Anévrismes concomitants de l'aorte

PRÉSENTATION D'UN CAS CLINIQUE INUSITÉ

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CONFLITS D'INTÉRÊT

Aucun

PRÉSENTATION DU CAS
ÉVALUATION INITIALE

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

ID: Homme 80 ans

RC: Masse abdominale pulsatile

ATCD: - HTA
- Ex-fumeur
- MCAS (PACx4, remplacement Ao. asc.)
- Ulcère gastrique avec Hx d'hémorragie

ATCD familiaux: Père MCAS

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

Rx:

- ASA 80
- Cardizem SR 240 DIE
- Bisoprolol 5mg DIE
- Crestor 10 DIE

- Pantoloc 40 DIE
- Multivitamines
- Palafer 300 BID

All: Aucune

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

Hx: - Il sent une pulsation au ventre la nuit
et voit parfois son ventre bouger
depuis plusieurs années
- Ø douleur abdominale/thoracique/dos

RDS: - Ø limitations à l'effort, Ø angine, Ø syncope
- Ø Sx neuro
- Ø claudication MI

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

E/P: TA: 128/85 FC: 80/min, rég.

Légère obésité abdominale

Abdomen: **Masse pulsatile palpable ≈ 7cm**

Extrémités: Pouls palpables s/p

MI et MS bien perfusés

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

Tests de laboratoires:

HB: 112

GB: 5.2

Pl: 234

Créat: 67

GFR: 105 ml/min

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

Défi diagnostic ici? **Pas vraiment**

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

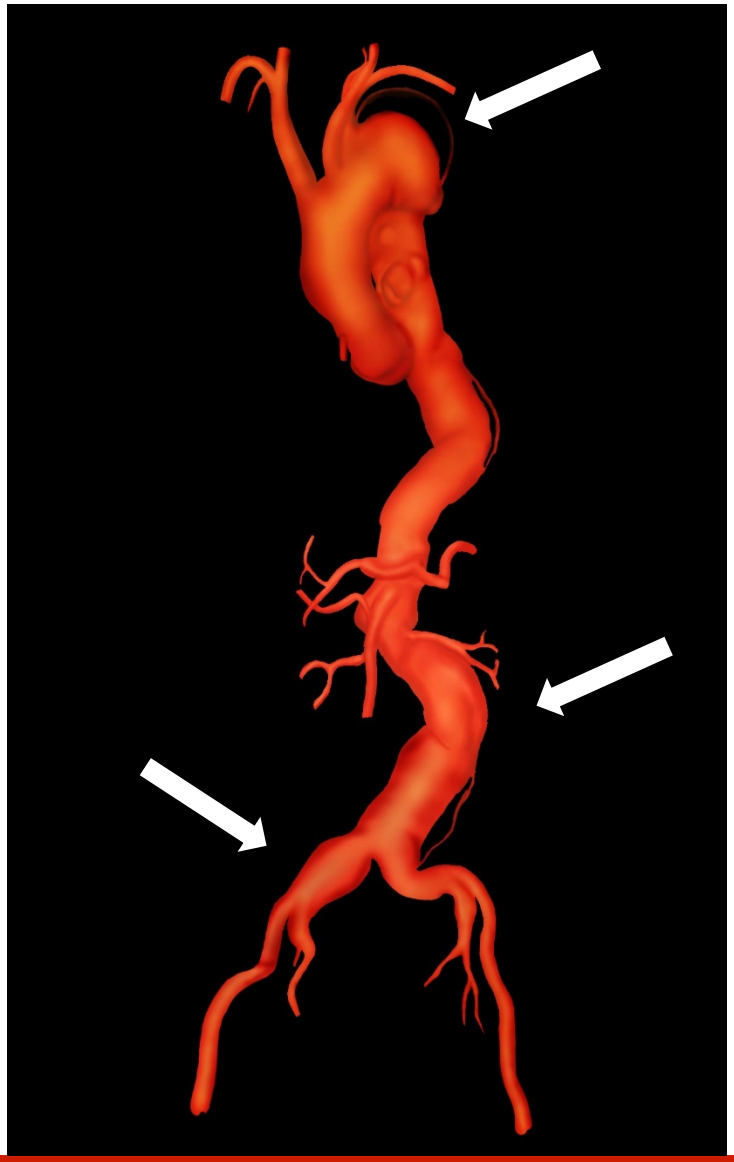
Défi diagnostic ici? **Pas vraiment**

Imagerie:

CTA

PRÉSENTATION DU CAS – ÉVALUATION INITIALE

PRÉSENTATION DU CAS – ÉVALUATION INITIALE



PLAN DE LA PRÉSENTATION

Anévrismes de l'aorte

1) **Généralités**

2) **Options thérapeutique**

   -Anévrisme de la crosse aortique

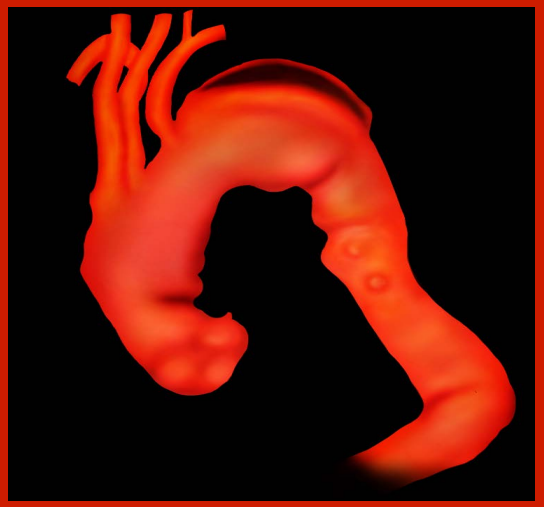
   -AAA

3) **Évolution de notre patient**

4) **Questions**

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME



GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

CROSSE AORTIQUE

AORTE ABDOMINALE

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

DÉFINITION:

- **1.5x diamètre normal**

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

AORTE ABDOMINALE

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

- **90% des anévrismes de l'aorte**
- **5% des hommes**
- **90% dégénératifs**

AORTE ABDOMINALE

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

CROSSE AORTIQUE

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

CROSSE AORTIQUE

- **<1% des anévrismes de l'aorte**
- **50% séquelles d'une dissection aortique**

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

CROSSE AORTIQUE

AORTE ABDOMINALE

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME

CROSSE AORTIQUE

AORTE ABDOMINALE

CONCOMITANT

GÉNÉRALITÉS – Anévrisme de l'aorte

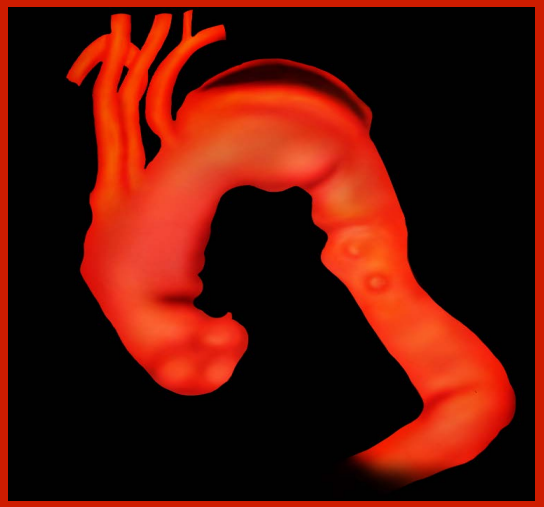
ANÉVRISME

CONCOMITANT

ANEURYSMOSIS
SYNCHRONUS ANEURYSMS
MULTIPLE ANEURYSMS

GÉNÉRALITÉS – Anévrisme de l'aorte

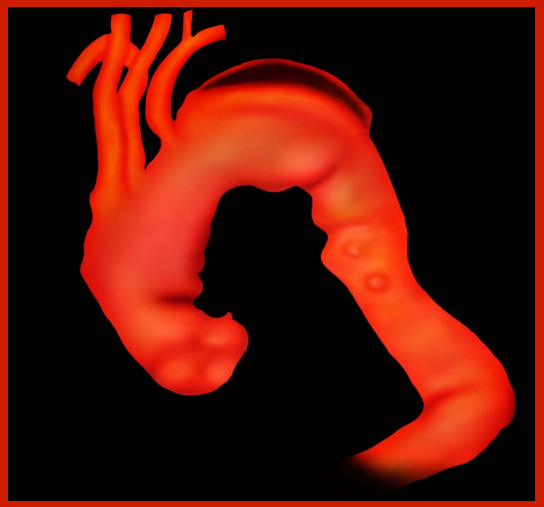
ANÉVRISME



50 %

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME



12 %

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME PÉRIPHÉRIQUE

40%

15%

ILIAQUE

POPLITÉ

GÉNÉRALITÉS – Anévrisme de l'aorte

ANÉVRISME PÉRIPHÉRIQUE

75%

50%

ILIAQUE

POPLITÉ

PRÉSENTATION CLINIQUE

GÉNÉRALITÉS – Anévrisme de l'aorte

Présentation clinique:

1) **Asymptomatique:**

-Dépister par examen physique

-Programme de dépistage

-Découverte fortuite

2) **Symptomatique**

(compression, embolisation, rupture imminente)

3) **Rupture**

GÉNÉRALITÉS – Anévrisme de l'aorte

Programme de dépistage canadien

Canadian Society for Vascular Surgery (CSVS)
Statement on AAA Screening

All men aged age 65-75 be screened for AAA
Individual selective screening for those at high risk for AAA

a. women over age 65 at high risk secondary to smoking, cerebrovascular disease and family history
b. men less than 65 with positive family history

INDICATION CHIRURGICALE

GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATION CHIRURGICALE:

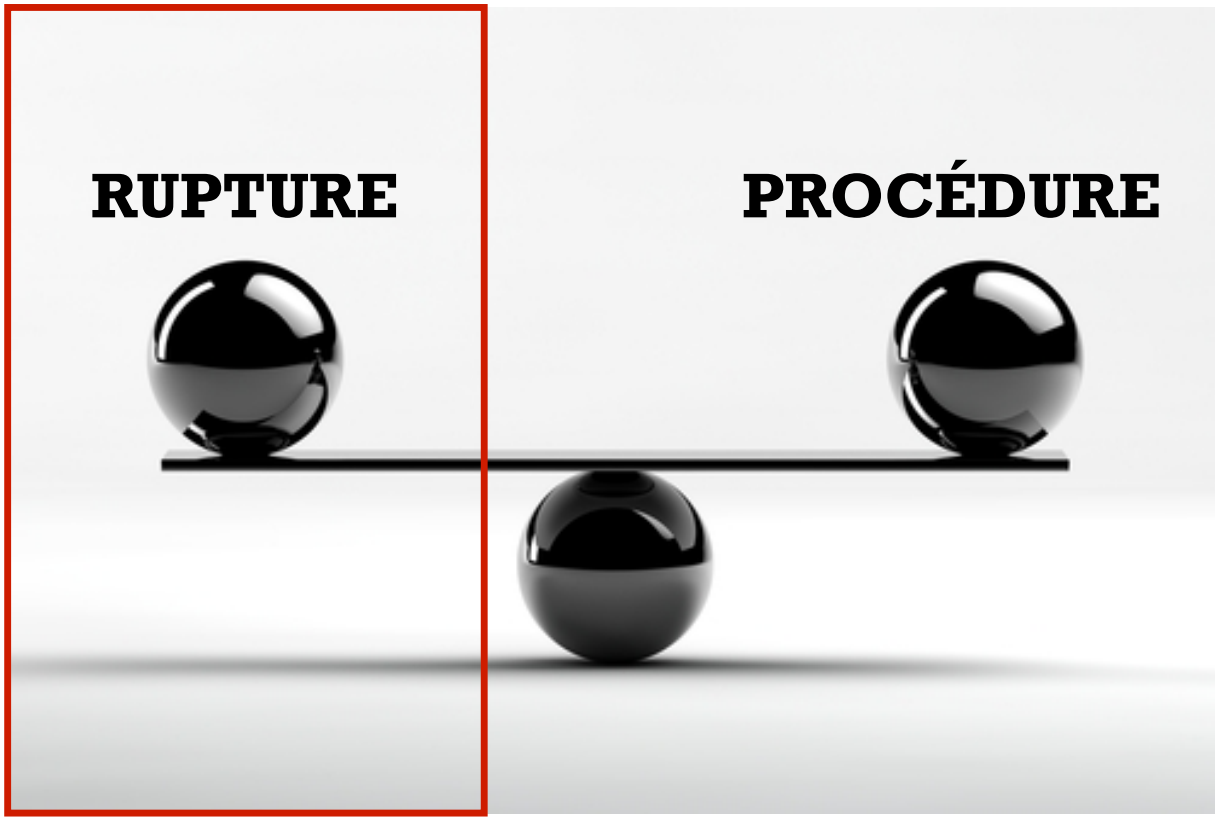
OBJECTIF: PRÉVENIR UNE RUPTURE

RUPTURE D'AAA:

- 15^{ieme} cause de mortalité (É.U.)
- Léthalité: 80-90%

GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATION CHIRURGICALE:



GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATION CHIRURGICALE:

RISQUE DE RUPTURE

Table 130-4	Range of Potential Rupture Rates for a Given Size of Abdominal Aortic Aneurysm
AAA Diameter (cm)	**12-Month Rupture Risk (%)**
3.0-3.9	0.3
4.0-4.9	0.5-1.5
5.0-5.9	1-11
6.0-6.9	11-22
>7	>30

Rutherford's Vascular Surgery References, 8e 8th Editionby Jack L. Cronenwett MD (Author), K. Wayne Johnston MD FRCSC (Author)

GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATIONS CHIRURGICALES:

-**Diamètre absolu** de l'anévrisme

(AAA: H ≥5.5cm, F ≥5.0cm)

(Crosse et desc.: 6.0cm)

-**Vitesse** de progression du diamètre

-**Forme** de l'anévrisme

-**Symptomatique**

-**Rupture**

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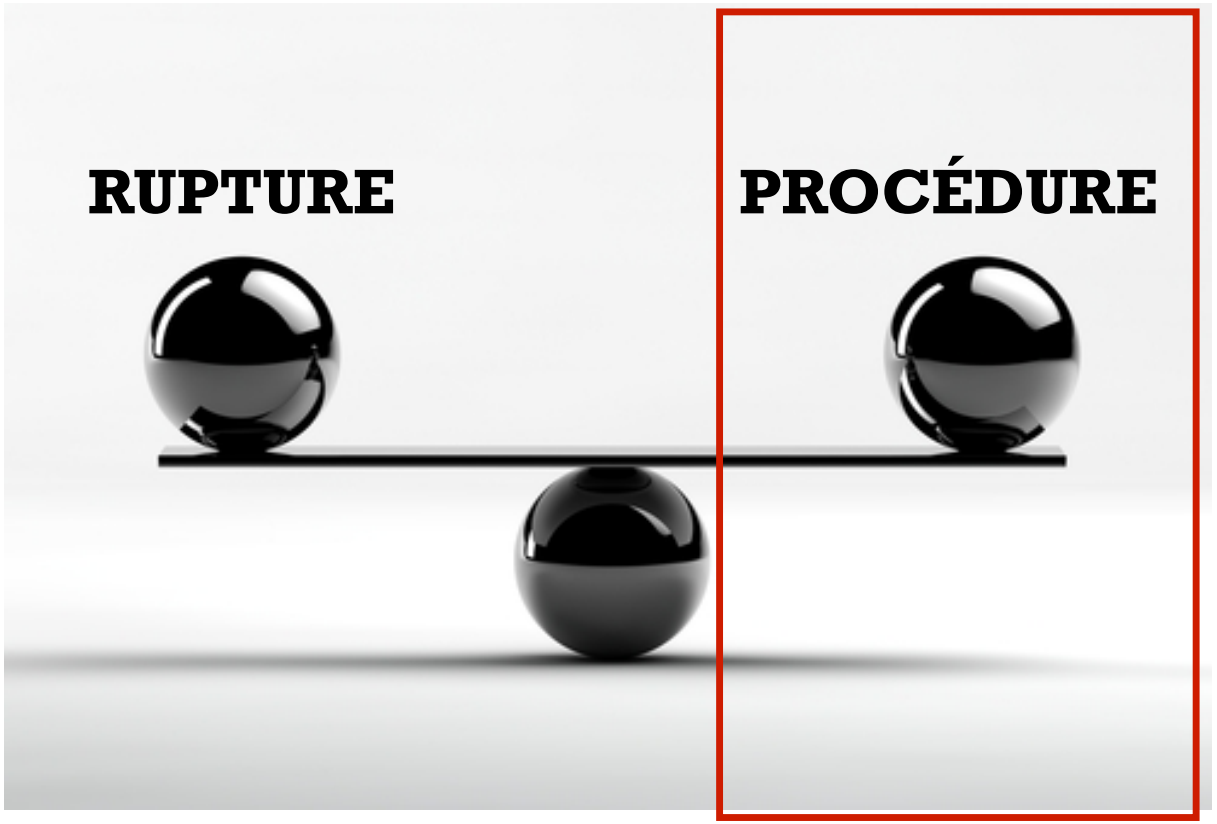
GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATION CHIRURGICALE:



GÉNÉRALITÉS – Anévrisme de l'aorte

INDICATION CHIRURGICALE:

RISQUES DE LA PROCÉDURE:

-**Comorbidités** unique au patient

-Risques spécifiques à la **chirurgie ouverte**

-Risques spécifiques à la **chirurgie endovasculaire**

OPTIONS CHIRURGICALES

Options chirurgicales

CONCEPT GÉNÉRAL

A) Isoler l'anévrisme de la circulation

B) Préserver le flot

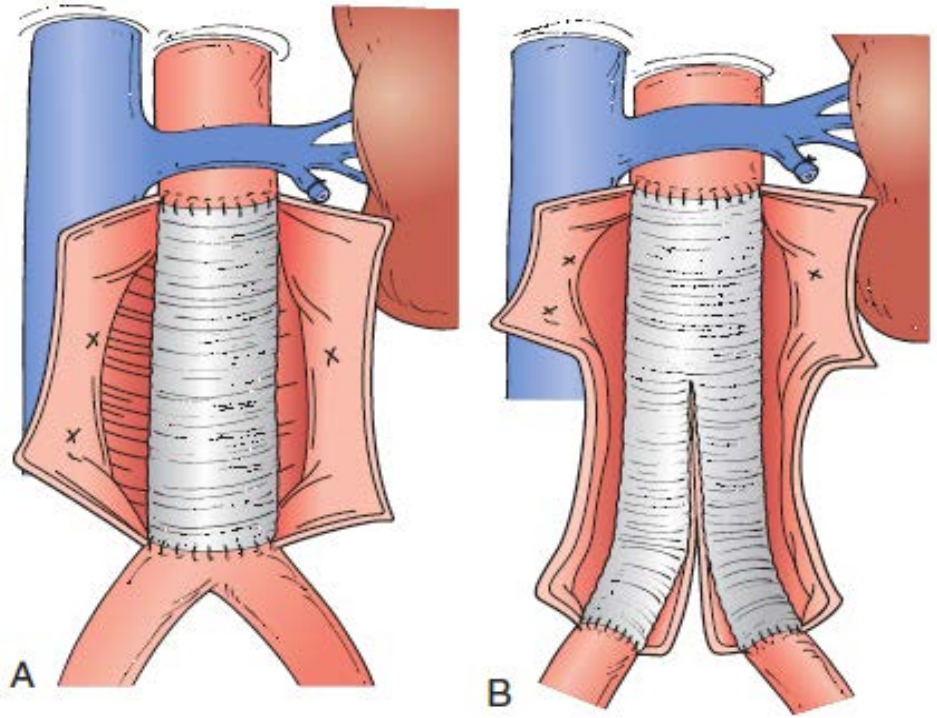
POSSIBILITÉS: OUVERT vs ENDOVASCULAIRE

Options chirurgicales

OUVERTE

Options chirurgicales

AAA



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Options chirurgicales

Crosse aortique

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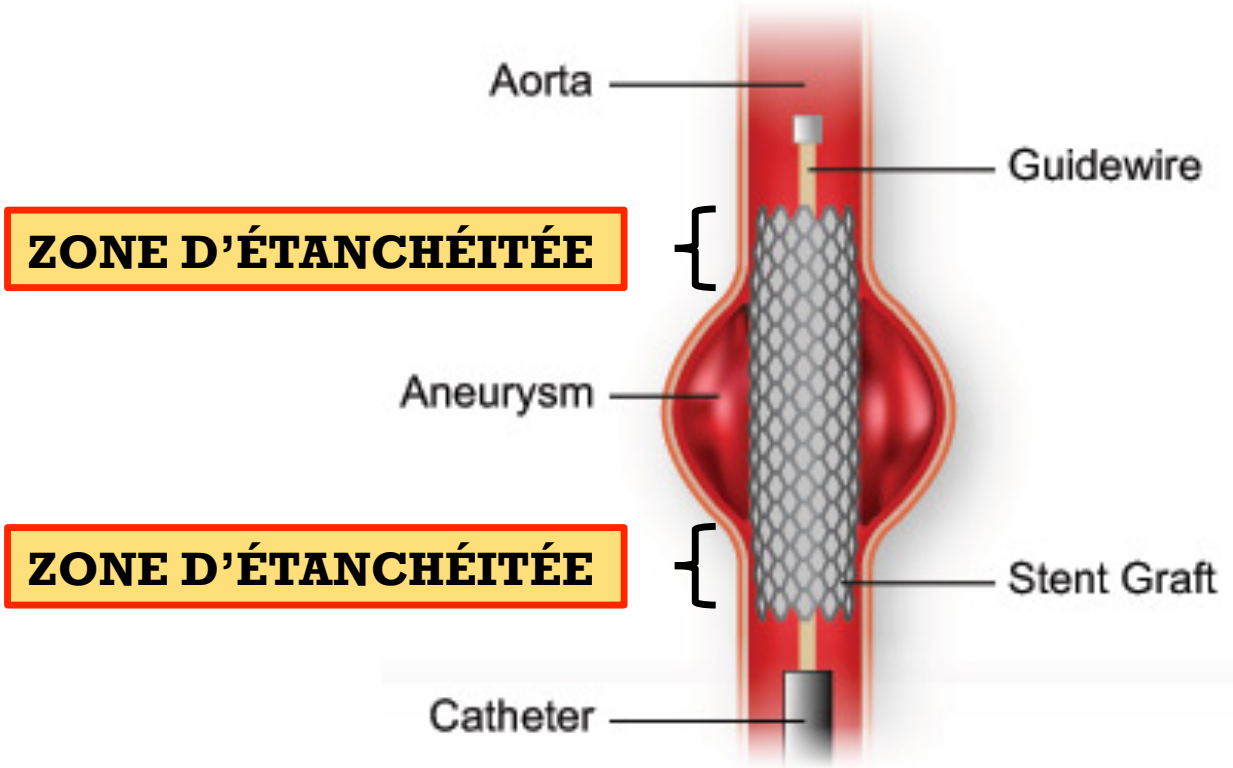
Options chirurgicales

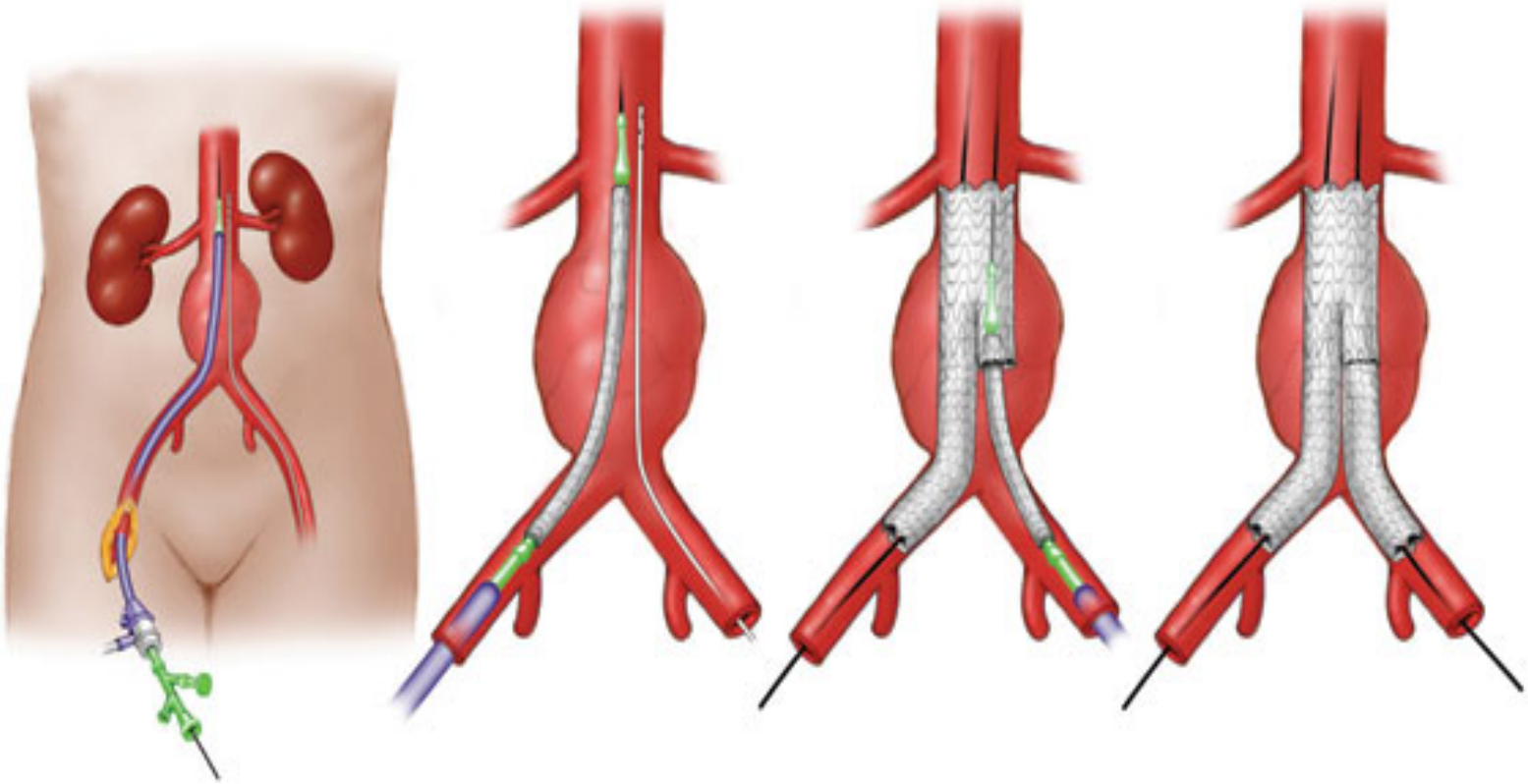
ENDOVASCULAIRE

Options chirurgicales - ENDOVASCULAIRES



Options chirurgicales - ENDOVASCULAIRES

AAA (EVAR)



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Options chirurgicales - ENDOVASCULAIRES

CROSSE AORTIQUE

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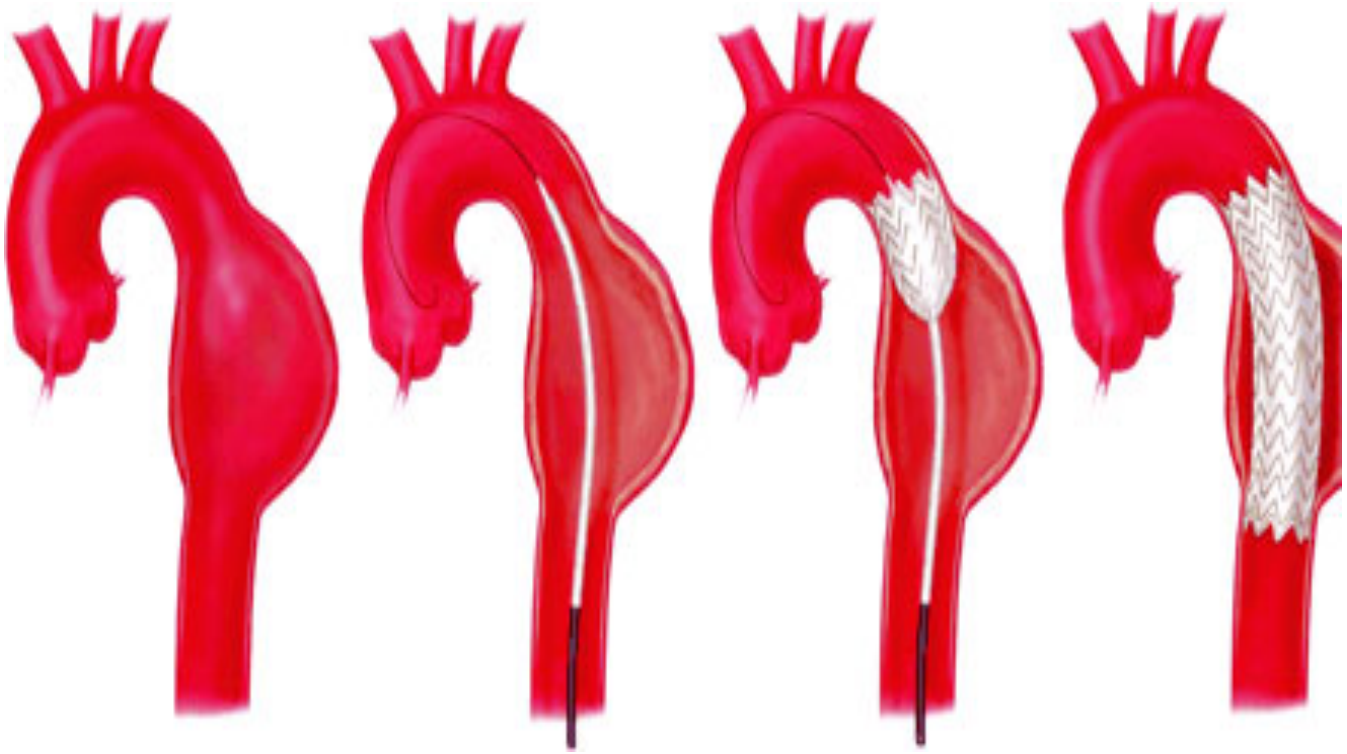
Options chirurgicales - ENDOVASCULAIRES

TEVAR



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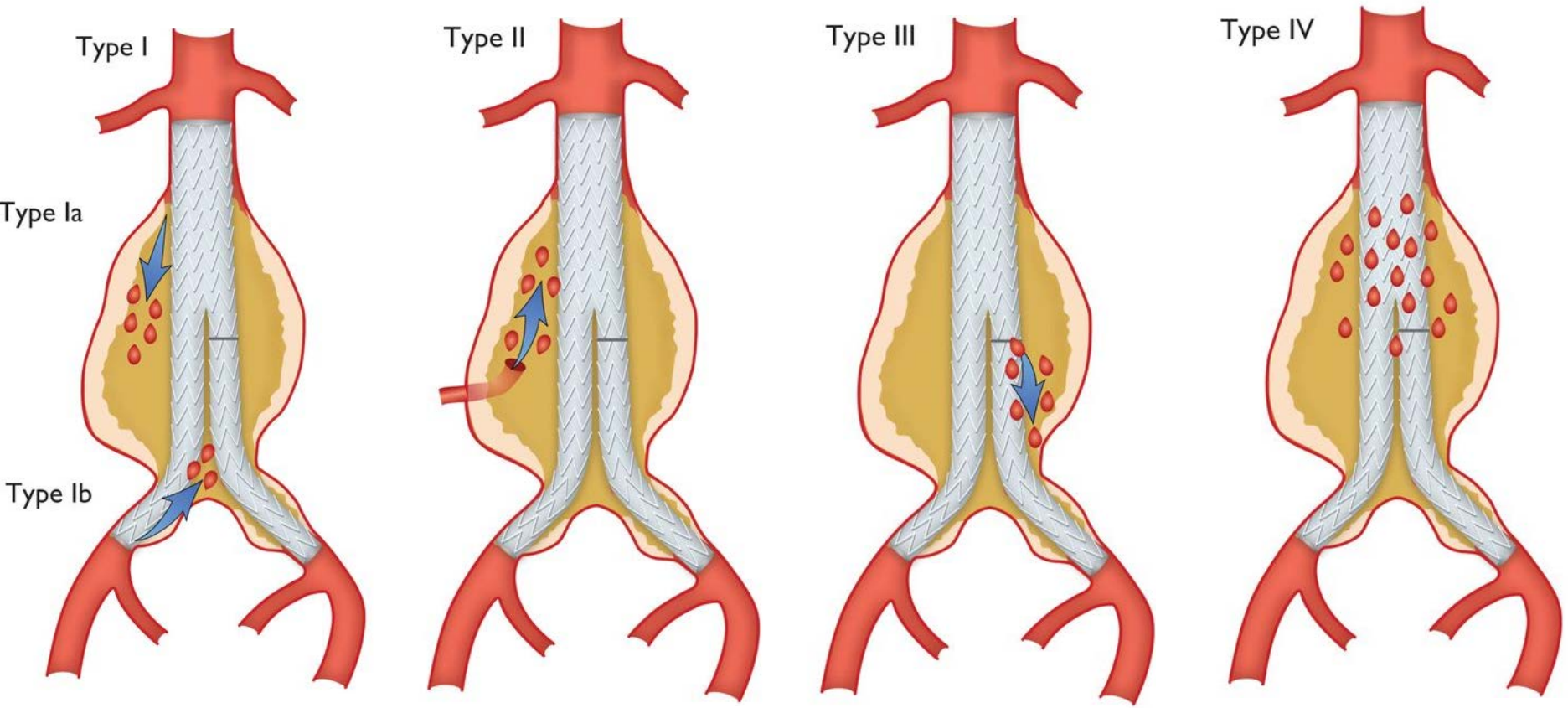
Options chirurgicales - ENDOVASCULAIRES

Concept d'endofuite



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NOTRE CAS

Notre cas

RISQUE DE RUPTURE: >40%

vs

PATIENT:

-80 ans

-MCAS

-ATCD de sternotomie

-Bonne qualité de vie

Notre cas

ÉVALUATION PRÉ-OP:

- **MIBI**: N

- **ETT**:

  FEVG:55-60%, crosse transverse 66mm,thrombus luminaire dans l'anévrisme, légère regurgitation mitrale

- **DUPLEX CAROTIDIEN**: N

Notre cas

Traiter 3 anévrismes en même temps?

1 TRAITEMENT

3 PROCÉDURES

Notre cas

CROSSE

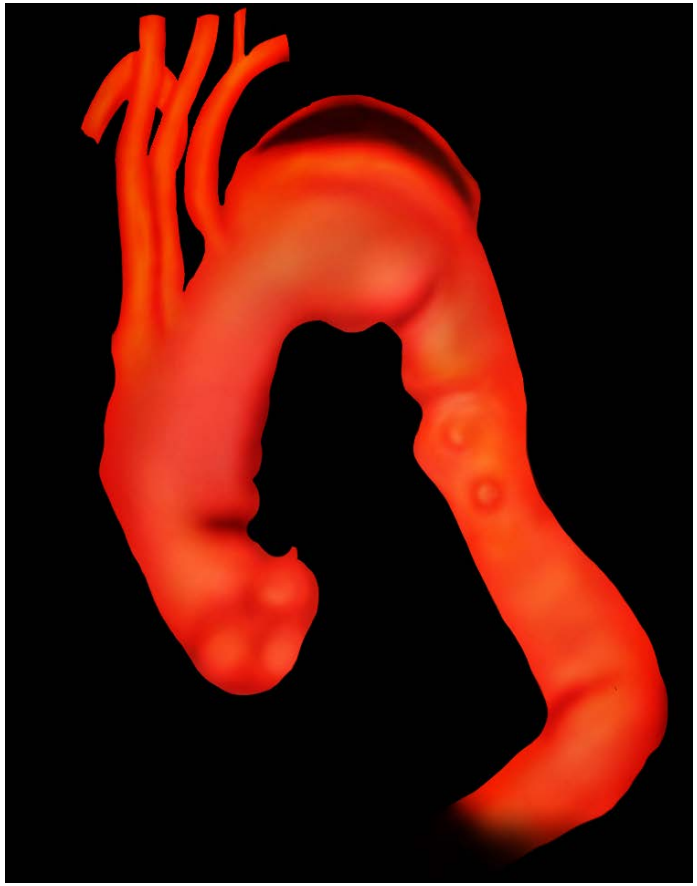
1) **CERVICAL DEBRANCHING**
2) **TEVAR**

AAA

3) **EVAR**

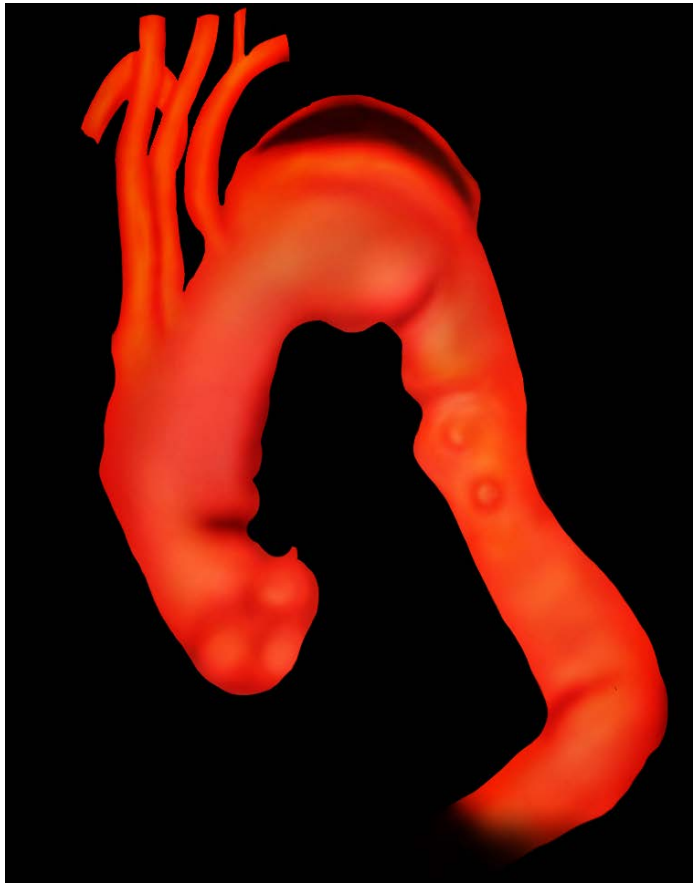
Notre cas

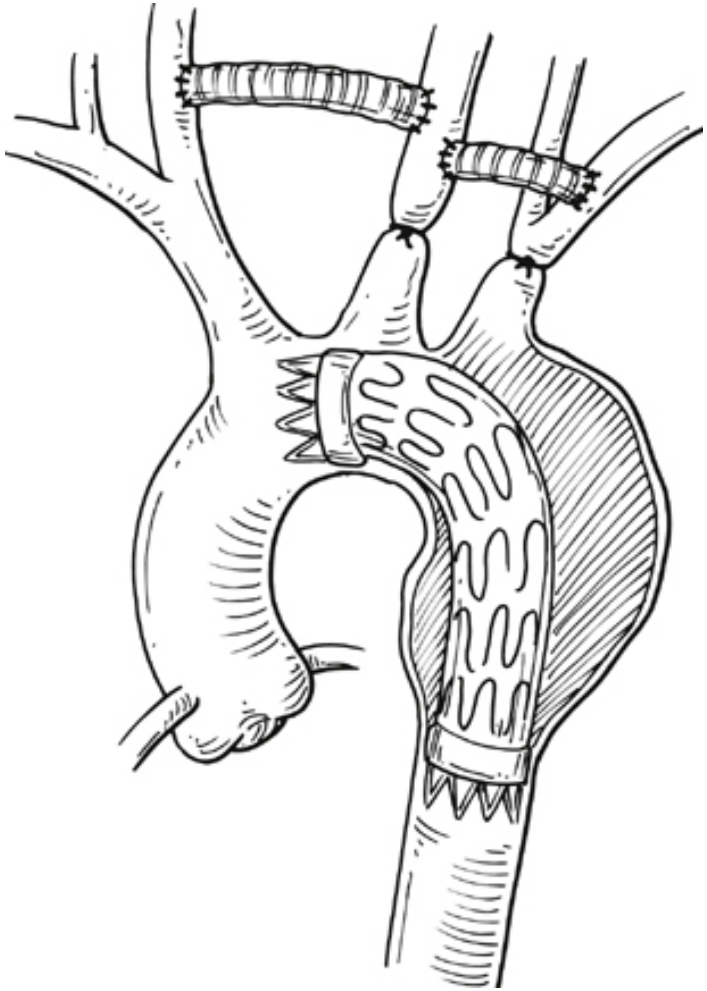
CROSSE - HYBRIDE



Notre cas

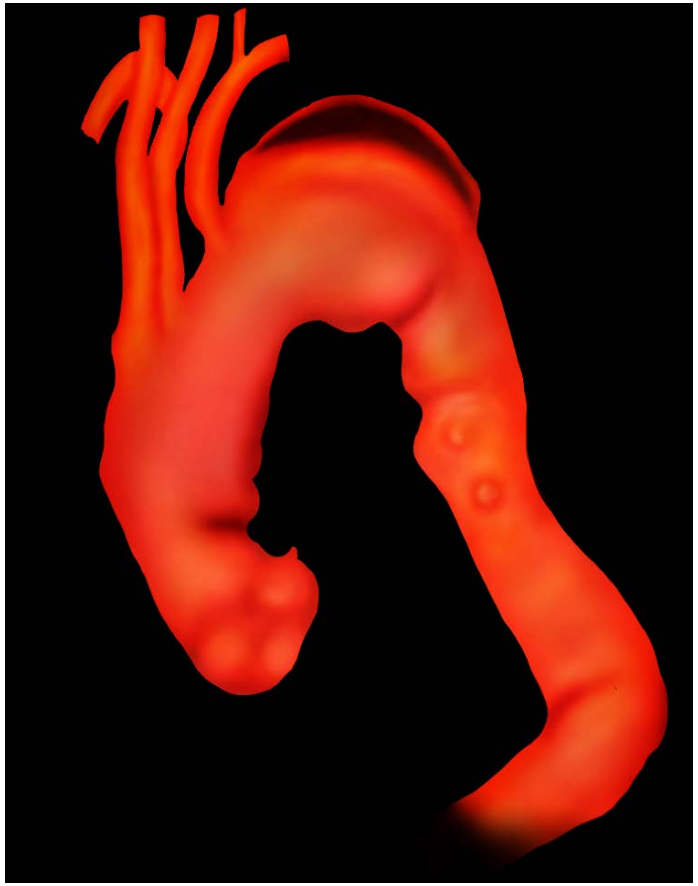
CROSSE - HYBRIDE

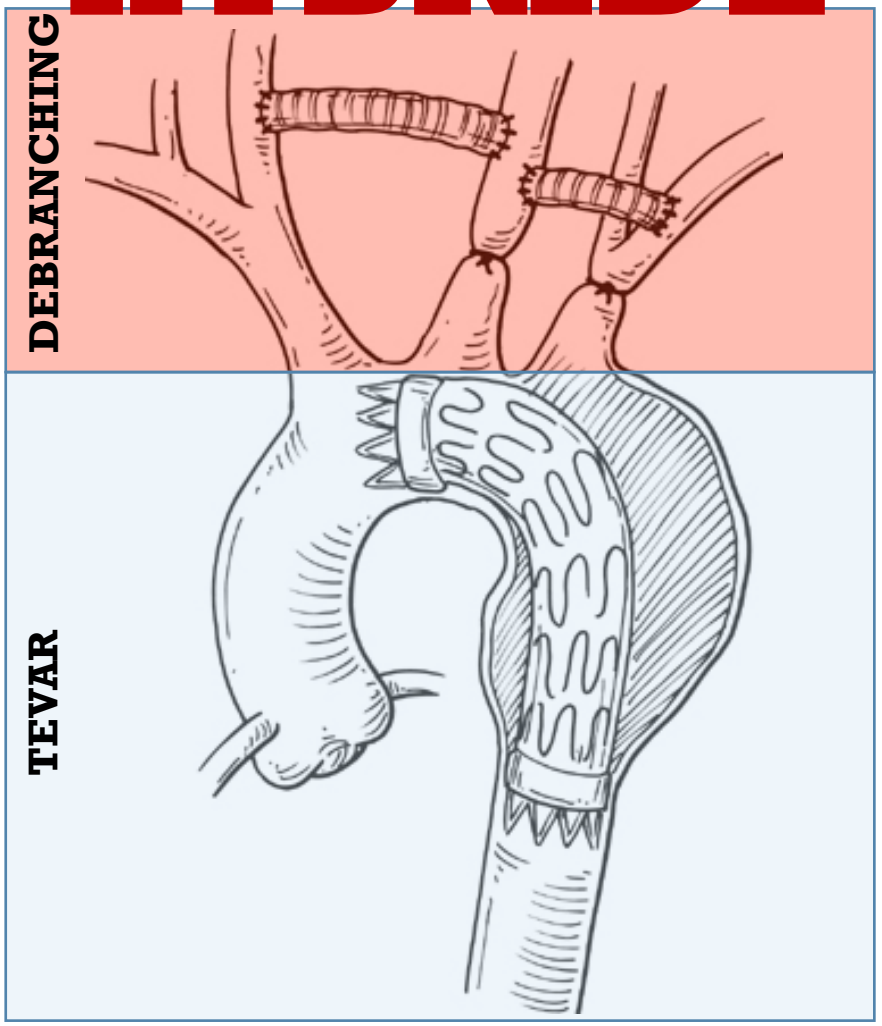




Notre cas

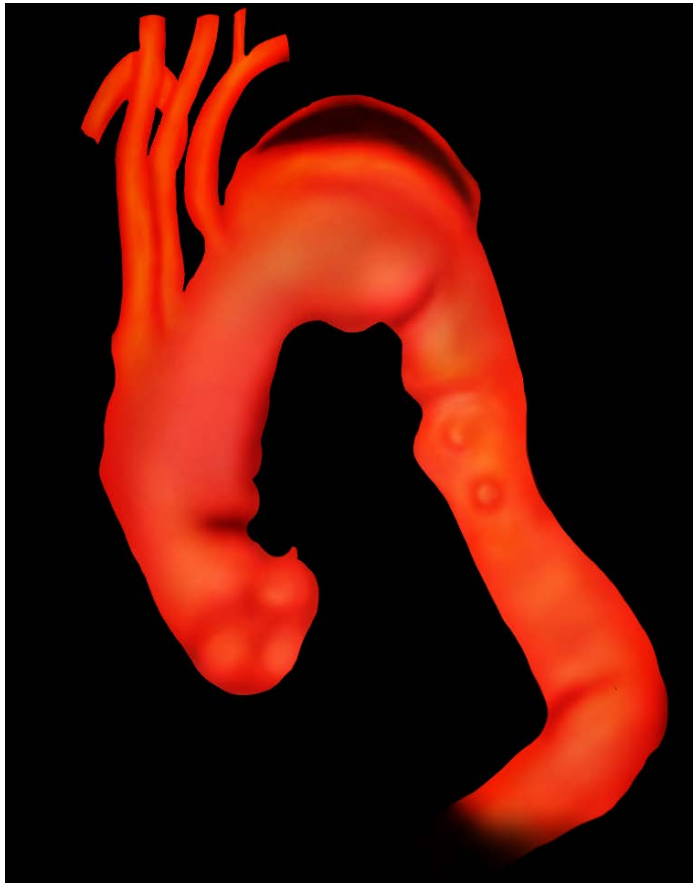
CROSSE - HYBRIDE

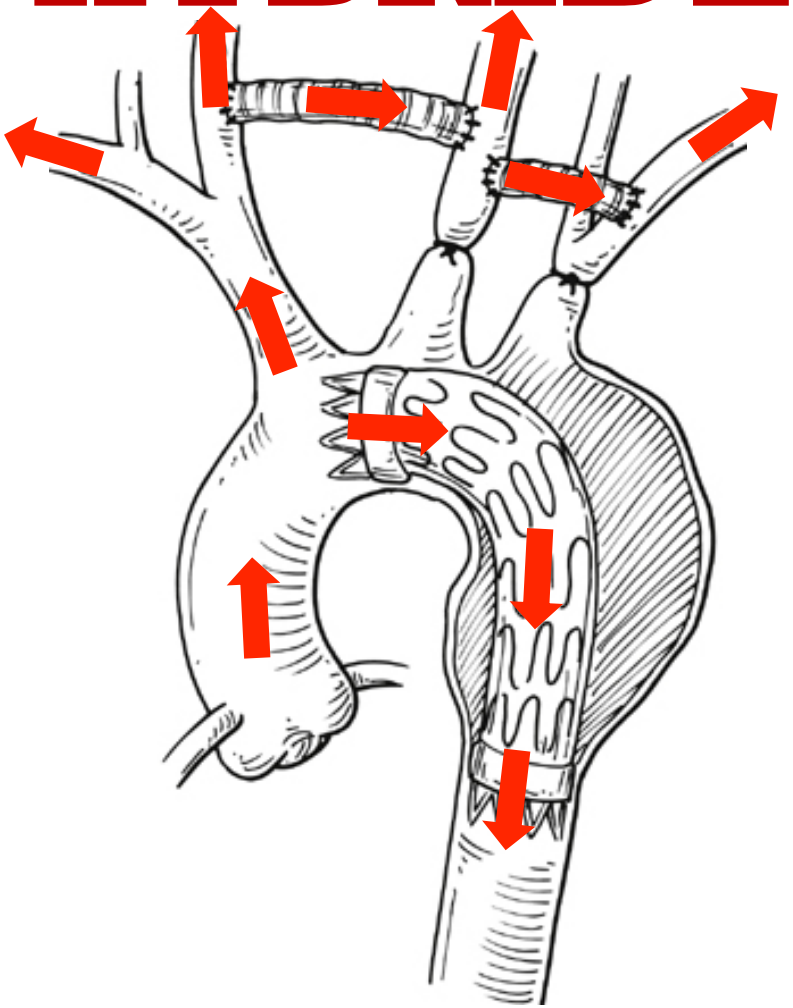




Notre cas

CROSSE - HYBRIDE

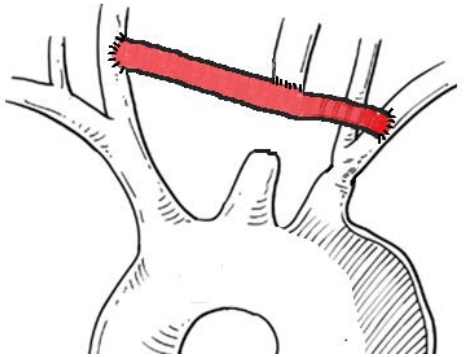




Notre cas

CROSSE

1) DEBRANCHING



- Perte sanguine150cc
- **Congé lendemain**

CROSSE

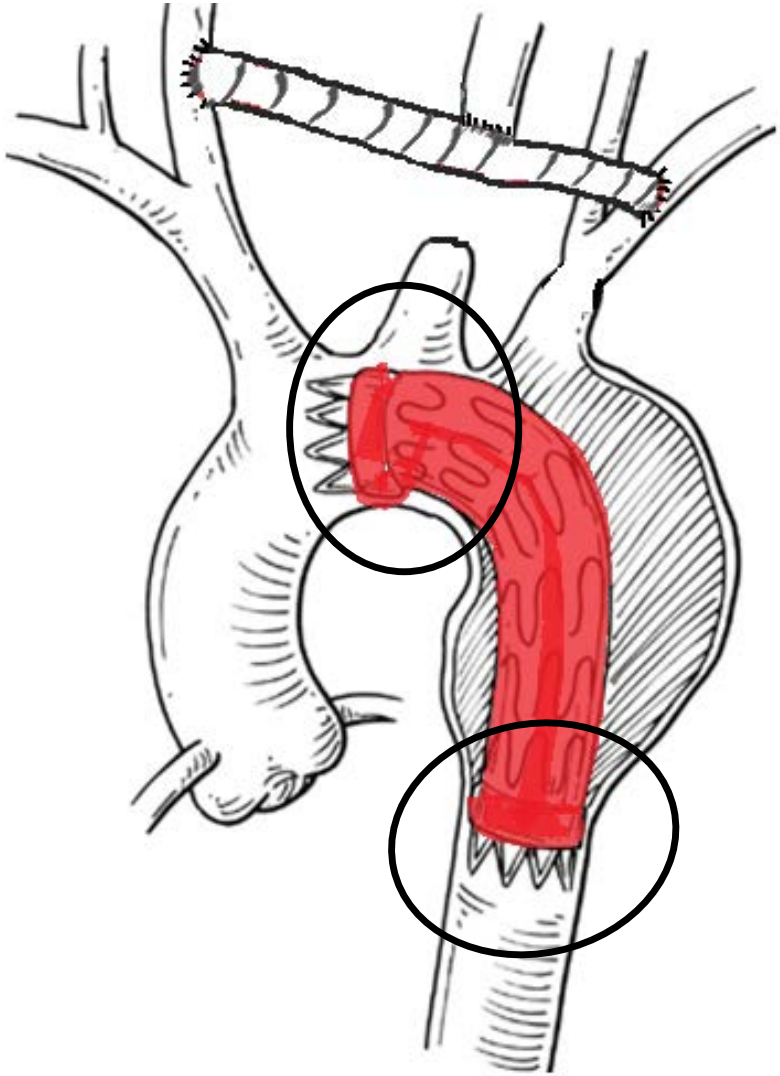
1) DEBRANCHING

- **COMPLICATIONS POTENTIELLES**
  - -AVC
  - -Canal thoracique
  - -Pneumothorax
  - -Horner
  - -Nerf: vague, phrénique, rec. Laryn.
    plexus brachial,
    long thoracique

Notre cas

CROSSE

2) TEVAR

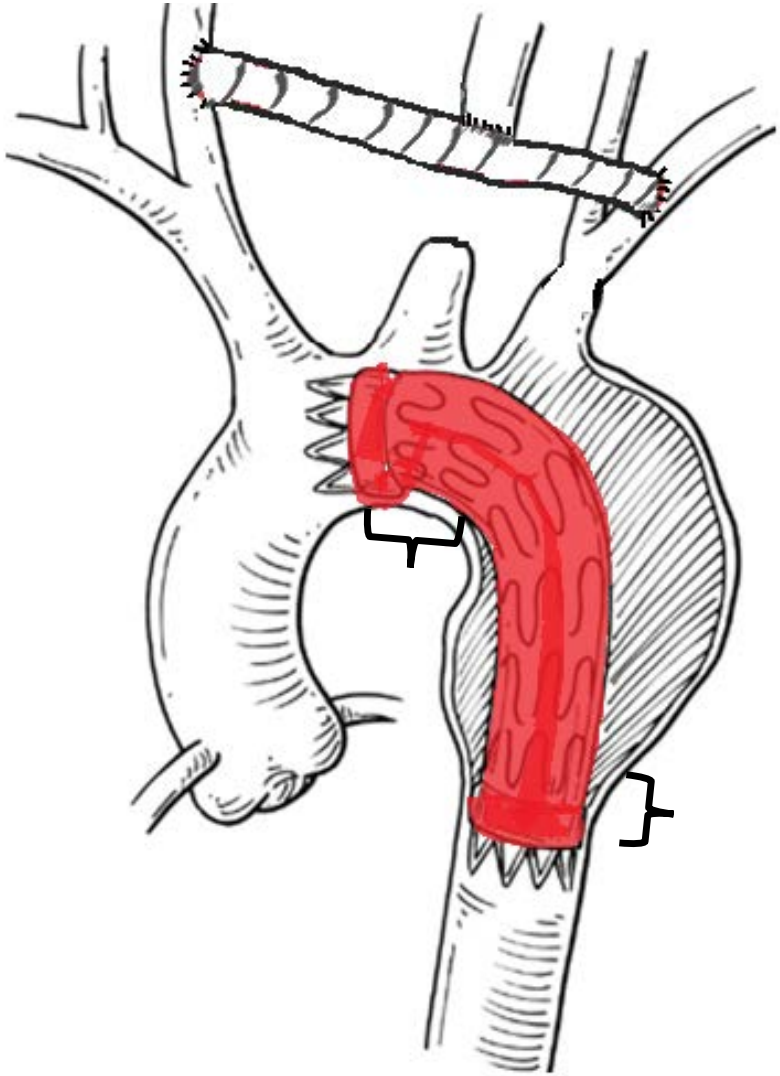


- **Zone d'étanchéité:**

Notre cas

CROSSE

2) TEVAR

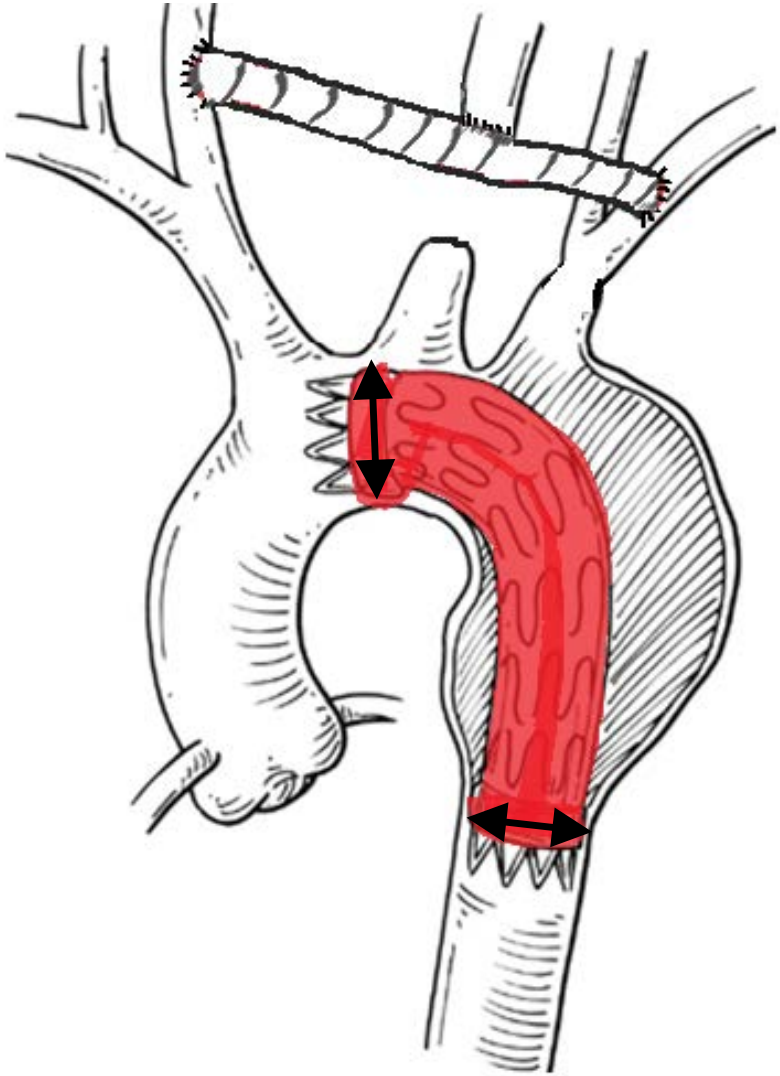


- **Zone d'étanchéité:**

Longueur: >2cm

CROSSE

2) TEVAR

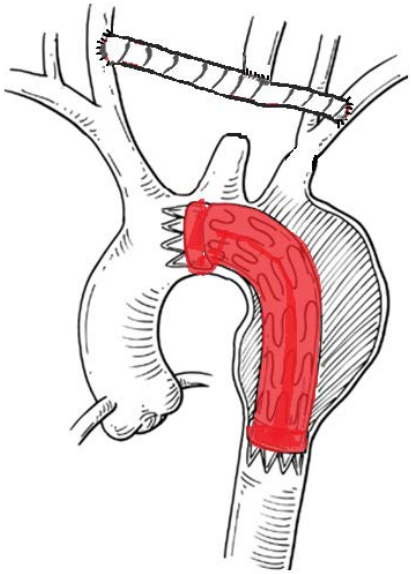


- **Zone d'étanchéité:**

Longueur: >2cm

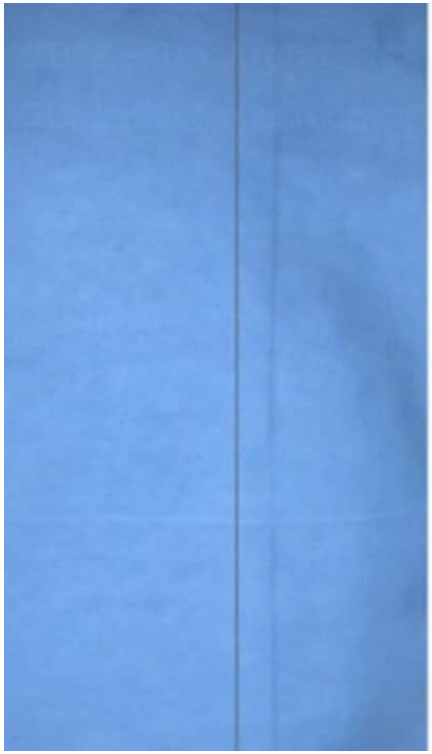
Oversizing: 10-20%

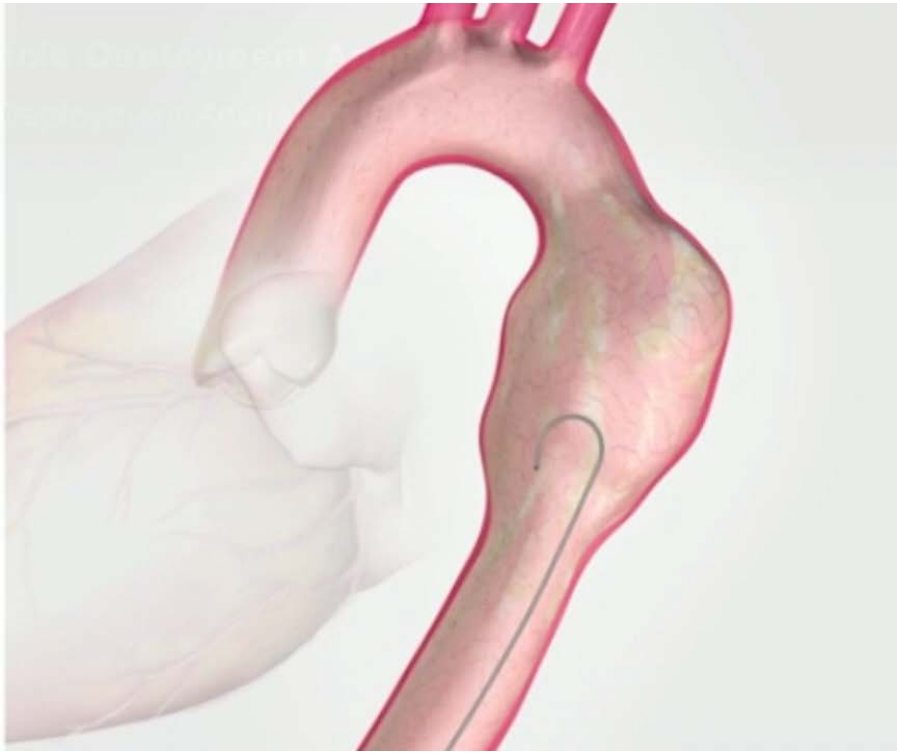
Notre cas



CROSSE

2) TEVAR



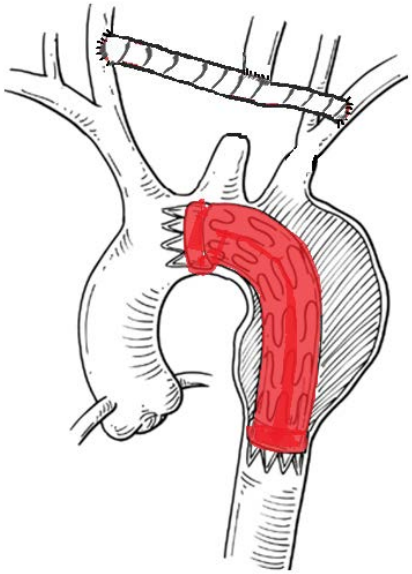


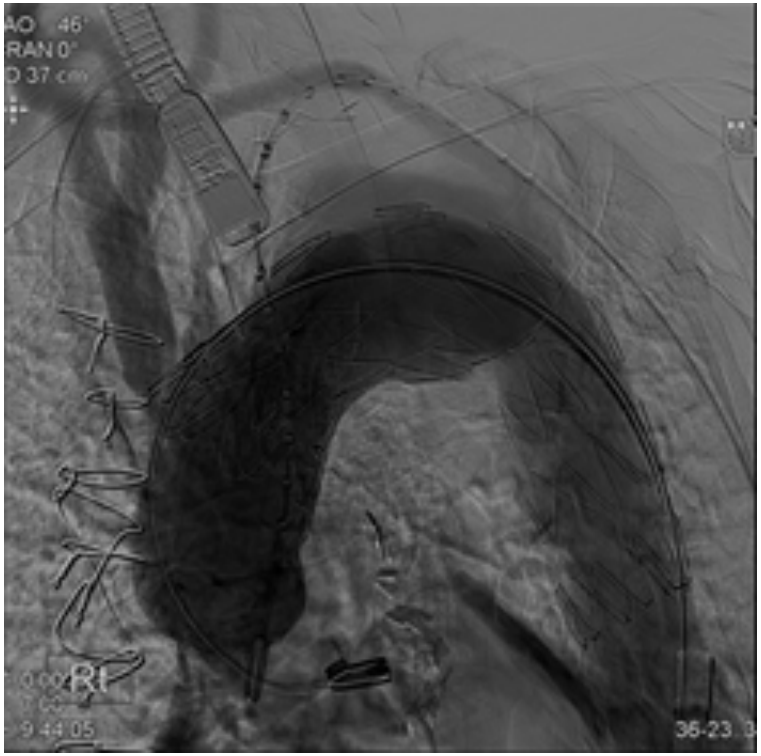
46mm x 172mm
COOK alpha thoracic graft device

Notre cas

CROSSE

2) TEVAR

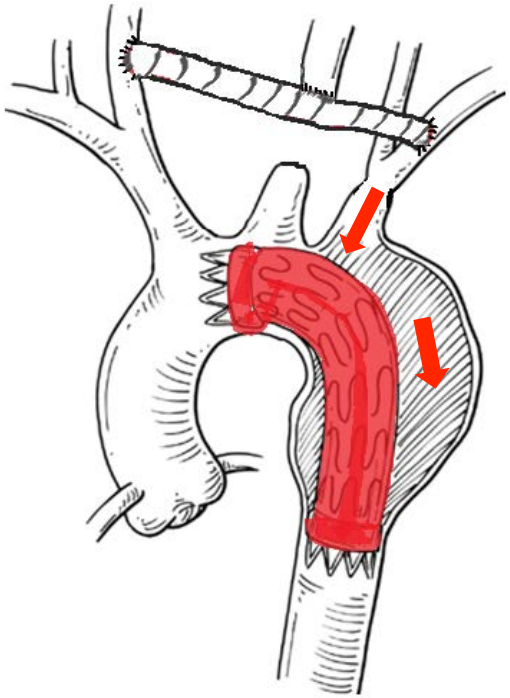


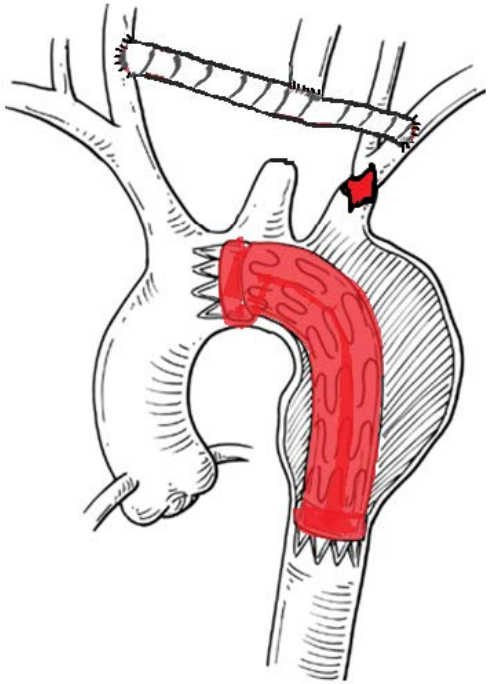


Angiographie
per op

CROSSE

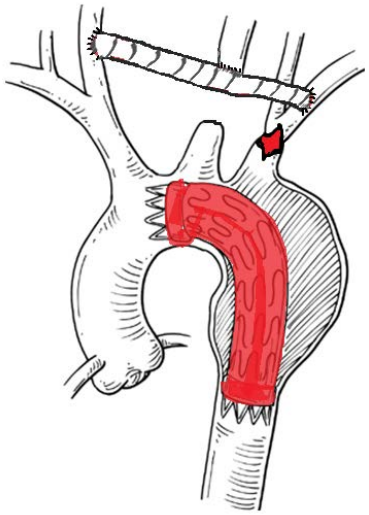
2) TEVAR





Amplatzer Plug

Notre cas



CROSSE

2) TEVAR

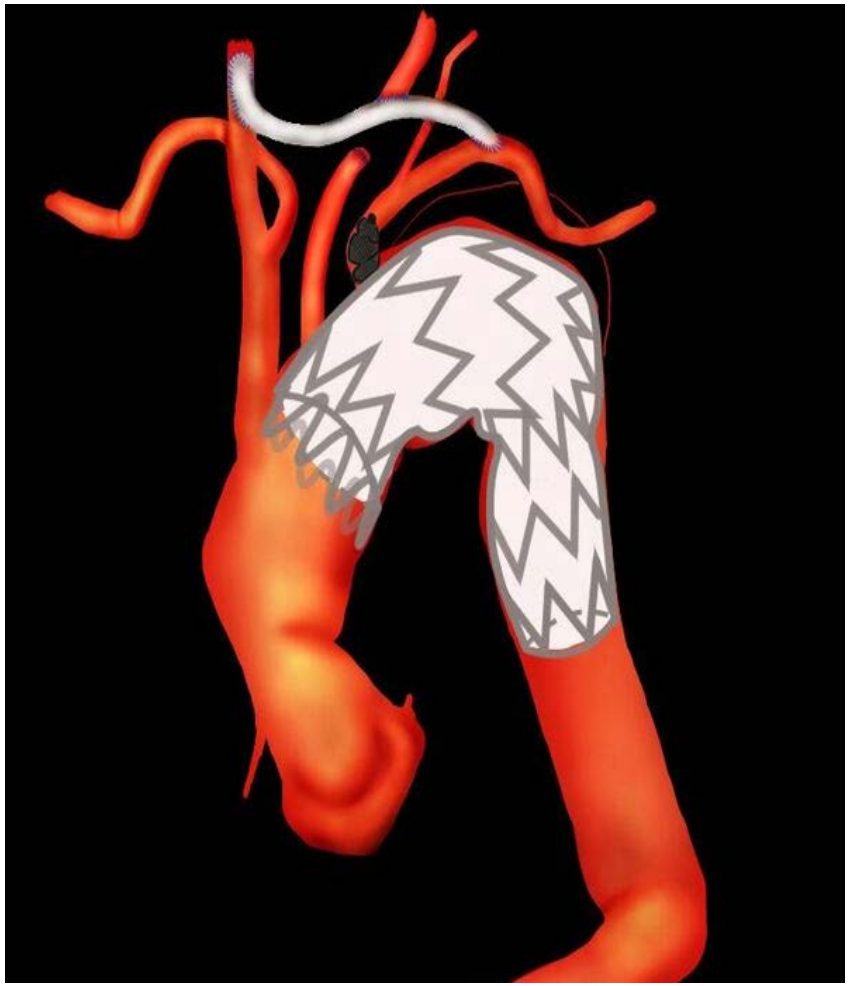
- Perte sanguine: 200cc
- Contraste: 77cc

Départ lendemain am

CROSSE

2) TEVAR

- **COMPLICATIONS POTENTIELLES**
  - **AVC**
  - **Ischémie moelle épinière**
  - **Relié à l'accès**
  - **Relié au contraste**
  - **Endofuite, migration, rupture**



Notre cas

AAA

3) EVAR

- **2 accès fémoral percutané**

Notre cas

AAA

3) EVAR

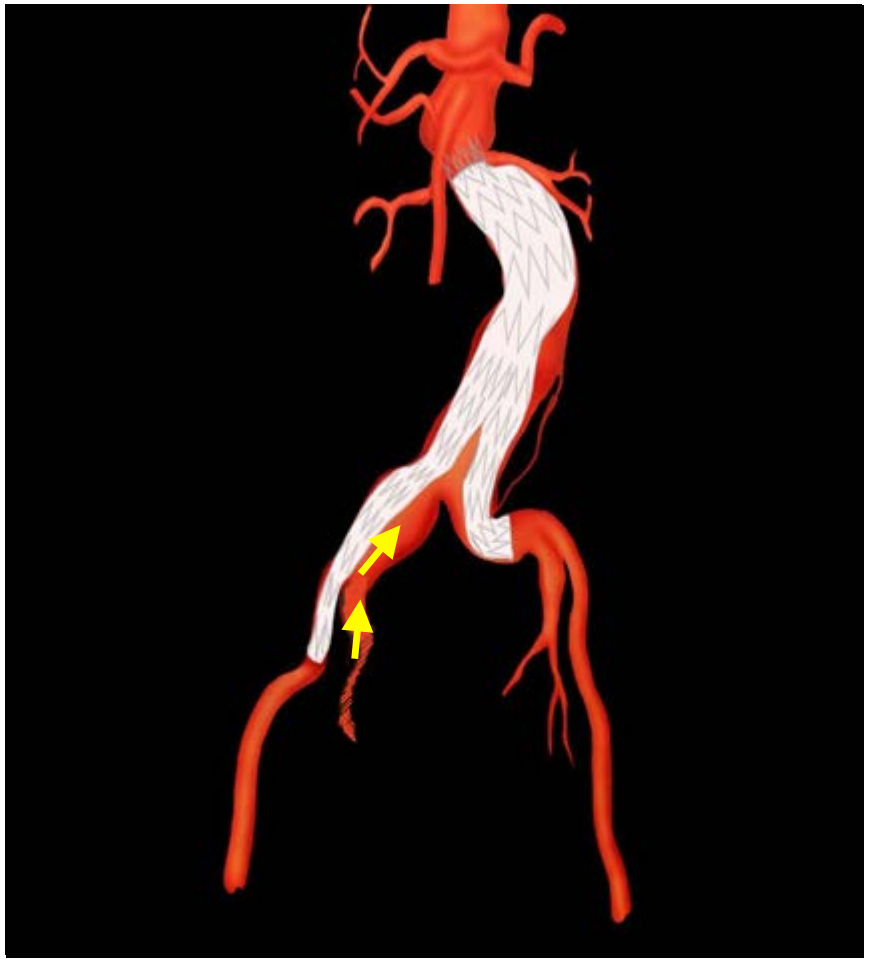
- **Zone d'étanchéité distale (droite)**

Notre cas

AAA

3) EVAR

- **Zone d'étanchéité distale (droite)**

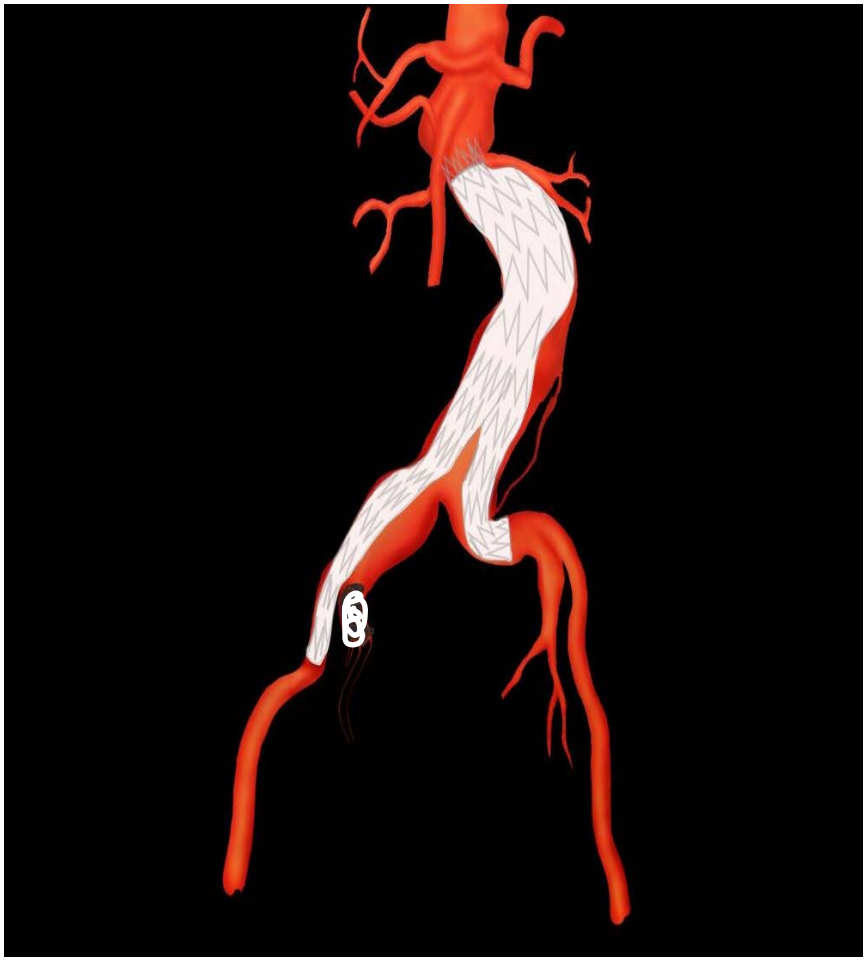


Notre cas

AAA

3) EVAR

- **Embolisation artère iliaque int. D**



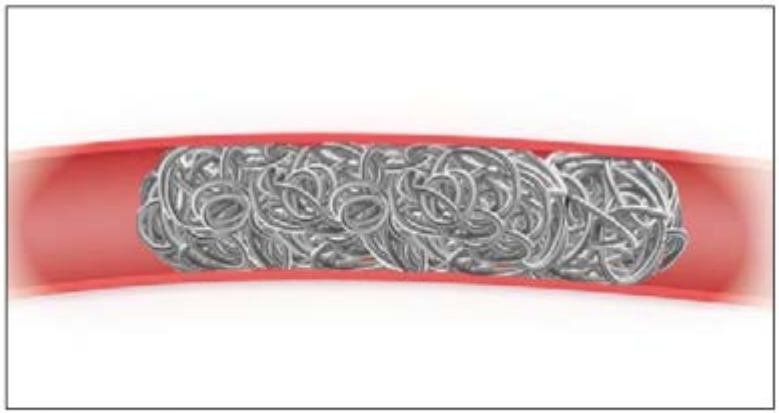


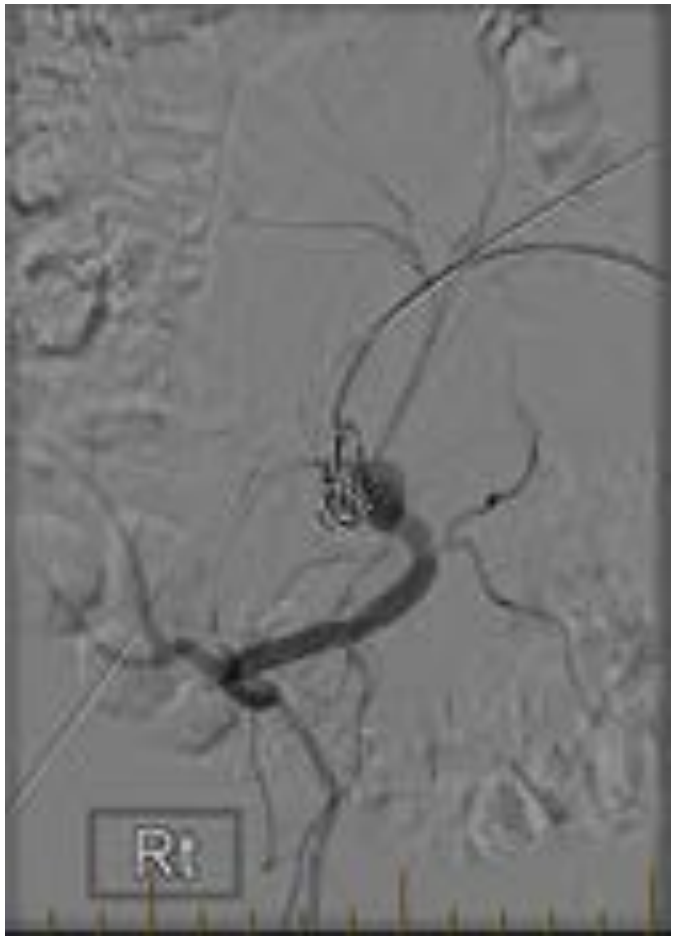
Figure 3. Tight coil packing.

Notre cas

AAA

3) EVAR

- **Embolisation artère iliaque int. D**

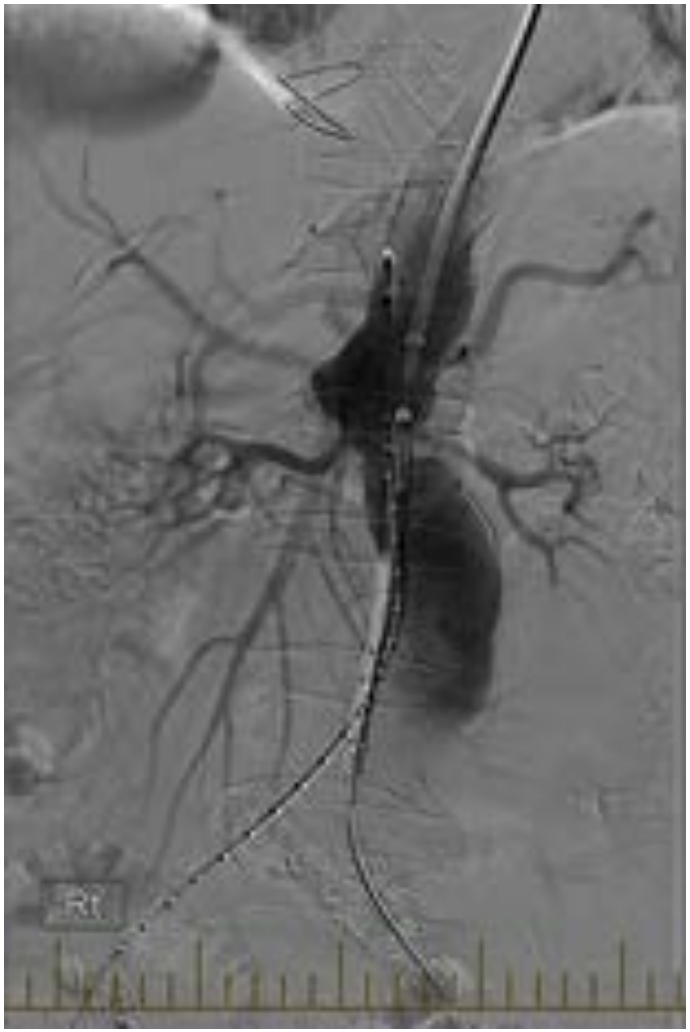


Notre cas

AAA

3) EVAR

- **Aortographie**

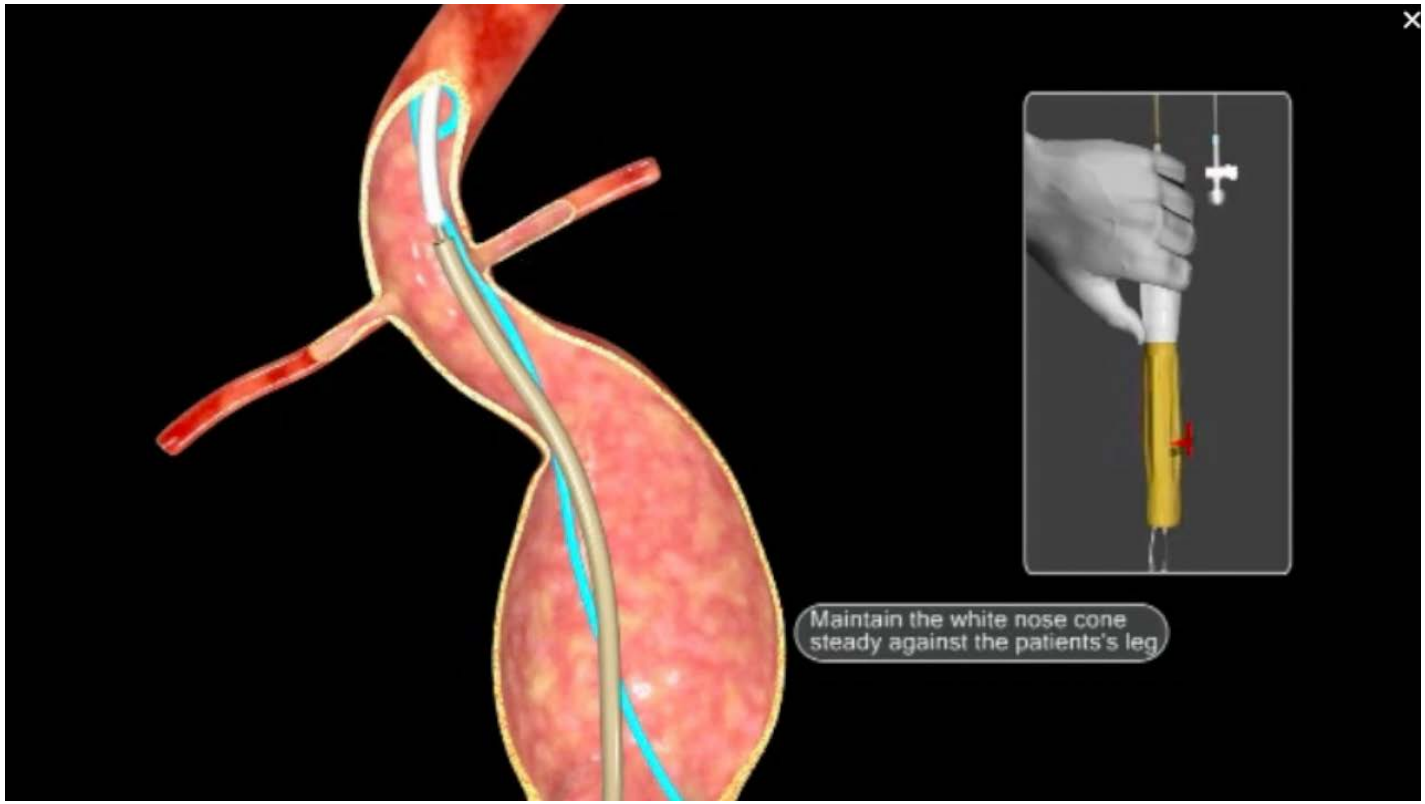


Notre cas

AAA

3) EVAR

INCRAFT® AAA Stent Graft System



Notre cas

AAA

3) EVAR

- Pas d'endofuite
- Perte sanguine: 250cc
- Contraste: 65cc

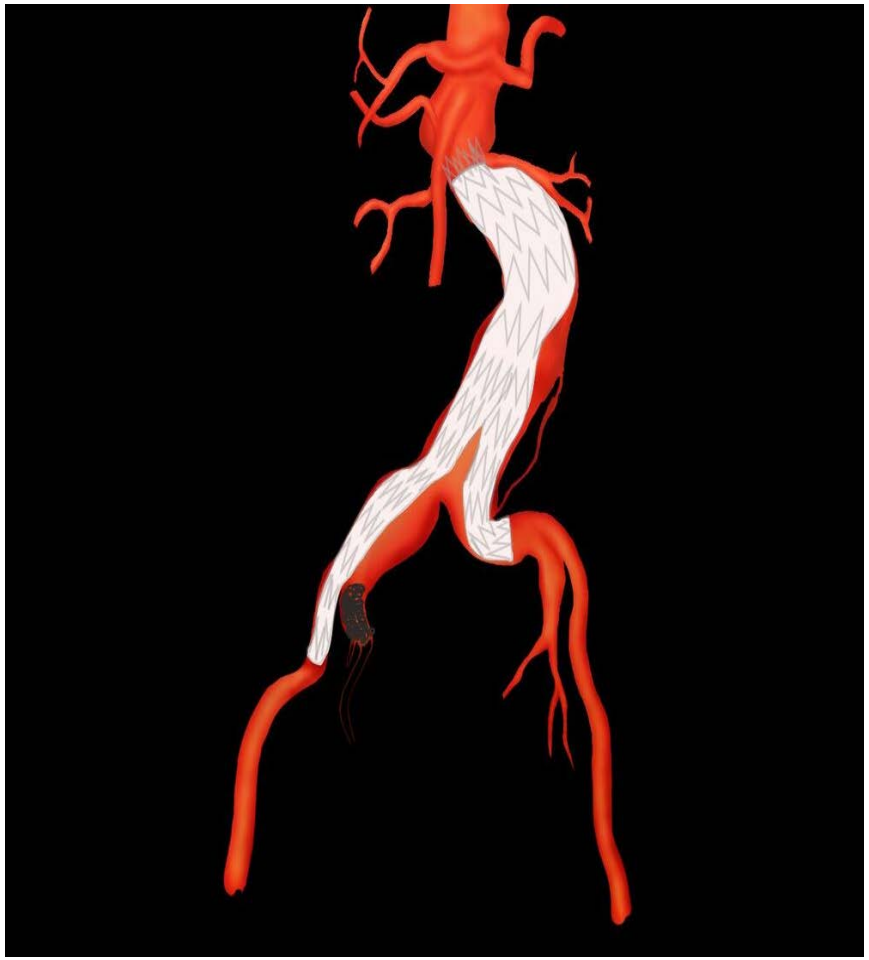
- **Départ le lendemain**

Notre cas

AAA

3) EVAR

- **COMPLICATIONS POTENTIELLES**
  - **AVC**
  - **Ischémie moelle épinière**
  - **Relié à l'accès**
  - **Relié au contraste**
  - **Endofuite, migration, rupture**



Notre cas

VISITE DE SUIVI

Table 3 – Recommended Imaging Schedule for Endograft Patients

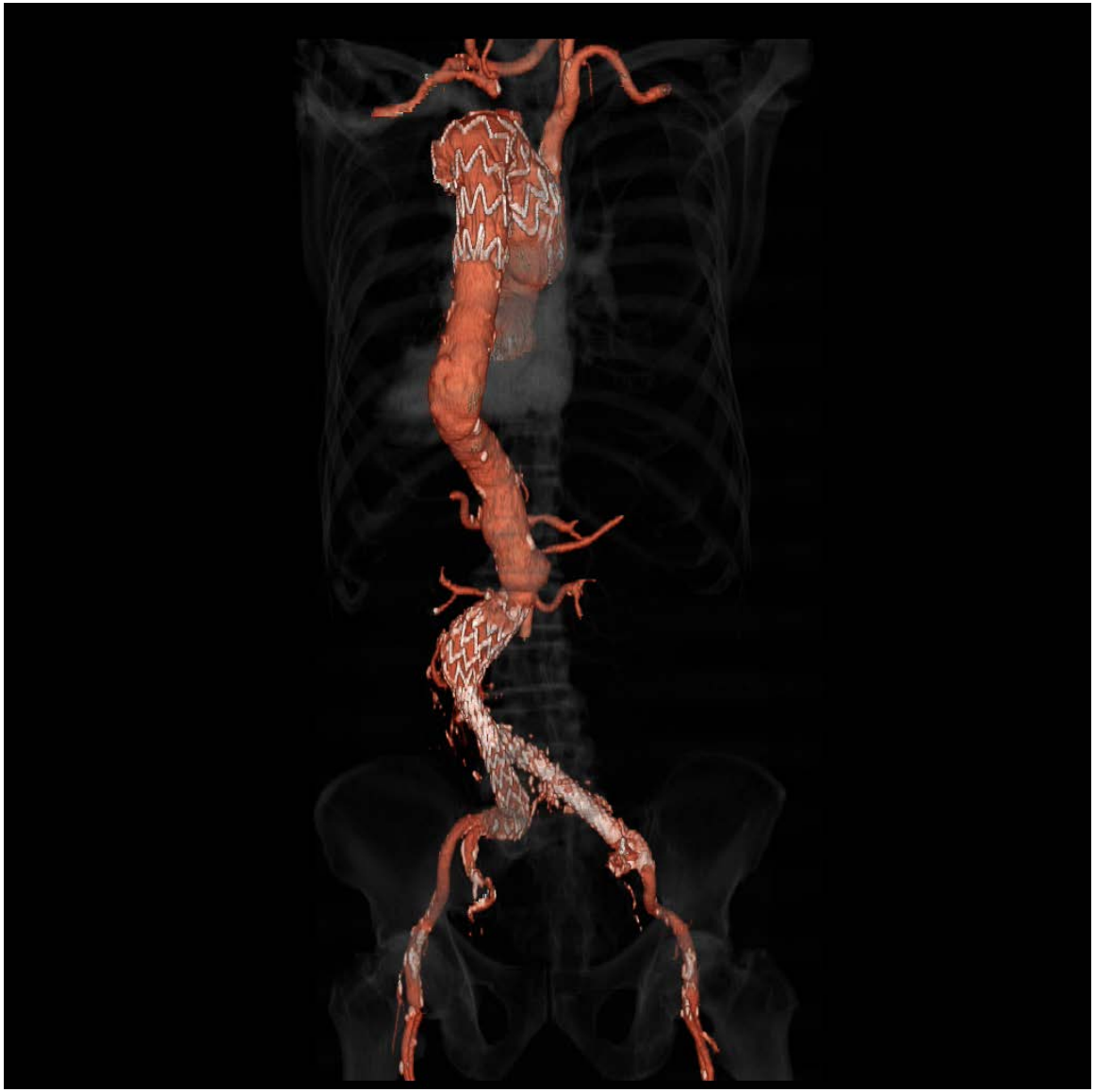
	Angiogram	CT (contrast and non-contrast)	Thoracic Device Radiographs
Pre-procedure		X[1]	
Procedural	X		
1 month		X[2]	X
6 month		X[2]	X
12 month (annually thereafter)		X[2]	X

[1] Imaging should be performed within 6 months before the procedure.

[2] MR imaging may be used for those patients experiencing renal failure or who are otherwise unable to undergo contrast-enhanced CT, with transesophageal echocardiography being an additional option in the event of suboptimal MR imaging. For Type I or III endoleak, prompt intervention and additional follow-up post-intervention is recommended. See **Section 12.5, Additional Surveillance and Treatment.**

https://www.cookmedical.com/aortic-intervention/

Notre cas



CONCLUSION

Conclusion

-Programme de dépistage AAA

-Chercher les anévrismes concomitants

-Stratégie de traitement hybride et séquentiel

Remerciements

DR. OREN STEINMETZ, MUHC

DR. KIATTISAK HONGKU, MALMÖ, SWEDEN

Merci

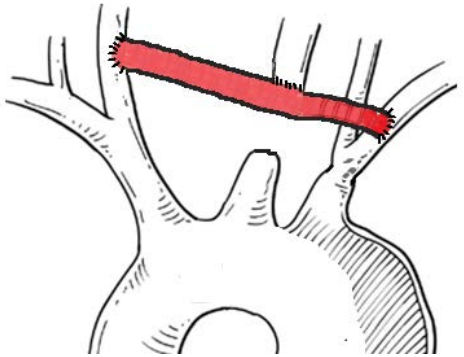
Questions?

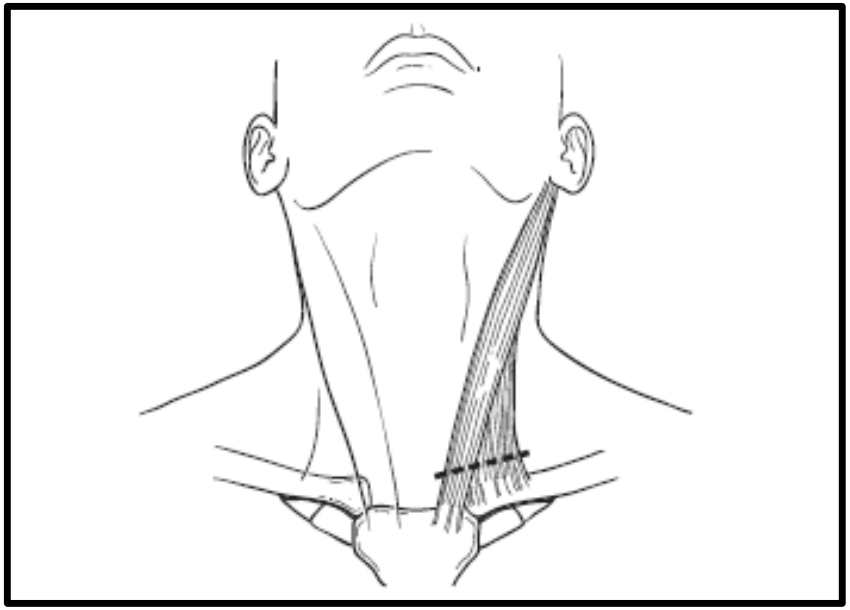

MAQUET
PHILIPS

Notre cas

CROSSE

1) DEBRANCHING





Notre cas

CROSSE

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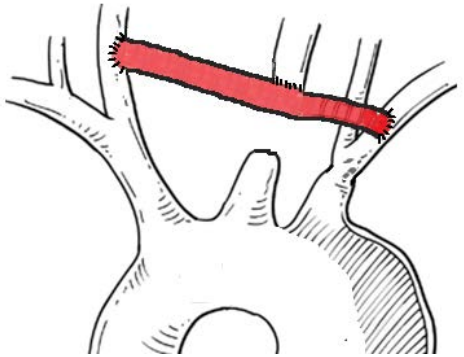

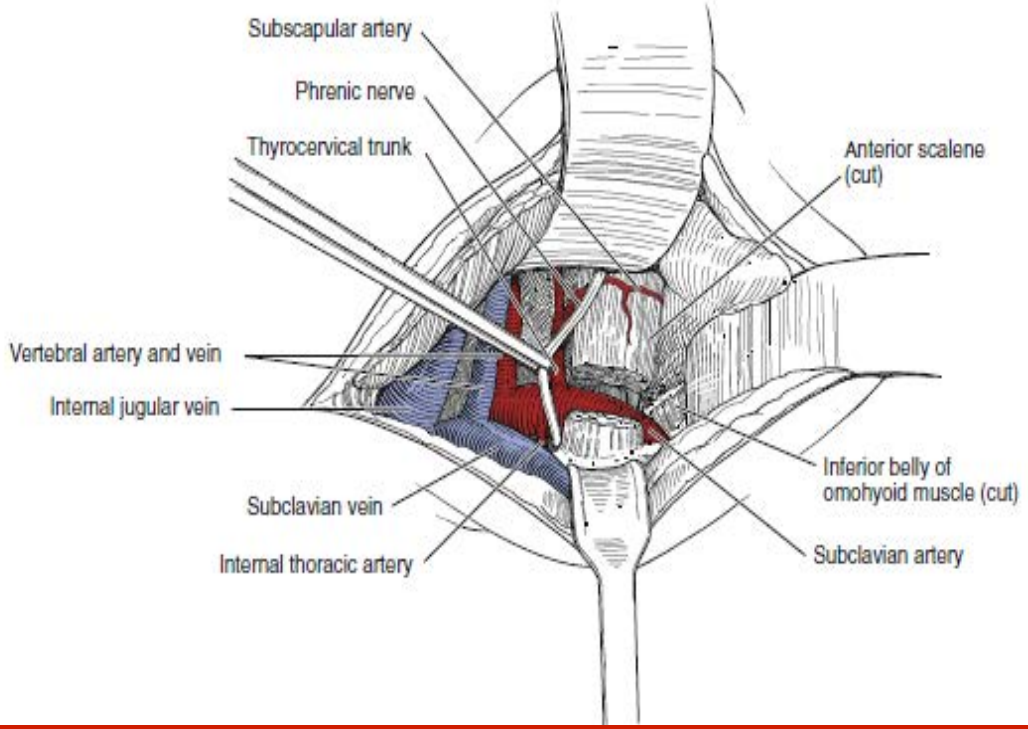

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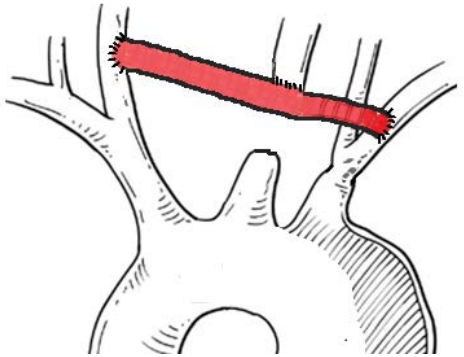

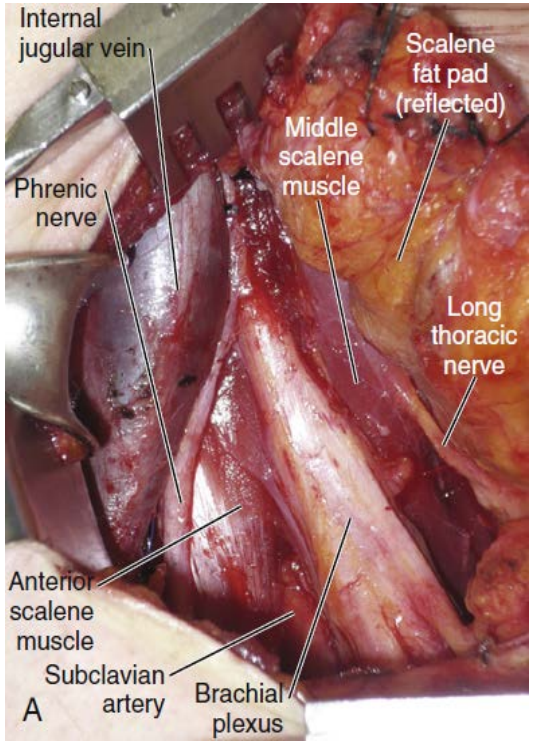

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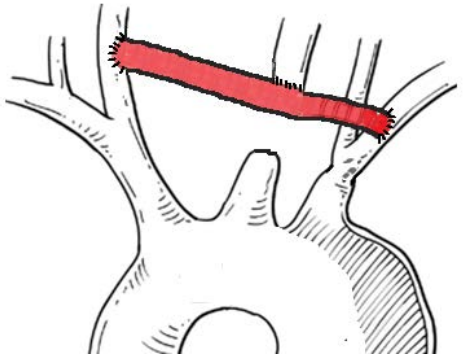

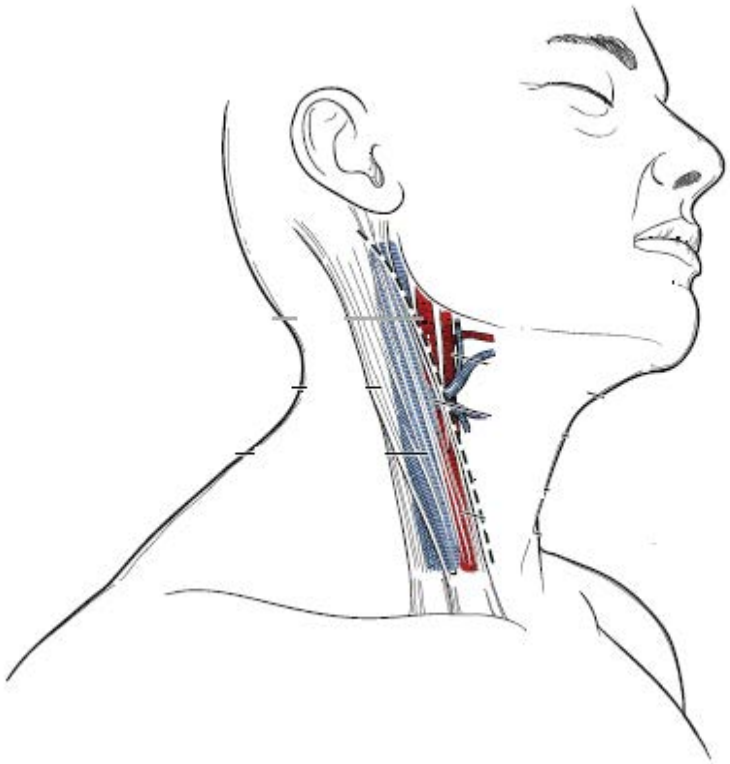

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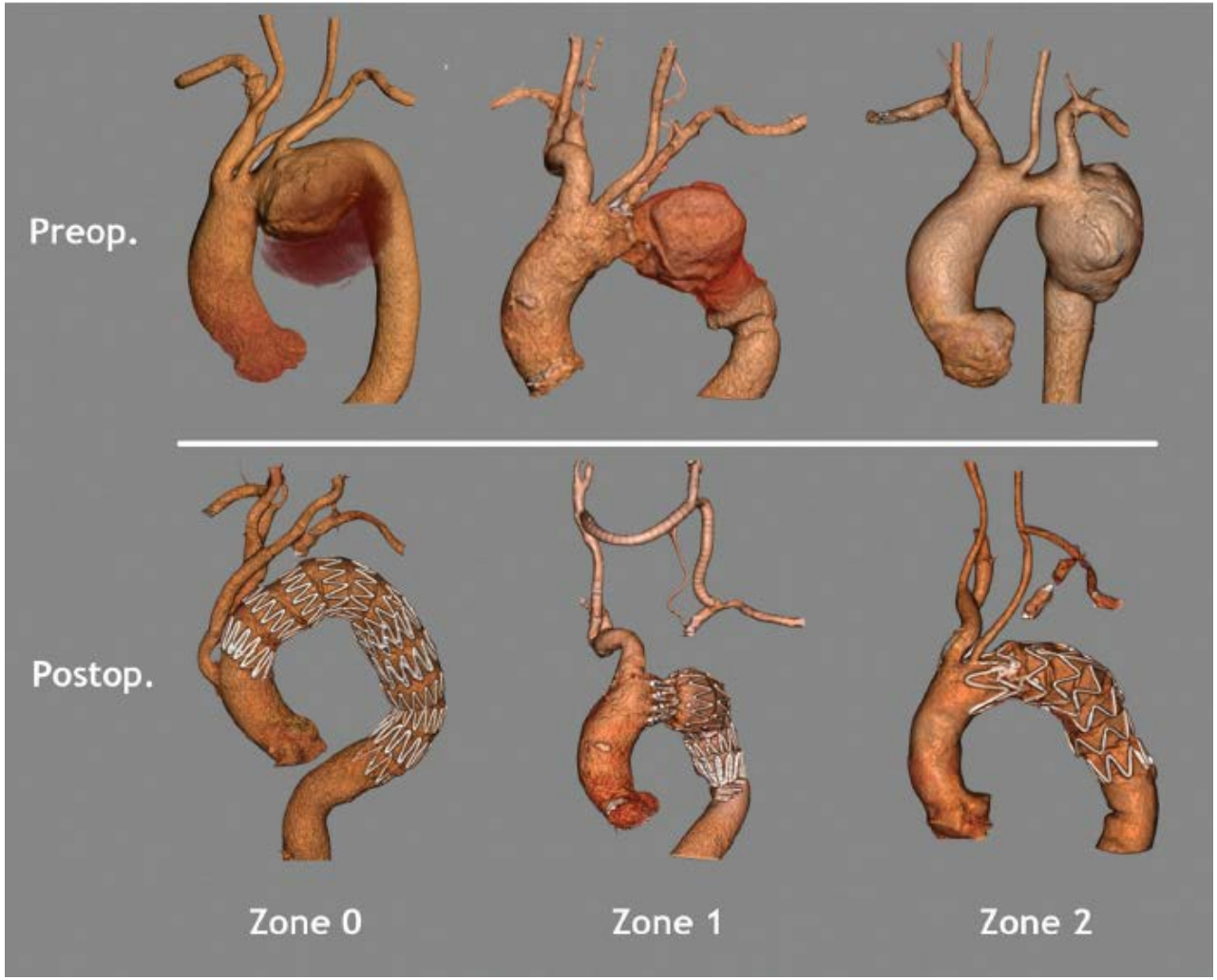
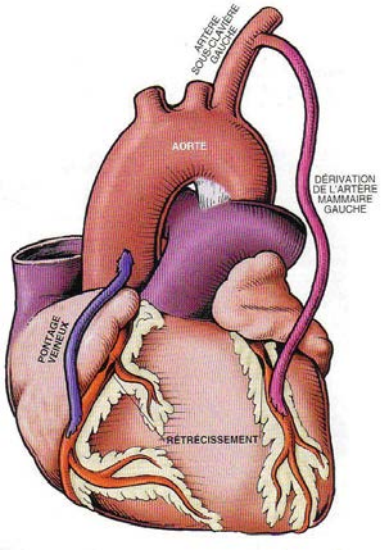


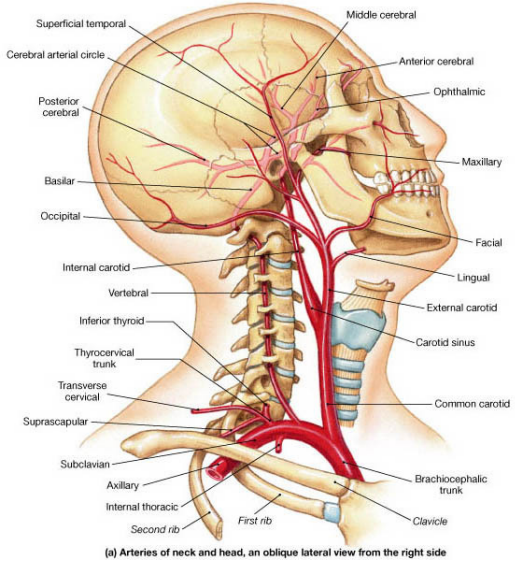
Notre cas

CROSSE

1) DEBRANCHING

Art. Sous-Clavière. G

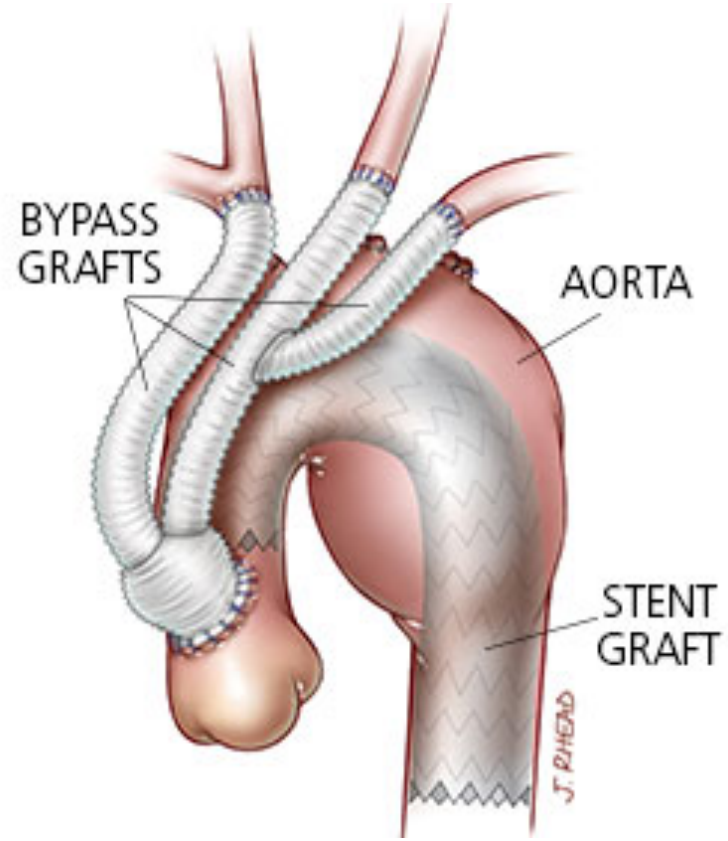




(a) Arteries of neck and head, an oblique lateral view from the right side

Options chirurgicales

Concept hybride



Notre cas

AAA

3) EVAR

Notre cas

AAA

3) EVAR - IFU

COLLET PROXIMAL

-**Diamètre :** 18-32 mm

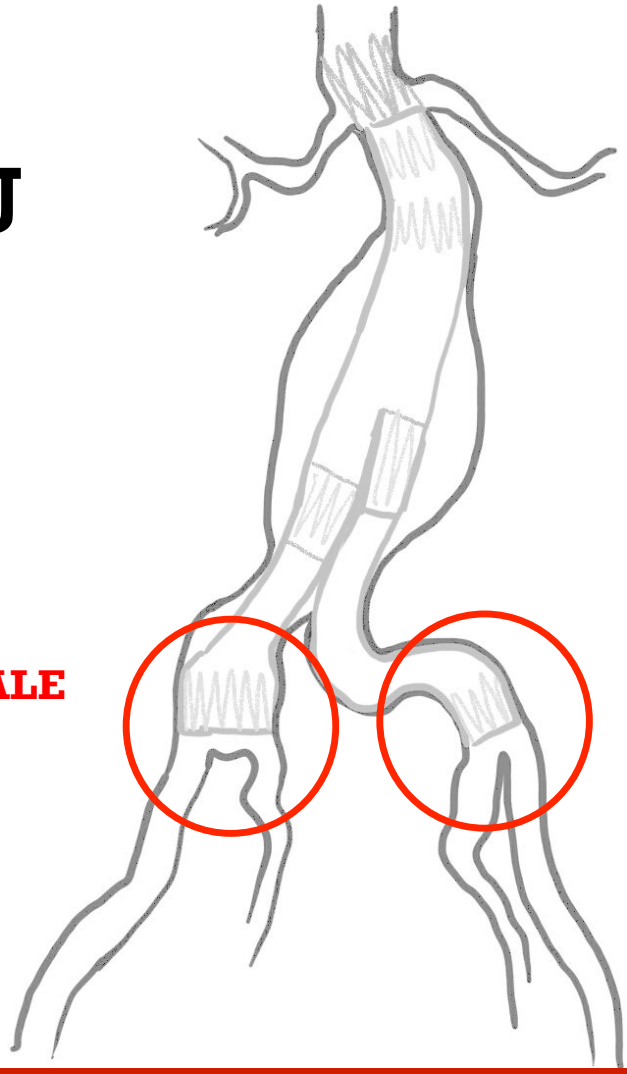
-**Longueur :** ≥ 10 à 15 mm

-**Angulation :** AIR ≤ 60

Notre cas

AAA

3) EVAR - IFU



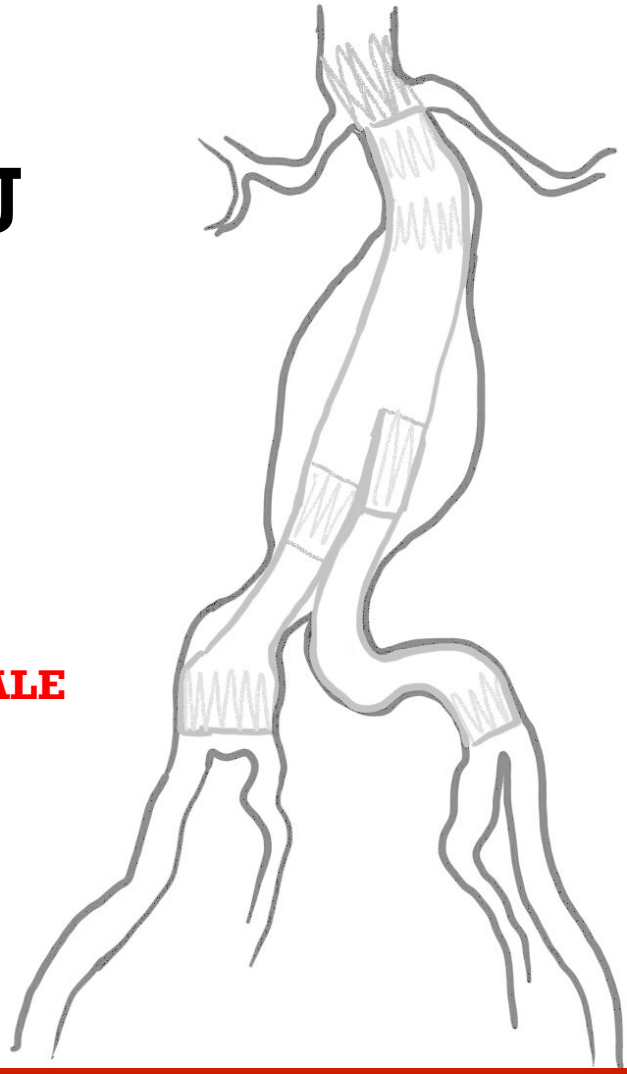
COLLET PROXIMAL
-**Diamètre :** 18-32 mm
-**Longueur :** ≥ 10 à 15 mm
-**Angulation :** AIR ≤ 60

ZONE D'ÉTANCHÉITÉ DISTALE
-**Diamètre :** 8-22 (24+) mm
-**Longueur :** >10 mm

Notre cas

AAA

3) EVAR - IFU



COLLET PROXIMAL
-Diamètre : 18-32 mm
-Longueur : ≥ 10 à 15 mm
-Angulation : AIR ≤ 60

ZONE D'ÉTANCHÉITÉ DISTALE
-Diamètre : 8-22 (24+) mm
-Longueur : >10 mm

ACCÈS (AIE)
-Diamètre : ≥ 8mm

Options chirurgicales

ENDOVASCULAIRE vs OUVERT

Moins de mortalités/morbidités péri-op

Cependant:

-Suivi radiologique nécessaire (irradiation + contraste)

-Complications: Endofuite, migration, rupture

-Réinterventions

-Dispendieux

EVAR vs Open AAA

	EVAR (%)	OPEN AAA(%)
Peri-op Mortality	1.2	4.8
Late survival (at 3yrs)	IDEM	IDEM
At 4 yrs: RUPTURE	1.8	0.5
RE-interventions	9.0	1.7
SBO	4.1	9.7
Abdo wall HERNIA	8.1	14.2

EVAR vs OPEN AAA

Lancet. 2016 Nov 12;388(10058):2366-2374. doi: 10.1016/S0140-6736(16)31135-7. Epub 2016 Oct 12.

Endovascular versus open repair of abdominal aortic aneurysm in 15-years' follow-up of the UK endovascular aneurysm repair trial 1 (EVAR trial 1): a randomised controlled trial.

Patel R[1], Sweeting MJ[2], Powell JT[1], Greenhalgh RM[3]; EVAR trial investigators.

Author information

Abstract

BACKGROUND:

Short-term survival benefits of endovascular aneurysm repair (EVAR) versus open repair of intact abdominal aortic aneurysms have been shown in randomised trials, but this early survival benefit is lost after a few years. We investigated whether EVAR had a long-term survival benefit compared with open repair.

METHODS:

We used data from the EVAR randomised controlled trial (EVAR trial 1), which enrolled 1252 patients from 37 centres in the UK between Sept 1, 1999, and Aug 31, 2004. Patients had to be aged 60 years or older, have aneurysms of at least 5·5 cm in diameter, and deemed suitable and fit for either EVAR or open repair. Eligible patients were randomly assigned (1:1) using computer-generated sequences of randomly permuted blocks stratified by centre to receive either EVAR (n=626) or open repair (n=626). Patients and treating clinicians were aware of group assignments, no masking was used. The primary analysis compared total and aneurysm-related deaths in groups until mid-2015 in the intention-to-treat population. This trial is registered at ISRCTN (ISRCTN55703451).

FINDINGS:

We recruited 1252 patients between Sept 1, 1999, and Aug 31, 2004. 25 patients (four for mortality outcome) were lost to follow-up by June 30, 2015. Over a mean of 12·7 years (SD 1·5; maximum 15·8 years) of follow-up, we recorded 9·3 deaths per 100 person-years in the EVAR group and 8·9 deaths per 100 person-years in the open-repair group (adjusted hazard ratio [HR] 1·11, 95% CI 0·97-1·27, p=0·14). **At 0-6 months after randomisation, patients in the EVAR group had a lower mortality** (adjusted HR 0·61, 95% CI 0·37-1·02 for total mortality; and 0·47, 0·23-0·93 for aneurysm-related mortality, p=0·031), but beyond 8 years of follow-up open-repair had a significantly lower mortality (adjusted HR 1·25, 95% CI 1·00-1·56, p=0·048 for total mortality; and 5·82, 1·64-20·65, p=0·0064 for aneurysm-related mortality). **The increased aneurysm-related mortality in the EVAR group after 8 years was mainly attributable to secondary aneurysm sac rupture (13 deaths [7%] in EVAR vs two [1%] in open repair), with increased cancer mortality also observed in the EVAR group.**

INTERPRETATION:

EVAR has an early survival benefit but an inferior late survival compared with open repair, which needs to be addressed by lifelong surveillance of EVAR and re-intervention if necessary.

FUNDING:

UK National Institute for Health Research, Camelia Botnar Arterial Research Foundation.

EVAR vs OPEN AAA

Three principal randomised controlled trials for abdominal aortic aneurysm have shown marked benefits of (EVAR) for 30-day mortality, but total mortality benefit was lost in these trials after 2 years (EVAR trial 1), 1–2 years (DREAM), and 5 years (OVER; catch-up of mortality).

AAA entre 4.1 et 5.5cm

SMALL AAA: Impact of EVAR?

-EVAR = much lower operative mortality [?] Alteration of Risk benefit balance of operating small AAA (compare to AAA)

-2 randomised trials address this: CAESAR and PIVOTAL

Comparison of Surveillance Versus Aortic Endografting for Small Aneurysm Repair (CAESAR): 2004-2008

-360 pts with AAA 4.1-5.4 [?] **immediate EVAR**

-Surveillance group (wait before OR for AAA >5.5, growth rate > 1cm/yr, Sx)

-Perioperative mortality 0.55%

-**No difference in all-cause mortality or Aneurysm related mortality** (EVAR:*14.5%* vs Surveillance:*10.1%*)

American Positive Impact of Endovascular Options for Treating Aneurysms Early (PIVOTAL):

-326pts early EVAR, age:40-90, 2yrs of F/U

-Surveillance group (wait before OR reached 5.5cm, **0.5cm/6month**, Sx)

-Perioperative mortality of early EVAR: **0.6%**

-Conclusion: longer term data were required to confirm that early EVAR conferred **no benefit** compared with Surveillance

-For **anxious pt** with small AAA, **EVAR** is a safe option

Options chirurgicales

Endovascular treatment has become the new standard for infrarenal aortic aneurysm repair. Better knowledge of natural history of aortic disease, improved imaging technology, evolving stent-graft technology as well as lessons learnt from more than twenty years of EVAR, have made the endovascular approach feasible to the diseases of the whole aorta. The aortic arch is a challenging area due to its complex anatomy and the proximity of critical supra-aortic trunk vessels. Although conventional open repair is still the standard treatment in this area, its invasiveness and negative consequences such as inflammatory response from heart-lung machine, blood transfusion and, more importantly, neurological complications, has opened the avenue for other, less invasive, endovascular therapies. This manuscript aims to provide an overview of endovascular techniques involving aortic arch.

Hybrid arch repair

Hybrid repair potentially offers a limited operative insult combining less invasive surgical procedures with endovascular repair. It combines thoracic stent-graft (TEVAR) placement proximal to zone 3 [1] with surgical great vessel revascularization procedures extending the proximal seal zone for TEVAR.

Hybrid repair can be classified into two main categories, hybrid arch repair (intrathoracic procedures) and extra-anatomic cervical debranching (extrathoracic bypass).

Hybrid arch repair

— Type I arch repair involves prosthetic bypass (-es) from native ascending aorta to supra-aortic trunk ves-

Options chirurgicales

sels. The ascending aorta must be healthy and leave enough length above the proximal bypass graft anastomoses site for the stent-graft proximal landing zone. A limited exposure of the left subclavian artery (LSA) can be achieved via a median sternotomy or can be revascularized with a left carotid-subclavian artery bypass or LSA transposition prior to aortic debranching;[2]

— type II arch repair is indicated in presence of concomitant ascending aortic pathologies. This provides a new zone 0 landing zone with an ascending aortic prosthetic graft. It requires healthy aortic tissue proximal to the innominate artery to allow construction of a distal anastomosis. The brachiocephalic bypass graft is constructed as a type I repair but based of the ascending aortic prosthetic graft. The main technical challenge is to assure that the remaining ascending prosthesis graft (distal to the bypass graft origins) is long enough to provide a proximal seal zone for the stent-graft and that the distal anastomosis does not create an acute angle between the prosthetic graft and the native transverse arch which might compromise an ideal stent-graft seal. Alternatively, the technique can be modified using a stented elephant trunk extending across the aortic arch;

— type III arch repair is a classic elephant trunk repair which replaces the ascending aorta and aortic arch. Frozen (stented) elephant trunk is an alternative to conventional elephant trunk and offers the benefit of improving the landing zone for a second stage TEVAR. A hybrid stent-graft provides the same benefit while facilitating the first stage procedure with a prefabricated stent-graft. Frozen elephant trunk procedures were previously associated with higher paraplegia rates,[3] but this was multifactorial. One analysis[4] identified deep insertion of stent-graft below the T9 level, low blood pressure (mean arterial pressure <70 mmHg), and diabetes as risk factors to develop spinal cord ischemia with an odds ratio of 15.1, 11.4 and 9.6 respectively.

These three types of repairs have increasing degrees of invasiveness, where type I does not require extra corporeal circulation, while type III usually requires deep hypothermia.

Options chirurgicales

Cervical debranching or extrathoracic bypass

These procedures include extra-anatomic bypasses between supra-aortic trunk vessels using inflow from non aortic vessels. The most common type of cervical debranching is left common carotid artery (LCCA) to left subclavian artery (LSA) bypass that might be performed independently for zone 2 repair or in combination with other revascularization procedures both open and endovascular for zone 0 and zone 1 repairs. Besides bypass, transposition of the LSA to LCCA is often used, but it requires more extensive dissection to expose the proximal LSA and vertebral artery. For LCCA revascularization, carotid-carotid bypass can be tunneled subcutaneously tissue or retropharyngeally.

Outcomes of hybrid repairs

Hybrid repair outcomes are inhomogeneous and quite varied depending on the indication for aortic repair and the definition of hybrid repair included in the analysis. A meta-analysis [5] of relatively early data showed an average 8.3% 30-day mortality, 4.4% stroke rate, 3.9% paraplegia and 9.2% endoleaks. More recently published data [6-12] reported approximately 6-7%, 6.0%, and 3.5% for 30-day mortality, stroke and paraplegia rates respectively. Compared to the results of open repair,[13] the early mortality, stroke rate and paraplegia rate were 9.3%, 5.7% and 2.0% for total transverse arch repair, and 8.9%, 6.2% and 0.4% in mixed total transverse and hemiarch repairs.

In conclusion, hybrid repair offers an alternative strategy for aortic arch repair that limits the extent of open surgery by combining limited revascularization with less-invasive TEVAR. Despite this, morbidity and mortality are not negligible often comparable to standard open arch procedures and should be considered carefully in select patients at high risk.

Options chirurgicales

Introduction

The treatment of aortic arch aneurysms remains challenging (1-6). The intraoperative and the postoperative care of these patients can be quite complex, as circulatory management strategies and optimization of neurologic outcomes has to be carefully planned. Although open operative techniques have been performed with improving results over the last two decades (6), neurologic and cardiovascular complications remain significant causes of morbidity and mortality (4,5). This is especially true in patients who are at prohibitively high risk for conventional repair—such as those with older age and a high comorbidity index (5). The introduction of thoracic aortic endovascular stent grafting (TEVAR) has provided alternative surgical options in patients with complex aortic arch aneurysms, especially in the high risk population (5). Combining conventional surgical techniques with endovascular technology, the "hybrid" aortic arch repair minimizes the operation by either eliminating or significantly simplifying and shortening the arch reconstruction period, thus limiting the duration of circulatory arrest and cerebral ischemia (7-9). The arch hybrid concept entails two main principles: (I) efficient debranching of the great vessels to minimize cardiopulmonary bypass, aortic cross clamp, and circulatory arrest times, and; (II) creation of optimal proximal and distal landing zones (LZ) for TEVAR. The TEVAR component of the operation can be performed concomitantly with the open procedure, or at a later time as a retrograde approach. The hybrid arch repair is especially appealing in older patients with significant comorbidities who may not tolerate prolonged cross clamp and circulatory arrest times.

Based on the aortic arch anatomy, the required hybrid arch operative technique may vary. Therefore, hybrid arch

Options chirurgicales

repairs are classified into three major types, I, II and III (1-3). Construction of the required LZ for TEVAR is more extensive in type I versus II versus III. Similarly, the circulation management strategy for each type can also be increasingly complex. This report focuses on the surgical treatment options for type II aortic arch hybrid repair, where the aortic anatomy is such that the arch and ascending aorta are aneurysmal, but the descending thoracic aorta is normal. Therefore, the type II arch hybrid repair constitutes reconstruction of ascending aorta (proximal LZ for TEVAR) along with great vessel debranching, followed by antegrade or retrograde TEVAR.

The concept of arch hybrid repair for aortic arch aneurysms has been recently extended by our group for the management of complex DeBakey I aortic dissection (10). In aortic dissection patients with malperfusion syndromes, pseudocoarctation of the true lumen, or the existence of a dynamic flap, we consider the type II arch hybrid repair approach for the treatment of the aortic dissection–standard type A dissection repair with creation of a proximal LZ via a transverse hemiarch or total arch reconstruction, followed by concomitant antegrade stent grafting of the descending thoracic aorta for establishment/stabilization of true lumen flow.

Preoperative considerations

In addition to the standard work-up for open heart surgery, patients being considered for arch hybrid repair should undergo evaluation for endovascular stent grafting. This includes computed tomography angiogram (CTA) of the chest, abdomen, and pelvis, along with a programming modality to obtain three dimensional reconstruction of the entire aorta and the bilateral iliac arteries. At our institution, M2S (M2S, New Hampshire) reconstruction of the aorta is performed for all arch hybrid cases. Understanding the proximal and distal landing zones, and the ileofemoral access, is critical. There should be at least 2 cm of landing zone available both proximally and distally in order to achieve a good seal. Of note, over-extensive distal landing is not advised as it increases risk for spinal cord ischemia. In patients with previous abdominal aortic aneurysm repair, or those with long distal thoracic landing zones, spinal cord ischemia protective strategies are highly recommended. Techniques include intraoperative neuromonitoring and cerebrospinal fluid management using lumbar drain. Sensory or motor evoked potentials should be carefully monitored in the operating room. The operative plan has to be coordinated with the anesthesia and perfusion teams. These cases should be performed in hybrid operating rooms with sophisticated fixed imaging.

Options chirurgicales

Operative techniques

Proximal landing zones for TEVAR and the hybrid arch repair classification scheme

The classification scheme enables evaluation of the extent of proximal and distal LZ reconstruction and the appropriate circulatory management strategy for the operation. The hybrid arch concept entails extension of the proximal LZ to zone 0, which necessitates great vessel debranching to preserve cerebral perfusion (*Figure 1*). Typically TEVAR is performed with the proximal stent graft landing in zones (Z) 2 or 3. Z3 landing, which is distal to the left subclavian artery (LSCA) takeoff, is suitable for descending mid-thoracic aneurysmal disease, or some type B aortic dissections. But for proximal descending thoracic aortic aneurysms, Z2 landing, covering the LSCA is required. This may require a left common carotid (LCC) to LSCA bypass. In patients with a dominant left vertebral artery, left upper extremity ischemia, or with left internal mammary artery to left anterior descending artery coronary artery bypass grafting, the LCCA to LSCA bypass is a requirement. In these cases, we perform the bypass 2-4 days before the endovascular stent grafting. The hybrid arch concept is essentially an extension of the TEVAR proximal landing zone scheme, where typically, the stent graft is positioned in Z0.

Aortic arch anatomy and the TEVAR landing zones dictate the type of arch hybrid repair (*Figure 2A*). In the classic, isolated aortic arch aneurysm, there are adequate proximal Z0 and distal Z3/Z4 landing zones, therefore, in a type I arch hybrid, the great vessels are debranched to enable Z0 stent grafting, followed by concomitant antegrade or delayed retrograde TEVAR. For arch aneurysm without a good proximal Z0 LZ, but an adequate Z3/Z4 distal LZ, type II arch hybrid repair is performed (*Figure 2B*). Therefore, the open procedure here involves not only great vessel debranching, but creation of a proximal Z0 LZ by reconstructing the ascending aorta. Thus, type II arch hybrid necessitates a period of circulatory arrest for proximal LZ reconstruction. More complex aortopathies such as mega-aorta syndrome require type III arch hybrid repair (*Figure 2C*). In this case, there is no proximal or distal LZ. Therefore, typically the open surgical reconstruction is more extensive, involving total arch reconstruction with elephant trunk, for concomitant or later TEVAR deployment in the descending thoracic aorta. Given the extent of coverage required for type III repair, placement of lumbar drain is highly recommended for optimization of spinal cord perfusion. This report will focus on the type II arch hybrid repair.

Type II hybrid arch

Classic anatomy mandating a type II hybrid arch approach is shown in *Figure 3*. In its simplest form, hybrid repair for this anatomy entails creation of an optimal Z0 proximal landing zone via ascending aorta replacement, along with great vessel debranching, followed by TEVAR. Therefore, the open surgical component involves great vessel debranching + Z0 reconstruction. The proximal extension may also require aortic root/aortic valve repair/replacement. It is important to note that the ascending aorta need not be aneurysmal to meet surgical trigger for resection; ie it does not have to be >5.5 cm. If the ascending

Options chirurgicales

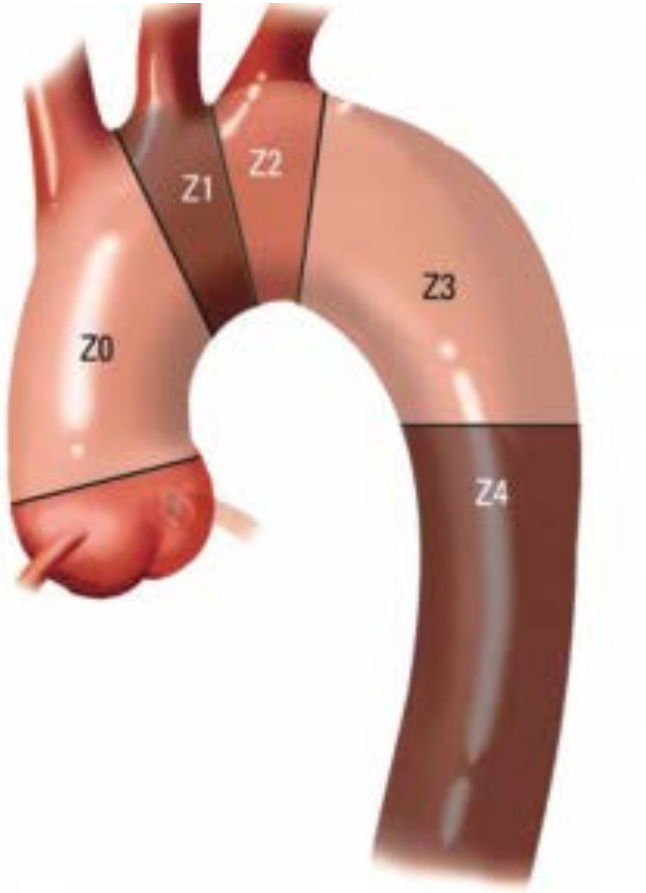


Figure 1 Proximal landing zones (0 to 4)

Options chirurgicales

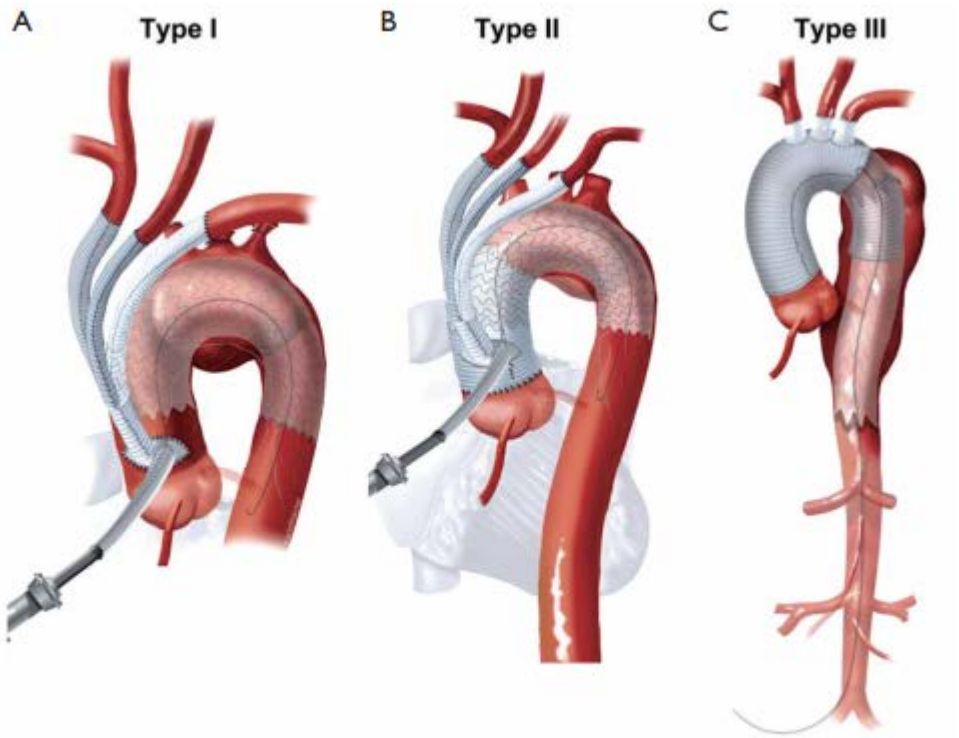


Figure 2 Aortic arch anatomy and the landing zones dictate the type of arch hybrid repair. In a type I arch hybrid, the great vessels are debranched to enable Z0 stent grafting, followed by concomitant antegrade or delayed retrograde TEVAR. For arch aneurysm without a good proximal Z0, but an adequate Z3/Z4 distal landing zone, type II arch hybrid repair is performed involving not only great vessel debranching, but creation of a proximal Z0 by reconstructing the ascending aorta. More complex aortopathies such as mega-aorta syndrome

Options chirurgicales

Historique:

- **Anastomose** (Carel, **1912**)
- 1ere ligature AAA (Matas, 1923)
- 1er **remplacement de l'aorte** avec homogreffe (Dubost, **1951**)
- 1er Tx crosse ouverte (besoin pompe)
- 1st **EVAR** réussi (Parodi, **1991**)
- 1er Tx crosse endovasc