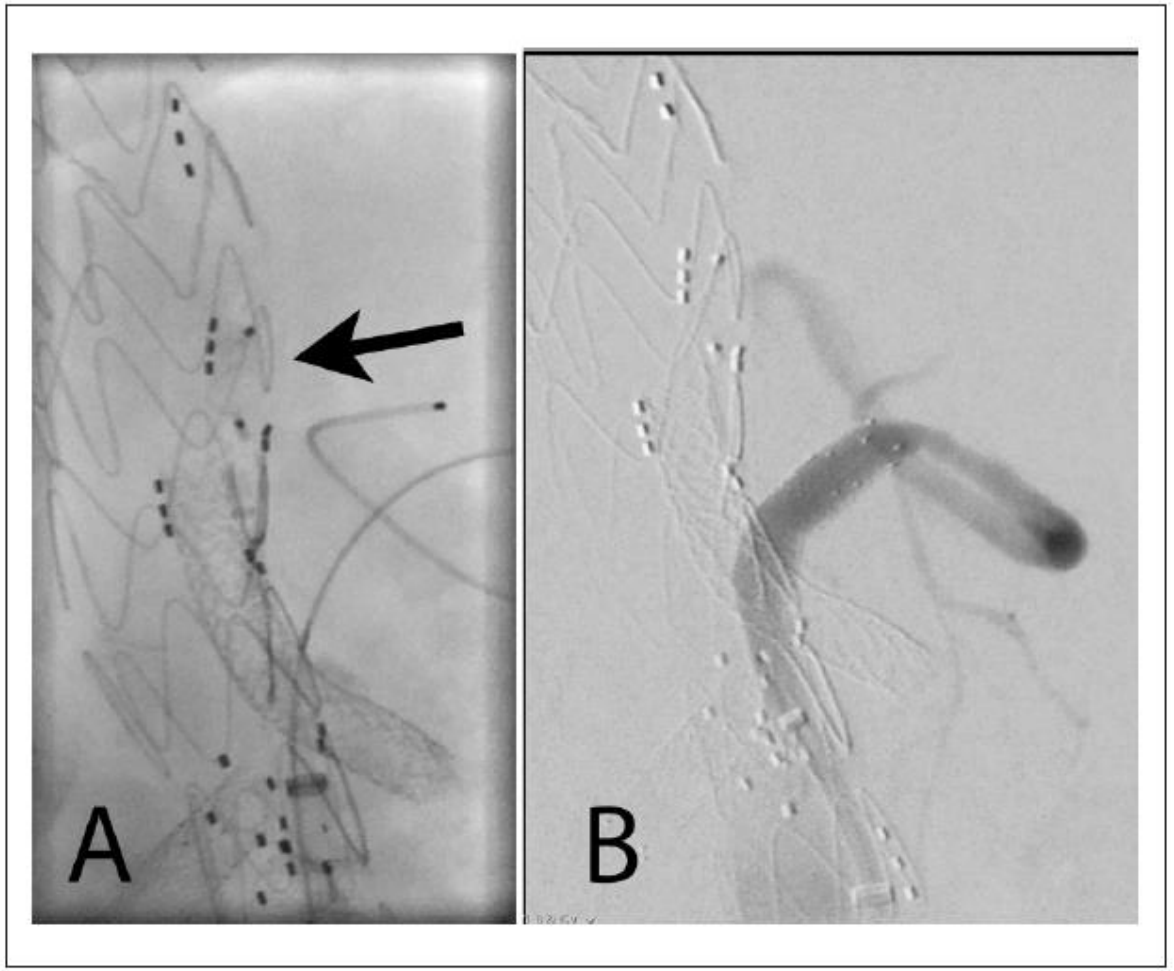
Short 8mm trunk of the left renal artery

Early renal division - keep it simple if possible



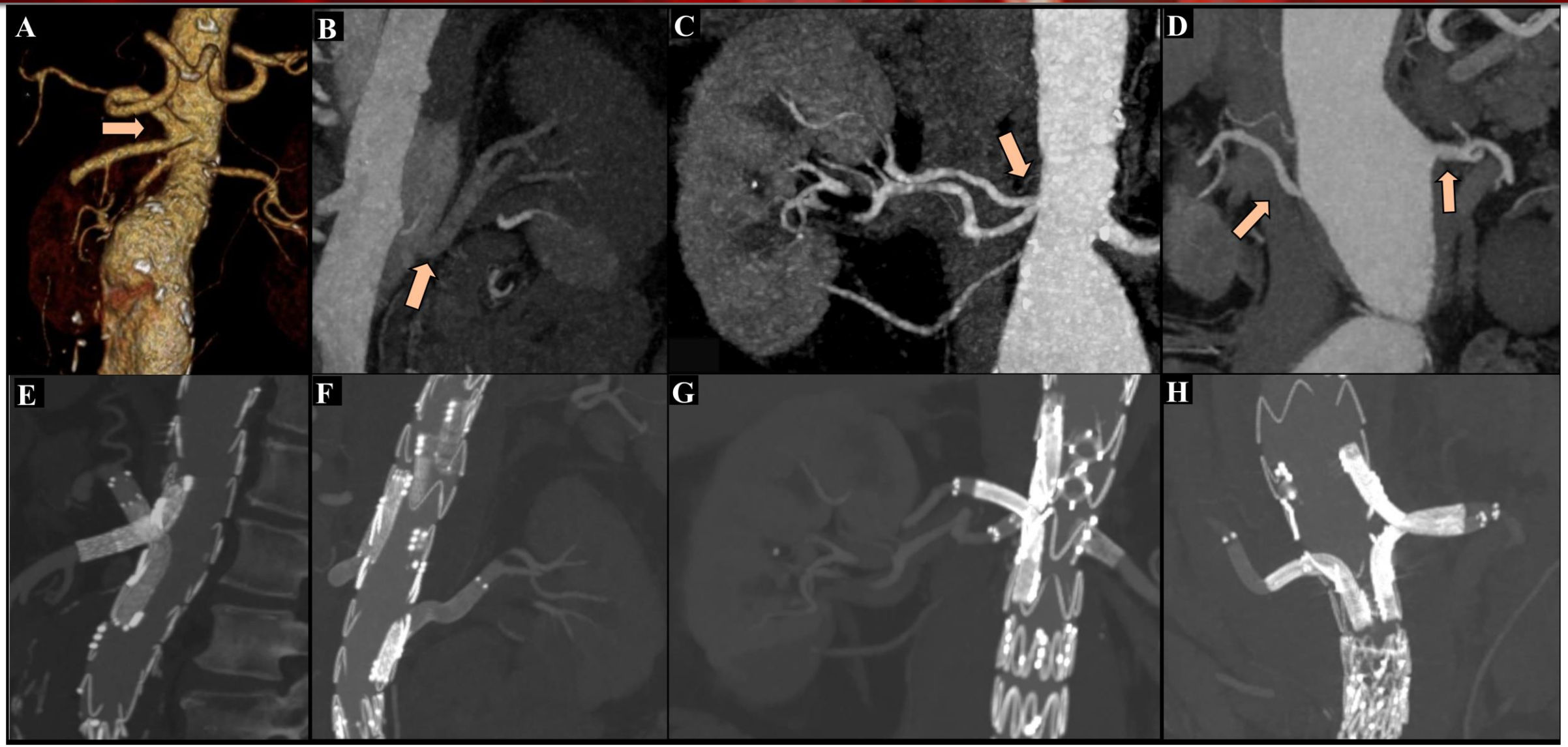
Double-Cuff Bidirectional Branch in Endovascular Aortic Repair: A New Way of Increasing the Flexibility of Inner Branch Endografting



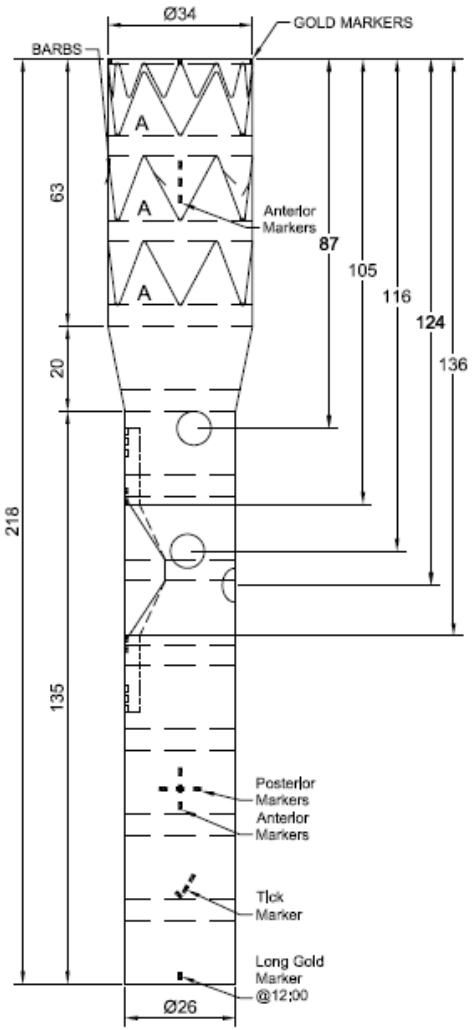


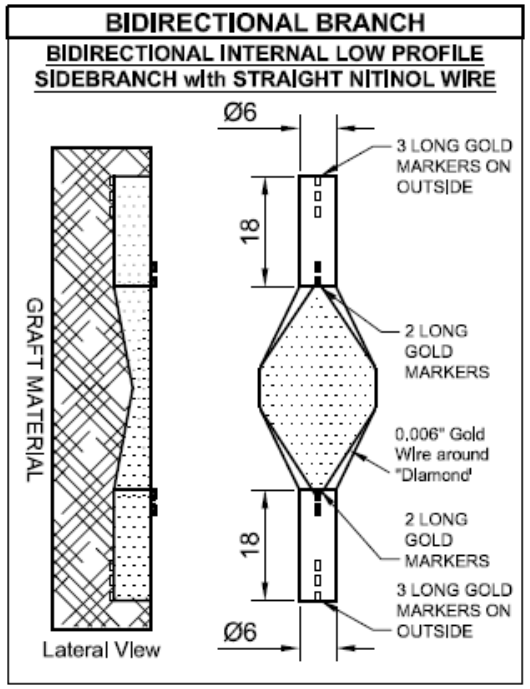
Dias et al., J Endovasc Ther 2022

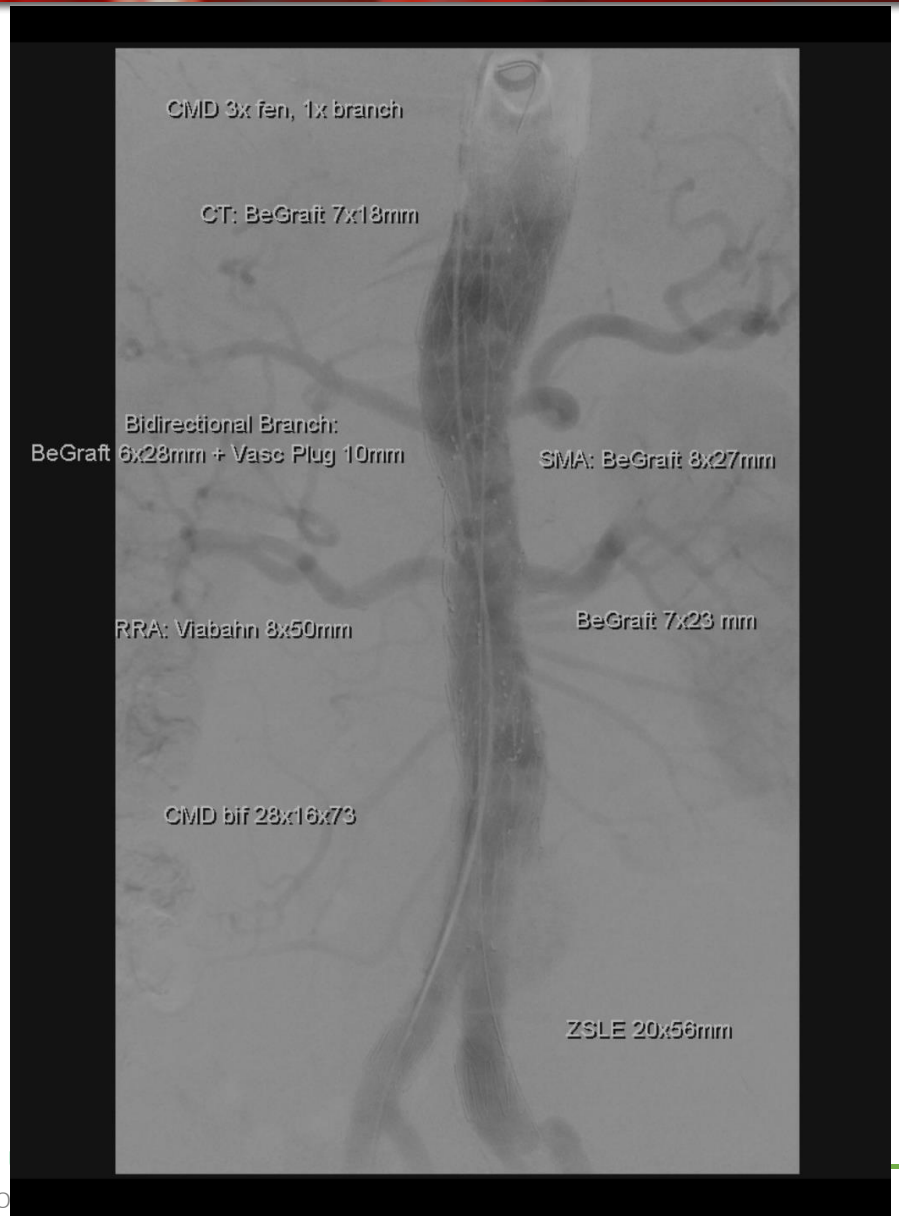
Initial multicenter results with a novel double-cuff bidirectional branched endovascular aortic repair



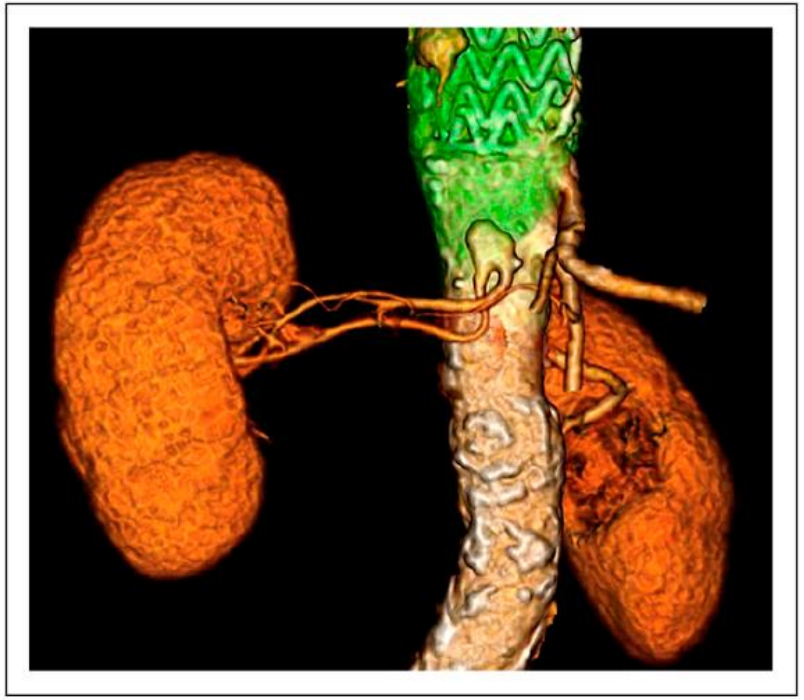
Bidirectional branch for chronic dissection

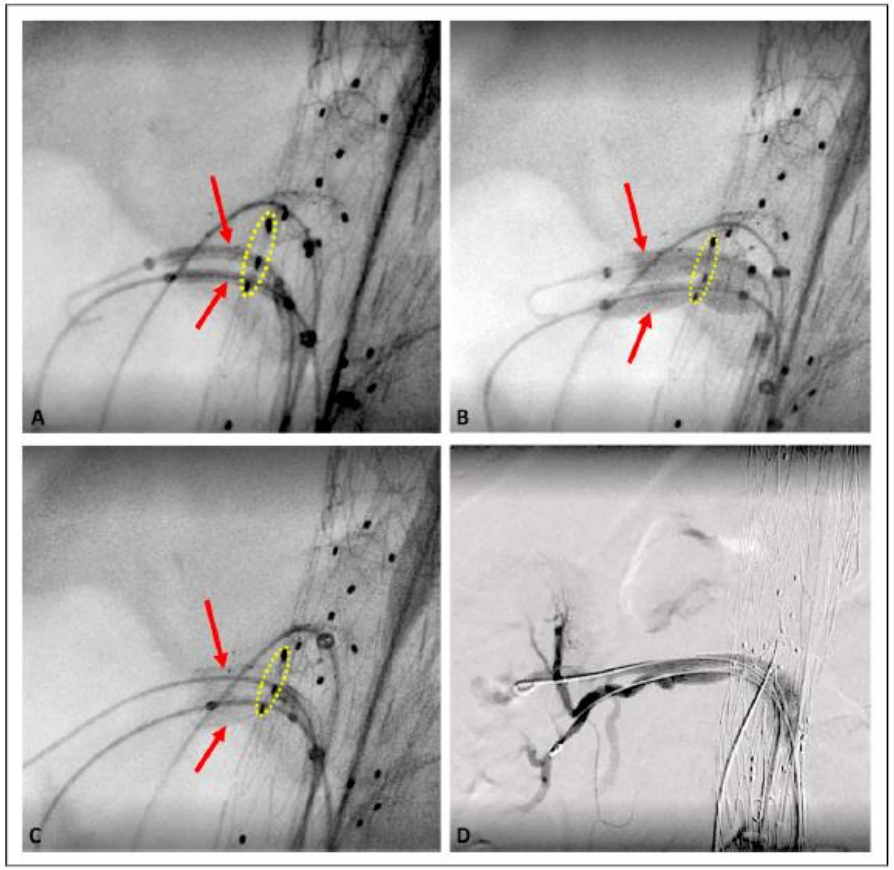

Ø34
GOLD MARKERS
BARBS
A
A
A
63
Anterior Markers
87
105
116
124
136
20
218
135
Posterior Markers
Anterior Markers
Tick Marker
Long Gold Marker @12:00
Ø26


BIDIRECTIONAL BRANCH
BIDIRECTIONAL INTERNAL LOW PROFILE SIDEBRANCH with STRAIGHT NITINOL WIRE
Ø6
3 LONG GOLD MARKERS ON OUTSIDE
18
2 LONG GOLD MARKERS
0,006" Gold Wire around "Diamond"
18
2 LONG GOLD MARKERS
3 LONG GOLD MARKERS ON OUTSIDE
Ø6
GRAFT MATERIAL
Lateral View


CMD 3x fen, 1x branch
CT: BeGraft 7x18mm
Bidirectional Branch:
BeGraft 6x28mm + Vasc Plug 10mm
SMA: BeGraft 8x27mm
RRA: Viabahn 8x50mm
BeGraft 7x23 mm
CMD bif 28x16x73
ZSLE 20x56mm

Case Series on Double-Barrel Stenting for the Renal Arteries Associated With Fenestrated Repair (FEVAR) of Complex Anatomy Aortic Aneurysms





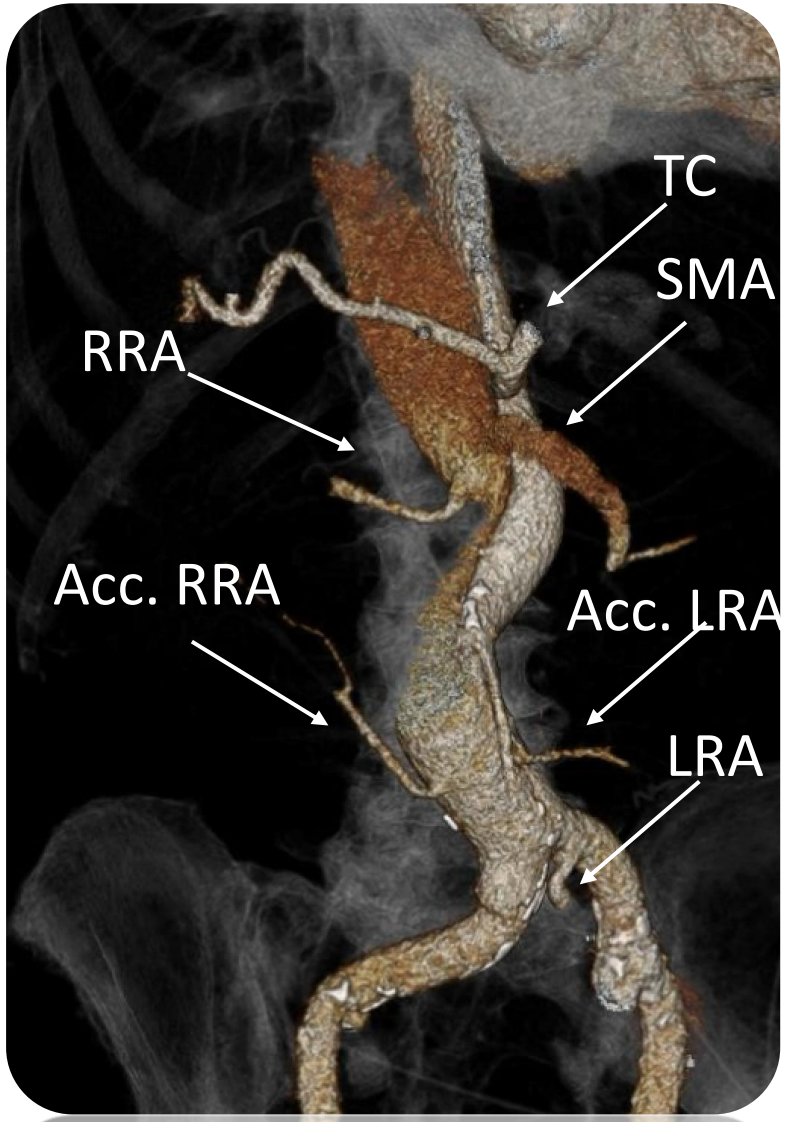
Double-barrel renal stenting is a viable option for the incorporation of ARA or early renal branches to a fenestrated repair of aortic aneurysms with complex anatomy. This is particularly interesting for patients that already present any degree of renal function deterioration prior to the aortic procedure.

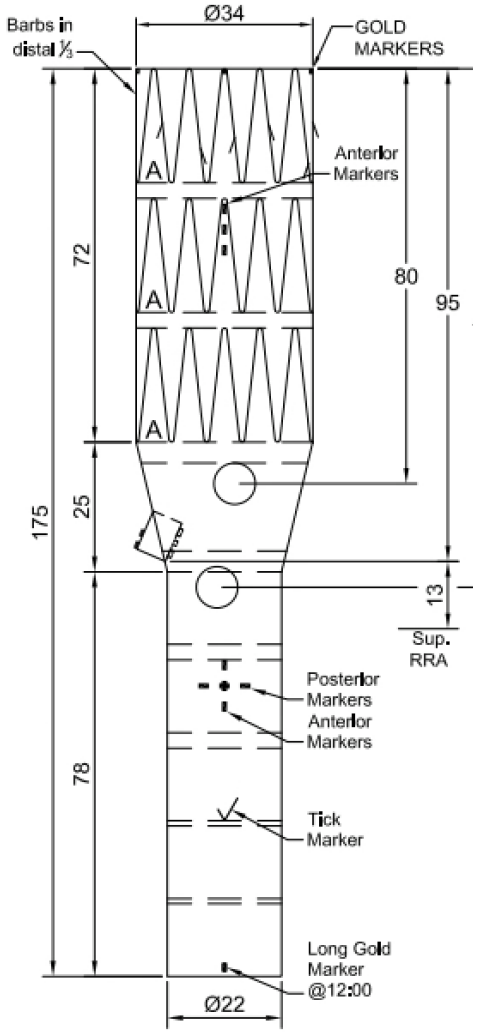
Although close follow-up is imperative for life, satisfactory results in terms of patency and target vessel instability can be obtained with this technique.

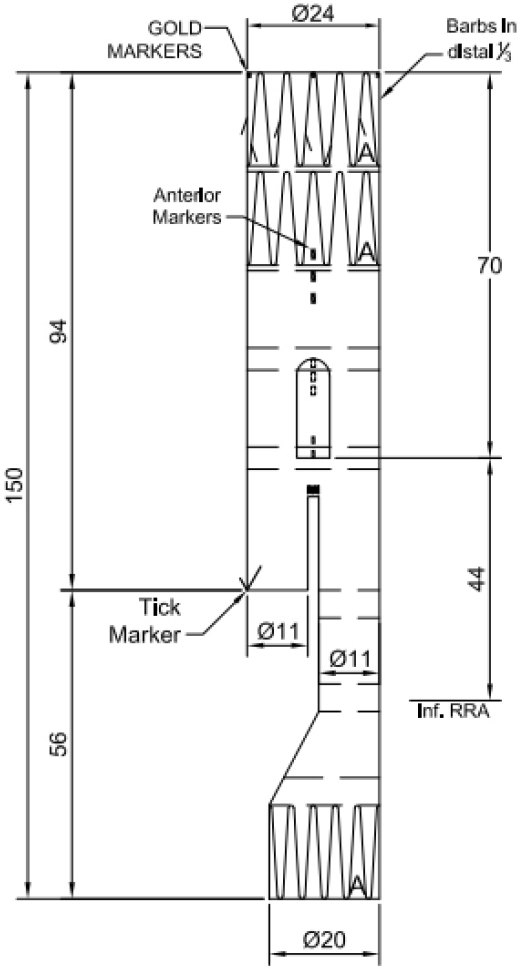
- Risk of compromising both branches
- Risk of occlusion
- Risk of Endoleak

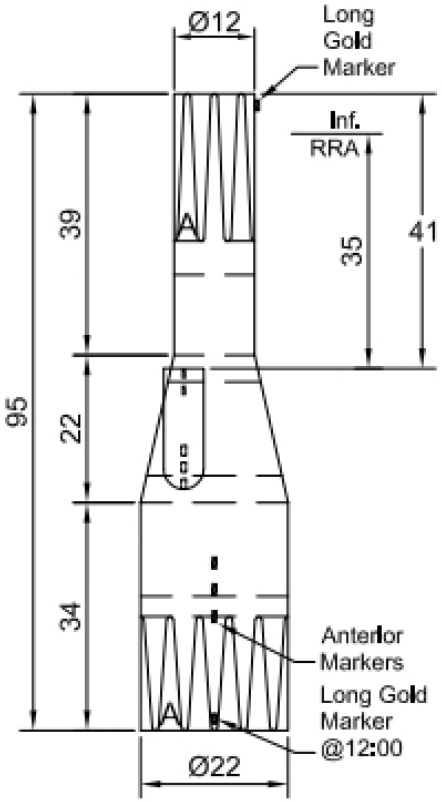
Gomes et al., Vasc Endovascular Surg 2023

When things get more complicated

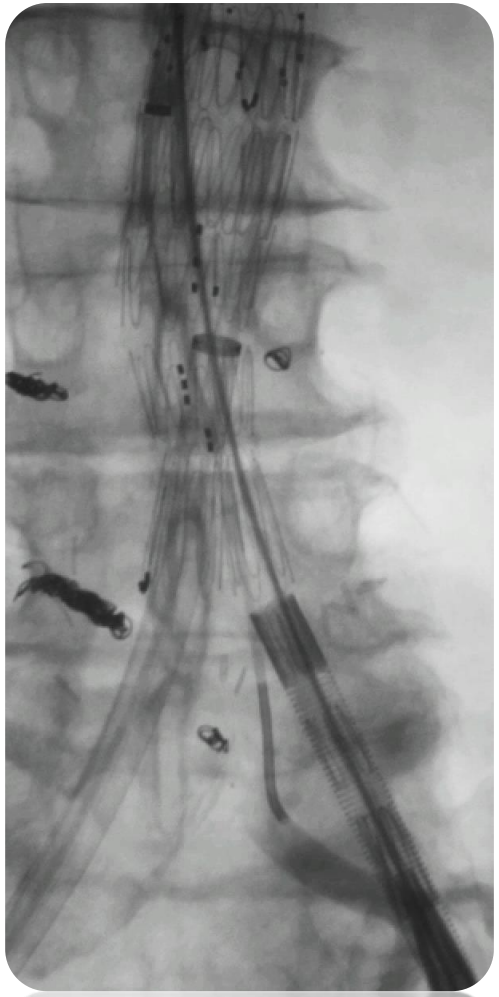


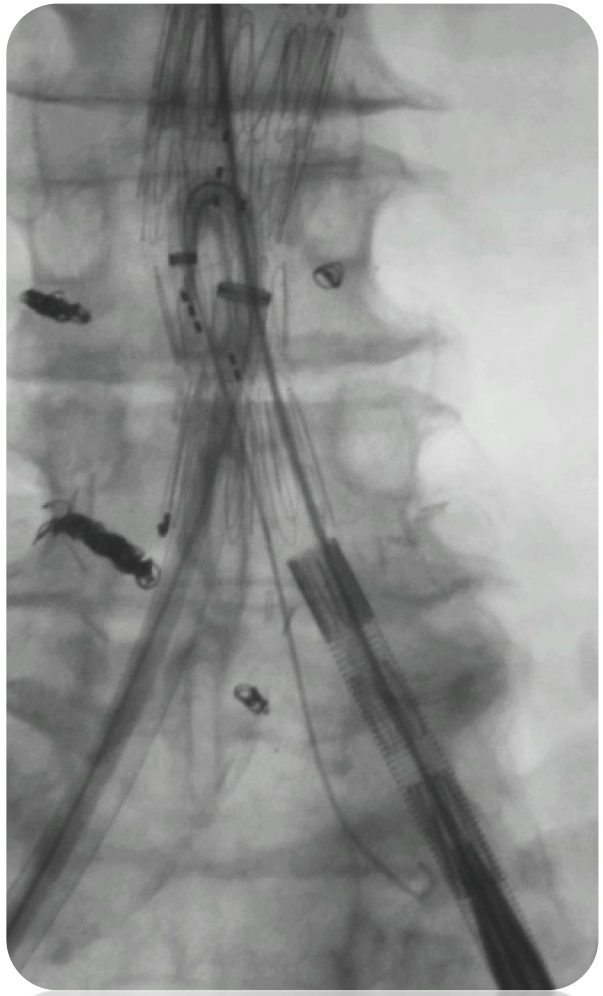




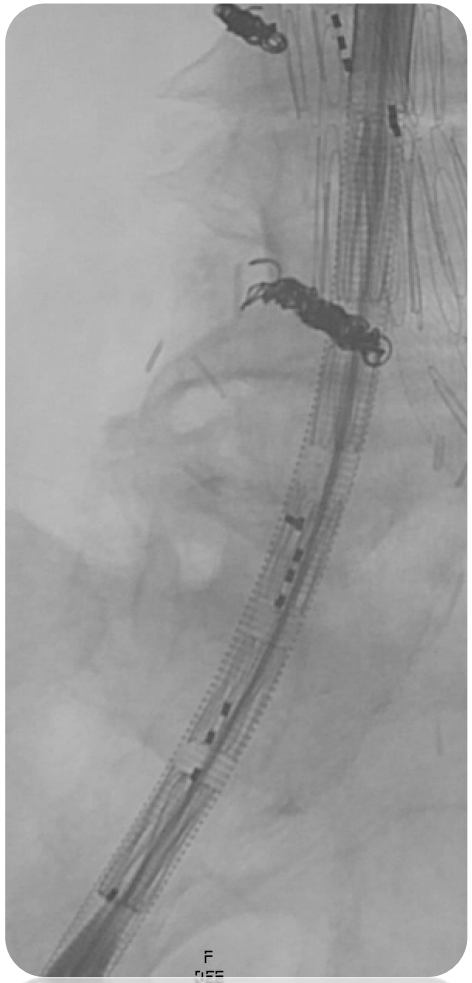


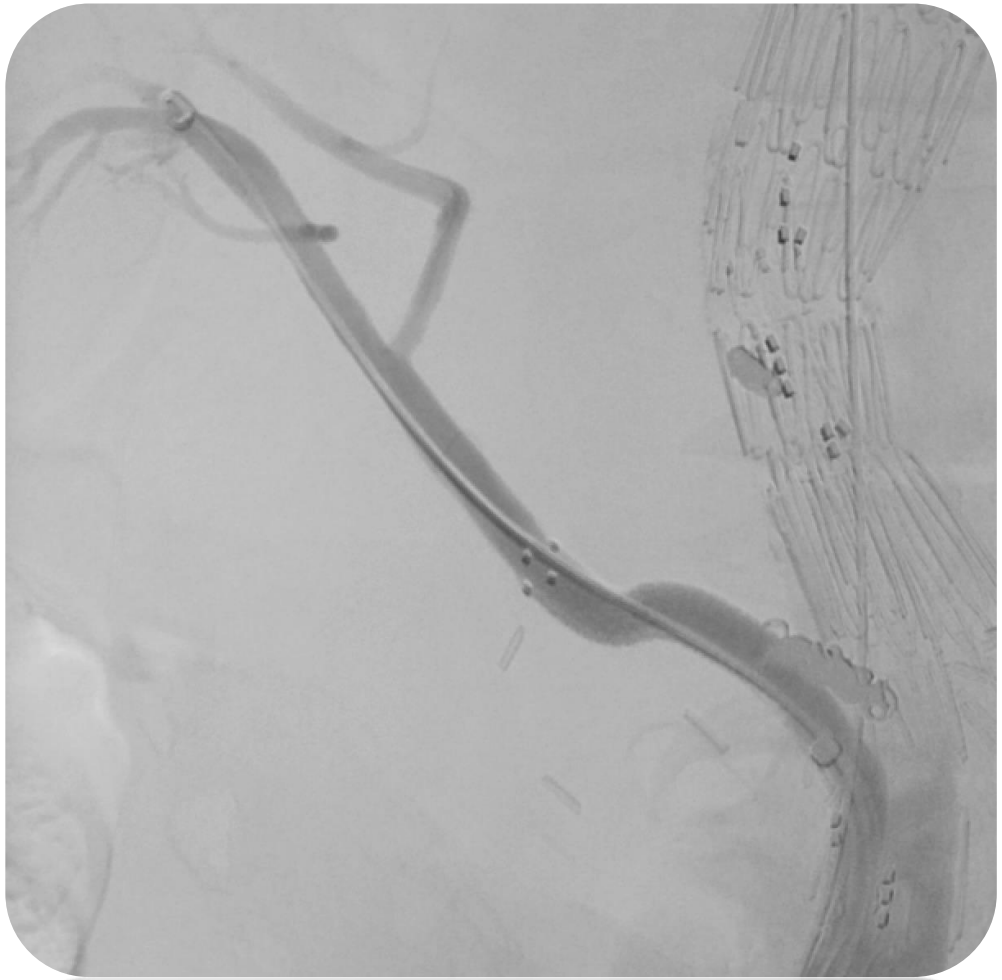
Antegrade branch LRA



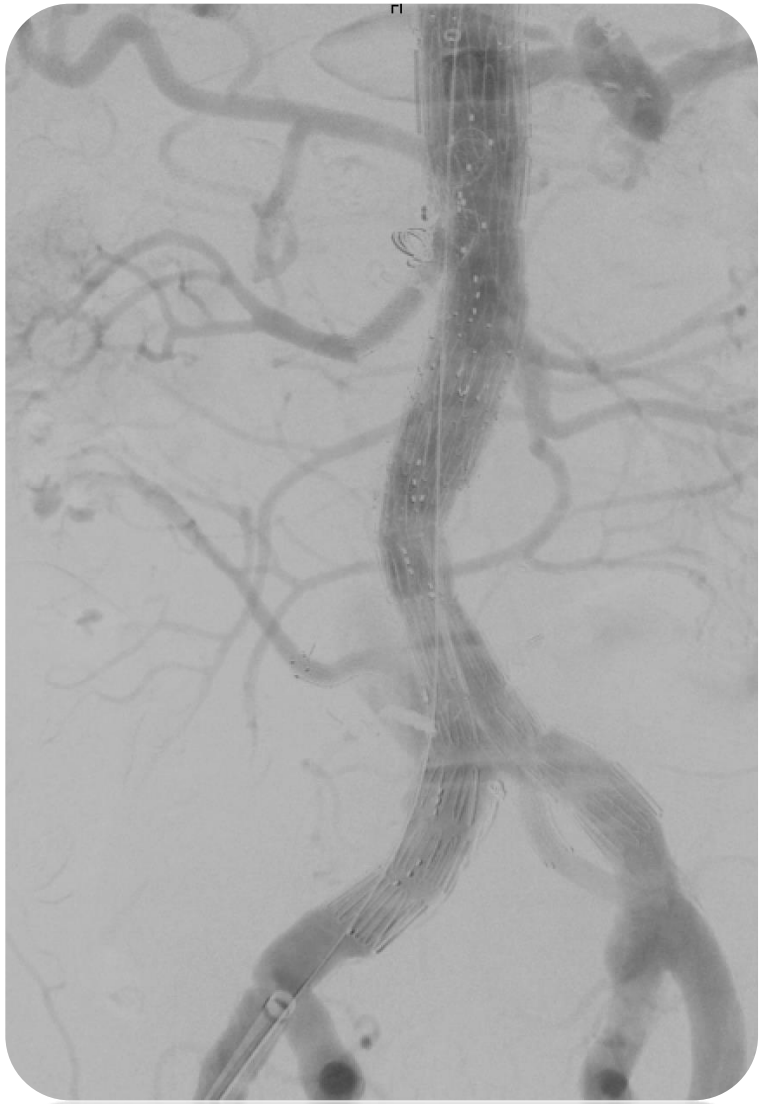


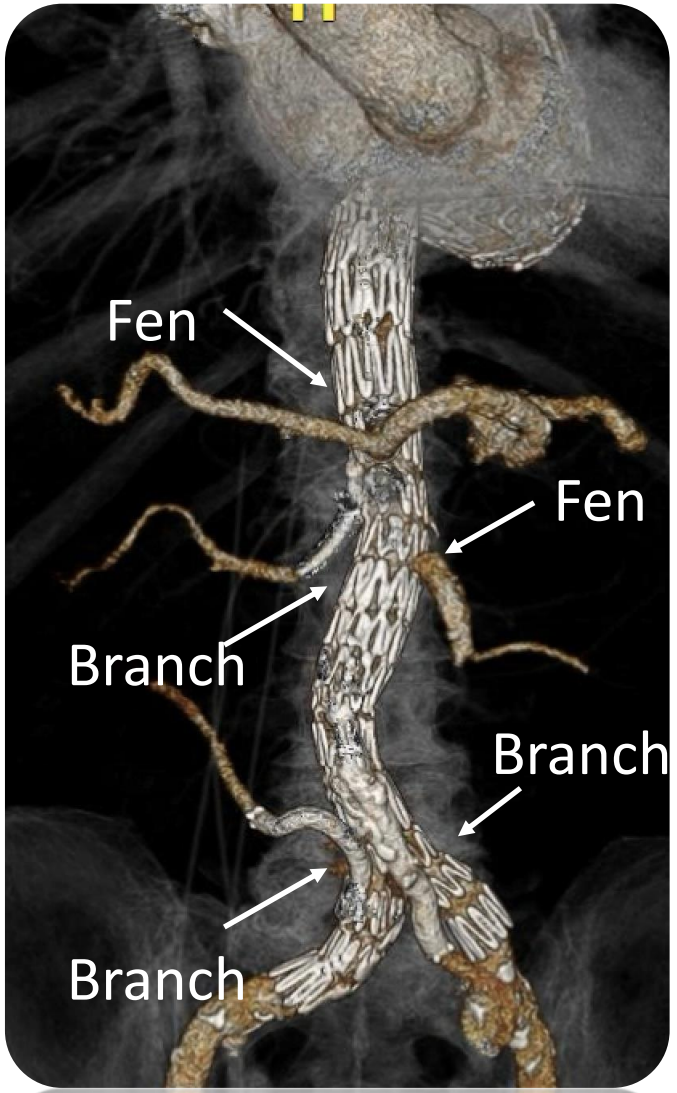
Retrograde branch RRA



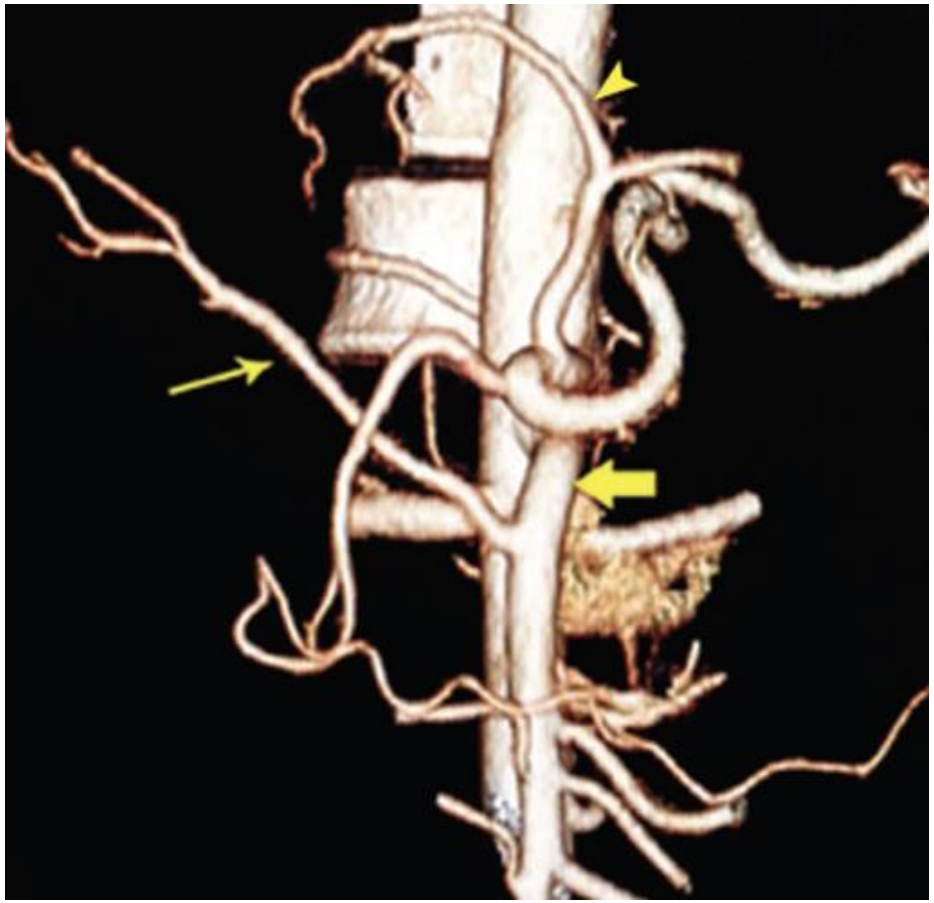


Completion angiography





Abberant target vessel anatomies - Visceral



Right hepatic from SMA

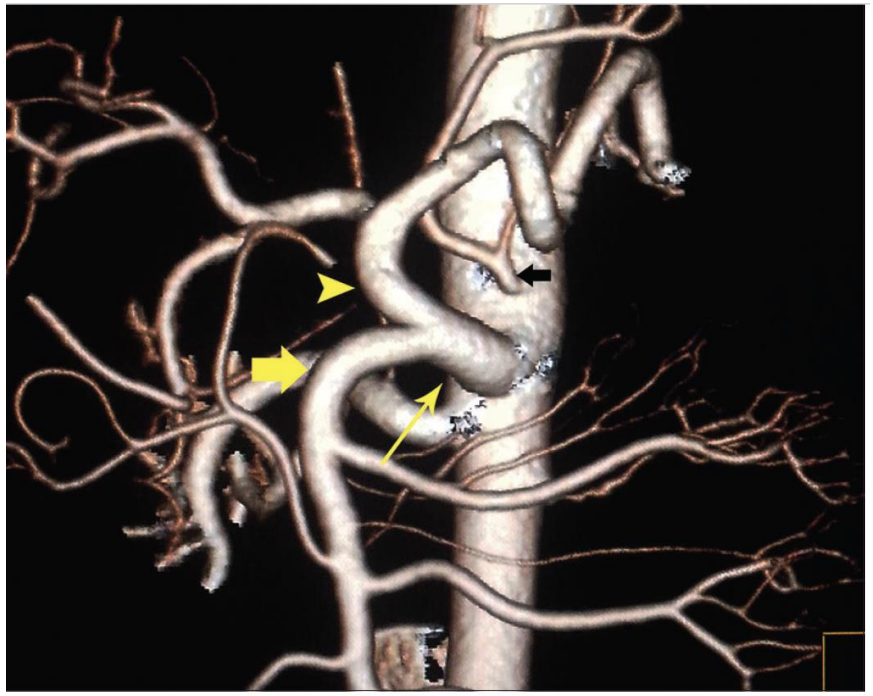
Celiaco-mesenteric trunk

Abberant target vessel anatomies - Visceral

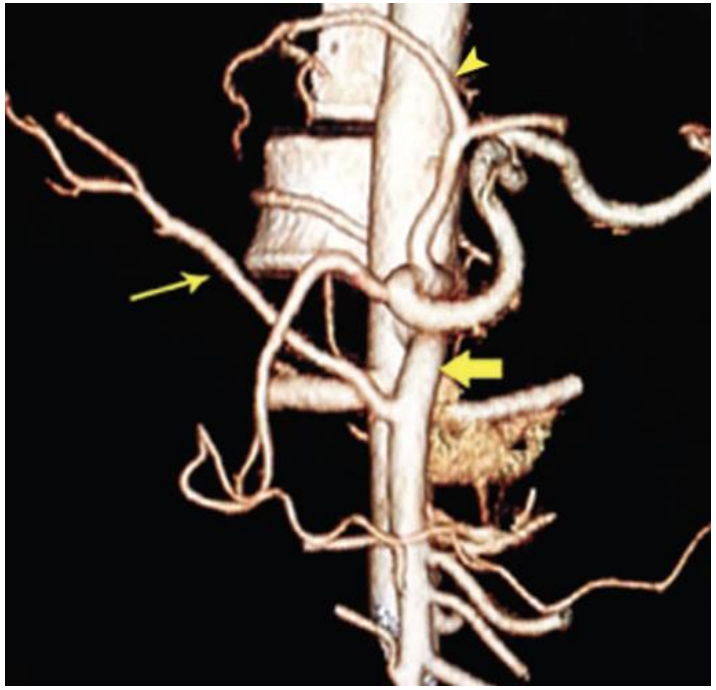
Table 2: Frequency of different types of arterial variation

Anatomical variation	Frequency (%)
Normal	388 (63.9)
RHA off SMA	58 (9.6)
LHA off LGA	40 (6.6)
Segments 2 and 3 off LGA	26 (4.3)
Segments 4A and 4B off RHA	2 (0.3)
Trifurcation of CHA into GDA, RHA, and LHA	11 (1.8)
RHA off celiac axis	11 (1.8)
Accessory LHA off LGA	9 (1.5)
LGA directly off abdominal aorta	9 (1.5)
CHA off SMA	8 (1.3)
CHA directly off aorta	8 (1.3)
RHA off GDA	3 (0.5)
Accessory RHA	3 (0.5)
Common trunk off celiac axis and SMA	4 (0.7)
Medial and lateral branches separate off CHA	2 (0.3)
LHA off CHA	4 (0.7)
SMA gives rise to GDA	1 (0.2)
LHA off celiac axis	1 (0.2)
RHA off aorta	3 (0.5)
Extrahepatic branching of RHA into anterior and posterior with artery to segment 4 off anterior division of RHA	1 (0.2)
LGA off CHA	3 (0.5)
Trifurcation of celiac into CHA splenic and LGA	5 (0.8)
Pancreaticoduodenal off celiac	5 (0.8)
Pancreaticoduodenal off RHA	1 (0.2)
Splenic off SMA	1 (0.2)
Total	607 (100.0)

RHA=Right hepatic artery; LHA=Left hepatic artery; LGA=Left gastric artery; SMA=Superior mesenteric artery; CHA=Common hepatic artery; GDA=Gastroduodenal artery



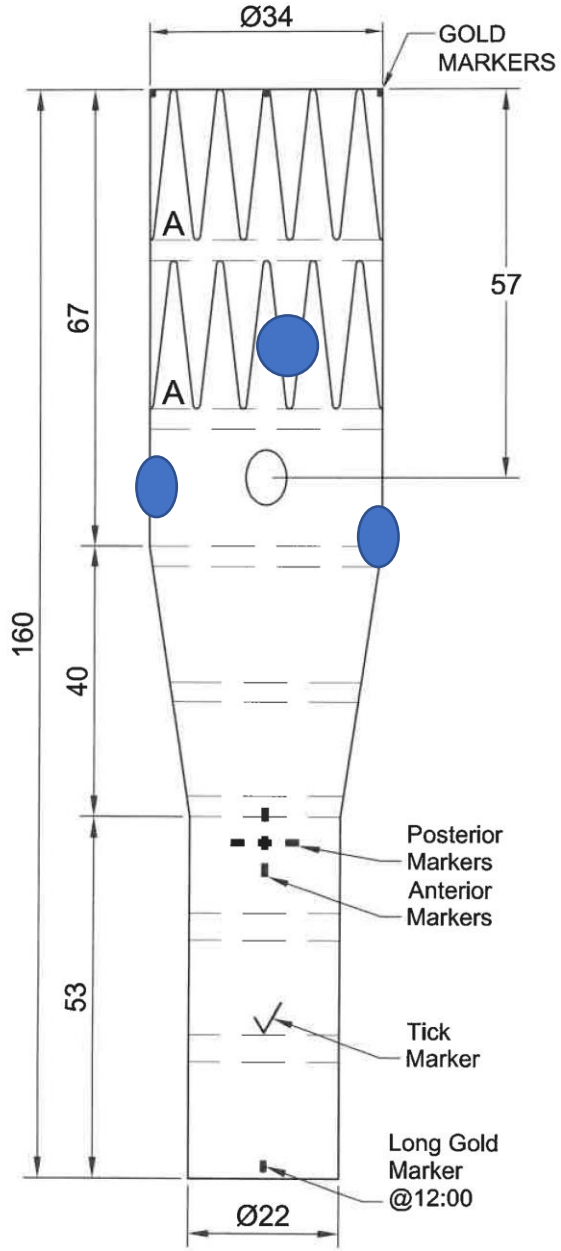
Celiaco-mesenteric trunk



Right hepatic from SMA

Modifiable CMD

Future of PMEG repair?



REINFORCED LARGE FENESTRATION #1

Strut Free

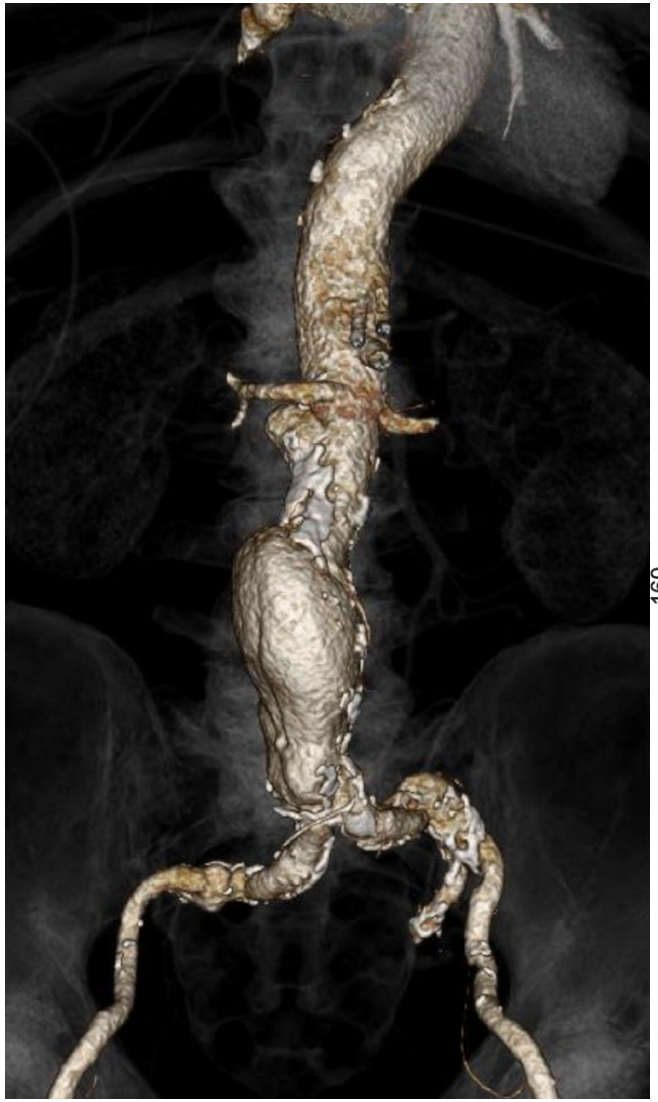
WIDTH: 6mm
HEIGHT: 8mm
DIST FROM PROX EDGE: 57mm
CLOCK: 12:00
IVD: 33mm

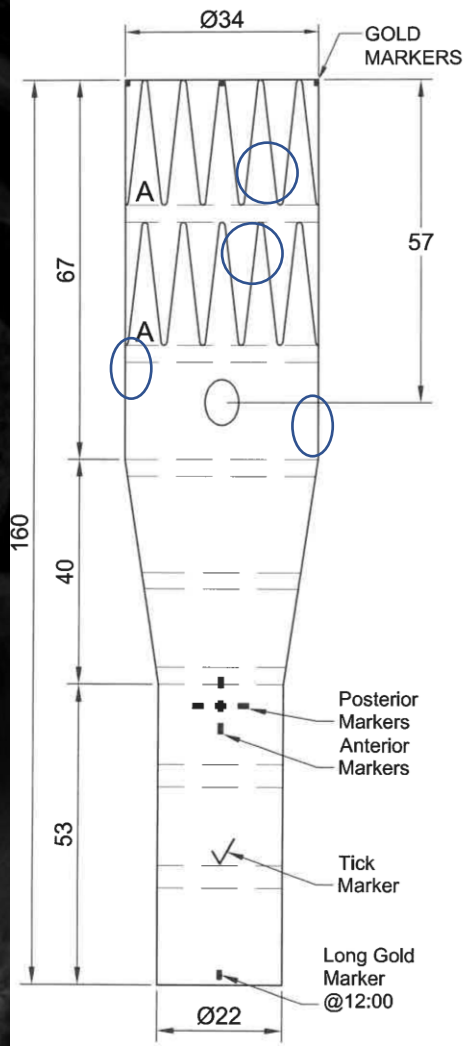
- SINGLE DIAMETER REDUCING TIES
- NON-STANDARD GOLD MARKER PLACEMENT
- LOW PROFILE FABRIC

Plus:

G32595 - AAA-BIFURCATED-GRAFT
(As per ZFEN-D-12-28-76)

Modifiable CMD for PMEG



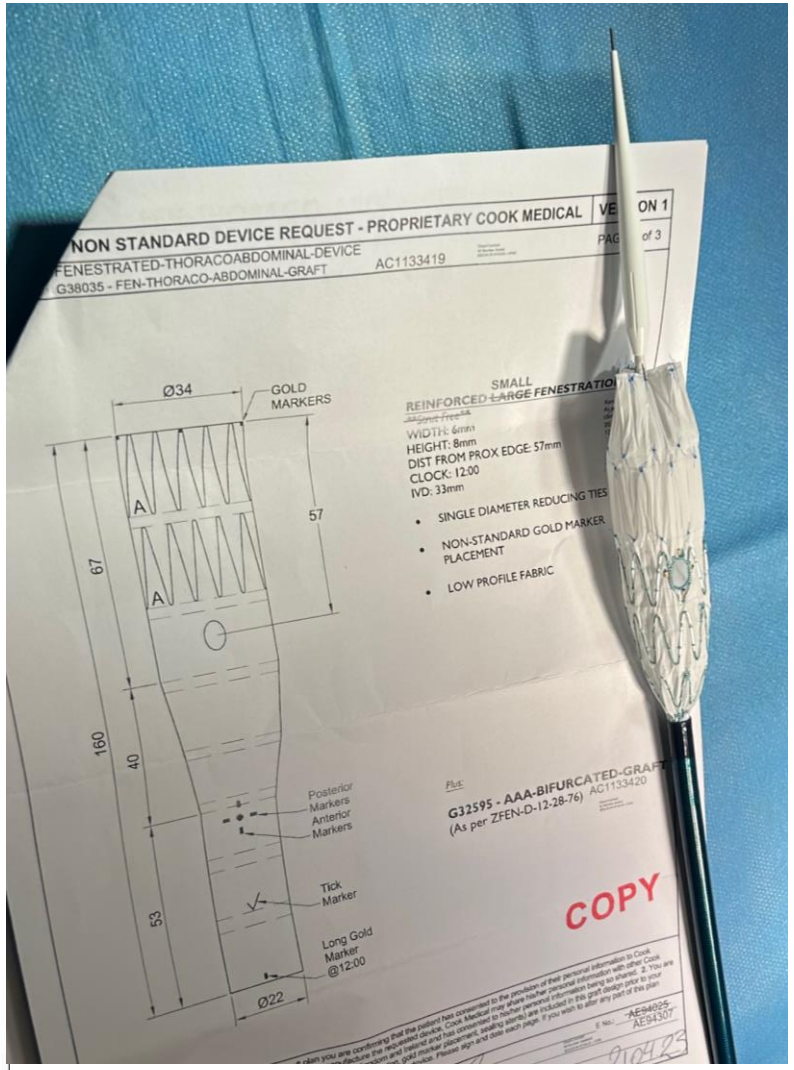


REINFORCED LARGE FENESTRATION #I
Strut Free
WIDTH: 6mm
HEIGHT: 8mm
DIST FROM PROX EDGE: 57mm
CLOCK: 12:00
IVD: 33mm

- SINGLE DIAMETER REDUCING TIES
- NON-STANDARD GOLD MARKER PLACEMENT
- LOW PROFILE FABRIC

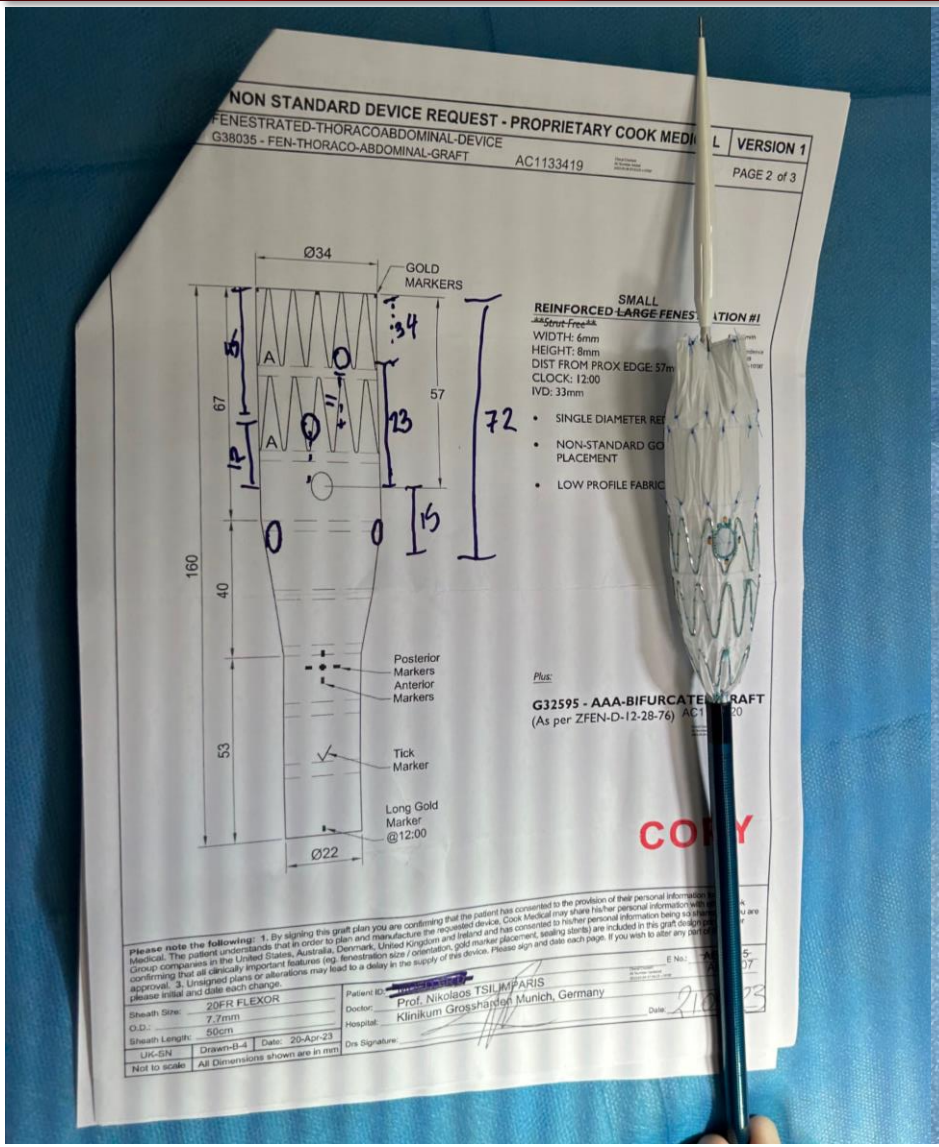
Plus:

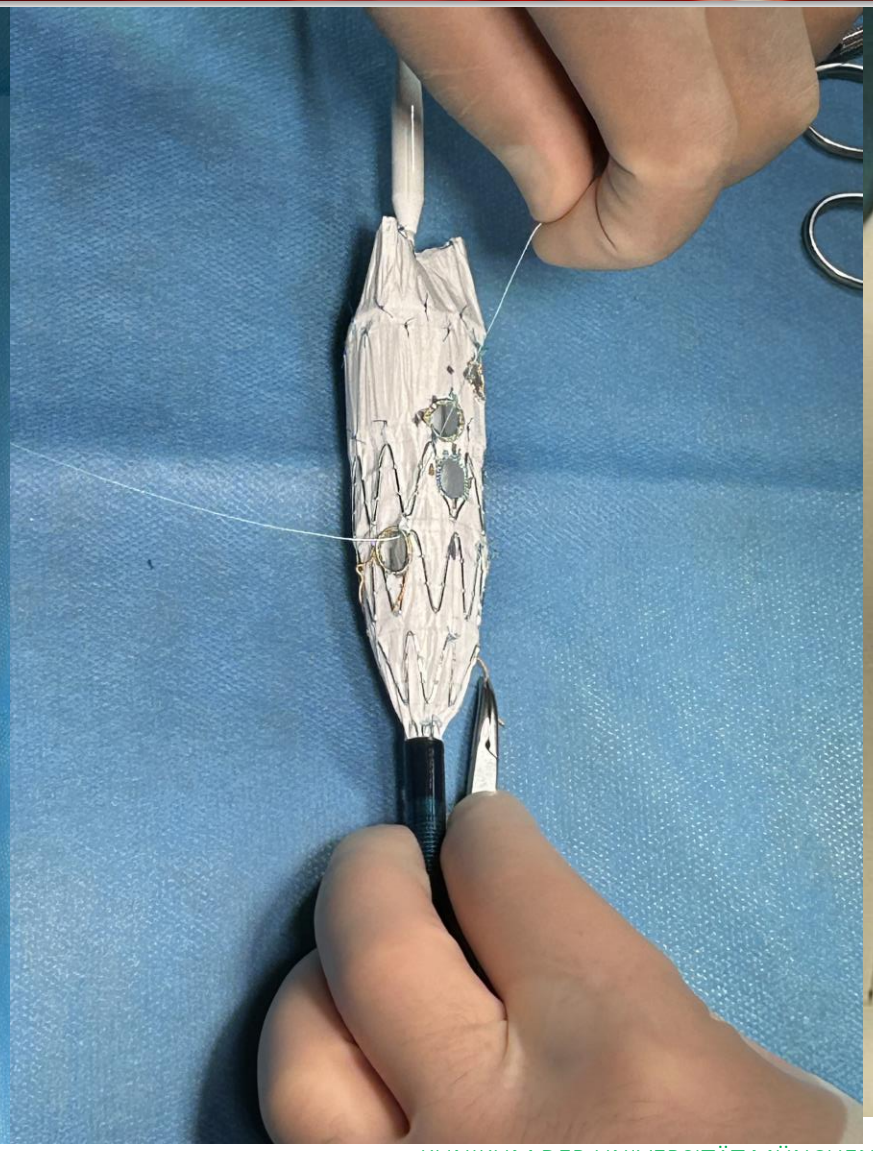
G32595 - AAA-BIFURCATED-GRAFT
(As per ZFEN-D-12-28-76)

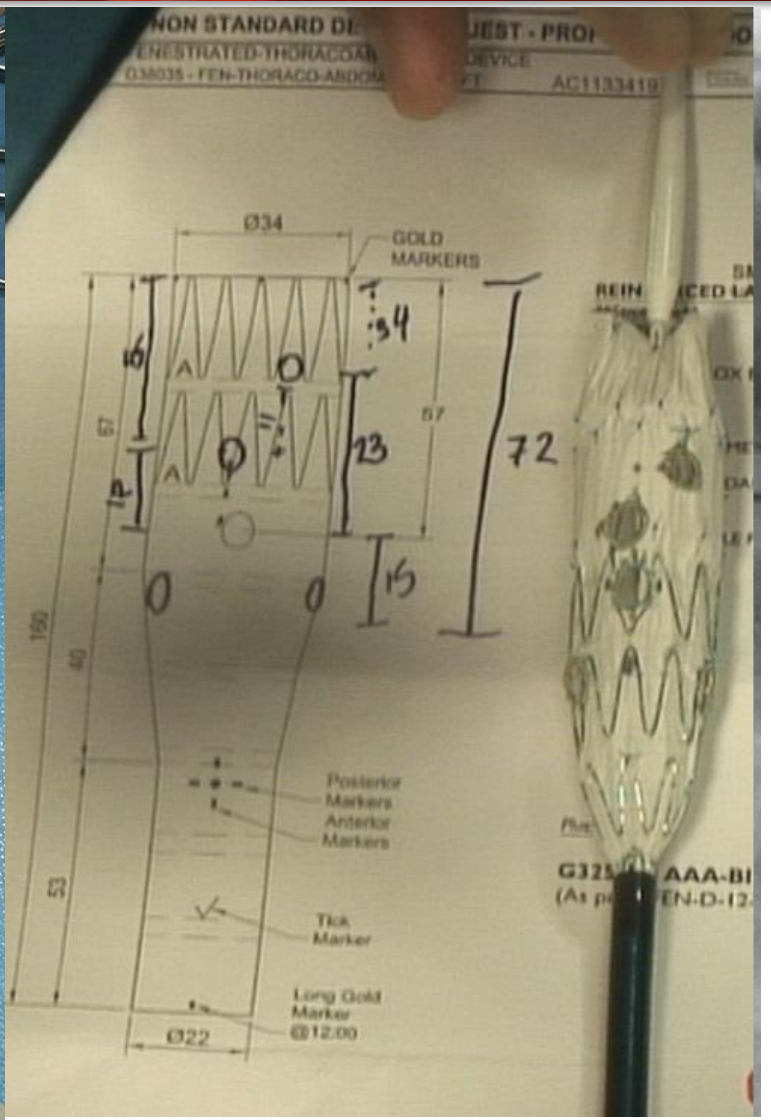


Separate hepatic and splenic artery origin

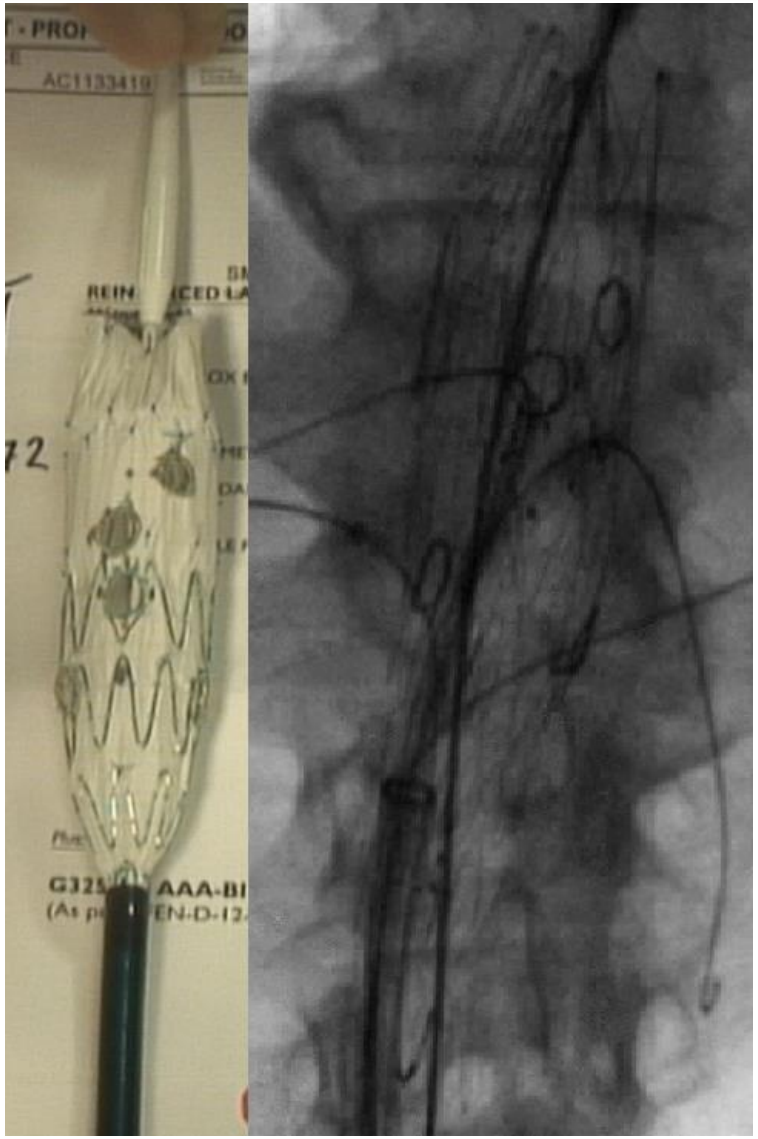
Modifiable CMD for PMEG







Case presentation: 5fen EVAR PMEG on CMD



Conclusion

- Accessory renal arteries and variant visceral branches should be preserved, whenever reasonably feasible
- Bidirectional branches offer a new interesting option for renovisceral variant anatomies
- More than 4 target vessels require adjustment in the access strategy and specific stengraft designs.

THANK YOU