Cathétérisme interventionnel

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Congénitales Complexes M3C

AHA Scientific Statement

Indications for Cardiac Catheterization and Intervention in Pediatric Cardiac Disease

A Scientific Statement From the American Heart Association

Endorsed by the American Academy of Pediatrics and Society for Cardiovascular Angiography and Interventions

Circulation. 2011;123:2607-2652.

Plan du cours

1. CIA
2. CIV
3. Canal artériel
4. Obstacle coeur gauche
5. Obstacle coeur droit

Plan du cours

6. Rashkind et création de CIA

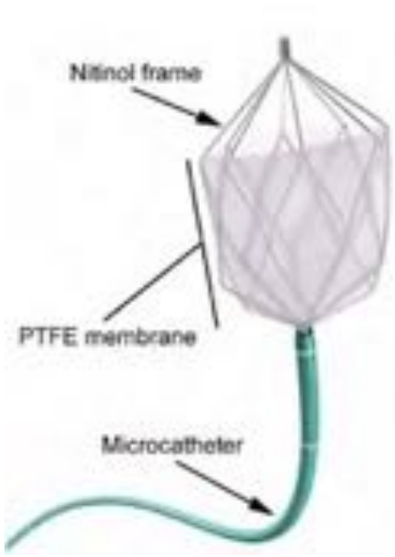
7. Embolisations et fistules coronaires

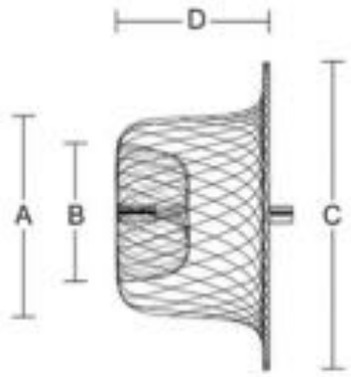
8. Cathétérisme cardiaque et ventricule unique

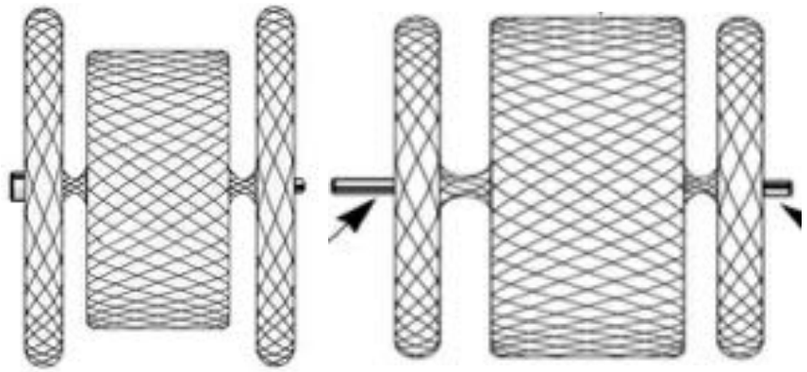
9. Techniques hybrides

10. Un peu de lymphe…

Prothèses d’occlusion







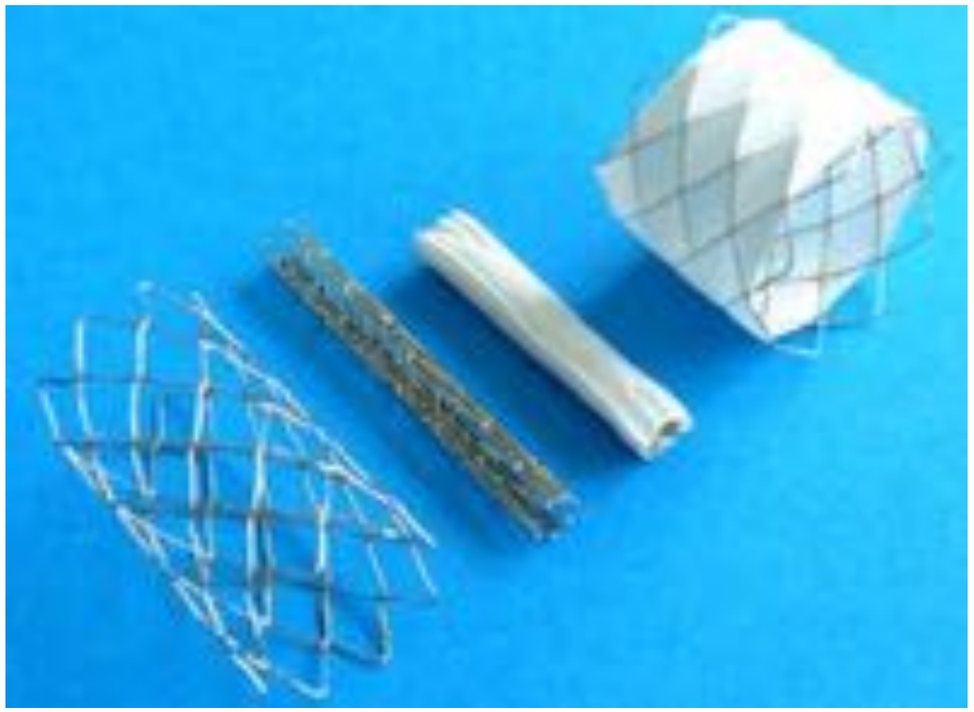
ADO

ADO II AS

AVP

ADO II

Stents



CIA

Fermeture des CIA de l’enfant

Conditions requises:

✓Poids 20 kg, âge 5 ans

✓anatomie de CIA OS

✓Berges sauf berge rétroaortique

✓Prothèse de 4 mm à 40 mm

Procédure:

✓Sous AG

✓Sous ETO

✓Complications: troubles du rythme, embolisation, AVC

✓Suivi, AAS à 6 mois

Physiopatholiogie de la CIA

- Shunt gauche-droite
- Shunt dépend de la compliance des ventricules, se faisant pendant la diastole
- Surcharge volumique du coeur droit
- Réactivité pulmonaire le plus souvent normale

Indications et CI à la fermeture de la CIA

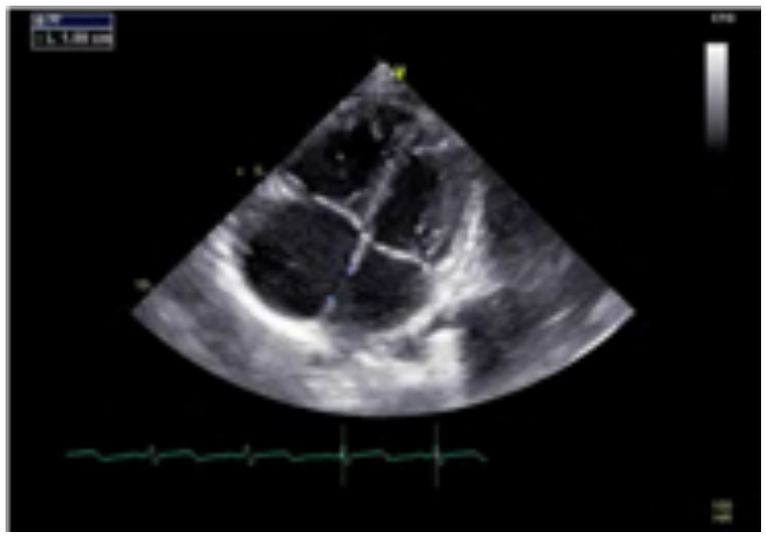
- Si shunt significatif

QP/QS > 1.5

Dilatation du coeur droit

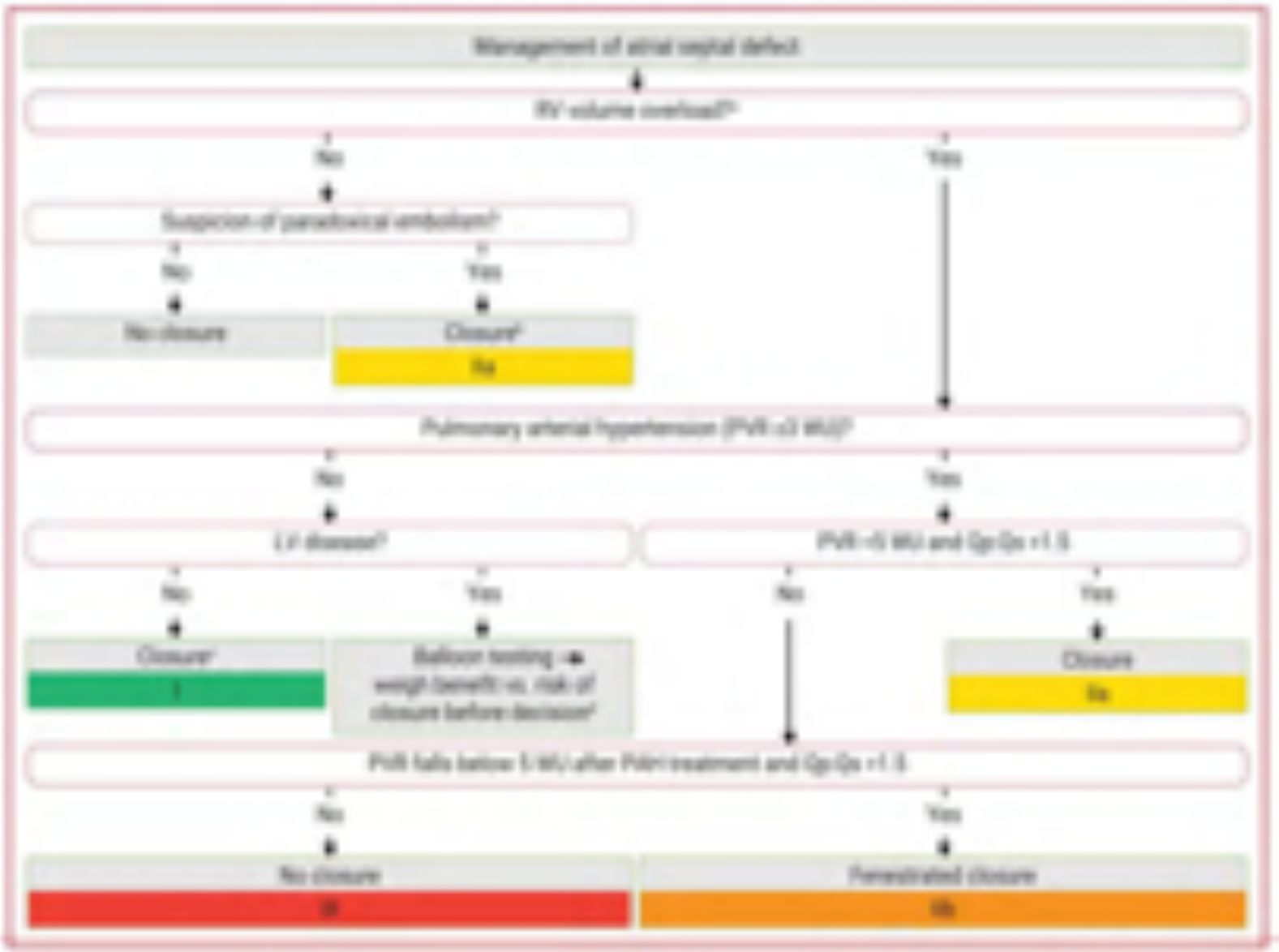
- Embole paradoxal
- CIA >10mm
- RVP < 5UW

CIA à l’âge adulte



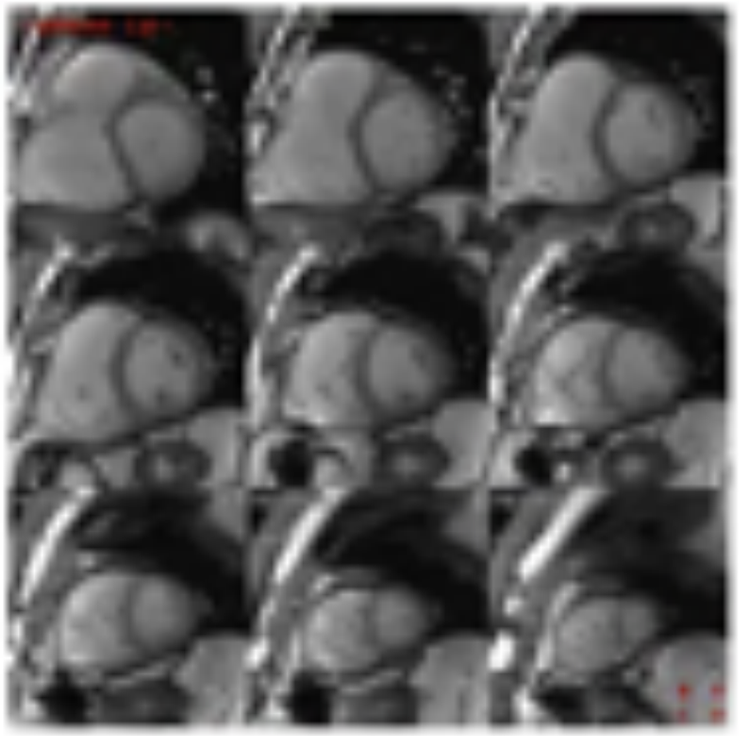
- Coeur droit dilaté

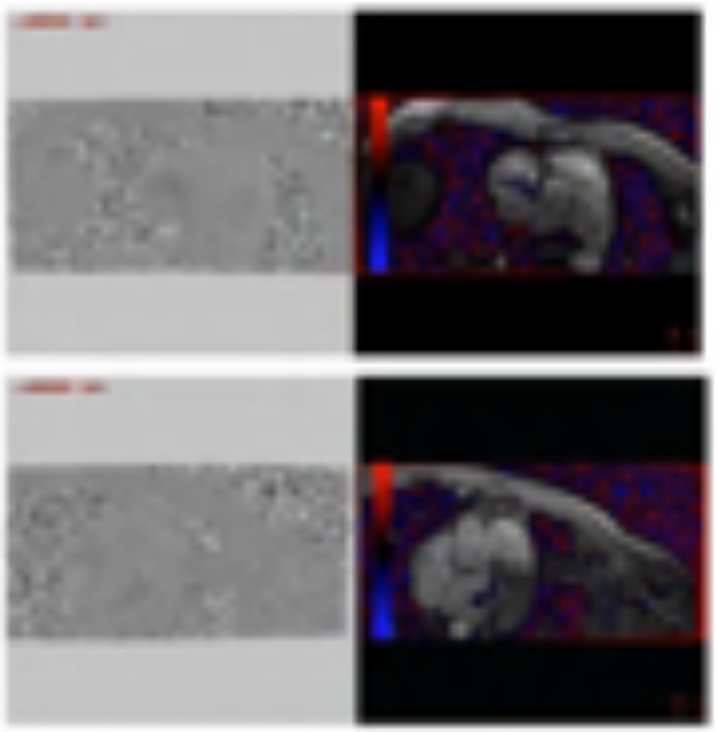
Should I close it?



Baumgartner et al. ESC 202

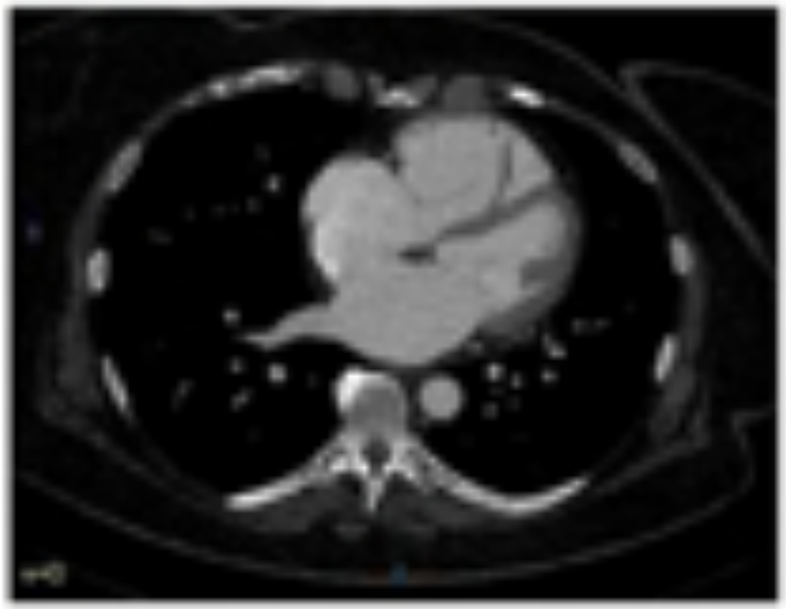
CMR QP/QS





Courtesy Gilles Soulat

Cardiac CT san



Define intracardiac anatomy

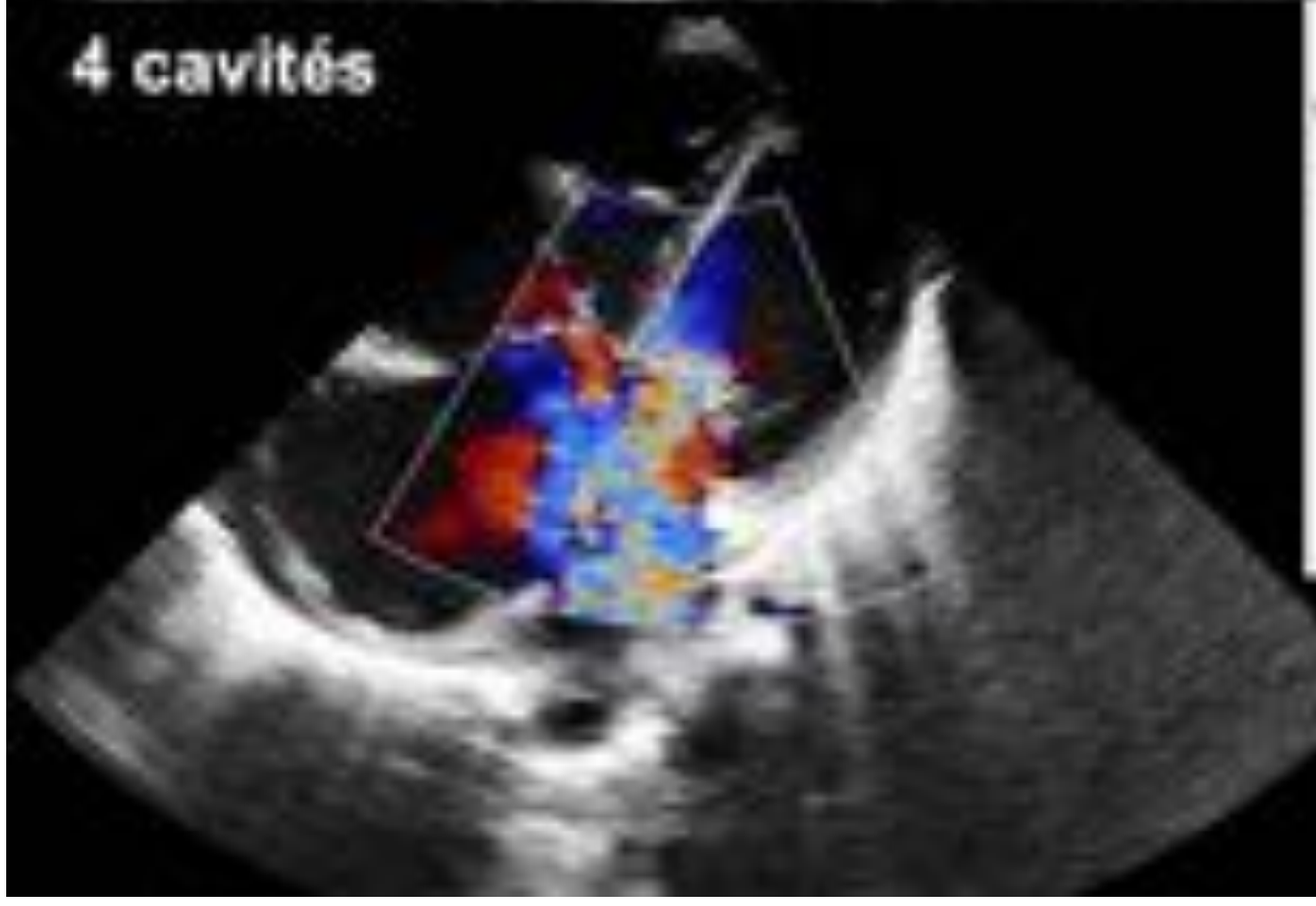
Define Pulmonary veins anatomy

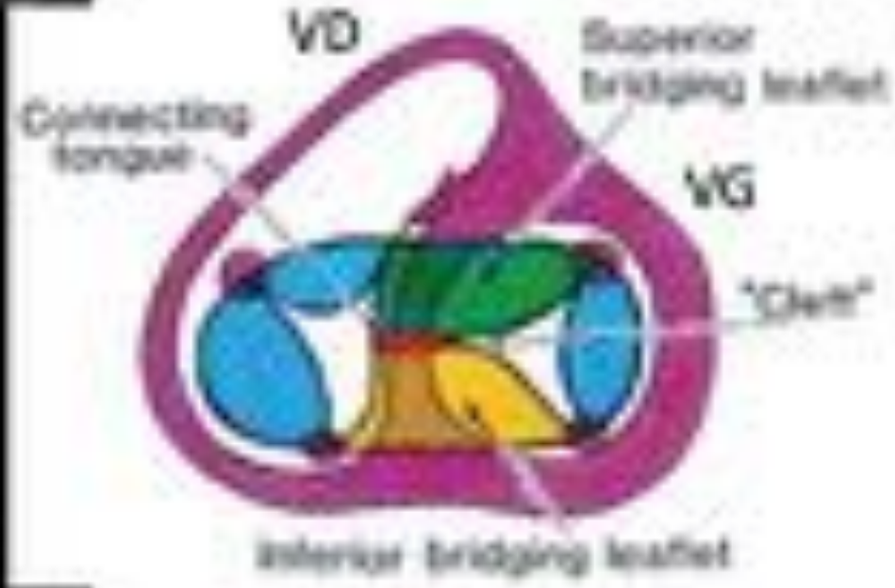
Courtesy Gilles Soulat


VD
VG
OD
OG
CIA ostium secundum
4 cavités

CIA ostium secundum

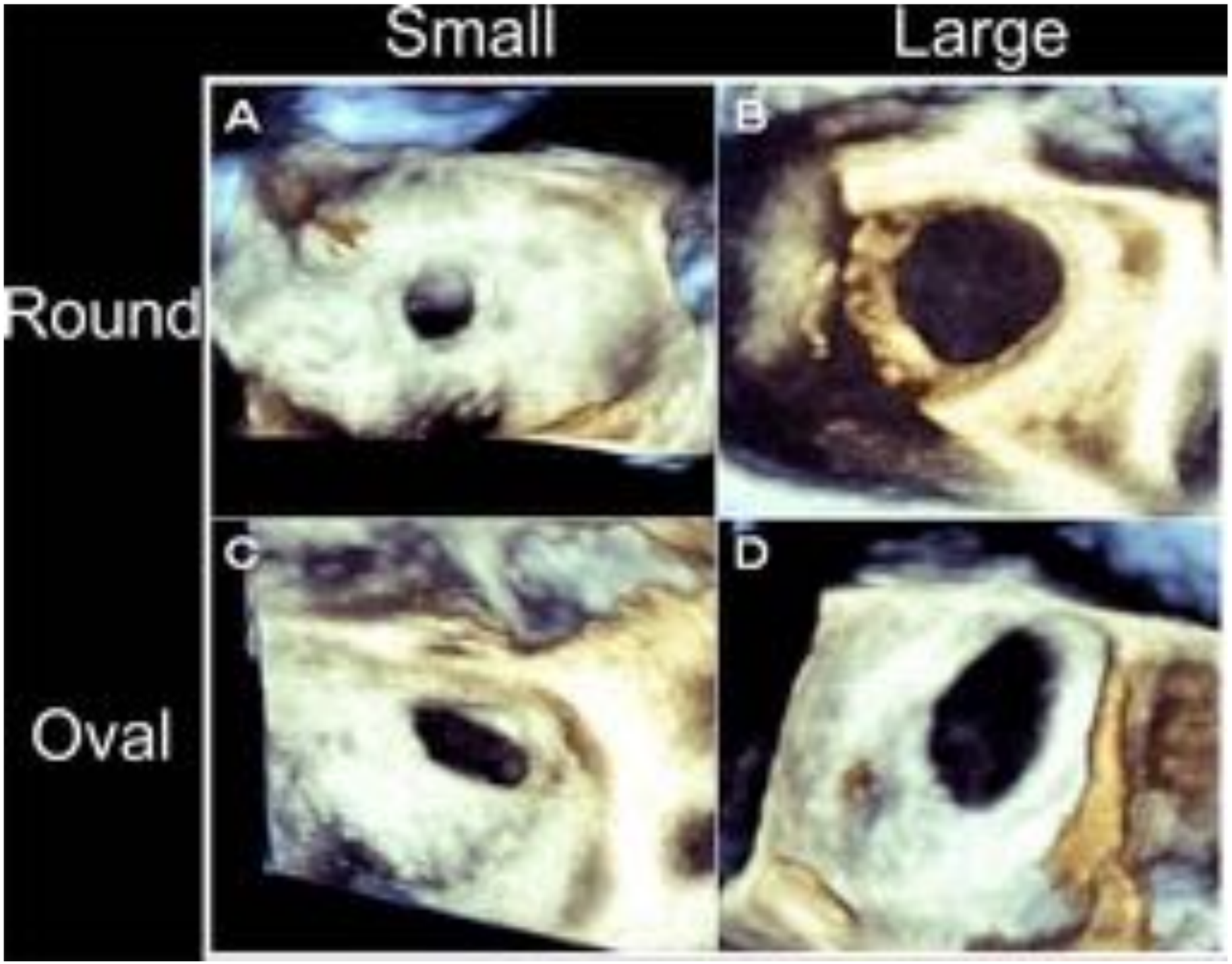
sous-costale



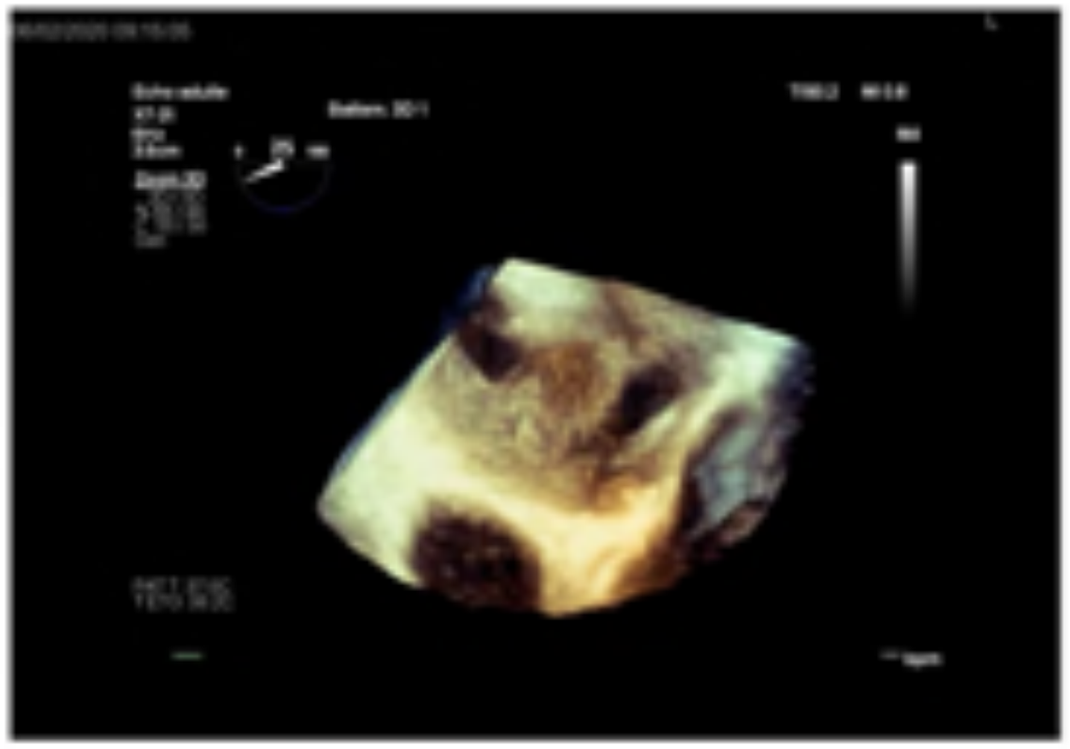


CAV = 1 seul anneau AV

CAV partiel : 2 orifices


Small
Large
Round
Oval
A
B
C
D

Multiperforated ASD 3D



Complications

Erosion cardiaque (tardive)

Arrythmies

BAV

Endocardite

Vavlulopathies

Shunt résiduel

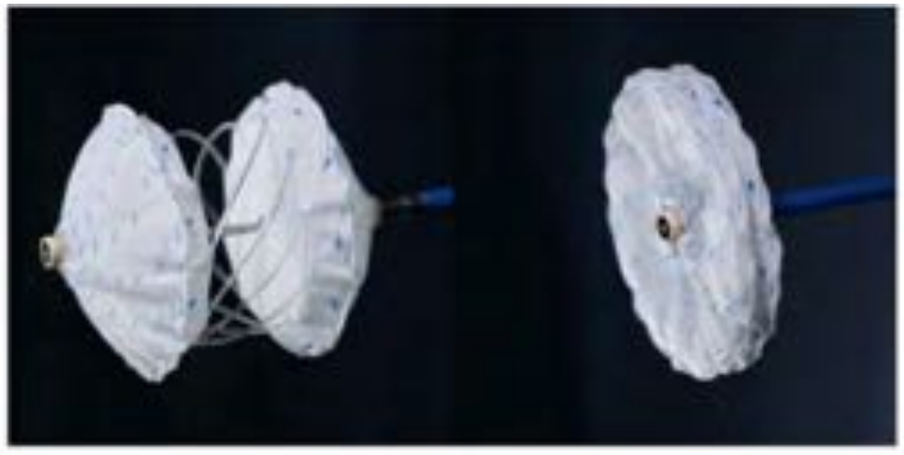
AVC

Table 1. Summary of the main long-term complications after percutaneous ASD

Complication	Incidence	Delay from closure	Complications
Cardiac erosion	0.04%-0.28%	Up to 9 y	Death (0.05%) Stroke
Device thrombosis	0.8%-1.2%	Up to 2 y	Stroke (10%-15%)
Atrial arrhythmias	11% 10 years after closure	–	Stroke
Complete AV block	5 published cases	Up to 4 y	–
Infective endocarditis	6 published cases	Up to 4 y	–

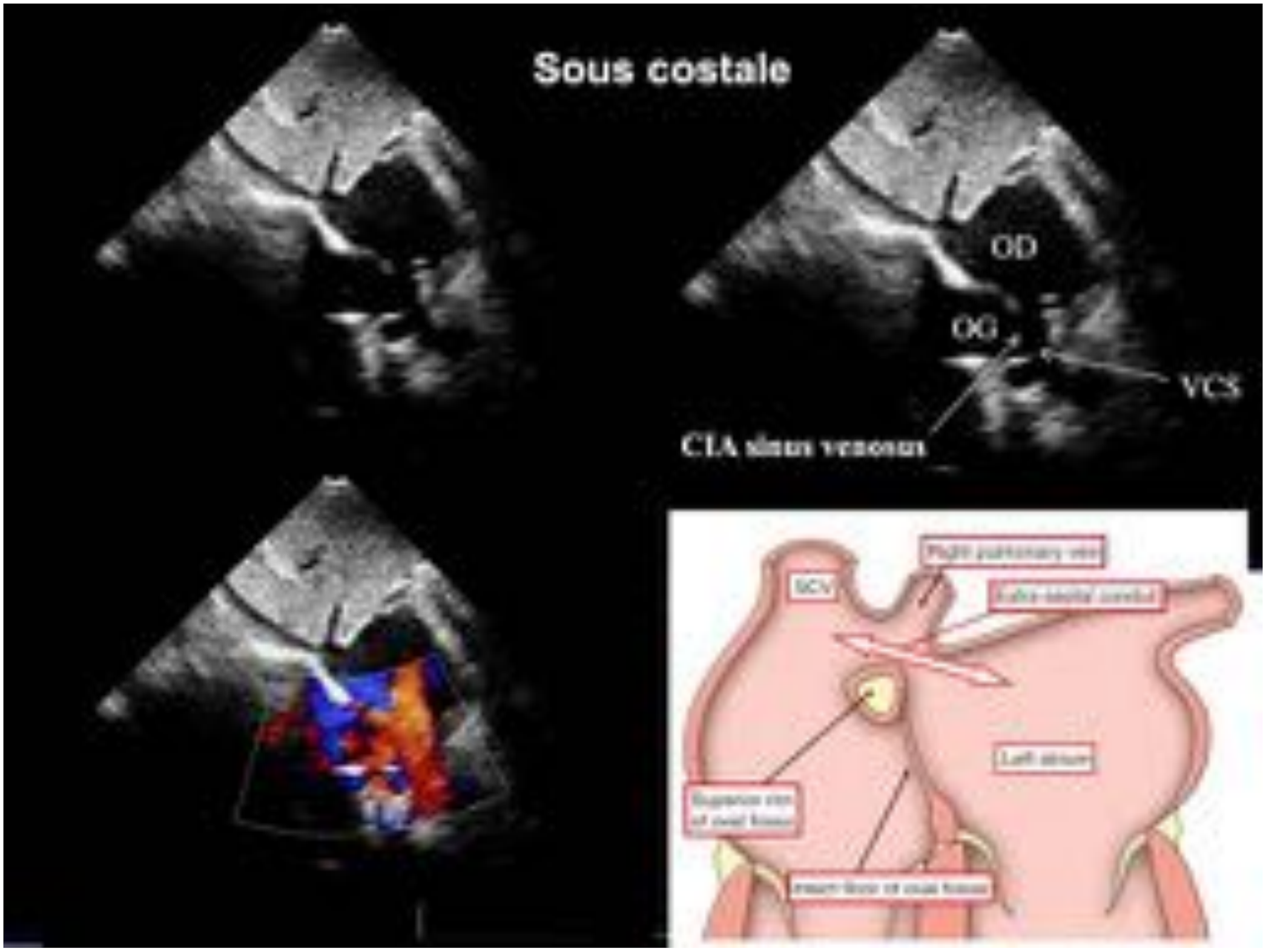
Jalal et al. Can Jour Cardiol 2016

Futur

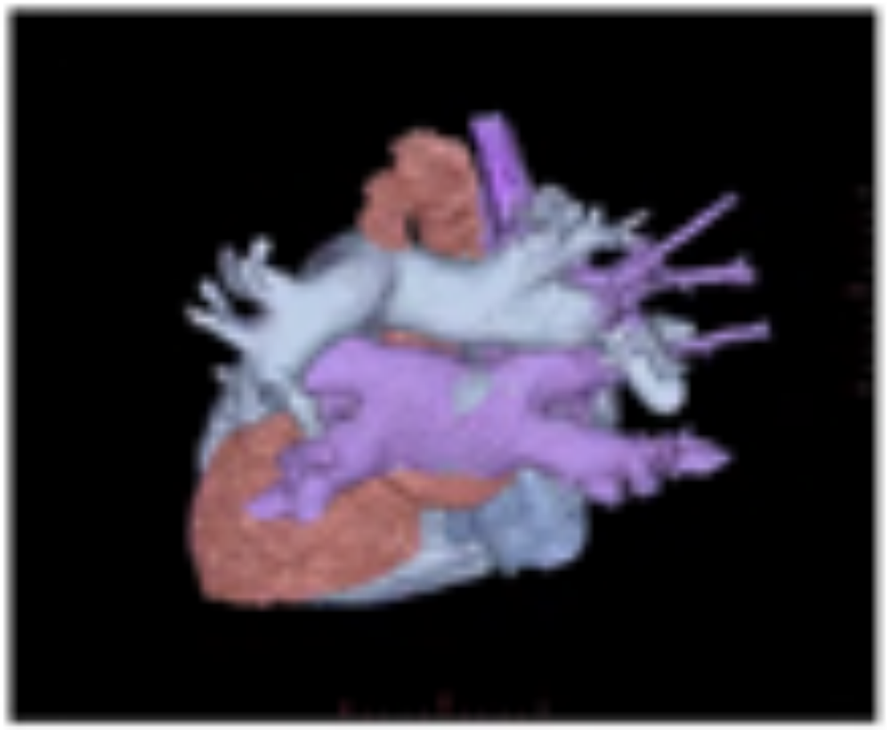


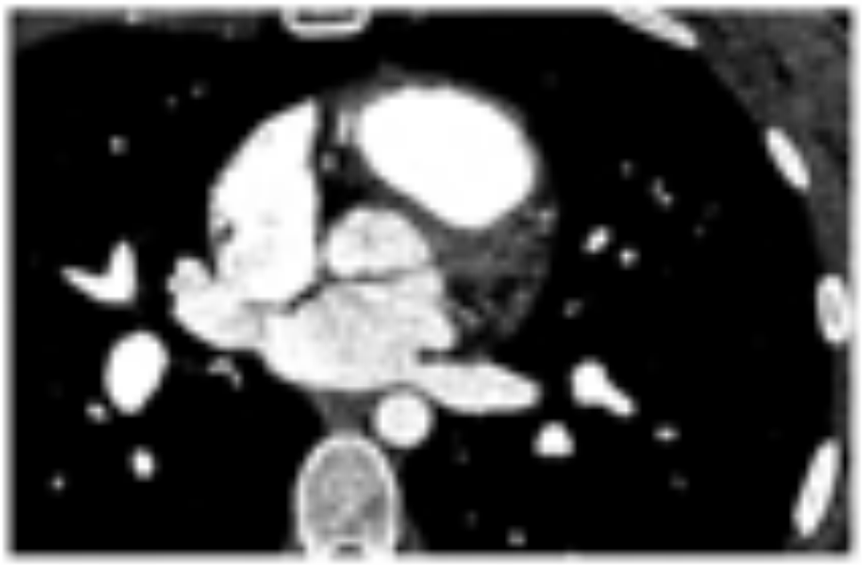
Prothèse biorésorbable
Carag

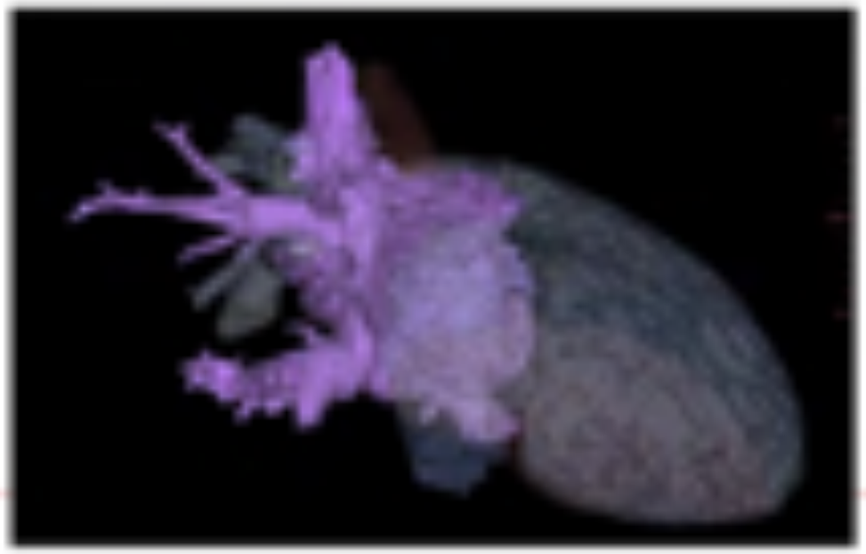
Prothèse trouée


Sous costale
OD
OG
VCS
CIA sinus veineux

Percutanous treatment of sinus venosus ASD

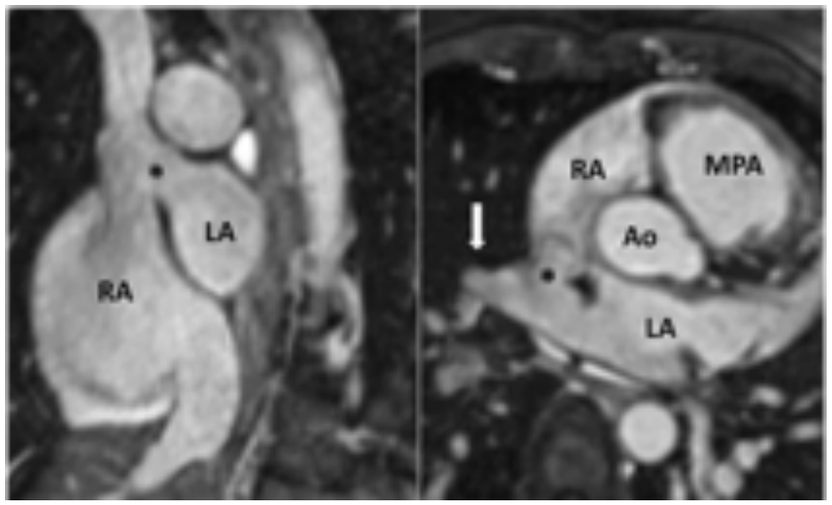


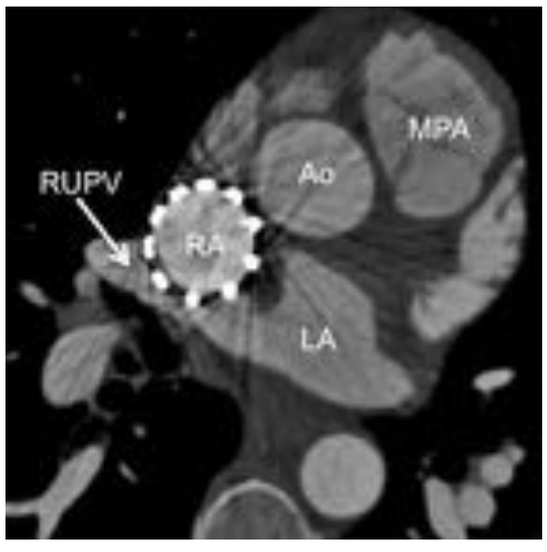


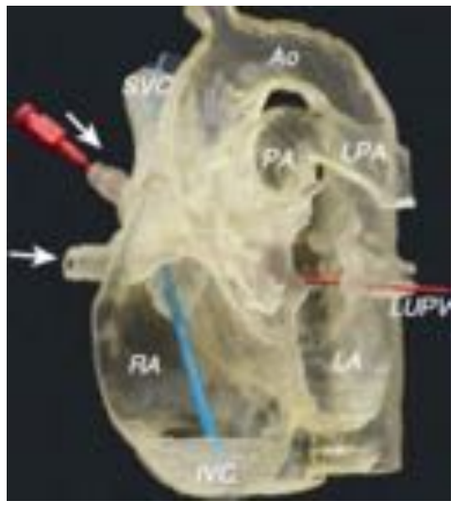


Courtesy G Soulat

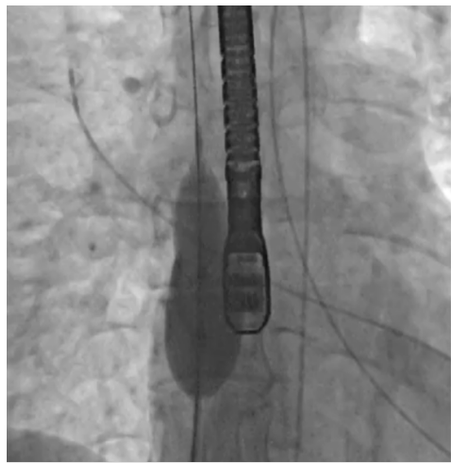
CIA sinus venosus



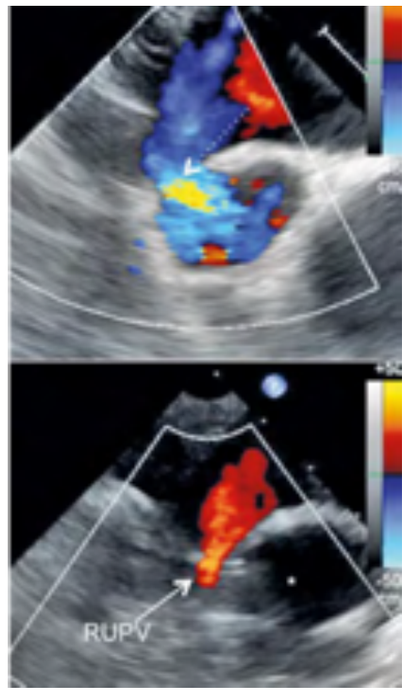




Ex vivo simulation



In vivo simulation

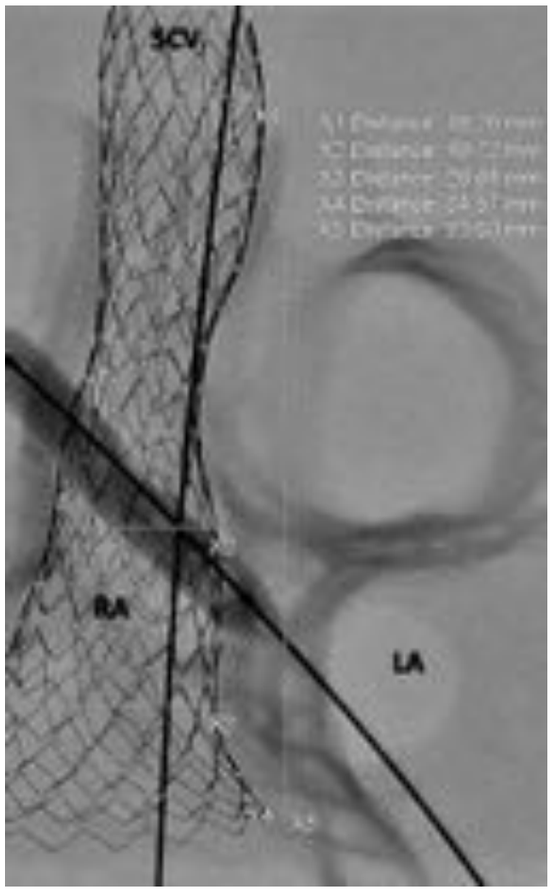


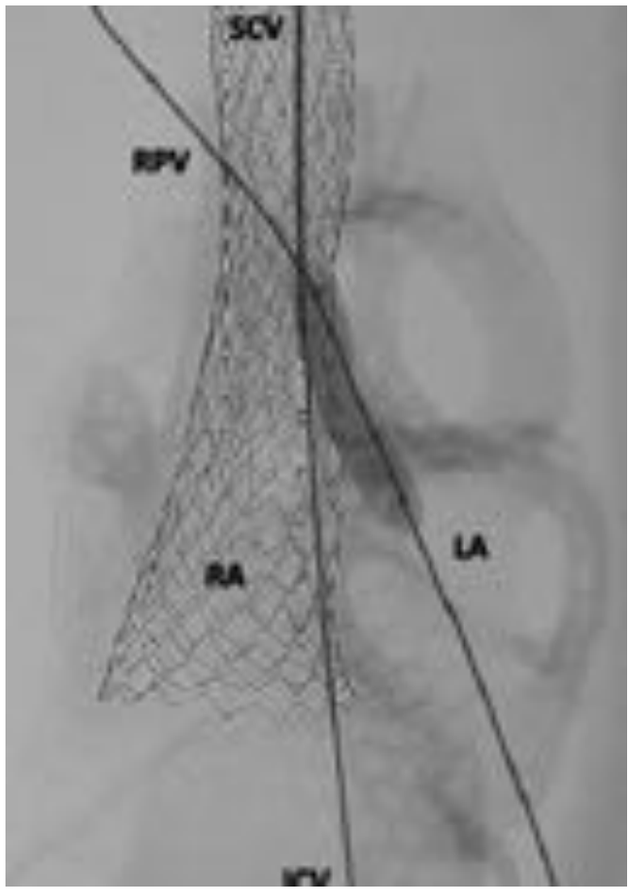
TOE guidance

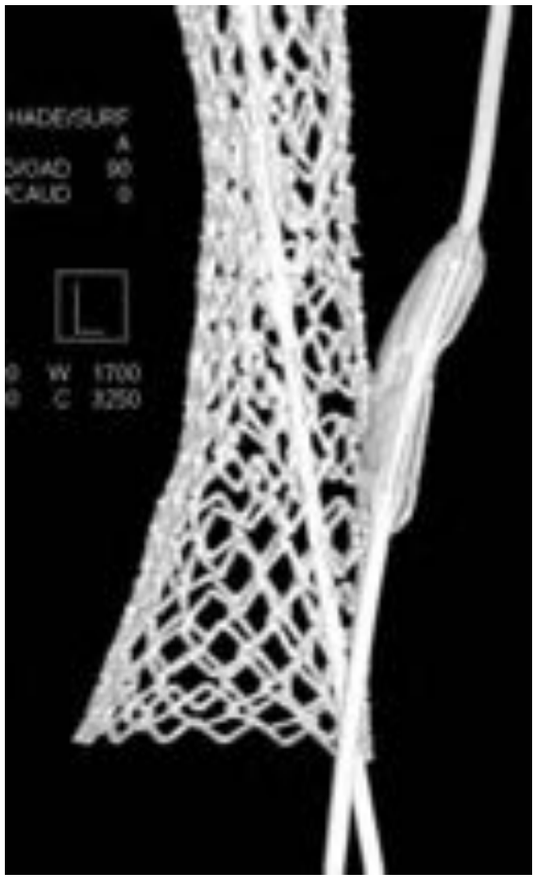
Courtesy A. Baruteau

Simulations pré procédure

Simulations pré procédure

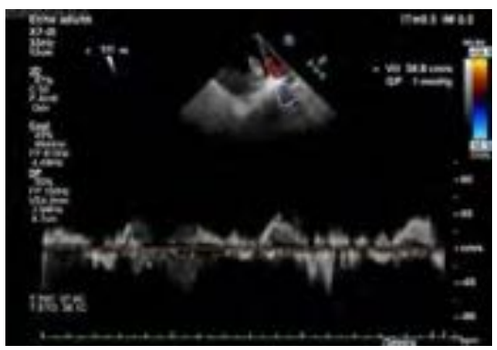




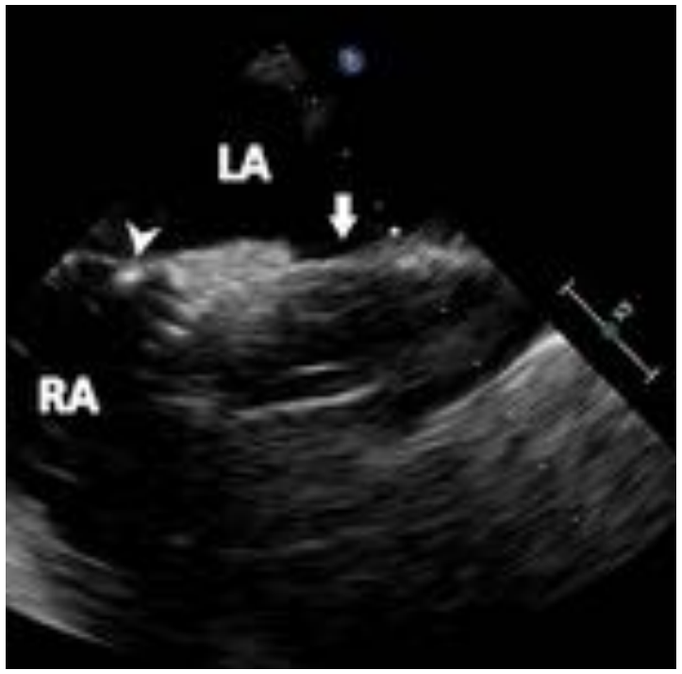


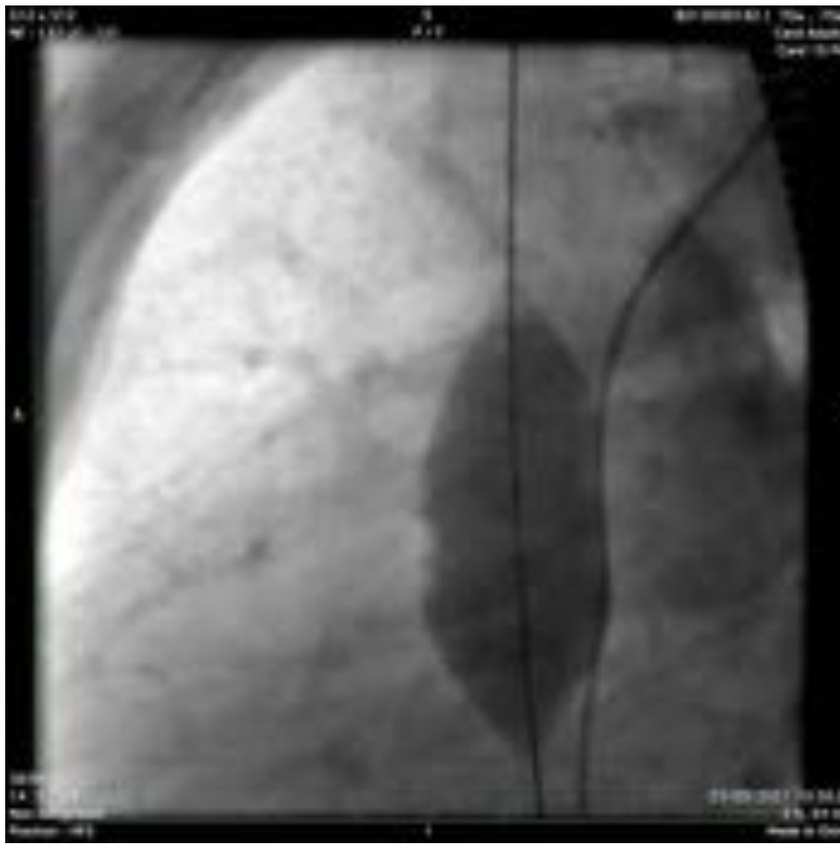
Procedure

After ANSM (french regulatory authorities) agreement



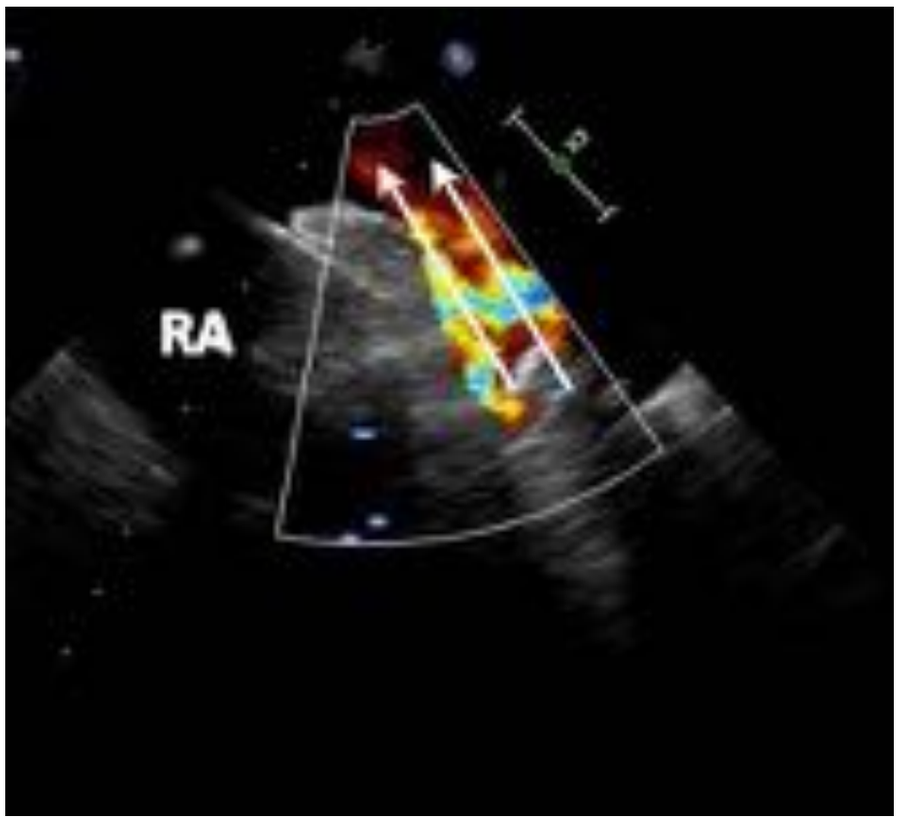
Procedure: In vitro simulation



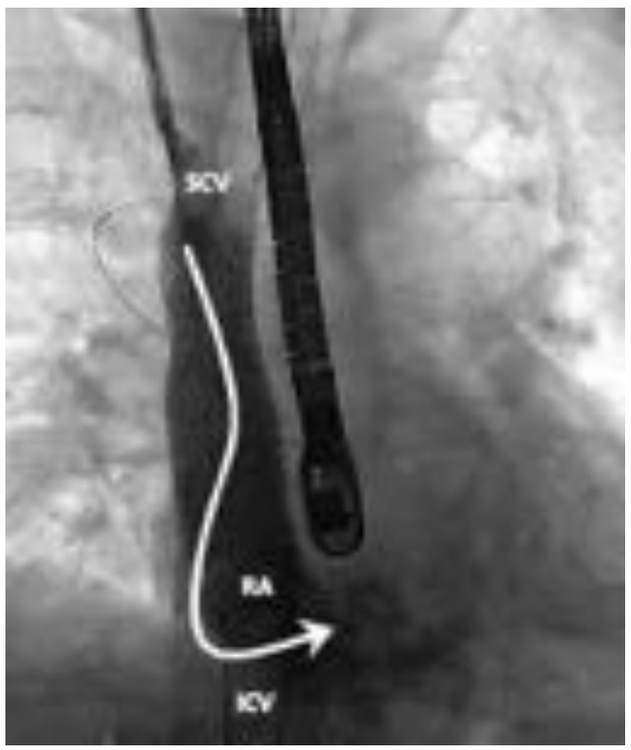


Procedure 3: stent placement

Procedure 3: not so happy

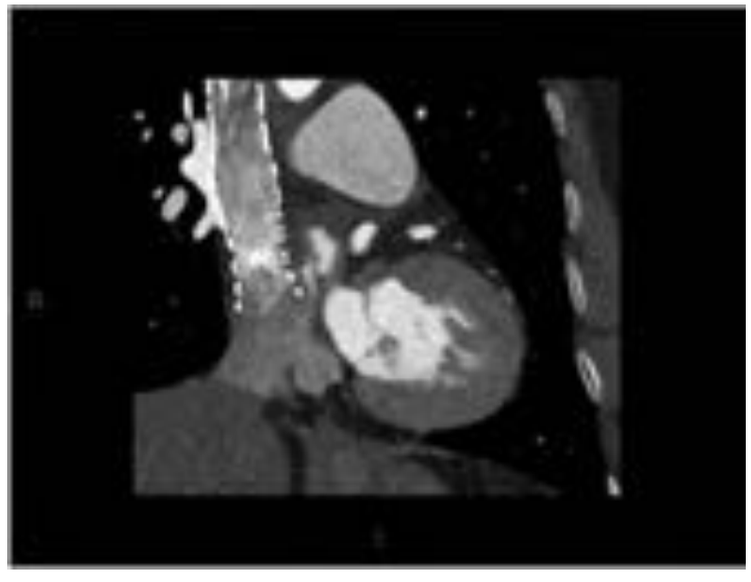


Final angiography



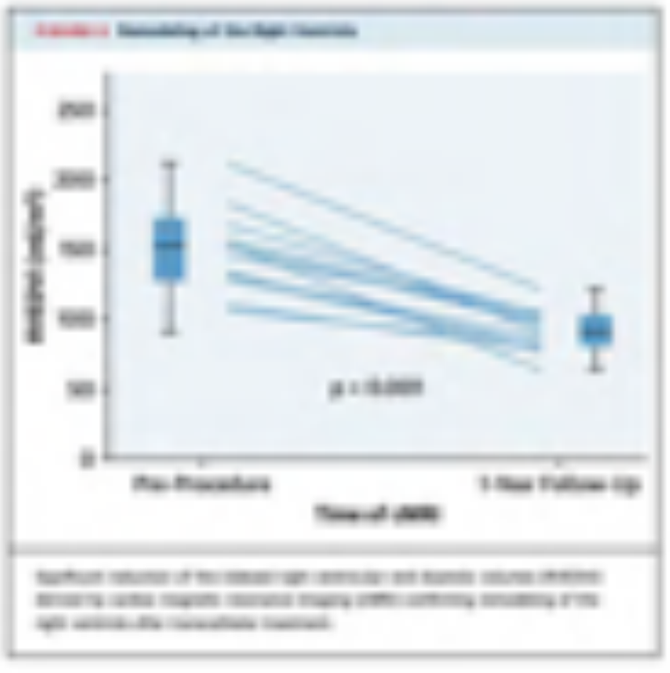
Follow-up

Patient is asymptomatic
Control CT scan
Normal PA pressure on TTE



Transcatheter Correction of Superior Sinus Venosus Atrial Septal Defects as an Alternative to Surgical Treatment

25 patients eligible
Mean FU 1.4 Y
No late complications
Remodeling of the RV



Hansen et al. JACC 202

Canal artériel

Passé

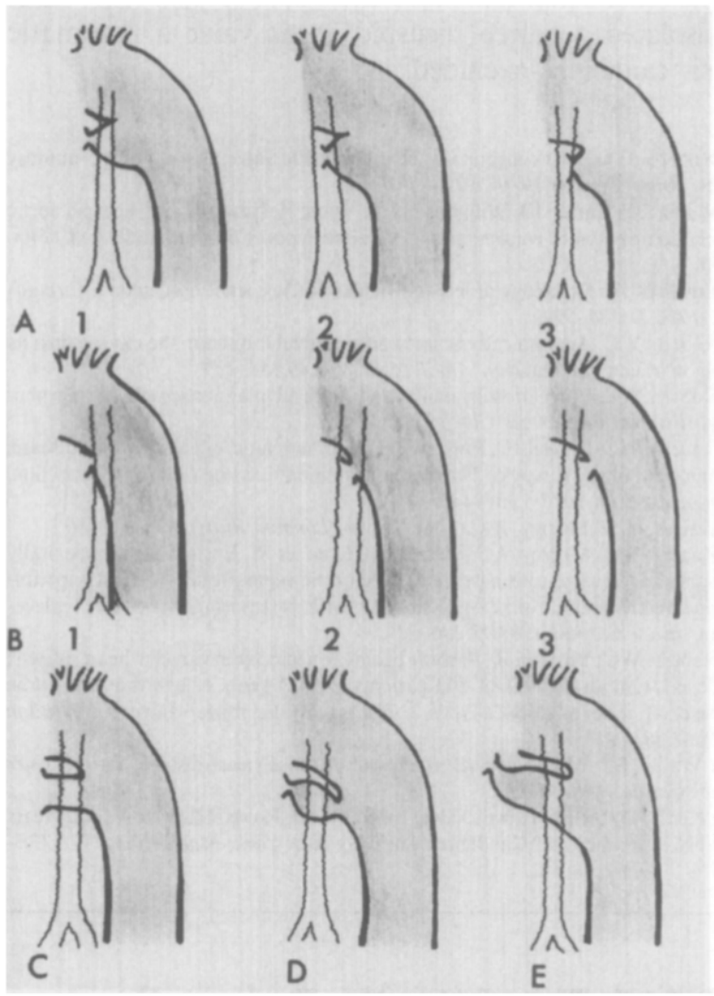


FIGURE 2. Configuration of the ductus seen angiographically (see text).

Accès veineux
Standardisation
Miniaturisation
Nombreux devices

Plus petits poids
Canaux plus larges

Présent

Recommendations for Transcatheter PDA Occlusion

Class I

1. **Transcatheter PDA occlusion is indicated for the treatment of a moderate-sized or large PDA with left-to-right shunt that results in any of the following: Congestive heart failure, failure to thrive, pulmonary overcirculation (with or without pulmonary hypertension), or an enlarged left atrium or left ventricle, provided the anatomy and patient size are suitable *(Level of Evidence: B)*.**

Class IIa

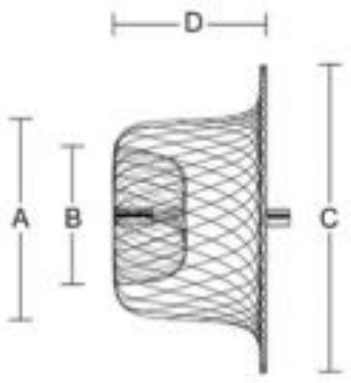
1. **Transcatheter PDA occlusion is reasonable in the presence of a small left-to-right shunt with normal-sized heart chambers when the PDA is audible by standard auscultation techniques *(Level of Evidence: C)*.**

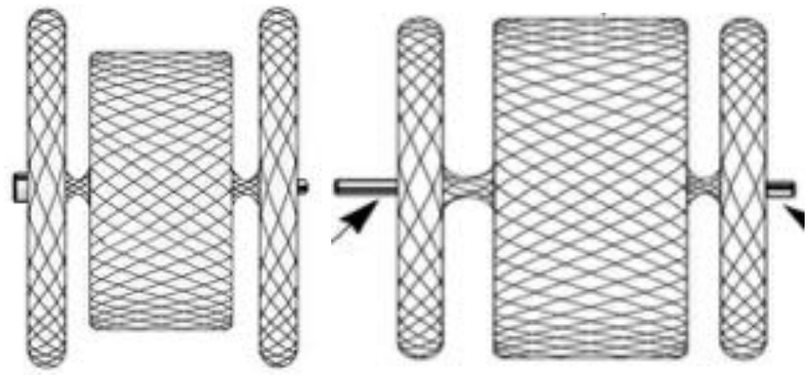
Class IIb

1. **In rare instances, transcatheter PDA occlusion may be considered in the presence of a bidirectional PDA shunt due to pulmonary hypertension and obstructive pulmonary vascular disease but reversible to pure left-to-right shunting with pulmonary vasodilator therapy *(Level of Evidence: C)*.**
2. **Transcatheter PDA occlusion may be considered in a PDA associated with a small left-to-right shunt with normal heart size and an inaudible murmur *(Level of Evidence: C)*.**

Class III

1. **Transcatheter PDA occlusion should not be attempted in a patient with a PDA with severe pulmonary hypertension associated with bidirectional or right-to-left shunting that is unresponsive to pulmonary vasodilator therapy *(Level of Evidence: C)*.**



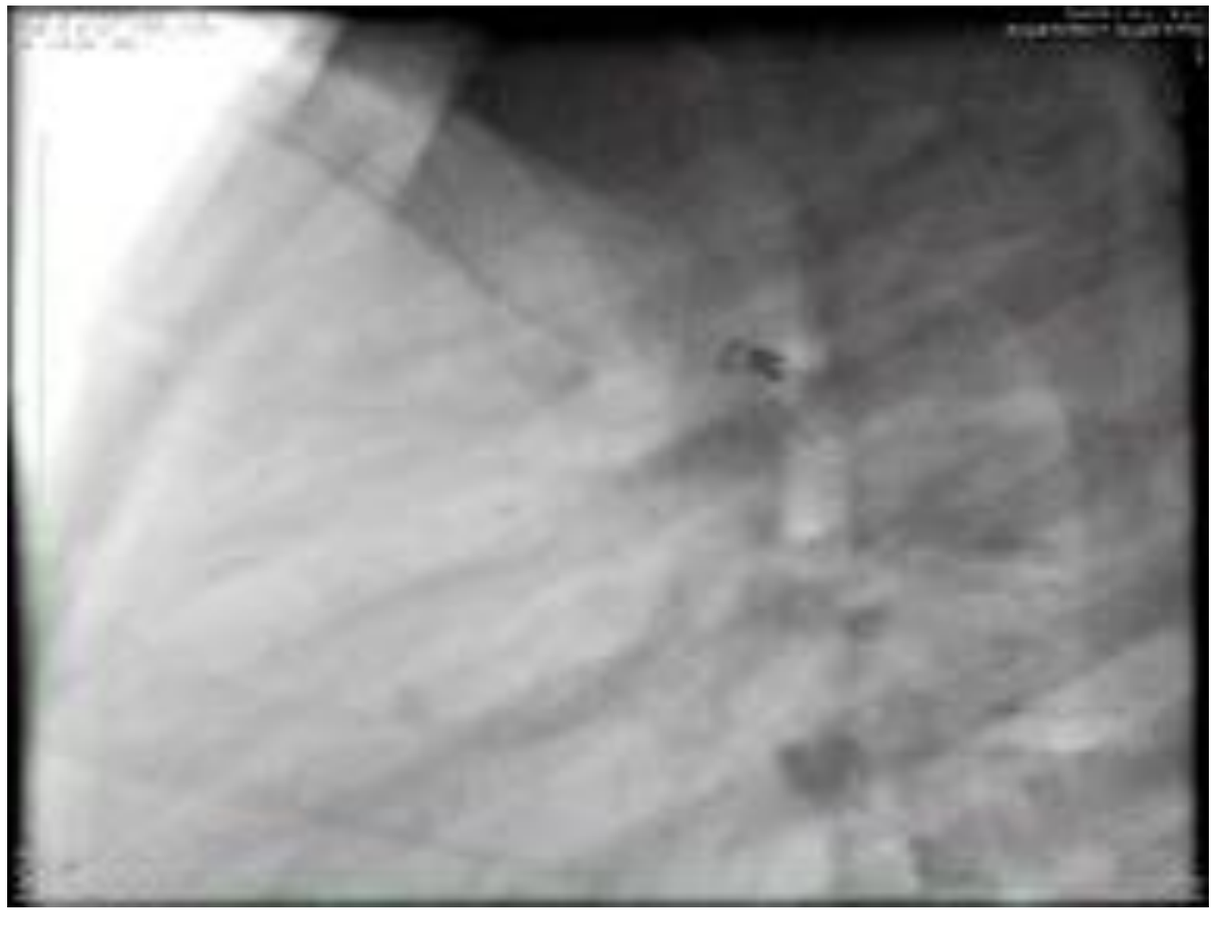


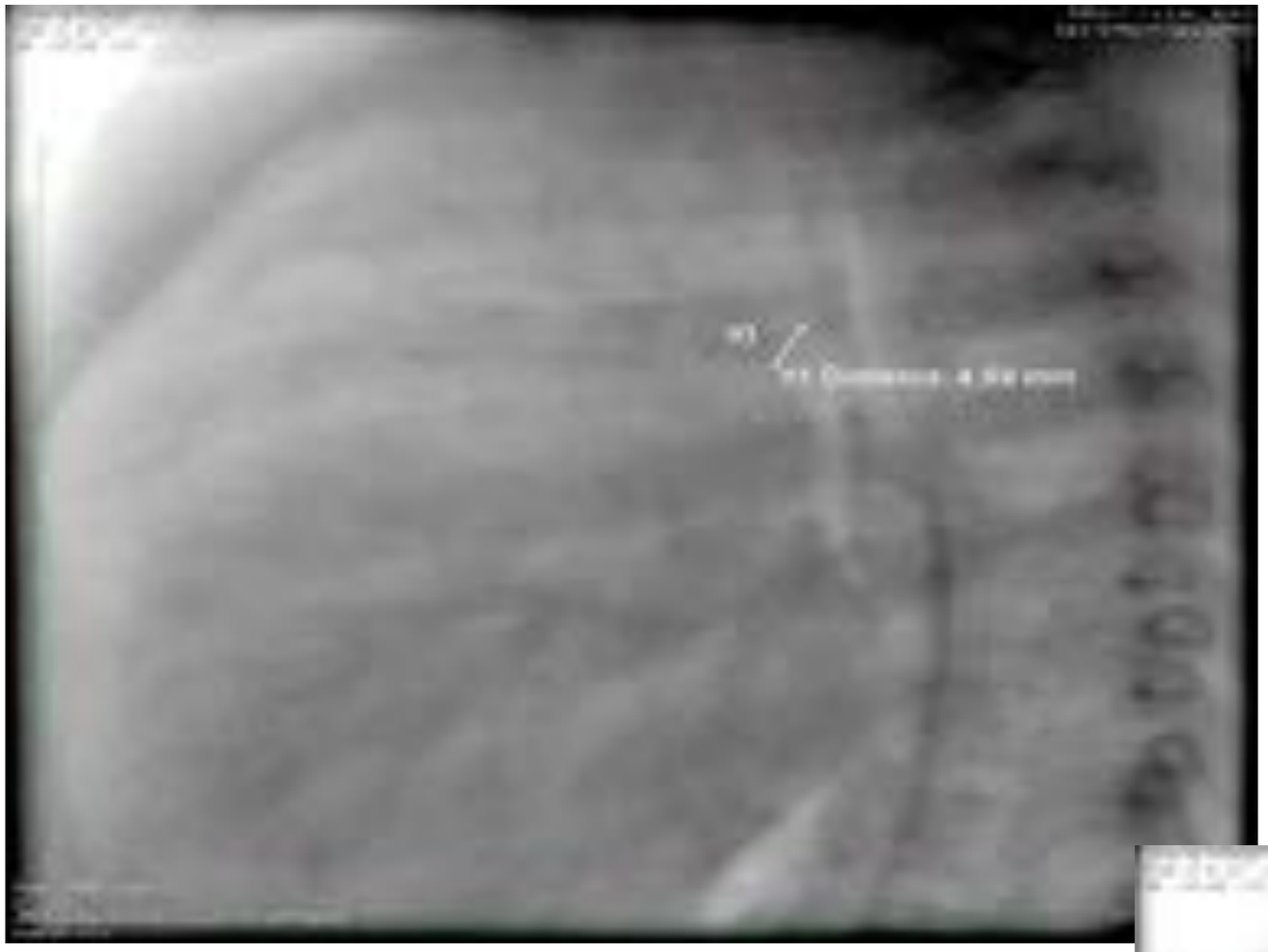
ADO

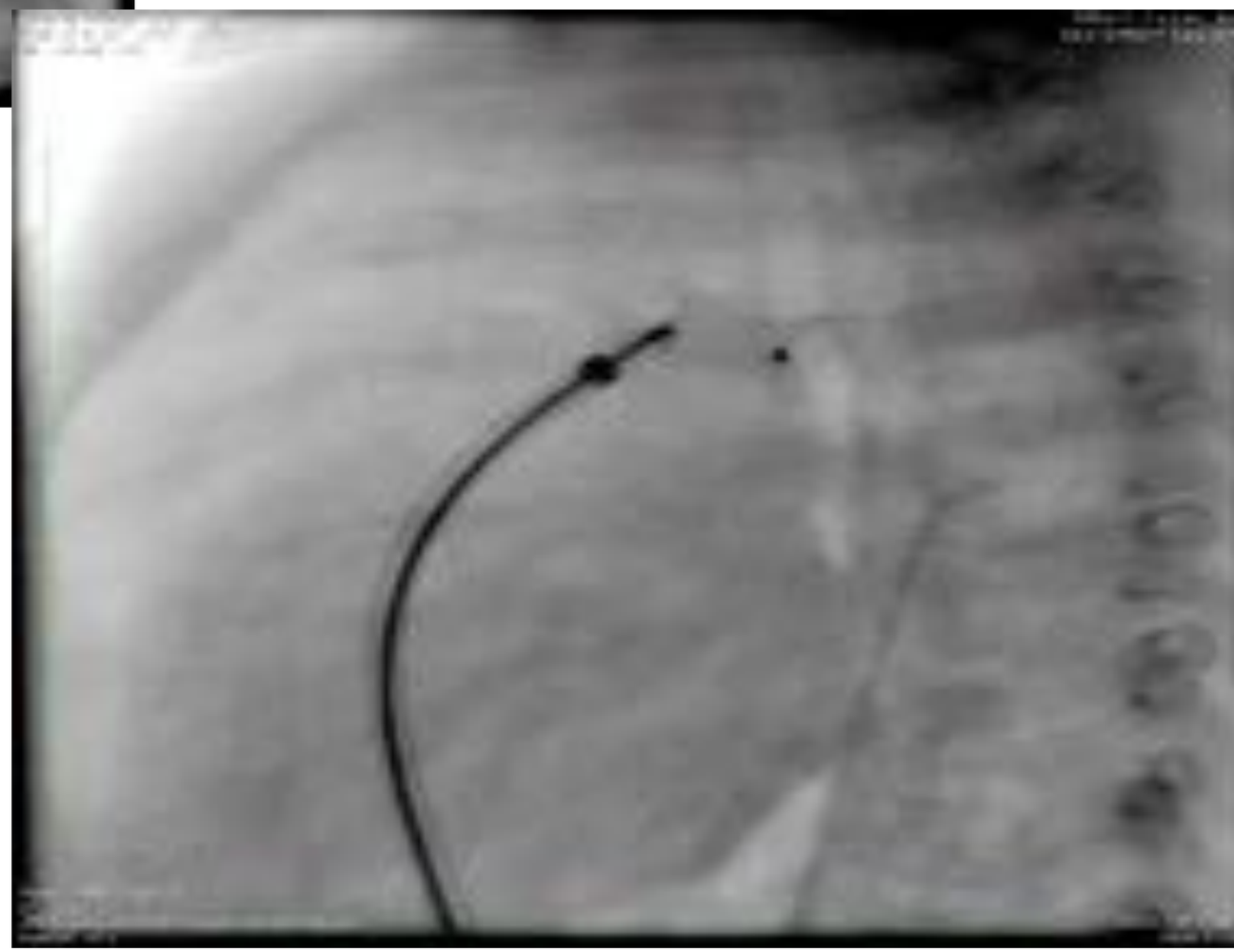
ADO II AS

AVP

ADO II





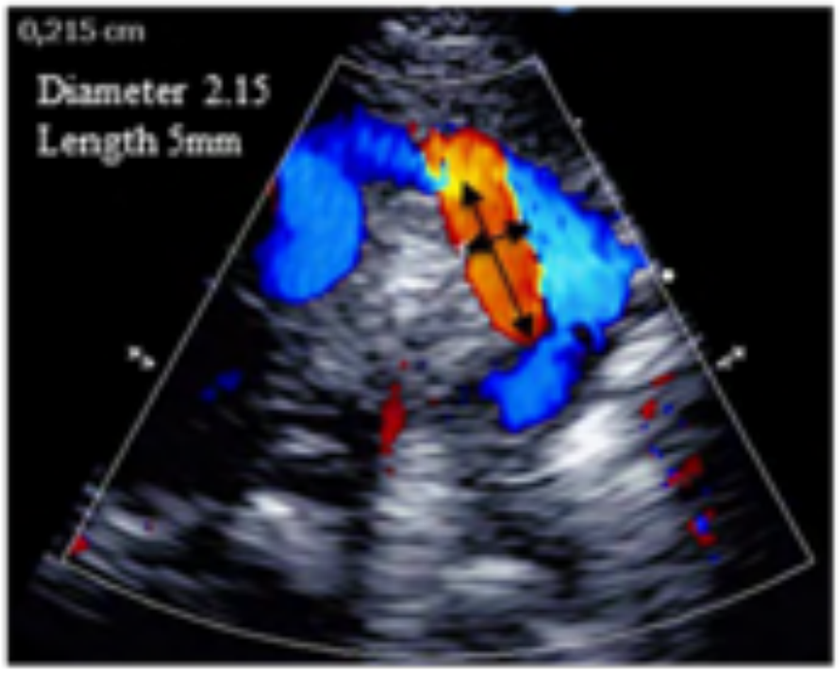


Présent

Transcatheter Closure of Hemodynamic Significant Patent Ductus Arteriosus in 32 Premature Infants by Amplatzer Ductal Occluder Additional Size-ADOIIAS

Patrice Morville[1*] and Ahmad Akhavi[2]

Catheterization and Cardiovascular Interventions 90:612–617 (2017)



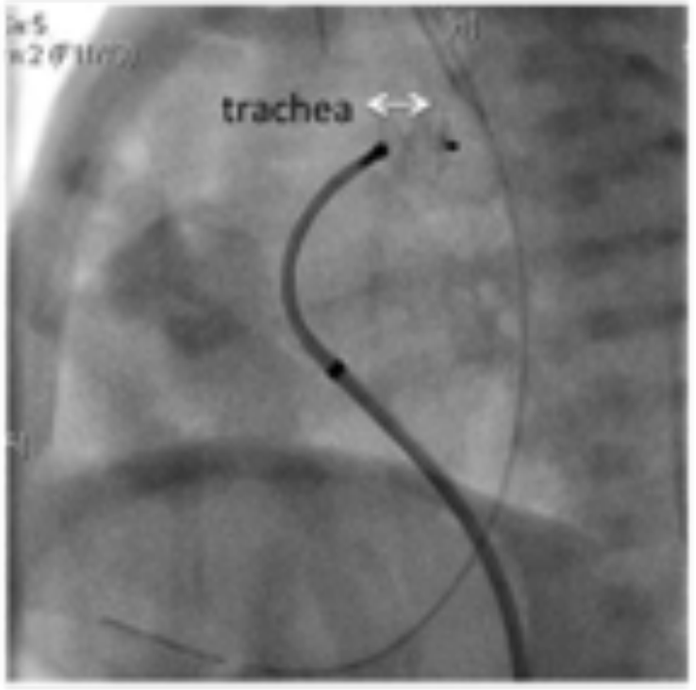


Fig. 2. Device positioning in lateral fluroscopy.

Challenging procedure

Transportation

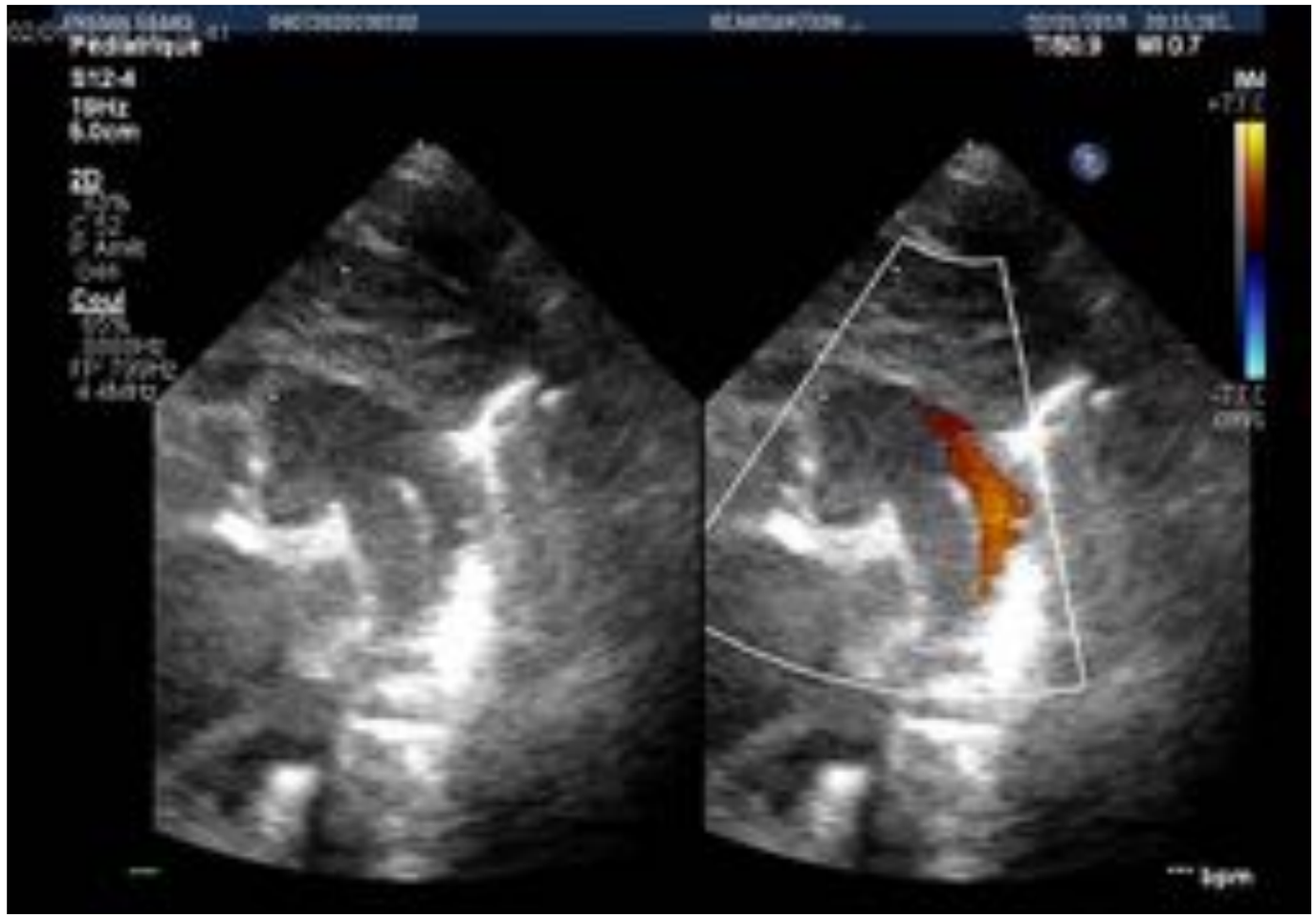
Intubation

Ventilation

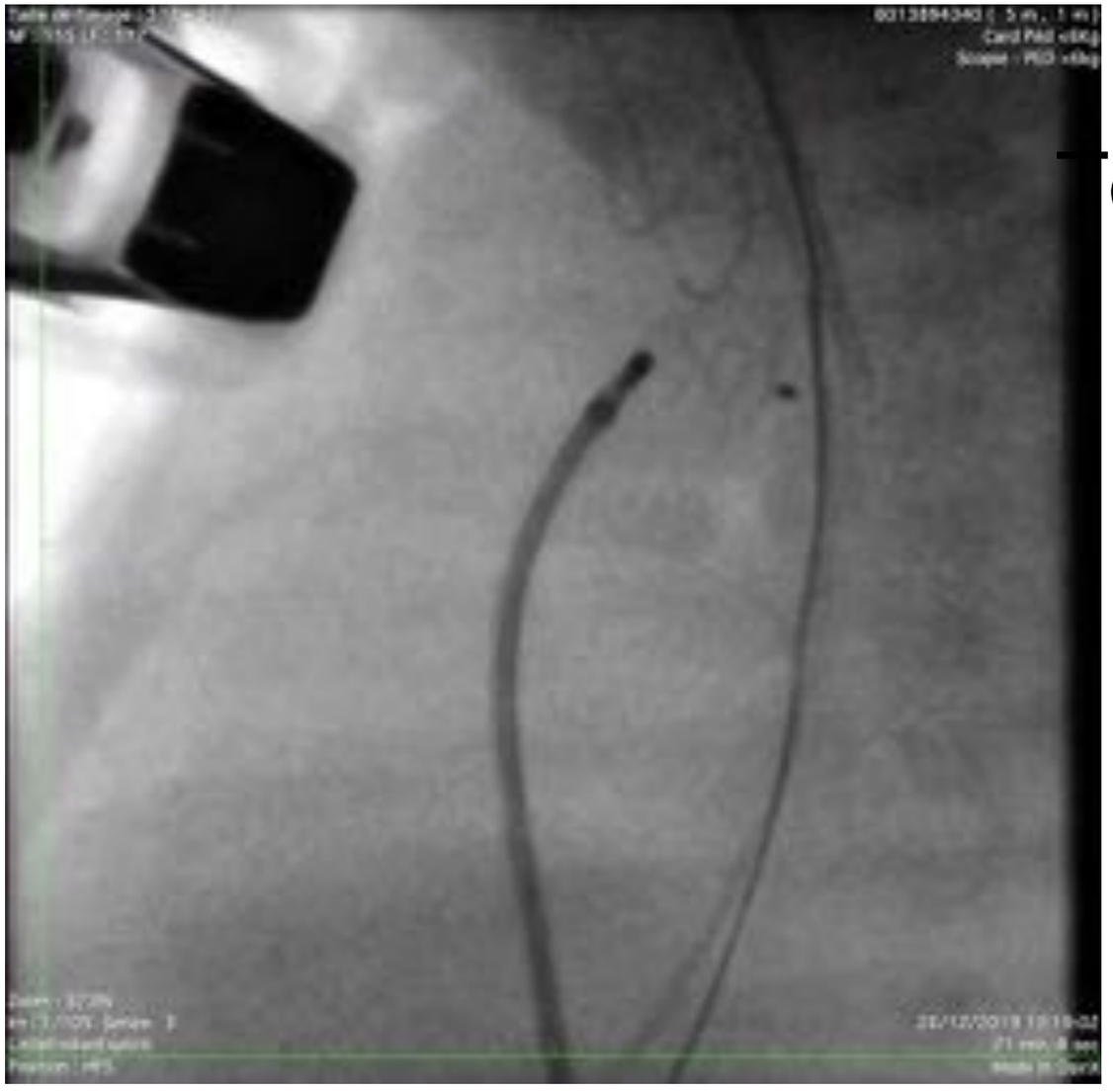
Access

Temperature

TTE evaluation



Release the device



Temperature prob

Trachea

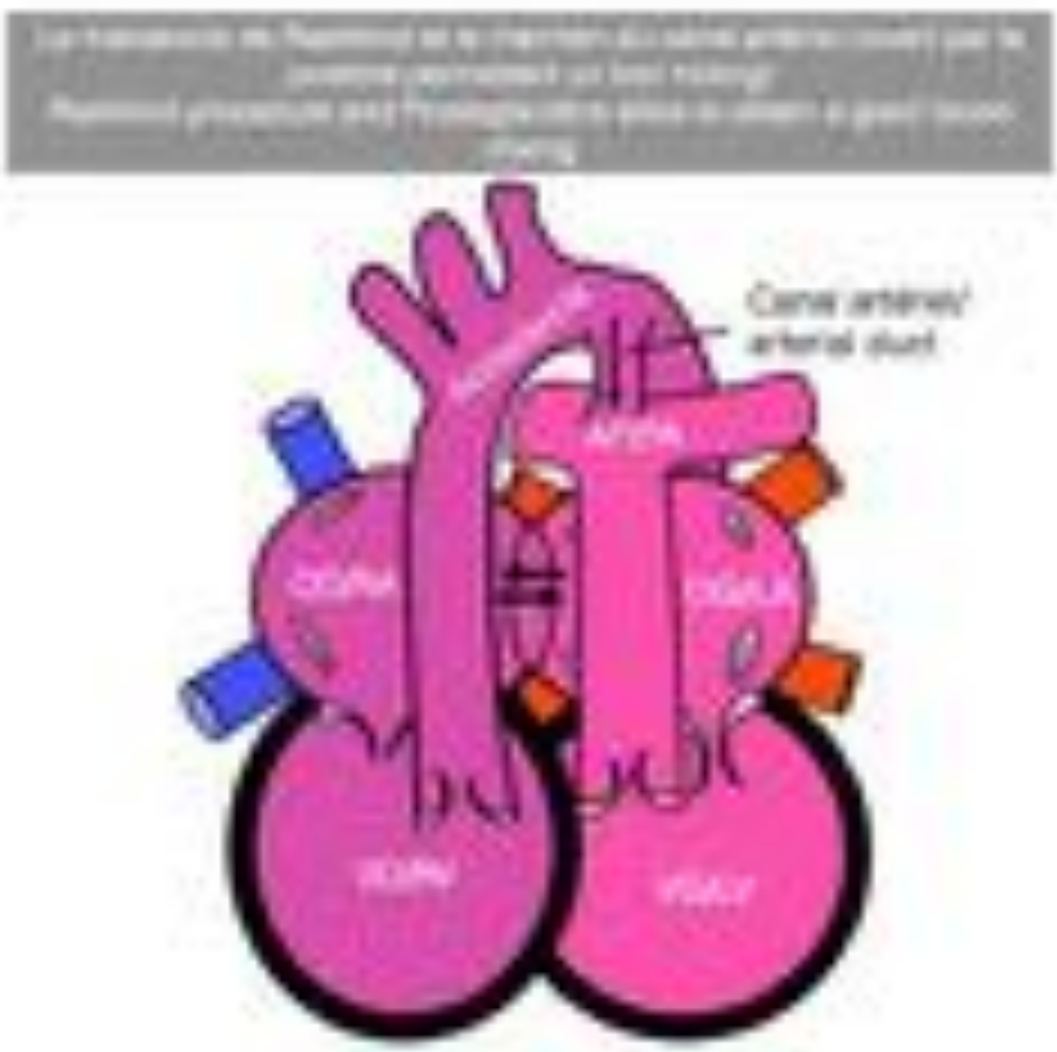
Simultaneous view of LPA and aorta

Création de CIA

Rashkind

- sondes différentes
- techniques différentes
- connaître les complications pour les éviter
- guidage échographique

Manœuvre de Rashkind

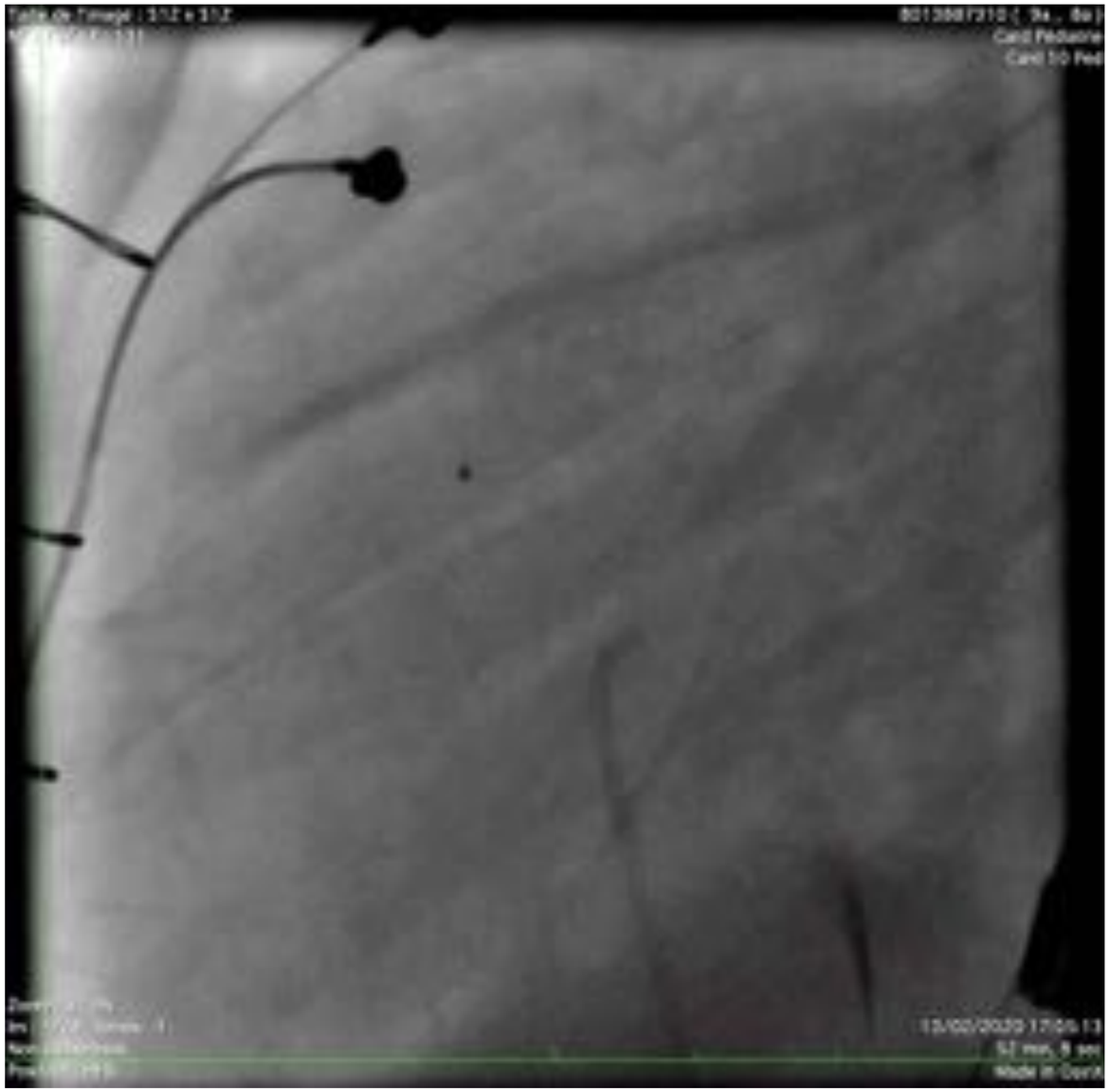


Rashkind

Création de CIA

- Indication: ECMO
- Guidage échographique
- Rapports modifiés

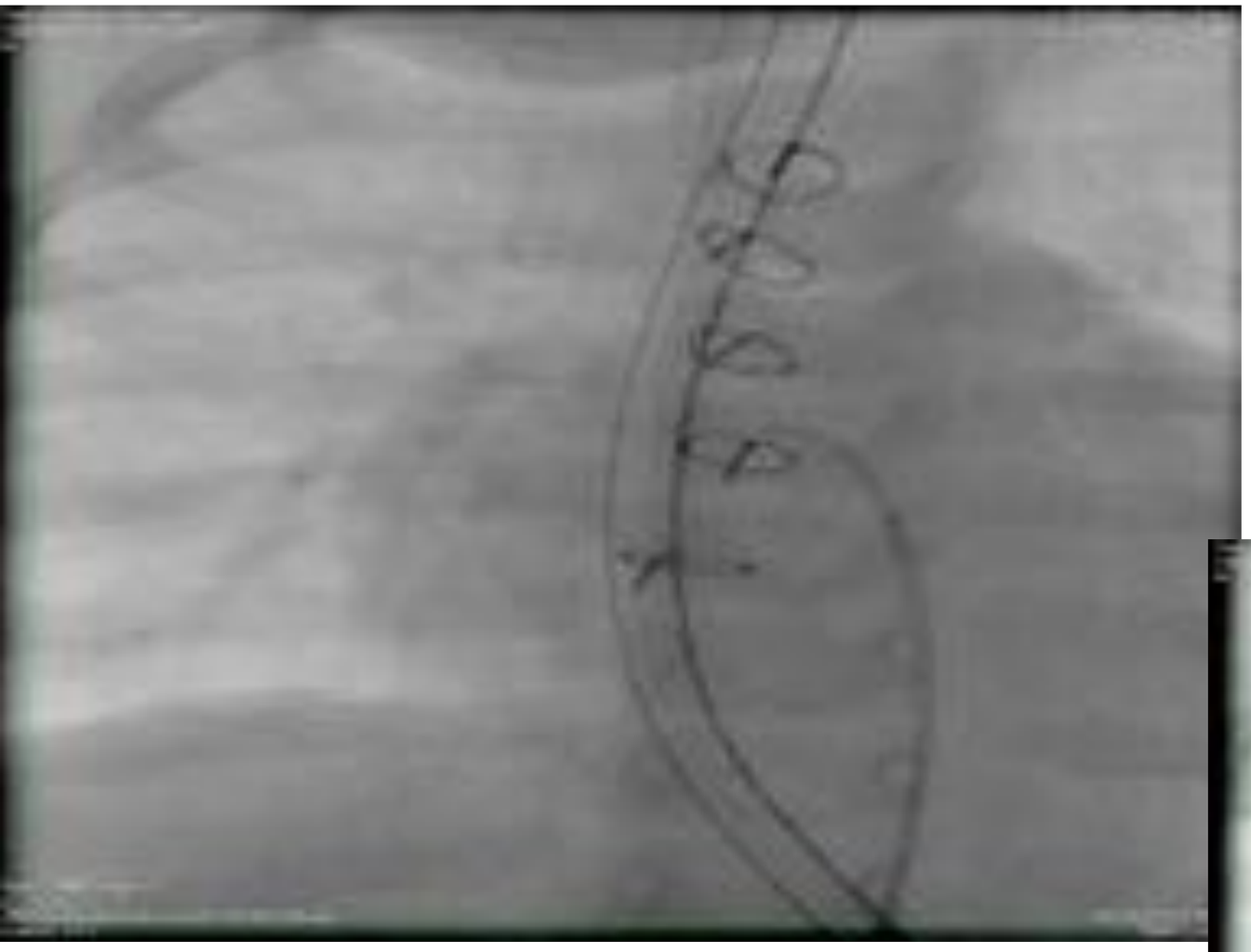
Septectomie pré-ECMO



Embolisation

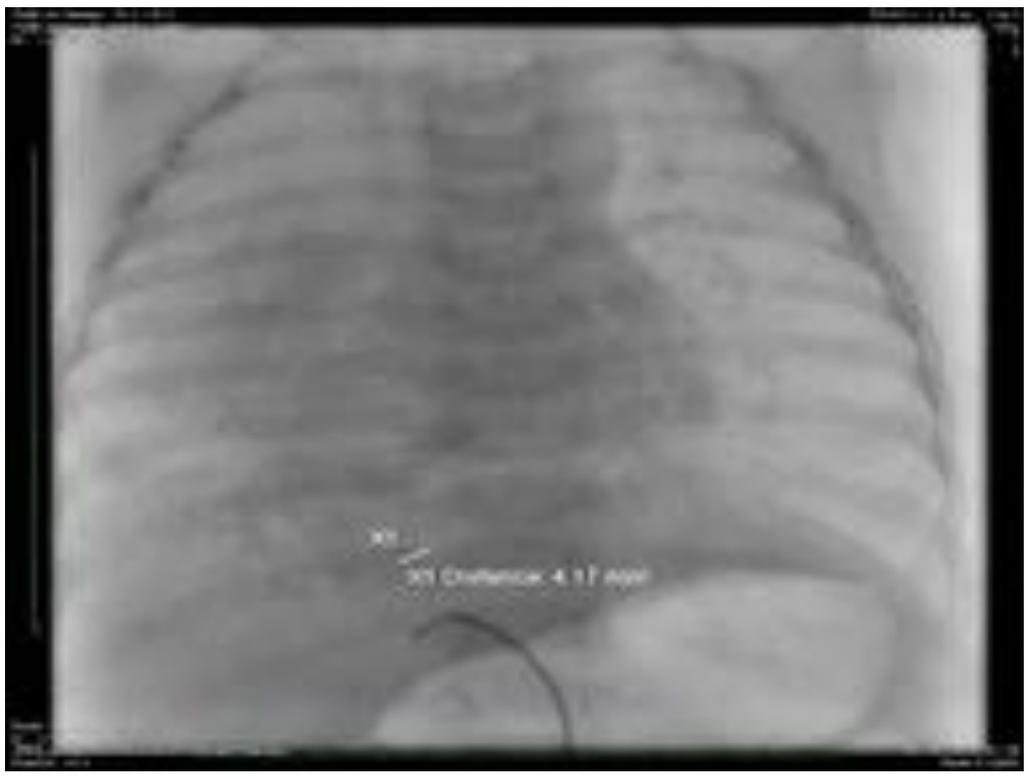
- Occlusion de MAPCA
- Occlusion de séquestre
- Occlusion de fistules veino-veineuse
- Occlusion veine cave supérieure gauche

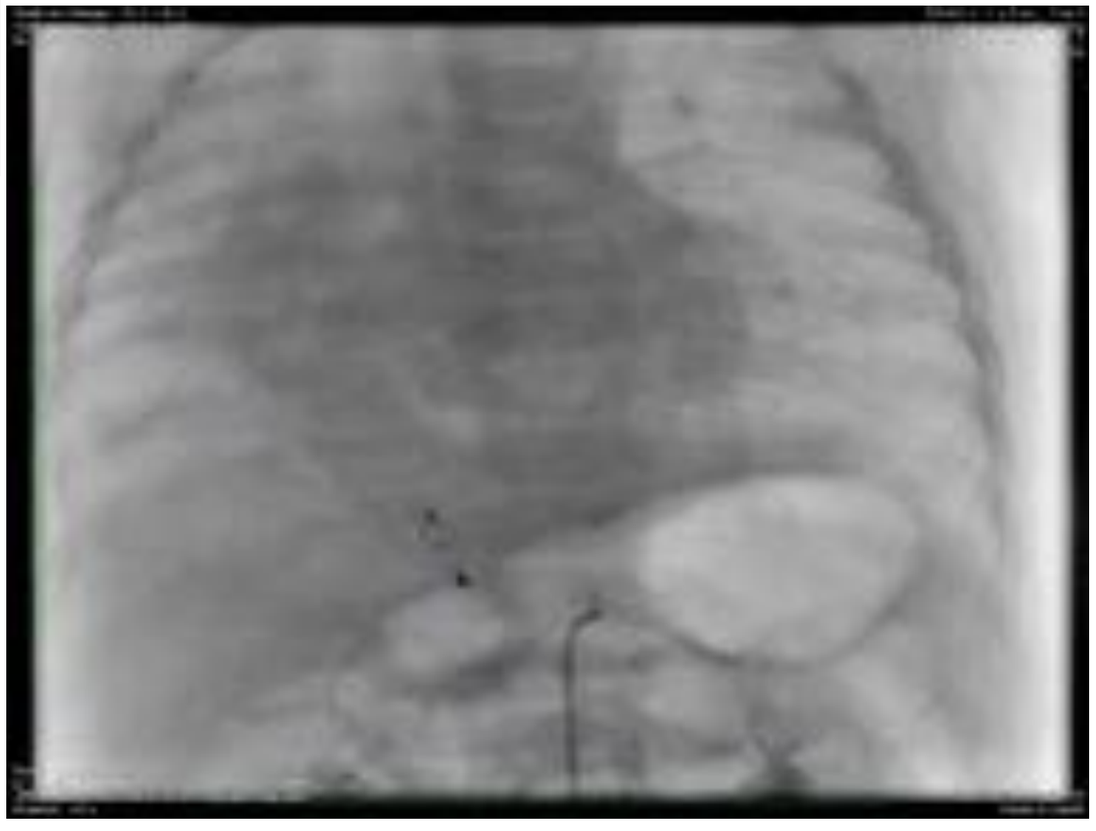
Occlusion MAPCA



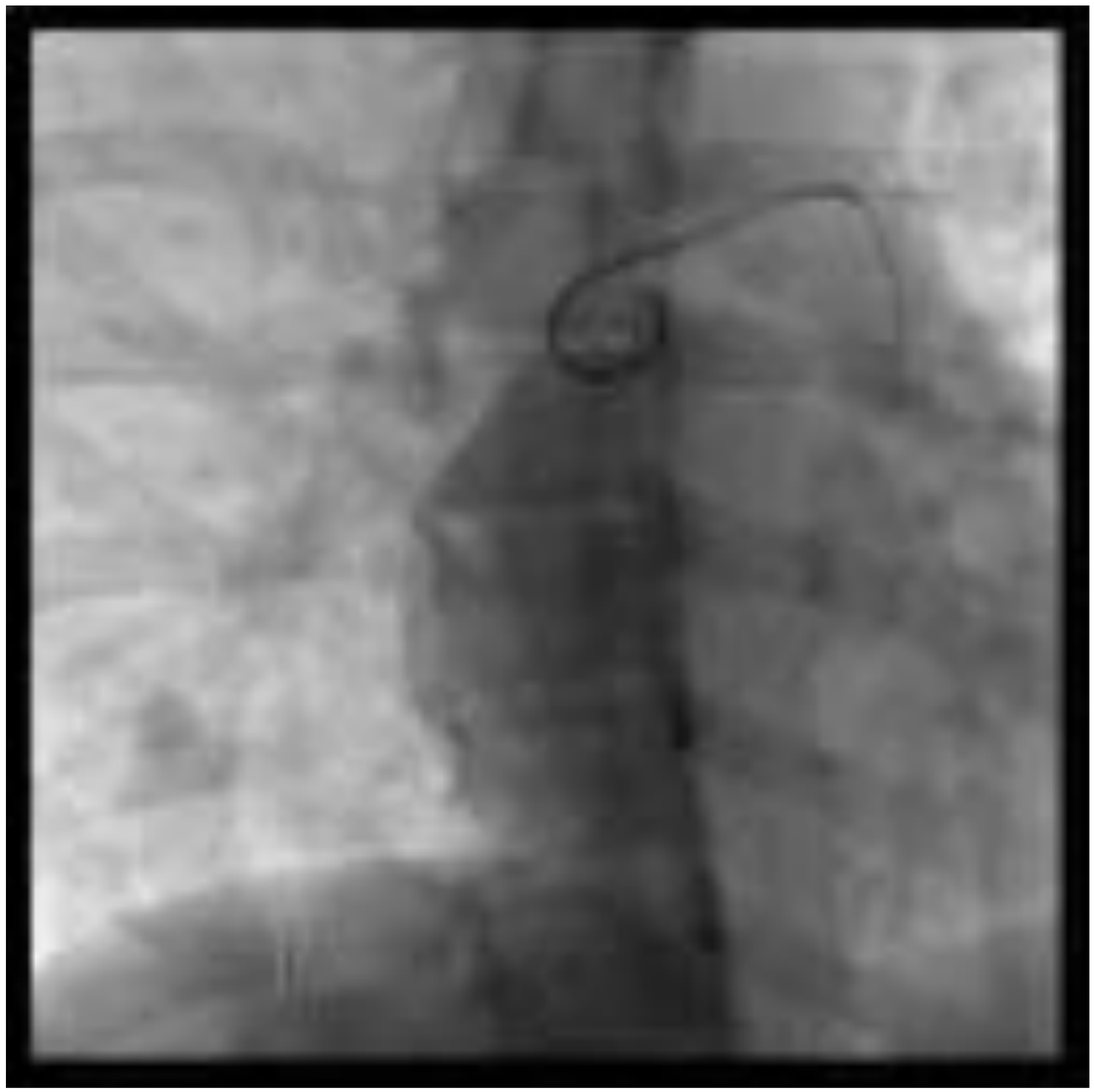
Occlusion MAPCA pré opératoire

Diagnostic?





Diagnostic



Diagnostic

Traitement

Quelle lésion?

Occlusion VCSG à l'OG

Quelle lésion?

Embolisation

Ventricule unique

Ventricule unique - cathétérisme

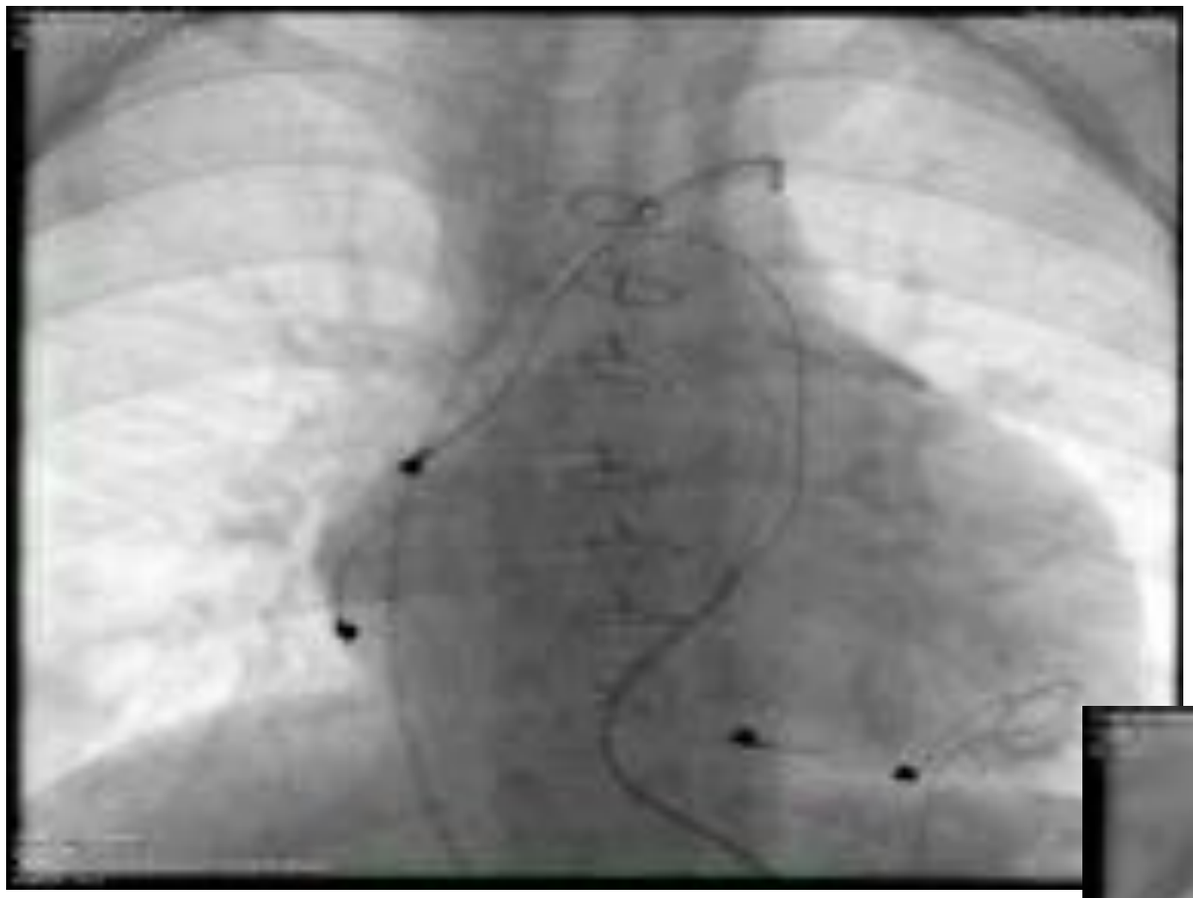
KT diagnostic

KT interventionnel:

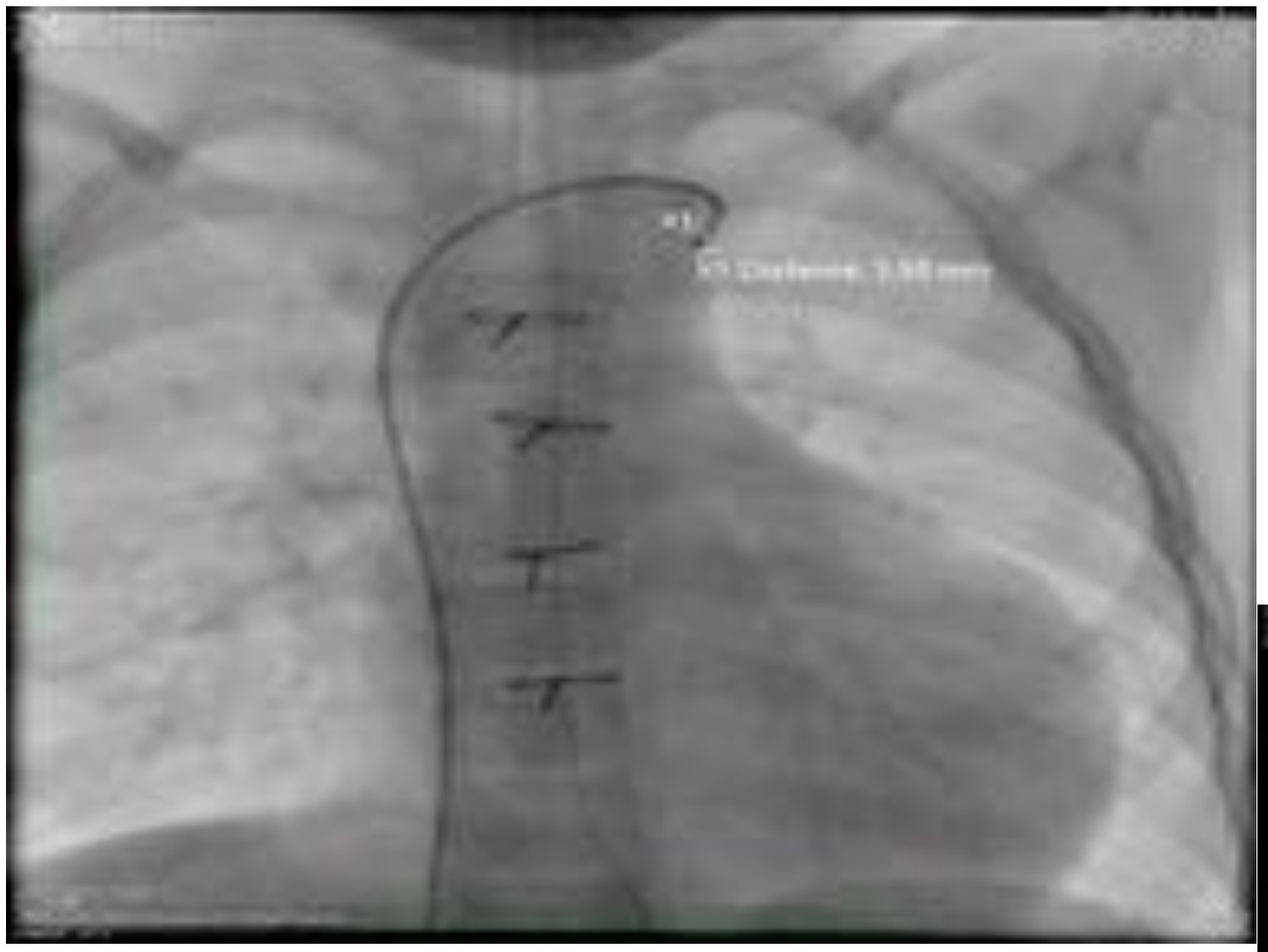
- stenting des AP, stenting de coarctation
- Occlusion de collatérales aorto-pulmonaires
- Occlusion de fistule veino-veineuse
- Fermeture de fenestration

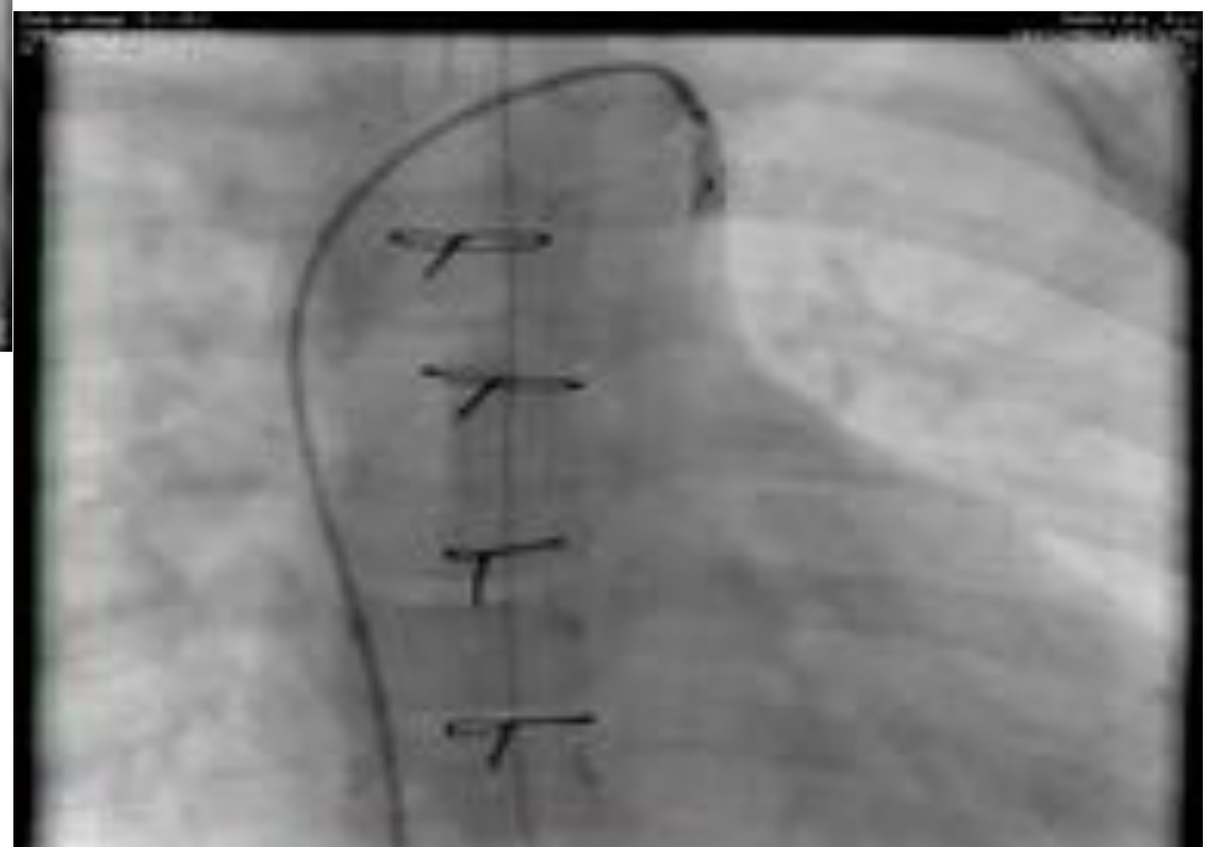
Stenting AP

Occlusion fistules veino-veineuses



Occlusion de fistule veino-cardiaque





Occlusion de collatérales aorto-pulmonaires

Occlusion de collatérales aorto-pulmonaires

Fenestration du circuit de Fontan

Vieux Concept (1972)

Décompression du système veineux systémique

Amélioration du post-opératoire (diminution de la durée de ventilation mécanique, de drainage pleural et d’hospitalisation

Au prix d’une cyanose plus ou moins marquée

Fenestration à moyen et long terme

Désaturation

Risque thrombo-embolique

Limitation à l’effort

Fermeture spontanée

Fenestration à moyen et long terme

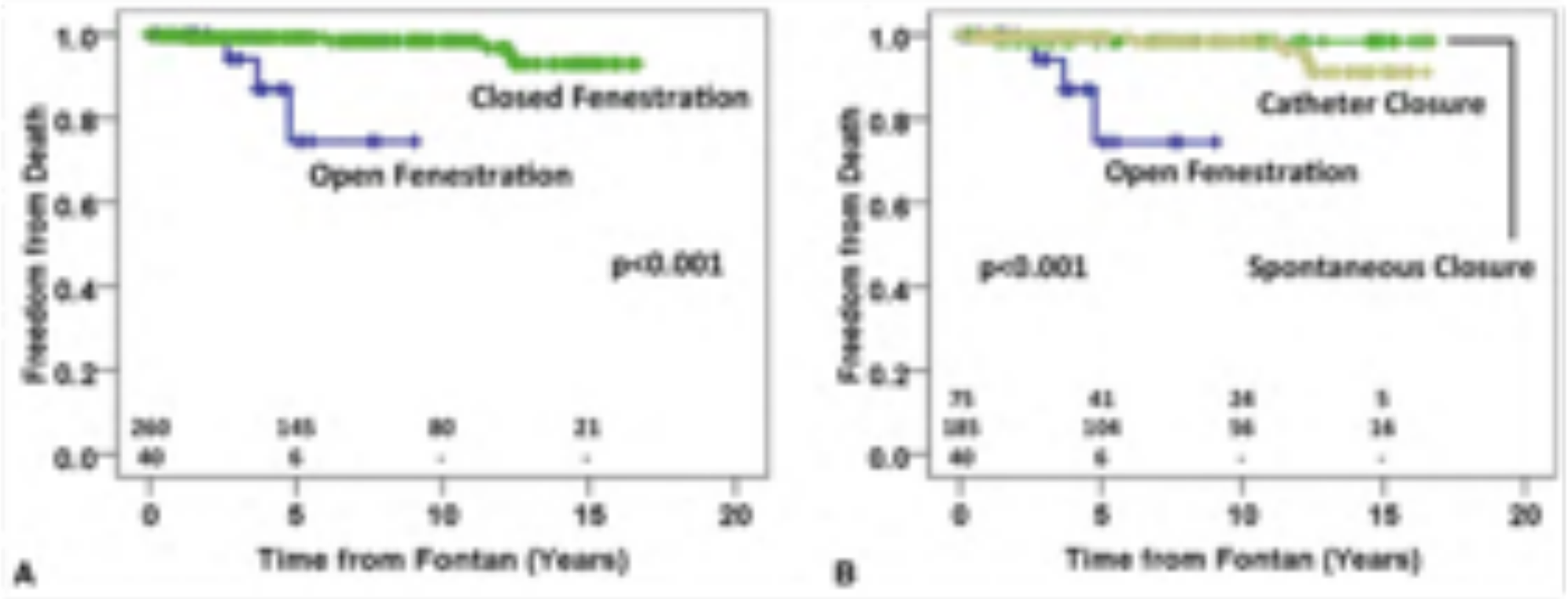
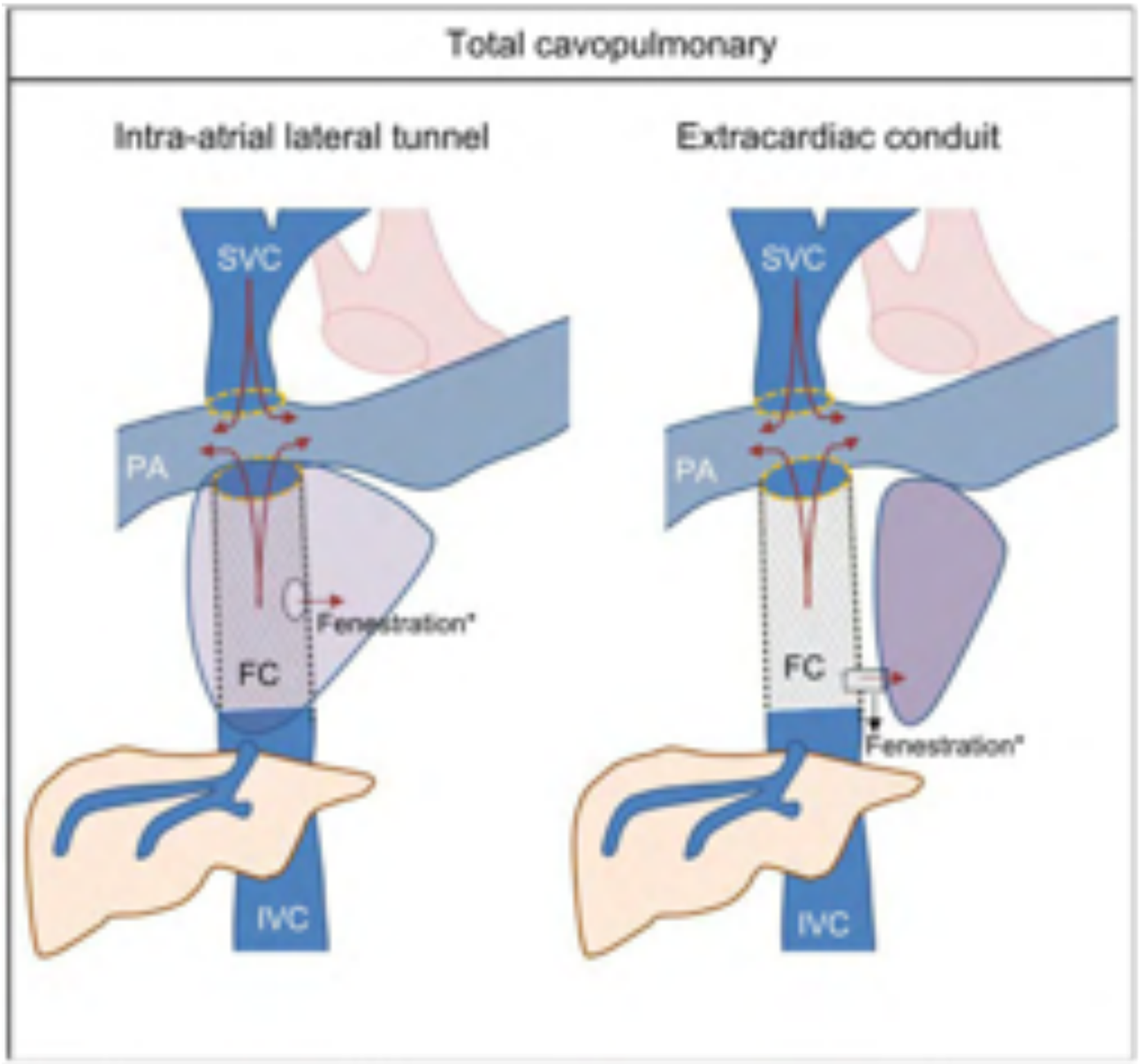


FIGURE 1. Freedom from death between open and closed fenestration (A) and stratified by mechanism of fenestration closure (B). The Kaplan-Meier curve showed that the mechanism of fenestration closure was not important but the presence of an open fenestration was associated with the lowest survival.

Kotani et al. JTCVS 2014

2 principaux types de circulation de Fontan



L. Téllez et al. / Rev Esp Cardiol. 2018;71(3):192–202

Quand ferme-t-on la fenestration? Chez qui?

Pas d’évidence sur le timing

Au moins après 6 mois après la chirurgie

Avant l’AVC

Test occlusion

RVP basses ?

PVC basses? Relativement basses? < à 15 mmHg; < à 18 mmHg

Comparaison

Prothèse

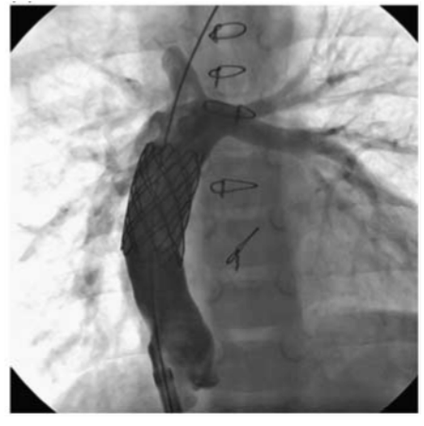
Gold standard

Littérature abondante

Différentes tailles, formes

Petits introducteurs

Stents couverts



Fontan extracardiaque

Peu de littérature

Différents fabricants

Introducteurs plus grands

Comparaison: avantages

Prothèses

Gold standard

Petits introducteurs

Stents couverts

Facilité

Pas d’échographie

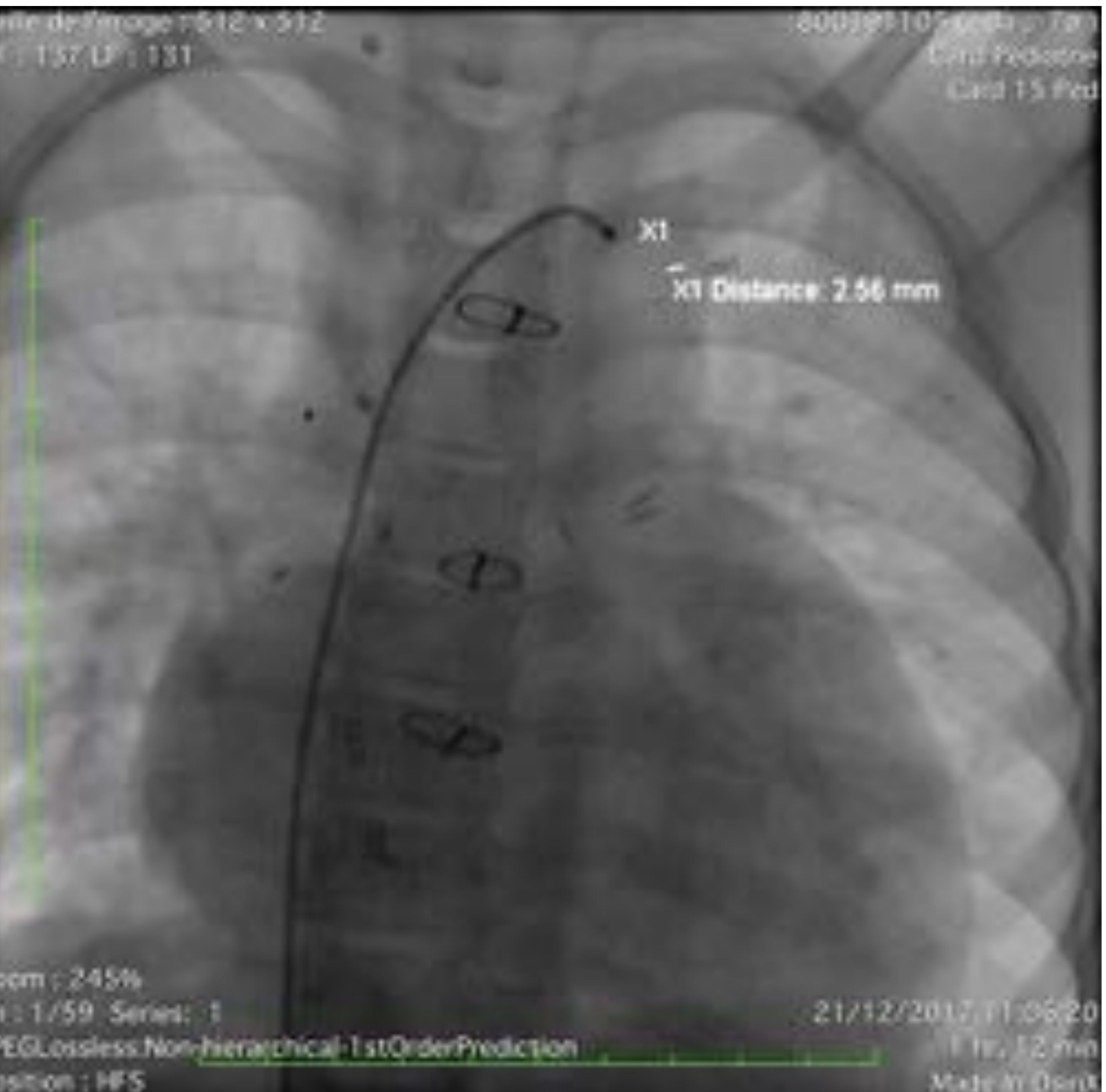
Temps de scopie court

Très peu de complications

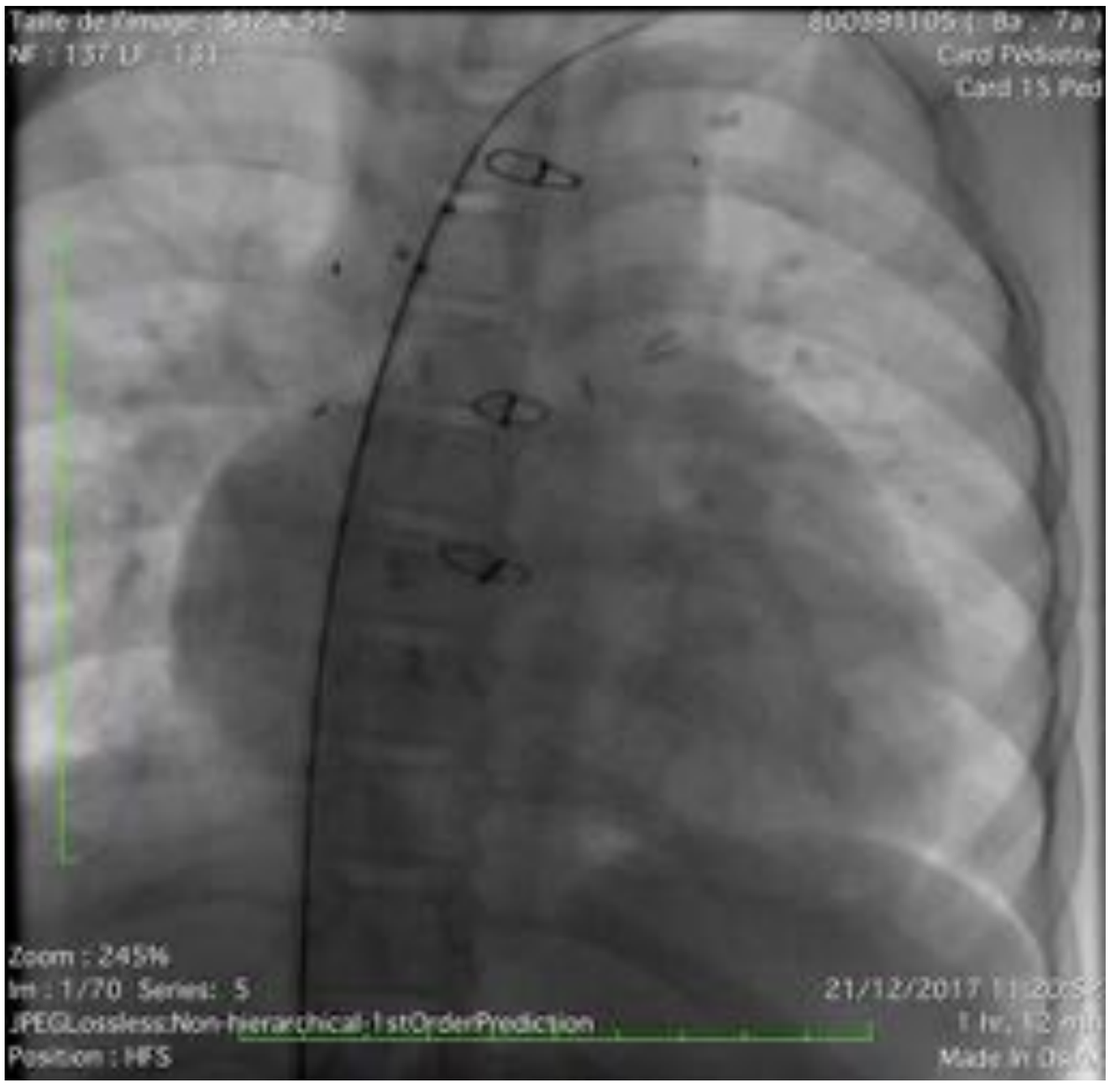
Réduction avec l’expérience de la taille de l’introducteur

Expansion du conduit de DCPT

En pratique



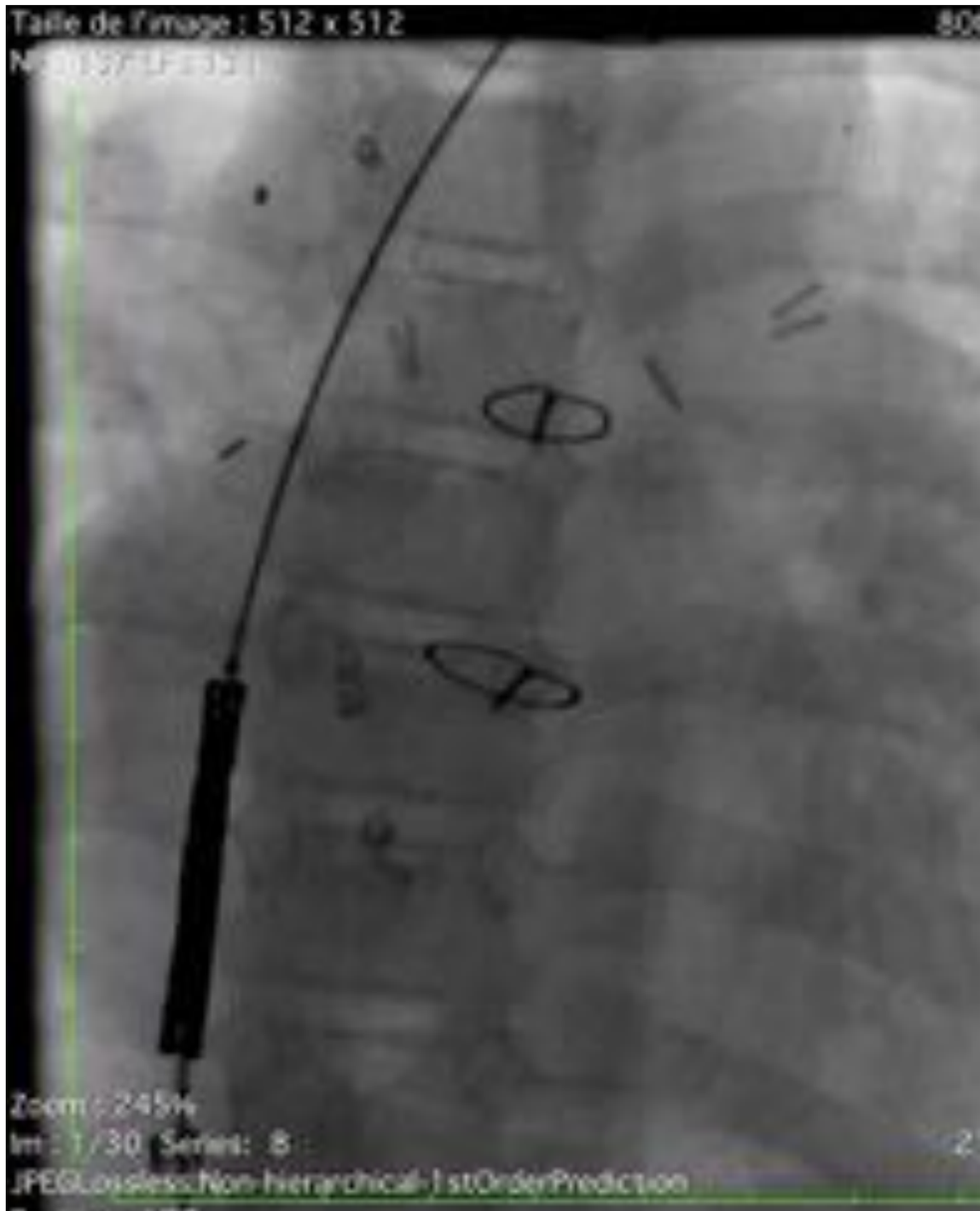
En pratique


Taille de l'image : 512 x 512
Card Pédiatre
Card 15 Ped
Zoom : 245%
Im : 1/70 Series: 5
JPEGLossless:Non-hierarchical-1stOrderPrediction
Position : HFS


Taille de l'image : 512 x 512
Zoom : 245%
Im : 1/58 Series: 6
JPEGLossless:Non-hierarchical-1stOrderPrediction
Position : HFS

En pratique


de l'image : 512 x 512
800391105 (8a , 7a)
Card Pédiatrie
Card 15 Ped
X1
X1 Distance: 34.60 mm
21/12/2017 11:21:40
1 hr, 12 min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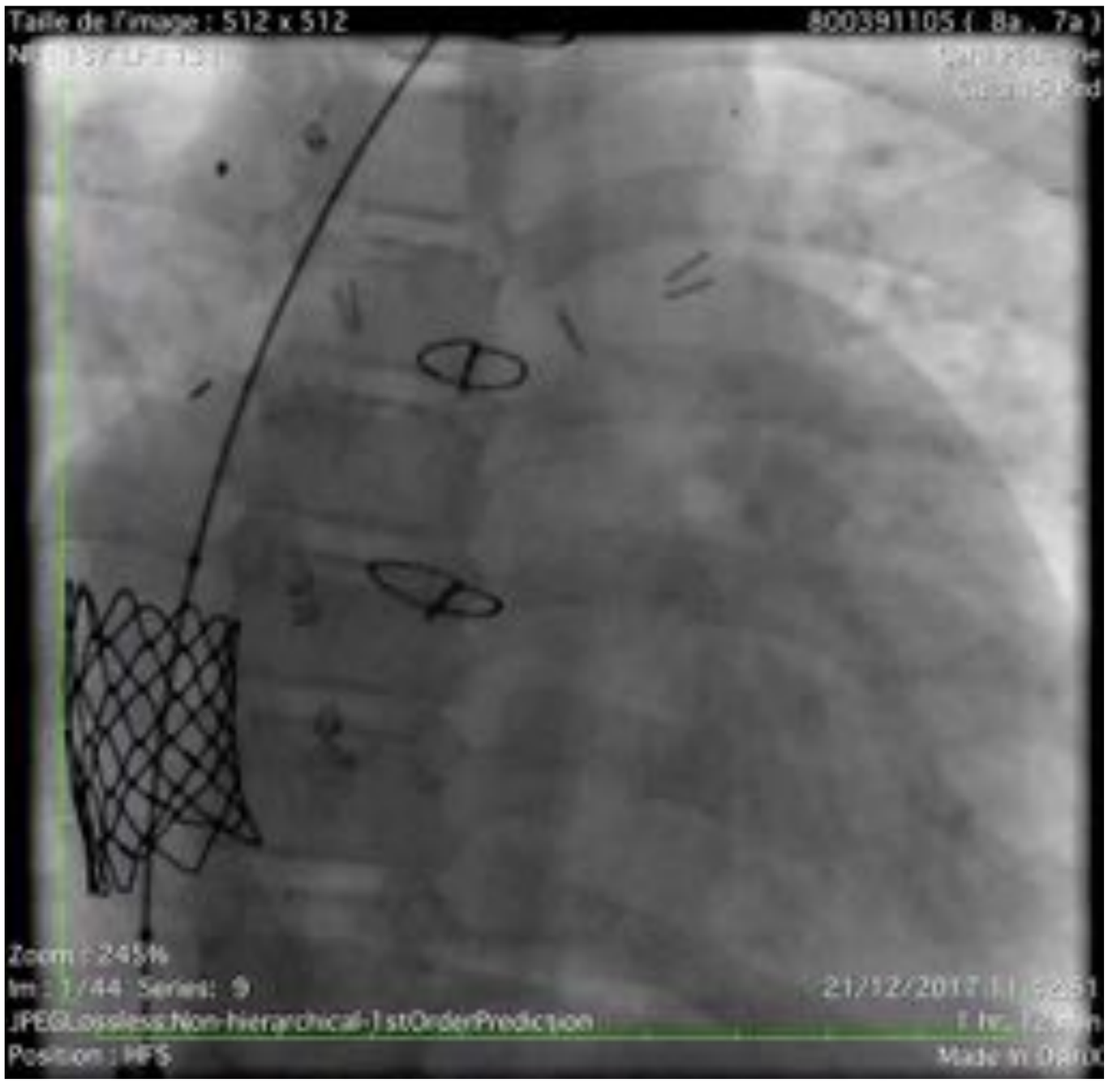
Zoom : 245%
Im : 1/30 Series: 8
JPEGLossless:Non-hierarchical-1stOrderPrediction

Pour terminer



Obstacles du coeur gauche

- Sténose aortique fœtale
- Sténose aortique critique
- Sténose aortique
- Coarctation native néonatale
- Coarctation native chez l’enfant
- Recoarctation

Evolution of the disease

[Allan, Int. J. Cardiology 1989]

22 weeks gestation

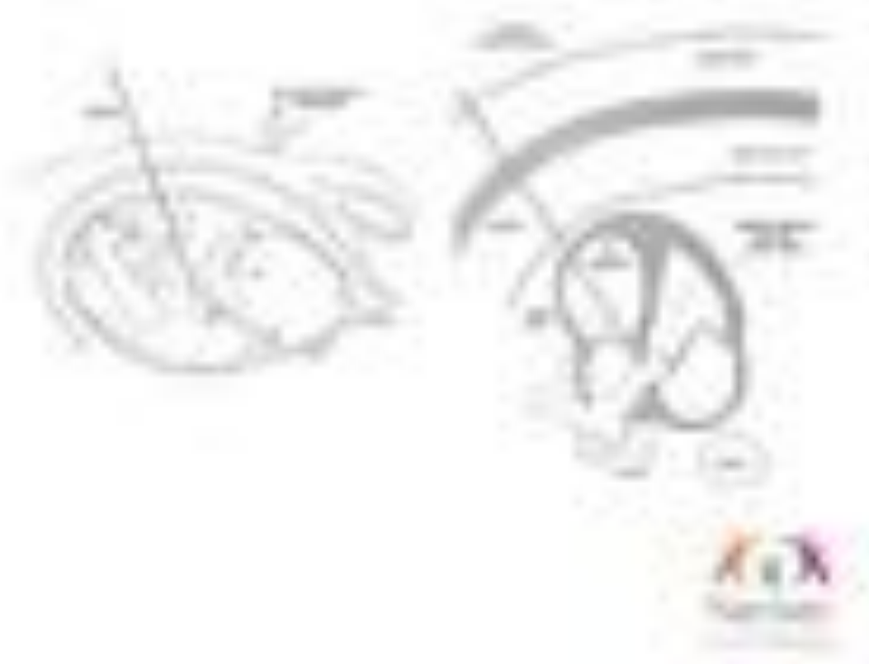
32 weeks gestation

Histoire de la dilatation foetale 1989-2000

Balloon dilatation of the aortic valve in the fetus: a report of two cases

Survival after fetal aortic balloon valvuloplasty

World Experience of Percutaneous Ultrasound-Guided Balloon Valvuloplasty in Human Fetuses With Severe Aortic Valve Obstruction

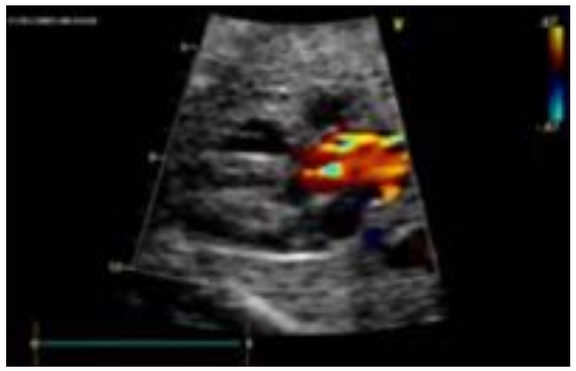


Rationnel pour proposer ce type de traitement

- ✓Maladie évolutive
- ✓Technique permettant de limiter l'évolution de la maladie
- ✓Pas ou peu de morbi-mortalité maternelle

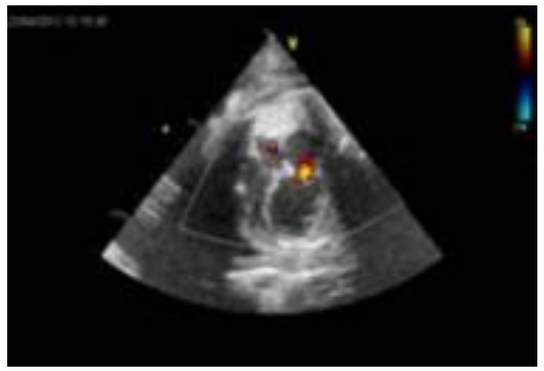
- ✓Résultats en demi-teinte mais petites séries, choix des bons candidats

3 phénotypes



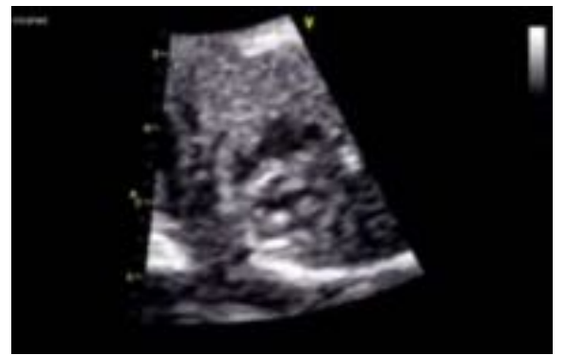
VG hypertrophié
Fonction normale
Dopplers normaux

FU très rapproché
Evolution défavorable possible



VG dilaté
Dysfonction
Fibroélastose

2d trimestre: potentielle évolution vers HypoVG
3ème trimestre: suivi rapproché



VG petit, fibreux

HypoVG à la naissance

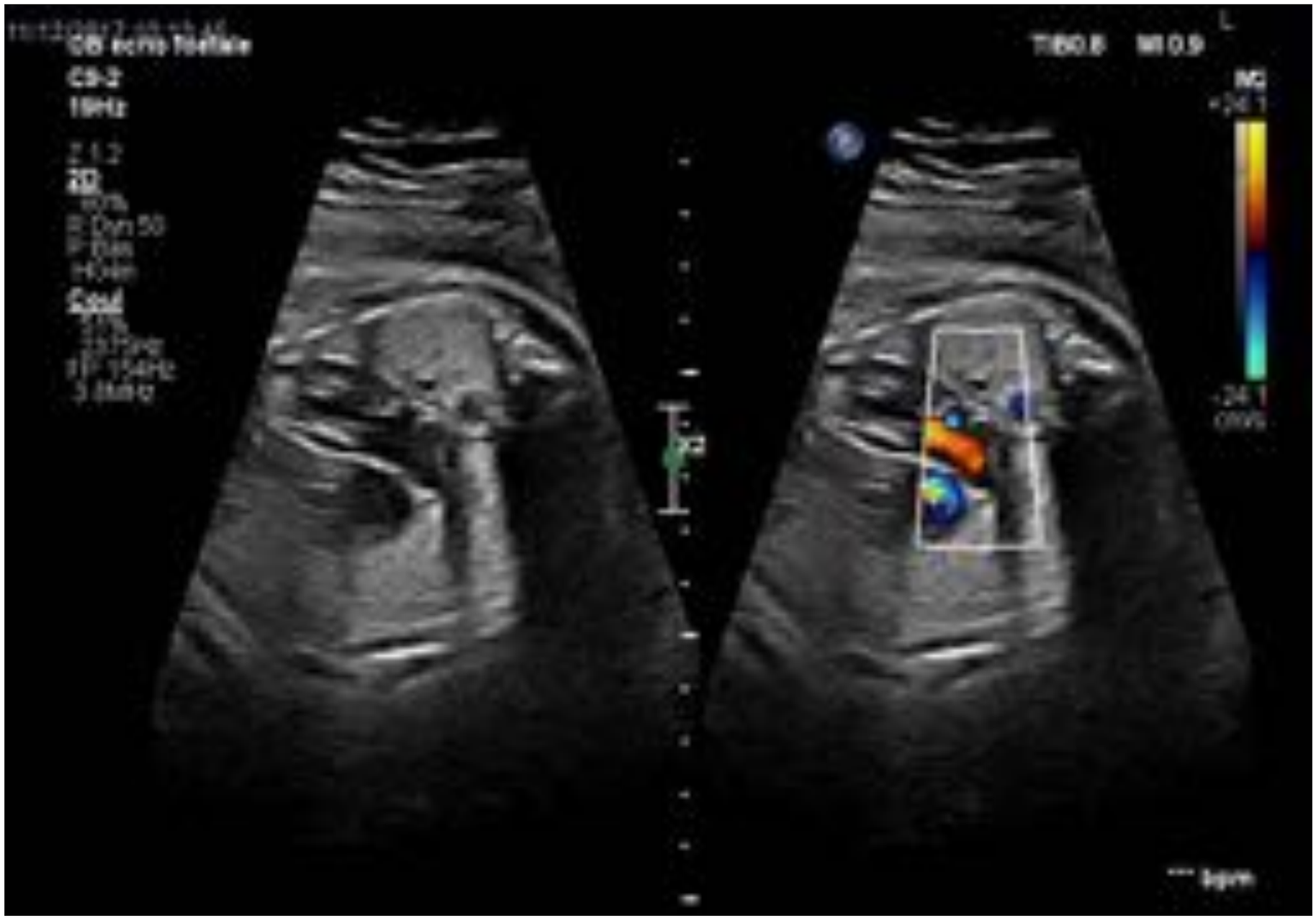
Restaurer la croissance du coeur gauche
Améliorer fonction systolique
Améliorer fonction diastolique

Les pratiques à l'hôpital Necker

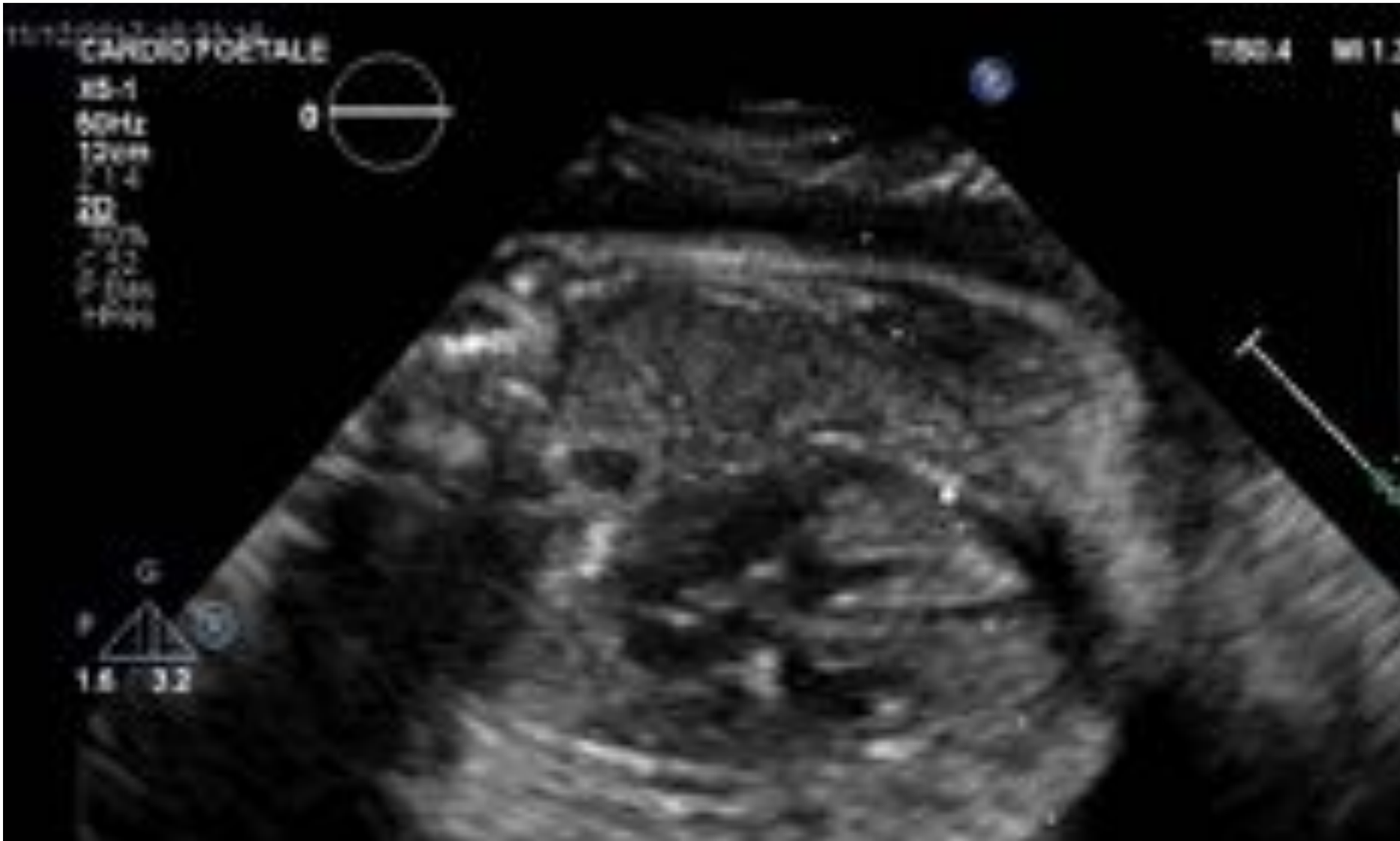
Sténose aortique
Z-score VG >-2
Z-score Mitrale >-2
PFO gauche-droite
Flux aortique rétrograde
AG 20-30 SA

Péridurale
Anesthésie foetale
Approche trans thoracique (17-19G)
Ballon coronaire
Adrénaline et sang disponible

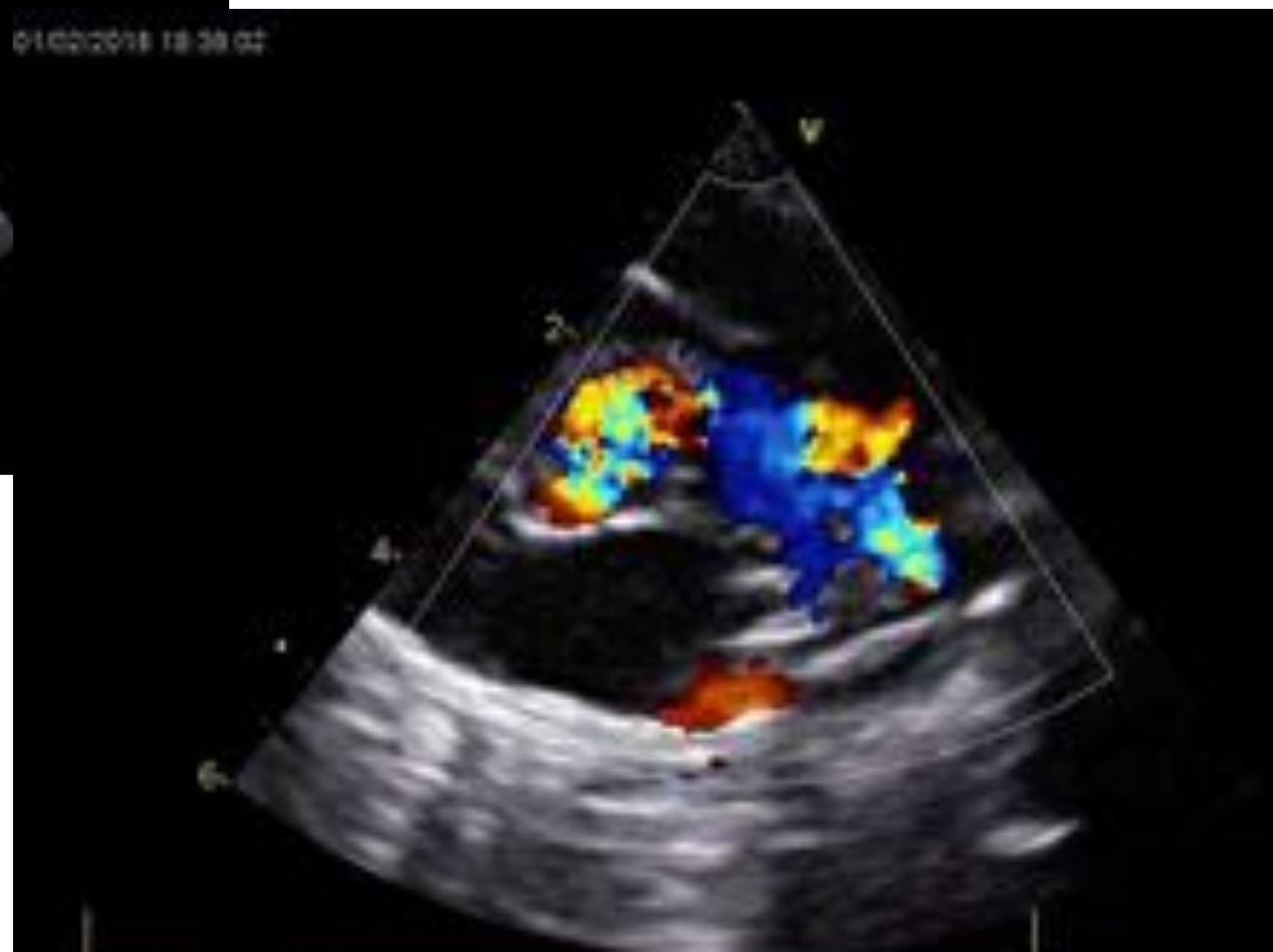
Exemple de sténose aortique foetale



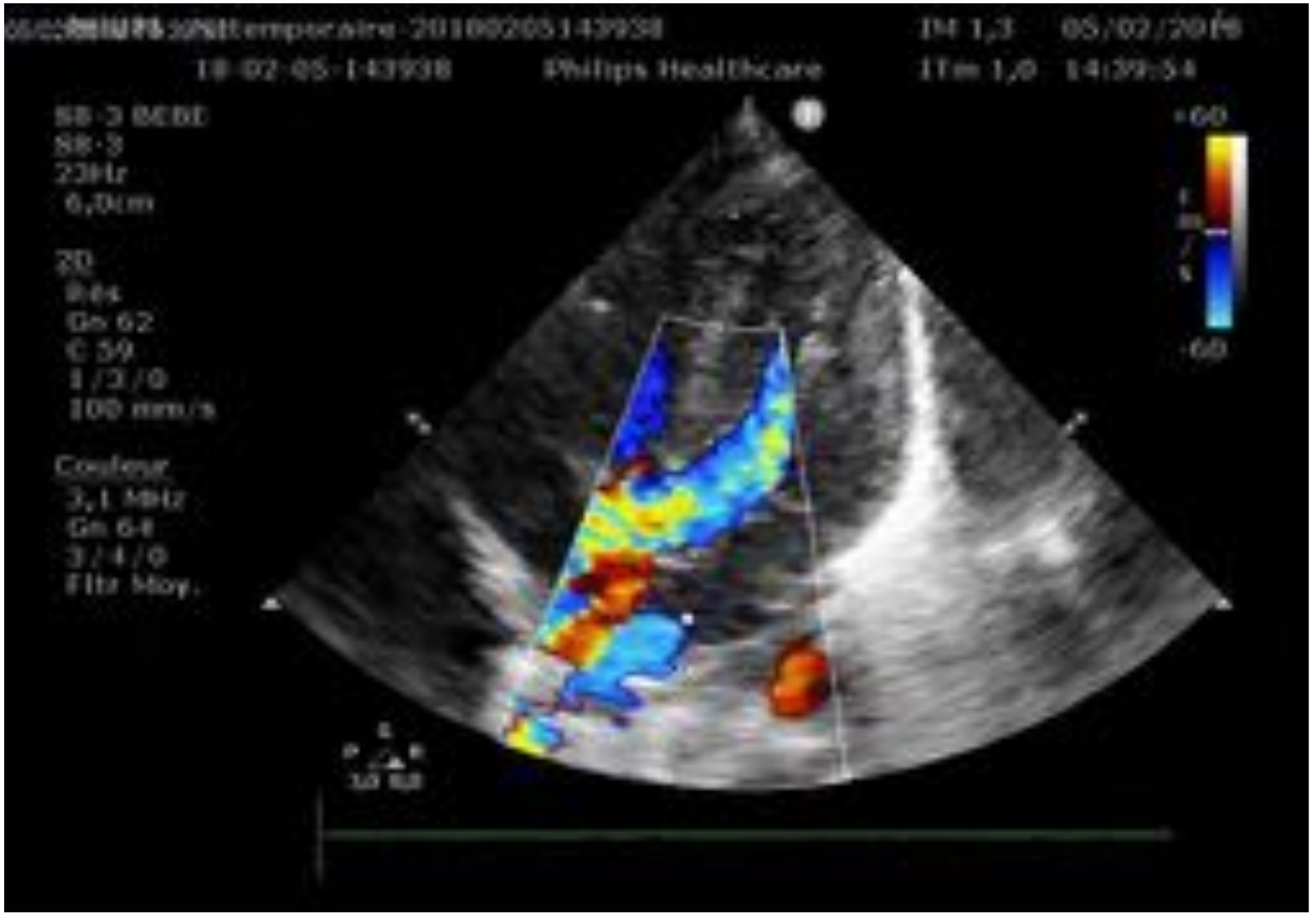
Post dilatation foetale: normalisation de la fonction



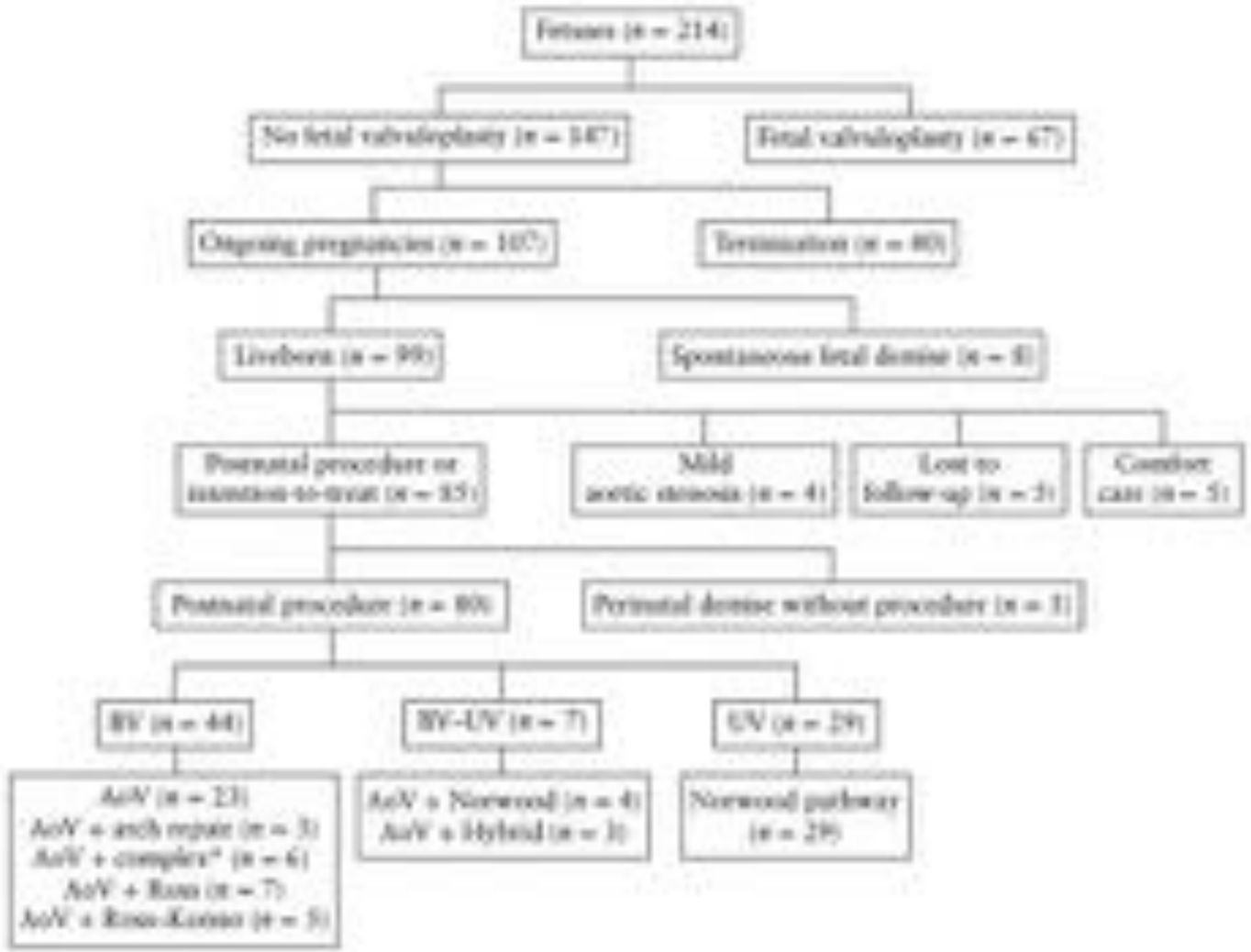
Evaluation post natale



Post dilatation néonatale



Natural history of 107 cases of fetal aortic stenosis from a European multicenter retrospective study

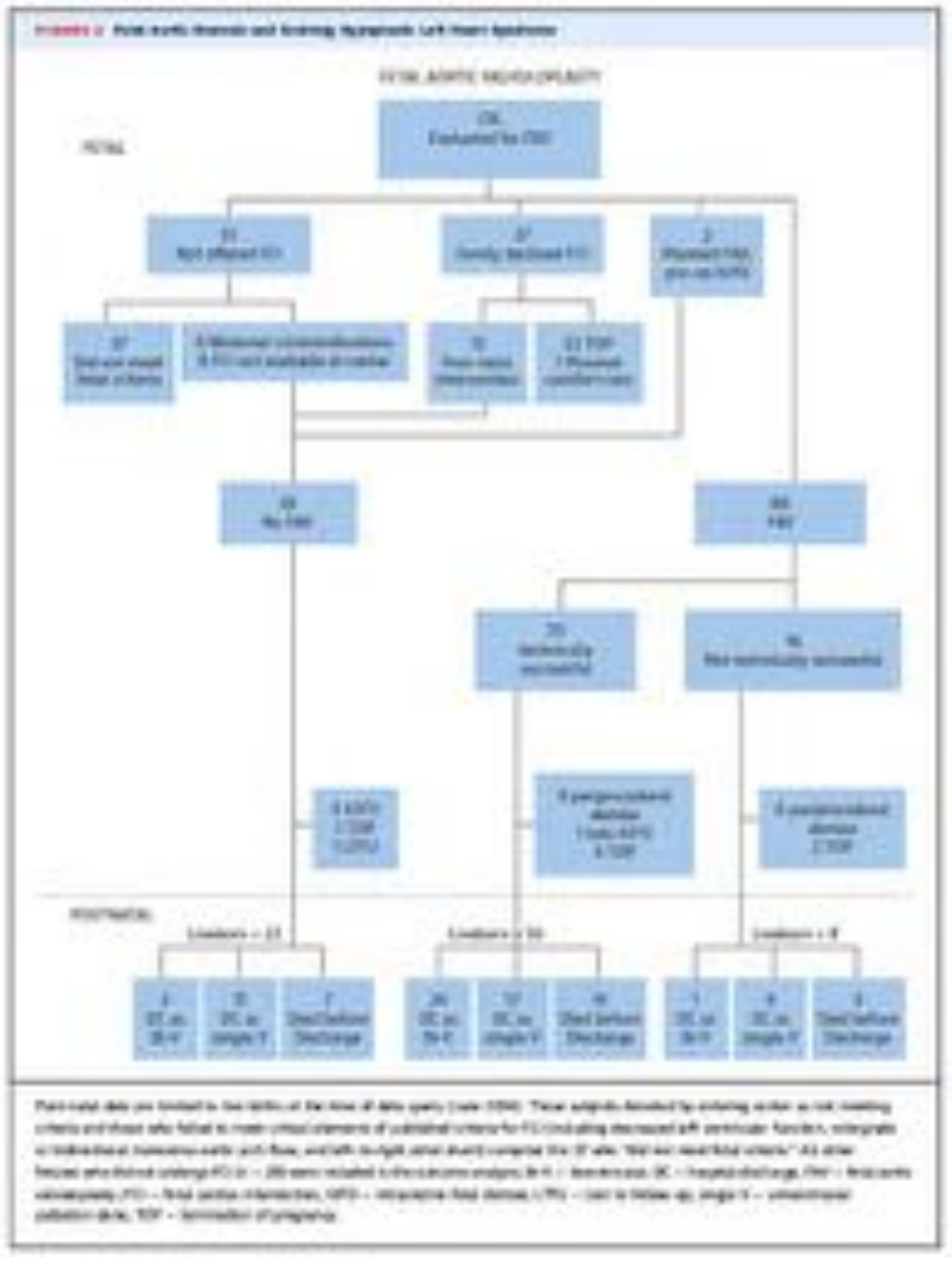


Gardiner et al. Ultrasound Obstet Gynecol 2016

International Fetal Cardiac Intervention Registry

A Worldwide Collaborative Description and Preliminary Outcomes

Moon-Grady, JACC 2015



Si compare le groupe avec et sans intervention en prenant que ceux qui ont une intervention qui q-a fonctionné: 42 vs 19% biv
Donc dilat fonctionne

Sténose aortique critique

- 2 techniques coexistent depuis des années: valvuloplastie chirurgicale ou endoluminale
- Peu d'évidence que l'une soit meilleure que l'autre
- Plutôt des stratégies qui dépendent des centres

Sténose aortique critique physiopathologie

- ✓Obstacle à l'éjection du ventricule gauche
- ✓Ducto-dépendance
- ✓Atteinte du ventricule gauche variable

VG dilaté ou hypertrophié

Dysfonction systolique

Dysfonction diastolique

- ✓Anomalie mitrale
- ✓Anomalie de la crosse de l'aorte

Faire le bilan des lésions

- ✓Fonction ventriculaire systolique, diastolique
- ✓Taille du ventricule gauche
- ✓Fibroélastose
- ✓Etude de la valve mitrale, importance de la fuite, de l'appareil sous valvulaire
- ✓Etude de la voie sous-aortique
- ✓Etude de la crosse de l'aorte

Prise en charge

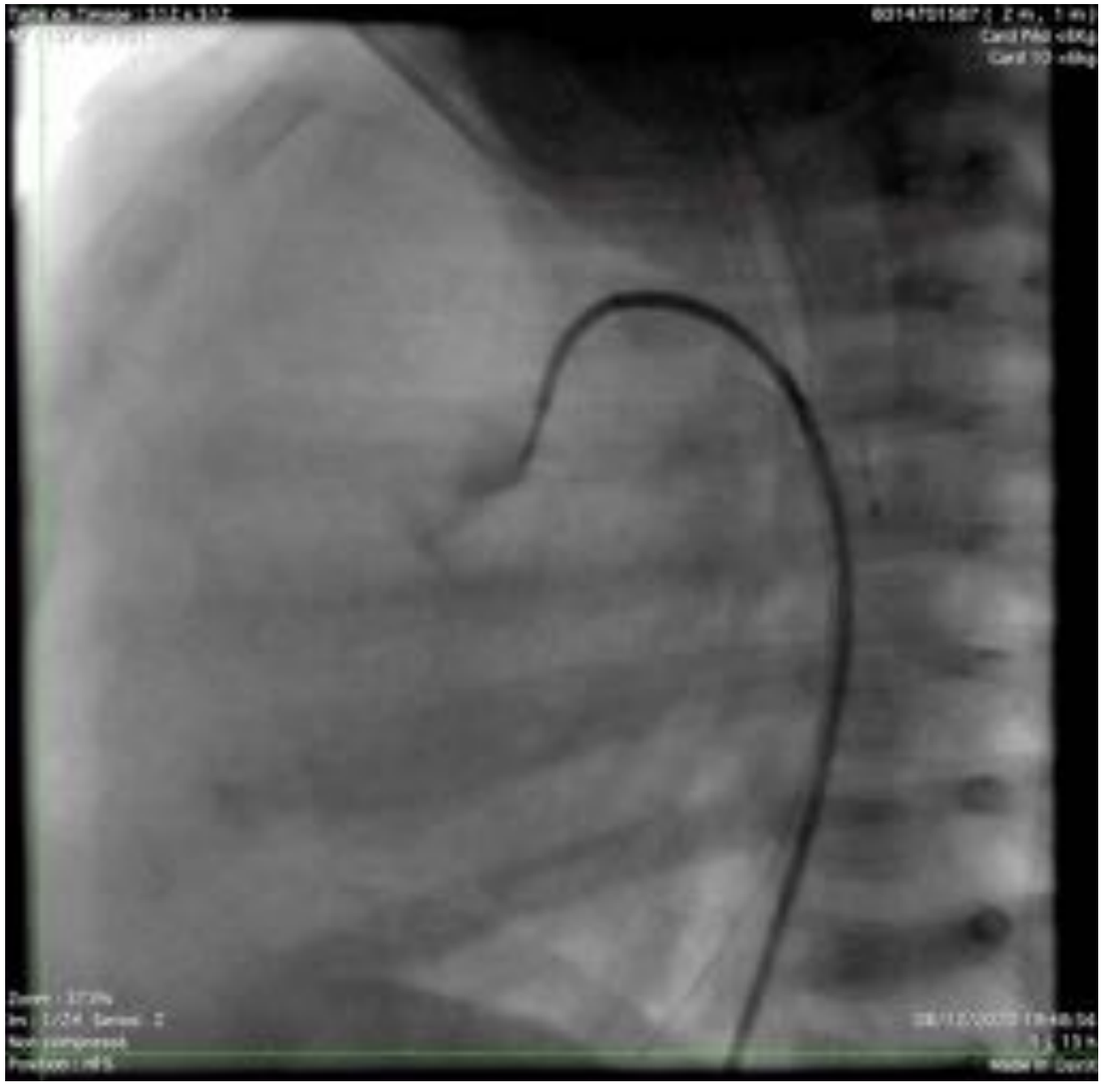
Prostaglandines, IET si nécessaire, réanimation agressive

VG adapté
Chirurgie

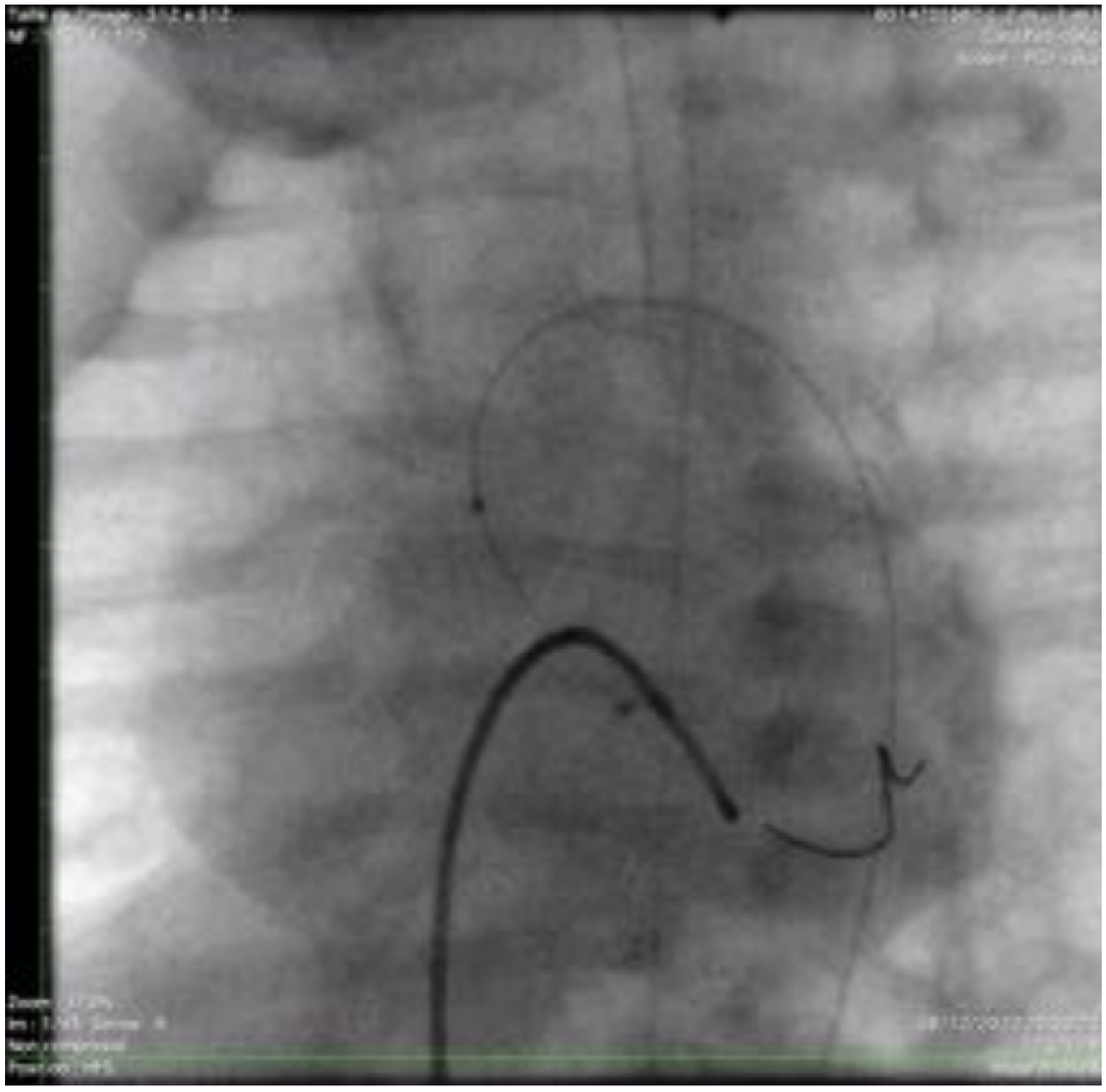
Forme la plus grave
VG poupée
Prise en charge Norwood avec ou sans réhabilitation du VG
Abstention

Dysfonction du VG
Dilatation endoluminale


X1
X1 Distance: 6.96 mm



Dilatation sous pacing rapide



Revue de la littérature: chirurgie versus cathétérisme: controverse

Neonatal Isolated Critical Aortic Valve Stenosis: Balloon Valvuloplasty or Surgical Valvotomy

Lung and heart circ 2006

Surgical Valvotomy and Repair for Neonatal and Infant Congenital Aortic Stenosis Achieves Better Results Than Interventional Catheterization

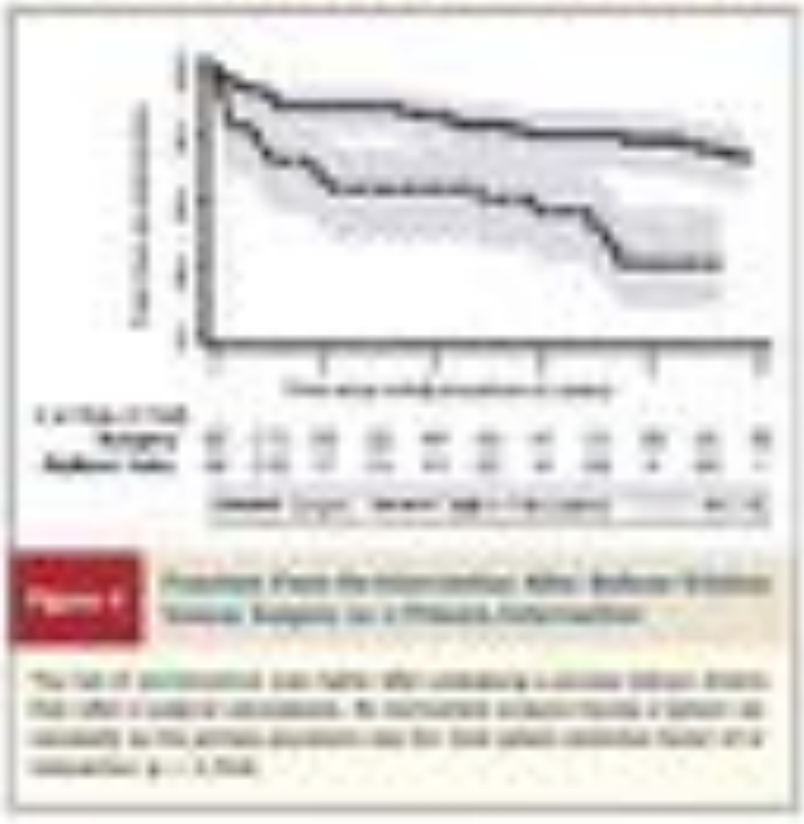
Neonatal Aortic Stenosis Is a Surgical Disease

Viktor Hraška

Chirurgie

Surgical Valvotomy and Repair for Neonatal and Infant Congenital Aortic Stenosis Achieves Better Results Than Interventional Catheterization

Sidiqqui et al. JACC 2013



Neonatal Aortic Stenosis Is a Surgical Disease

Viktor Hraška

Semin Thorac Cardiovasc Surg Pediatr Card Surg Ann 19:2:5 © 2016 I

Prise en charge multidisciplinaire
Si FE VG altérée: dilatation prudente puis chirurgie

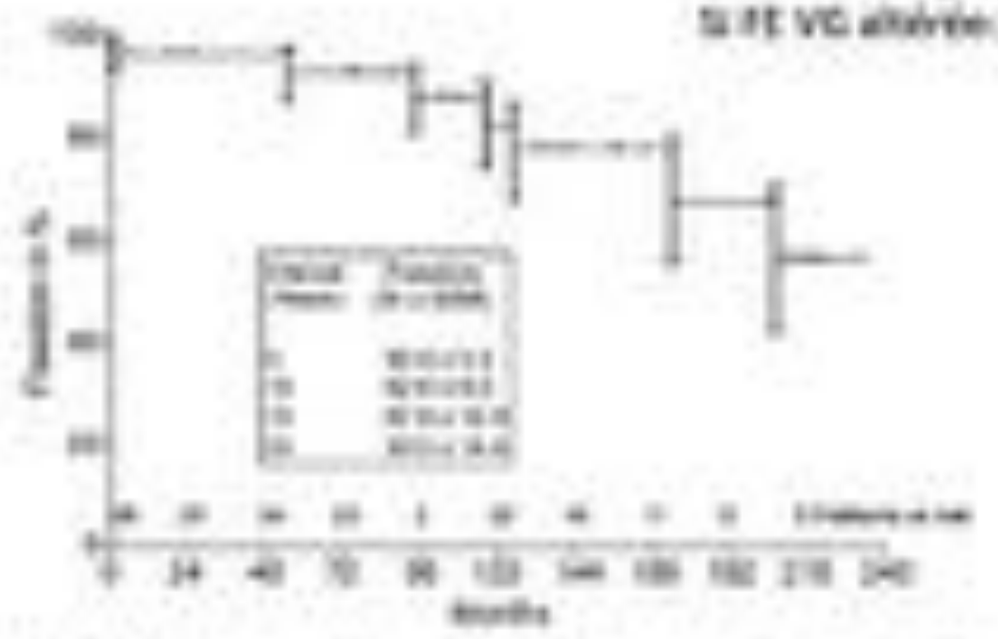
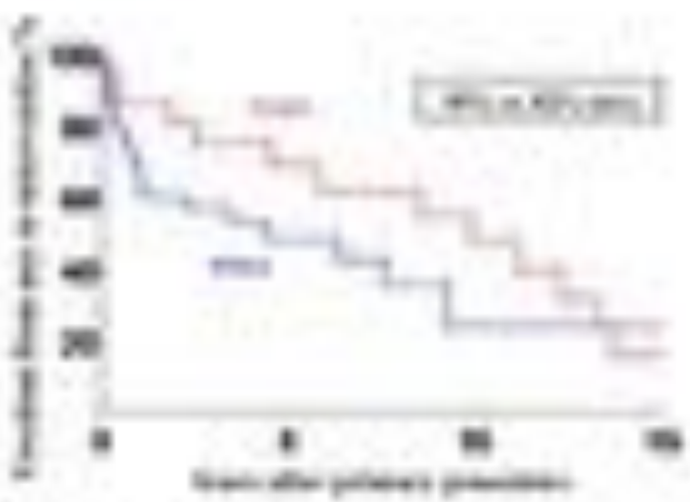
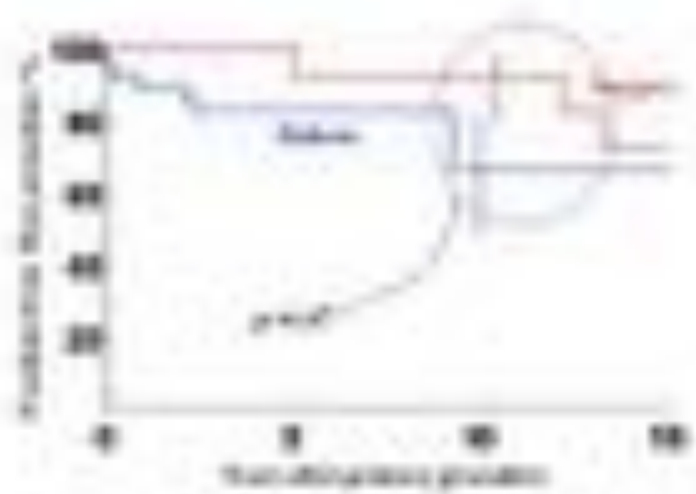


Figure 2 The Kaplan-Meier curve shows freedom from AVR after (N). The numbers of patients at risk is shown above the x-axis. The error bars indicate the standard error of the mean. (Reprinted with permission from Hraška et al.[7])

Neonatal Aortic Stenosis is a Surgical Disease: An Interventional Cardiologist View

Lee Benson





Cathétérisme

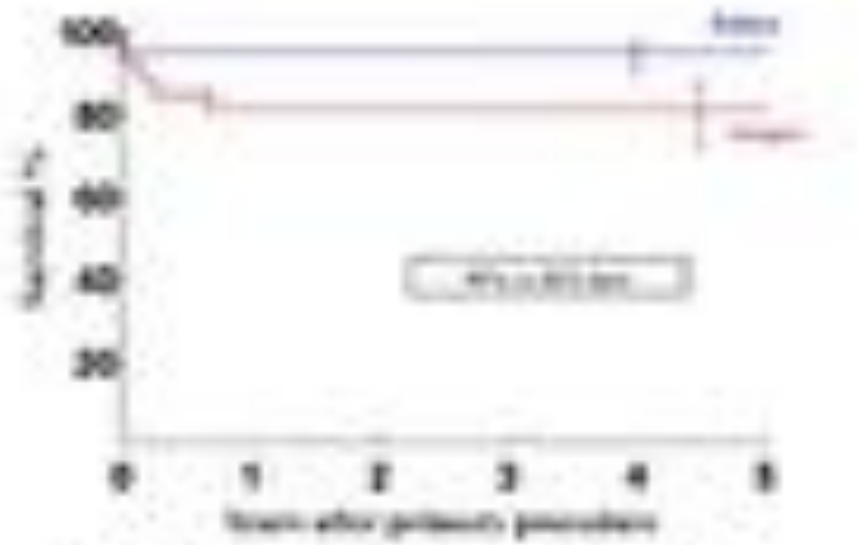


figure 1 Overall survival curves by stage

Cathétérisme: règles à suivre

- Dilatation prudente pour éviter la fuite
- Ratio ballon/anneau maximum 1

- Pacing rapide du VD en dehors de la période néonatale ou de la petite enfance pour stabiliser le ballon

Chirurgie vs cathétérisme

- ✓Interventions palliatives
- ✓Taux de mortalité élevé
- ✓Avant le remplacement de la valve aortique
- ✓Le moins de mortalité, la réintervention la plus tardive
- ✓Pas de dogme, cas par cas sans doute le plus adapté

Stratégie différente en fonction de l’âge et de la lésion

- Période néonatale

- Période de la petite enfance (<20 kg)

- Au delà (jusqu’à l’âge adulte) (nombreuses collatérales, chirurgie complexe)

- Coarctation native

- Recoarctation de l’aorte

Recoarctation de l'aorte

Class I

1. **Balloon angioplasty of recoarctation is indicated when associated with a transcatheter systolic coarctation gradient of >20 mm Hg and suitable anatomy, irrespective of patient age *(Level of Evidence: C)*.**
2. **Balloon angioplasty of recoarctation is indicated when associated with a transcatheter systolic coarctation gradient of <20 mm Hg and in the presence of significant collateral vessels and suitable angiographic anatomy, irrespective of patient age, as well as in patients with univentricular heart or with significant ventricular dysfunction *(Level of Evidence: C)*.**

Class I

1. **Stent placement is indicated in patients with recurrent coarctation who are of sufficient size for safe stent placement, in whom the stent can be expanded to an adult size, and who have a transcatheter systolic coarctation gradient >20 mm Hg *(Level of Evidence: B)*.**

Class IIa

1. **It is reasonable to consider placement of a stent that can be expanded to an adult size for the initial treatment of native or recurrent coarctation of the aorta in patients with:**
   - **a transcatheter systolic coarctation gradient of >20 mm Hg *(Level of Evidence: B)*.**
   - **a transcatheter systolic coarctation gradient of <20 mm Hg but with systemic hypertension associated with an anatomic narrowing that explains the hypertension *(Level of Evidence: C)*.**
   - **a long-segment coarctation with a transcatheter systolic coarctation gradient >20 mm Hg *(Level of Evidence: B)*.**

Recoarctation de l'aorte

Class IIb

1. **It may be reasonable to consider stent implantation for the treatment of coarctation in infants and neonates when complex aortic arch obstruction exists despite surgical or catheter-mediated attempts to relieve this obstruction and when further surgery is regarded as high risk. Implantation of a stent with less than adult-sized potential implies a commitment on the part of the surgical team to remove or enlarge this stent at a later date when the final diameter of this device is no longer adequate to maintain unobstructed aortic flow *(Level of Evidence: C)*.**

Coarctation native

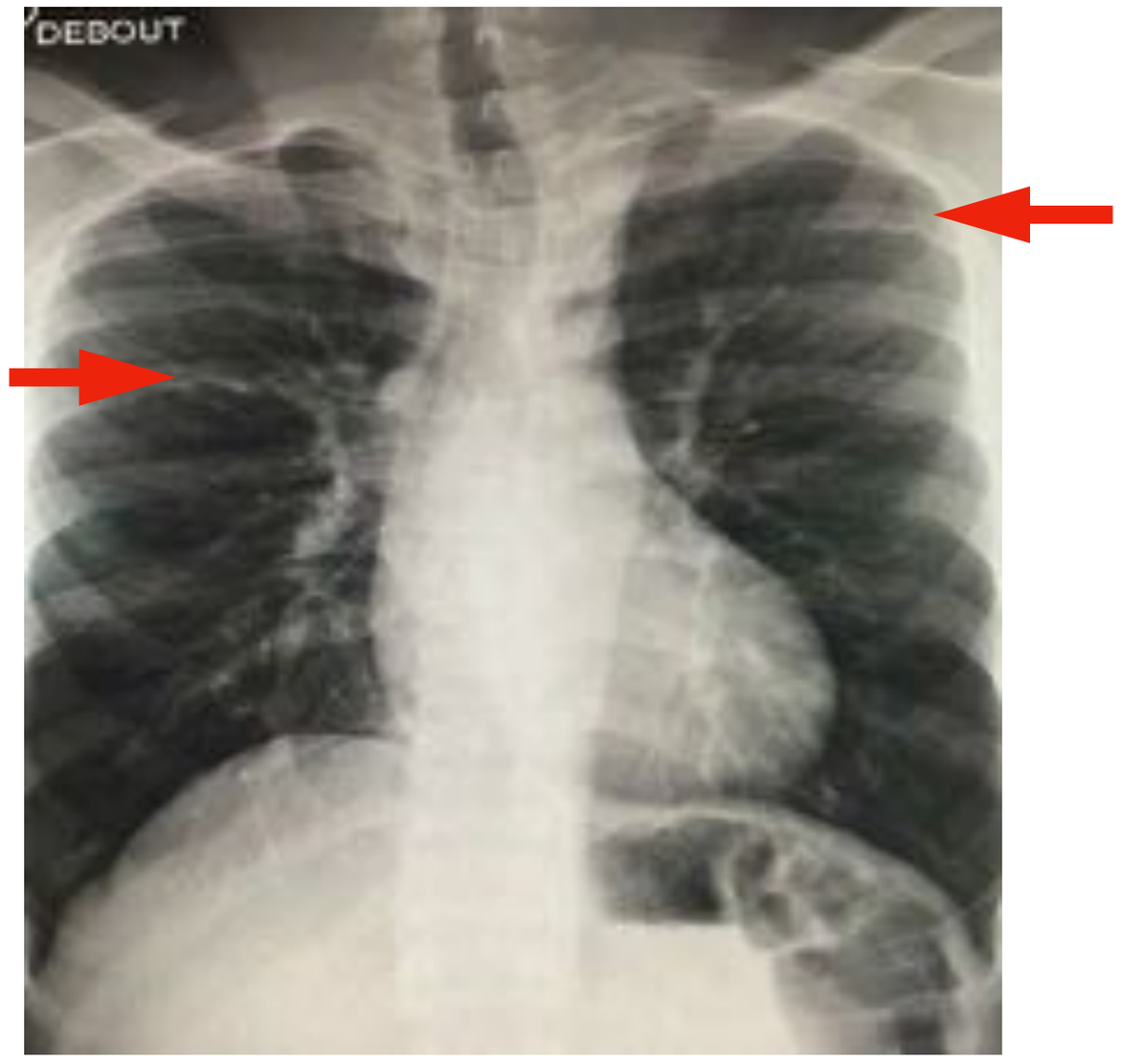
Class IIa

1. **It is reasonable to consider balloon angioplasty of native coarctation as a palliative measure to stabilize a patient irrespective of age when extenuating circumstances are present such as severely depressed ventricular function, severe mitral regurgitation, low cardiac output, or systemic disease affected by the cardiac condition *(Level of Evidence: C)*.**

Class IIa

1. **It is reasonable to consider placement of a stent that can be expanded to an adult size for the initial treatment of native or recurrent coarctation of the aorta in patients with:**
   - **a transcatheter systolic coarctation gradient of >20 mm Hg *(Level of Evidence: B)*.**
   - **a transcatheter systolic coarctation gradient of <20 mm Hg but with systemic hypertension associated with an anatomic narrowing that explains the hypertension *(Level of Evidence: C)*.**
   - **a long-segment coarctation with a transcatheter systolic coarctation gradient >20 mm Hg *(Level of Evidence: B)*.**
2. **Stent implantation for the treatment of coarctation (native or recurrent) is reasonable in patients in whom balloon angioplasty has failed, as long as a stent that can be expanded to an adult size can be implanted *(Level of Evidence: B)*.**

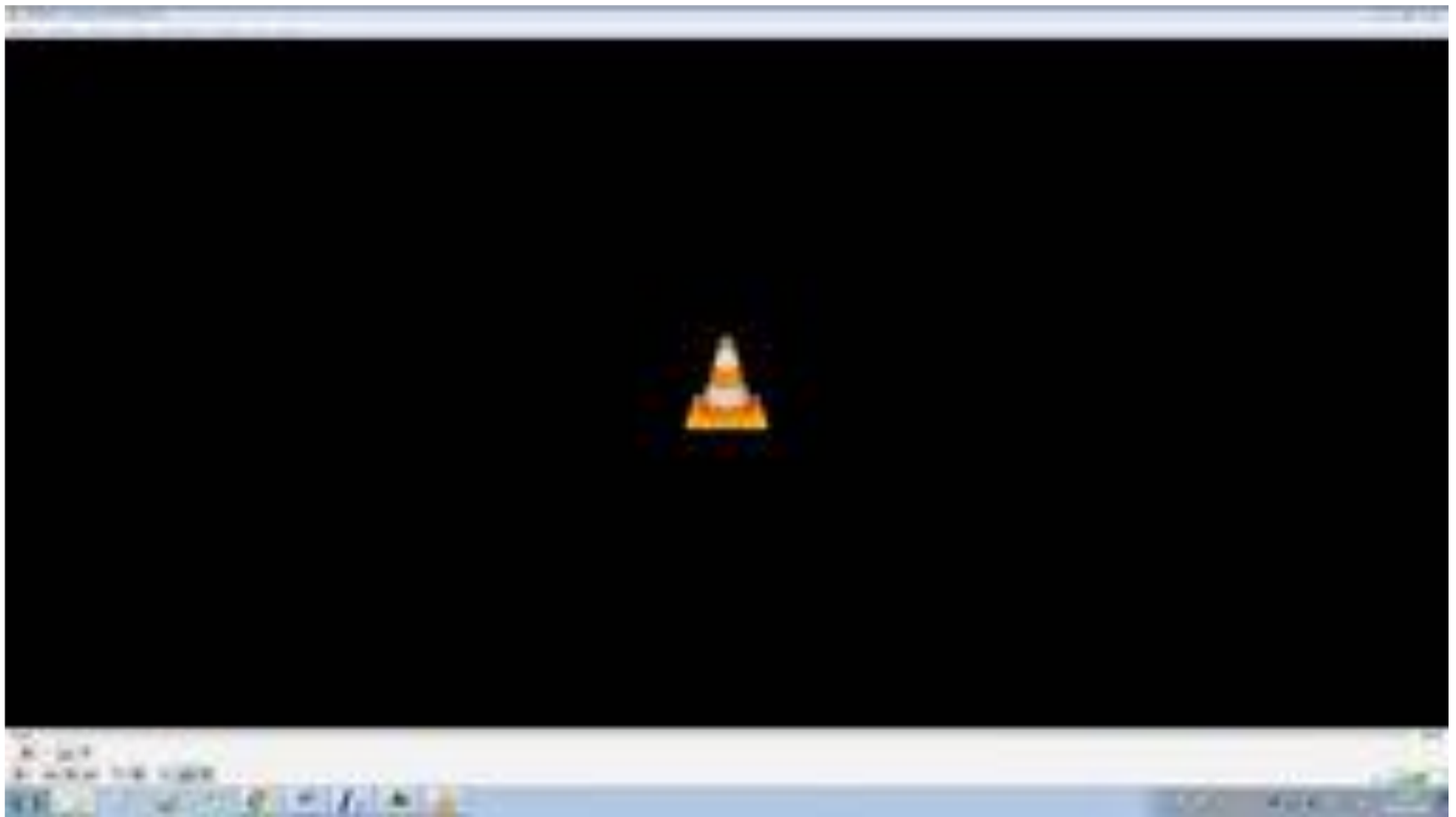
Anciennement
Mais toujours valable



Erosion costale

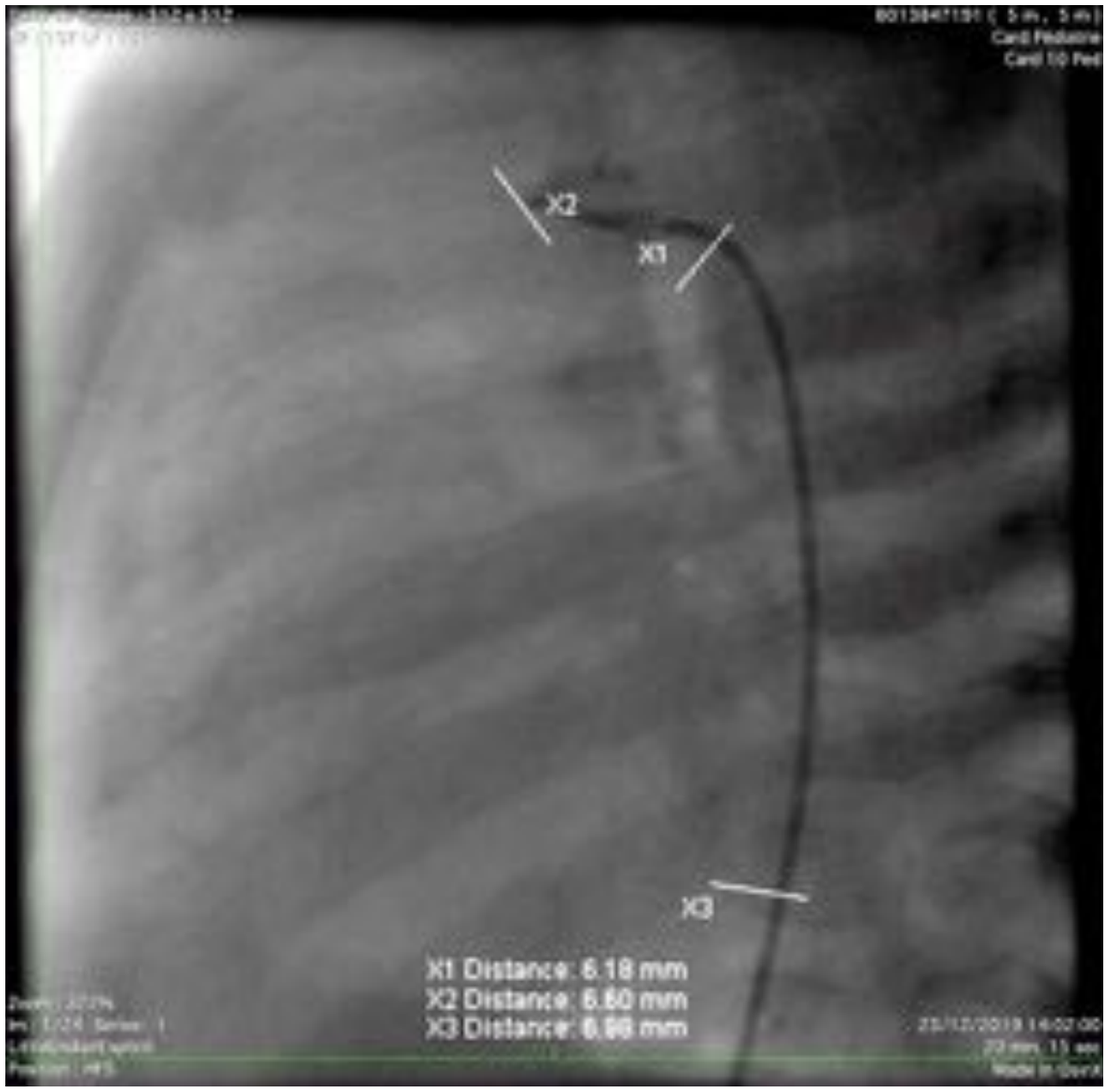
Bilan pré-cathétérisme

- Imagerie cérébrale (anévrismes)
- Imagerie de la crosse (IRM 4D flow; scanner)

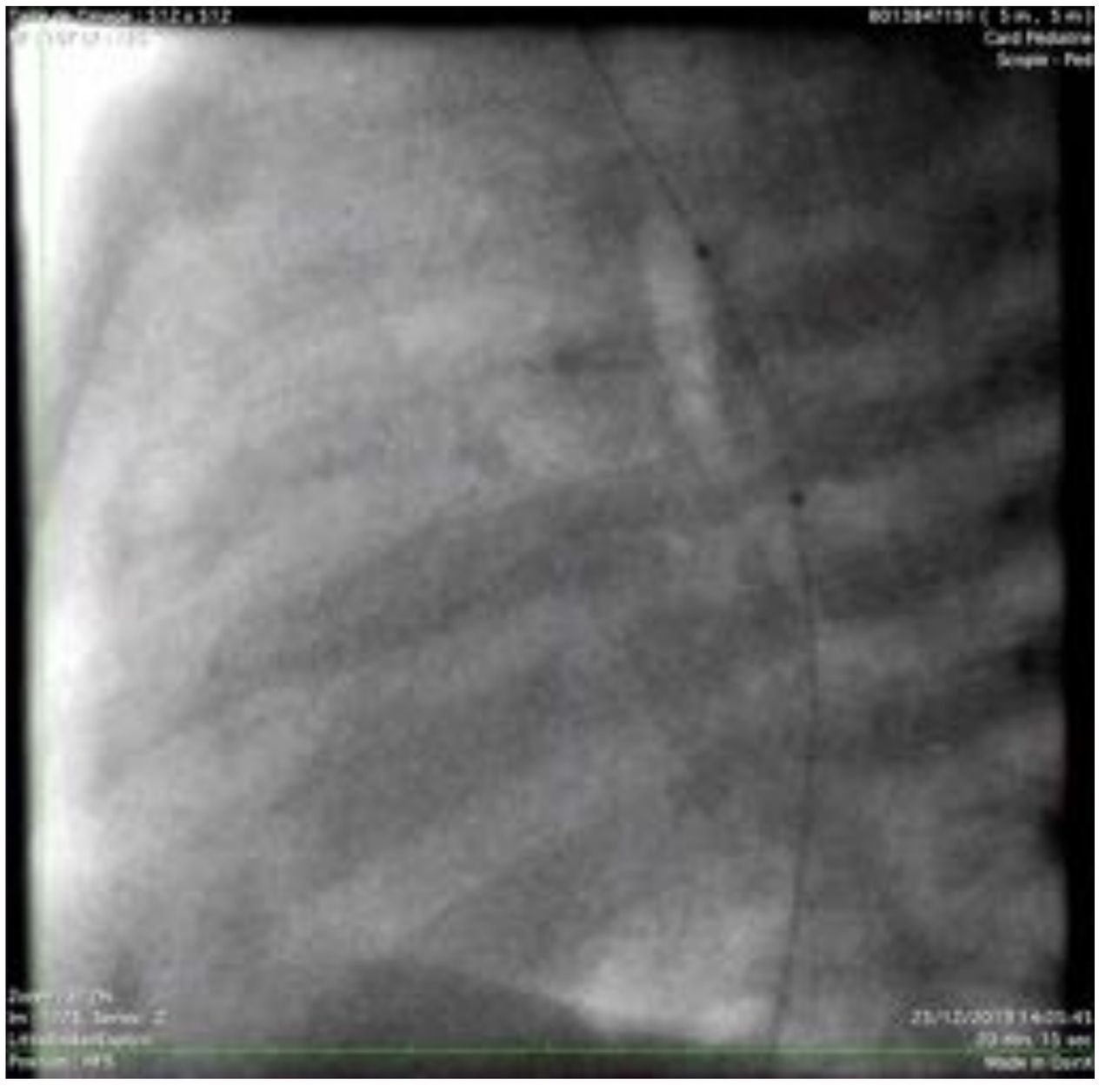


Recoarctation de l’aorte

Recoarctation de l’aorte dans la petite enfance



Recoarctation de l’aorte dans la petite enfance



Coarctation native

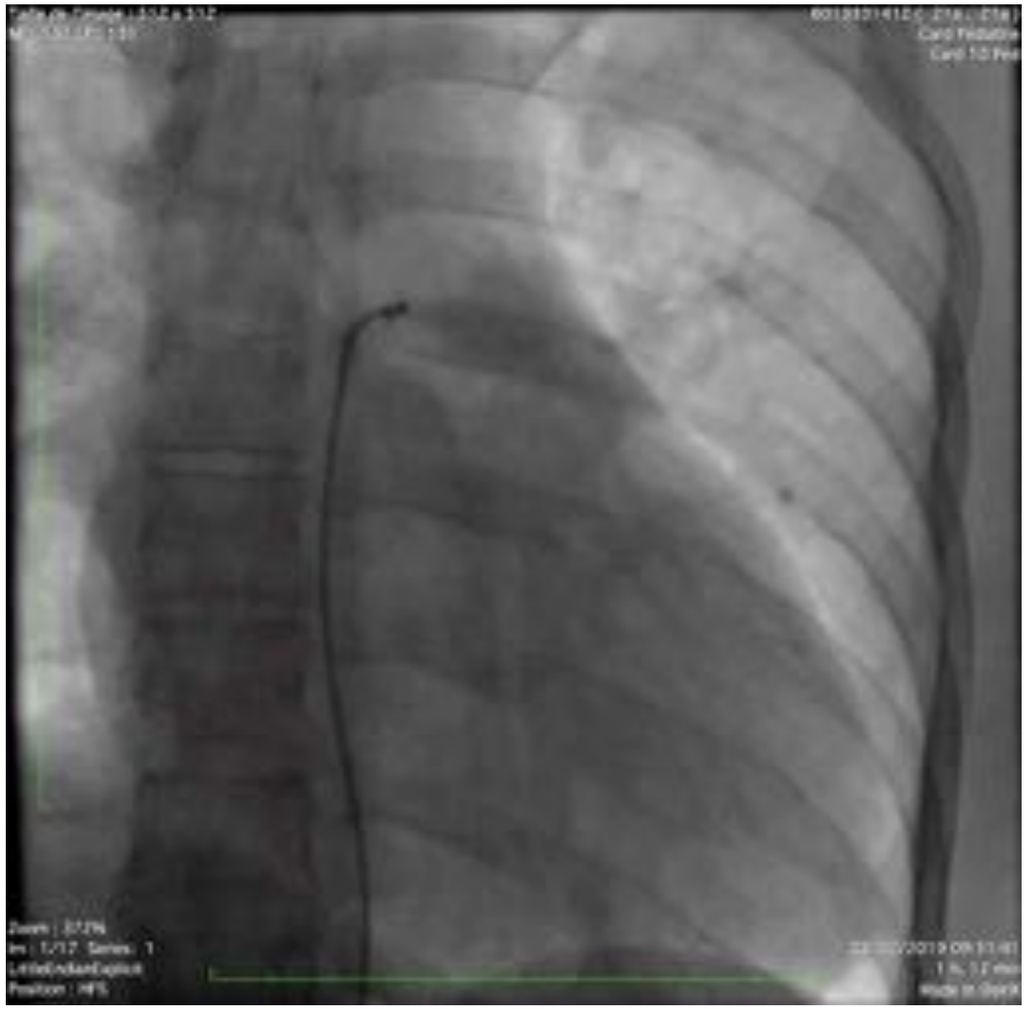
Coarctation native

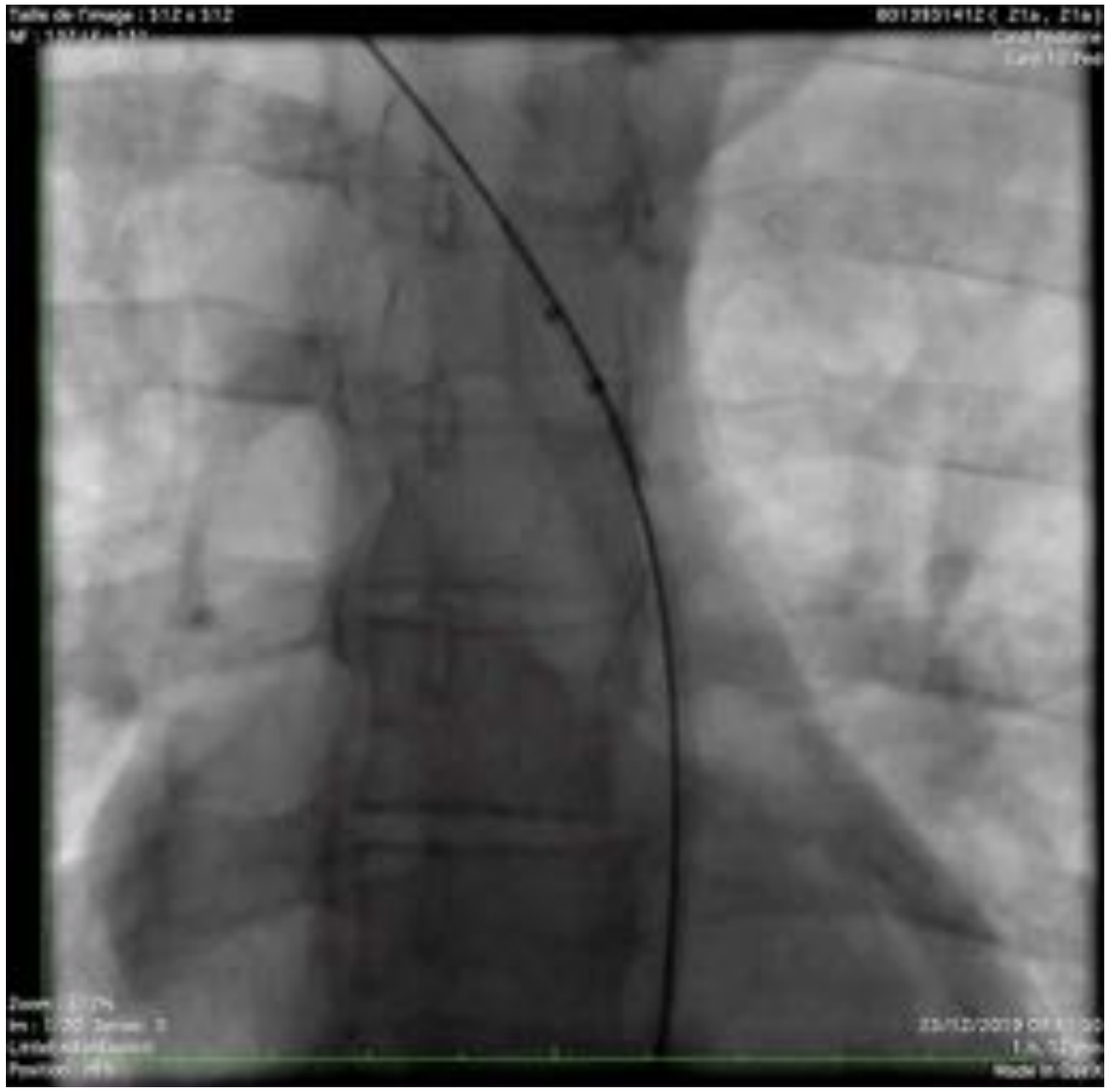
Coarctation native

Coarctation de l’aorte native traitement en 2 temps

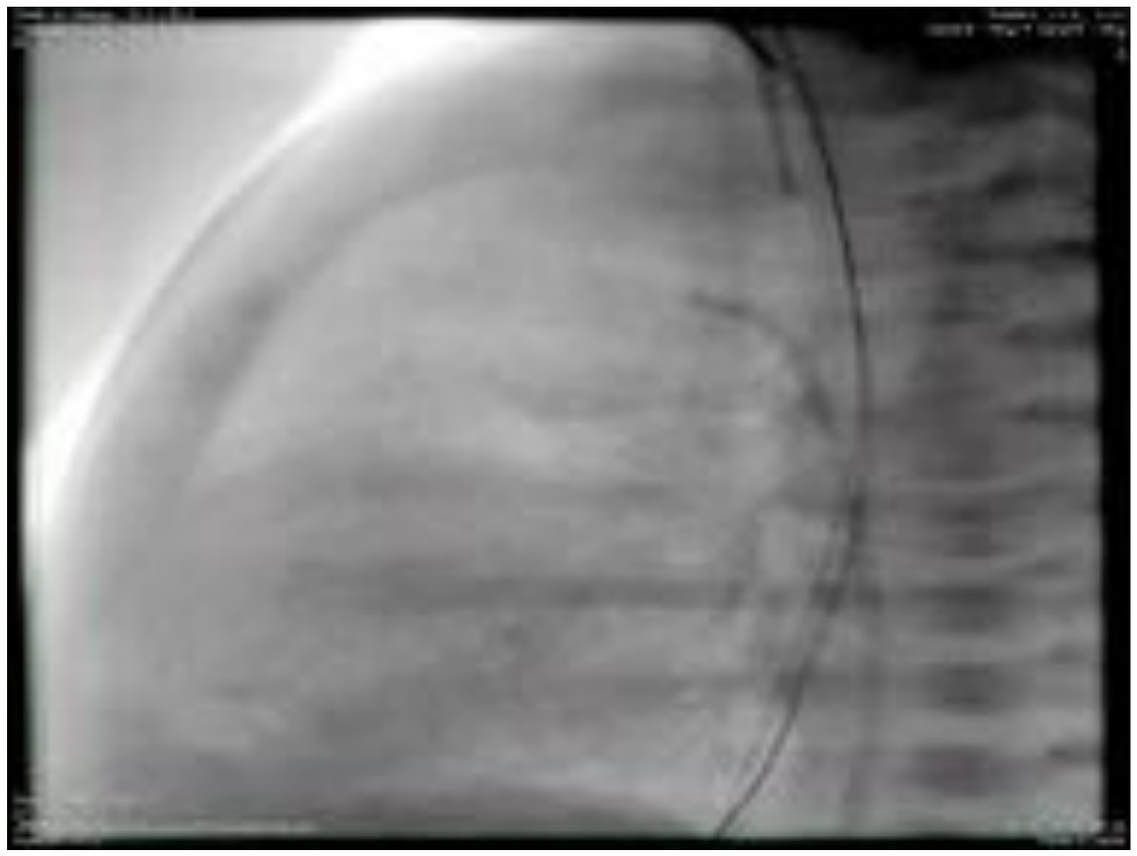
- laisser une encoche

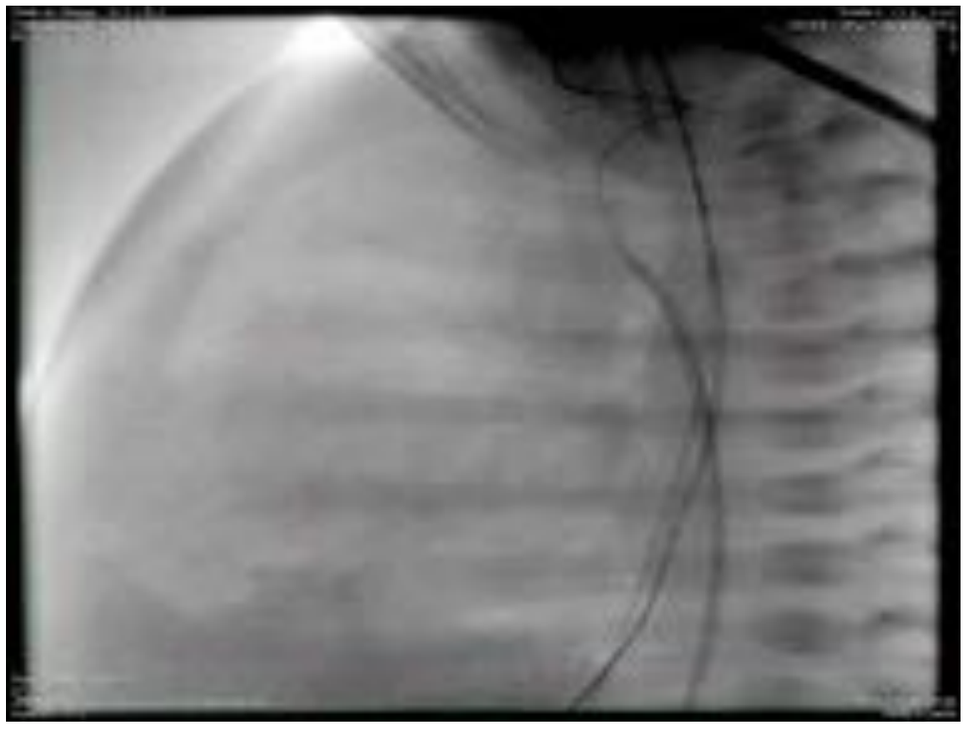
- revenir dans un second temps



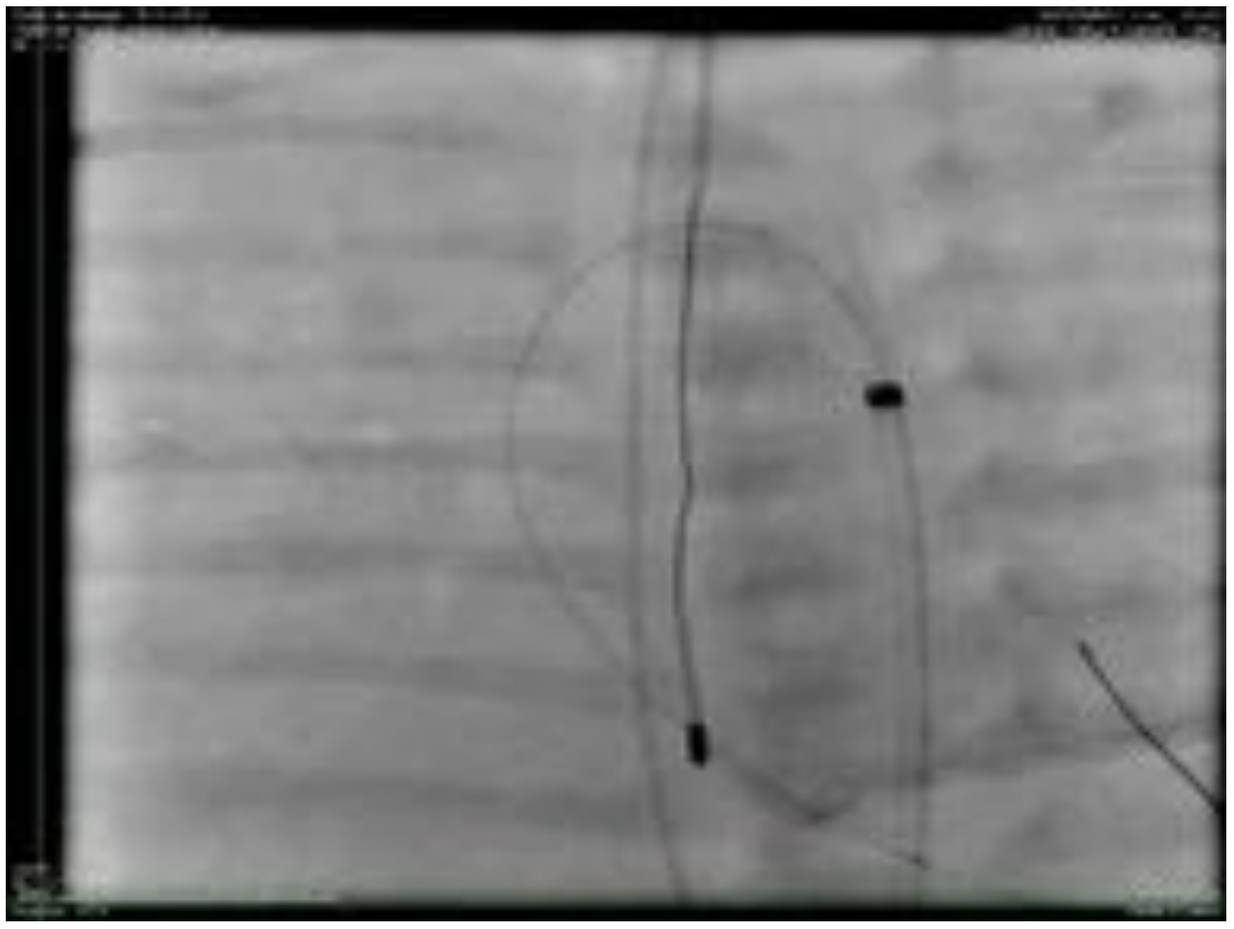


Coarctation néonatale native: dilatation

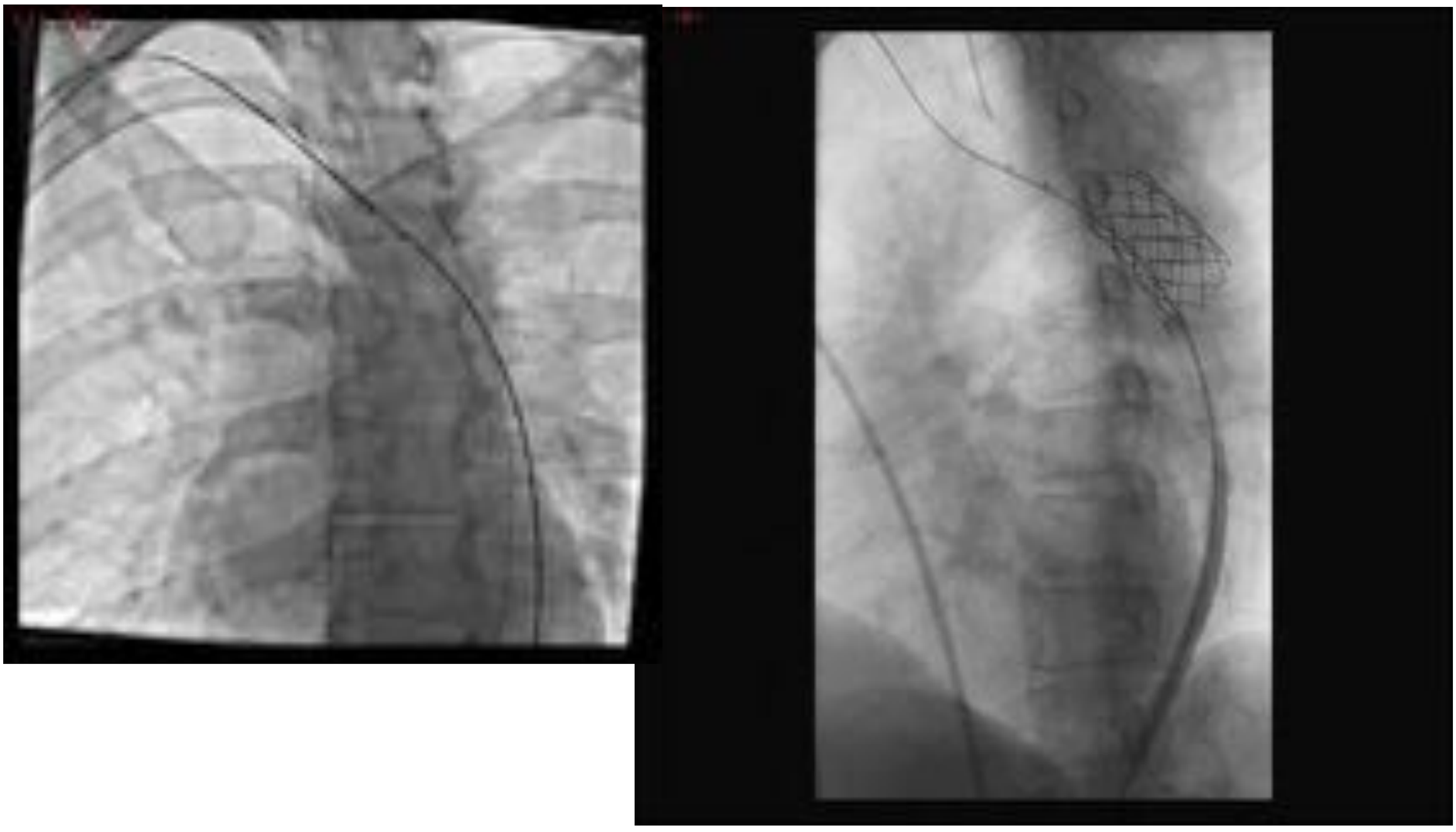


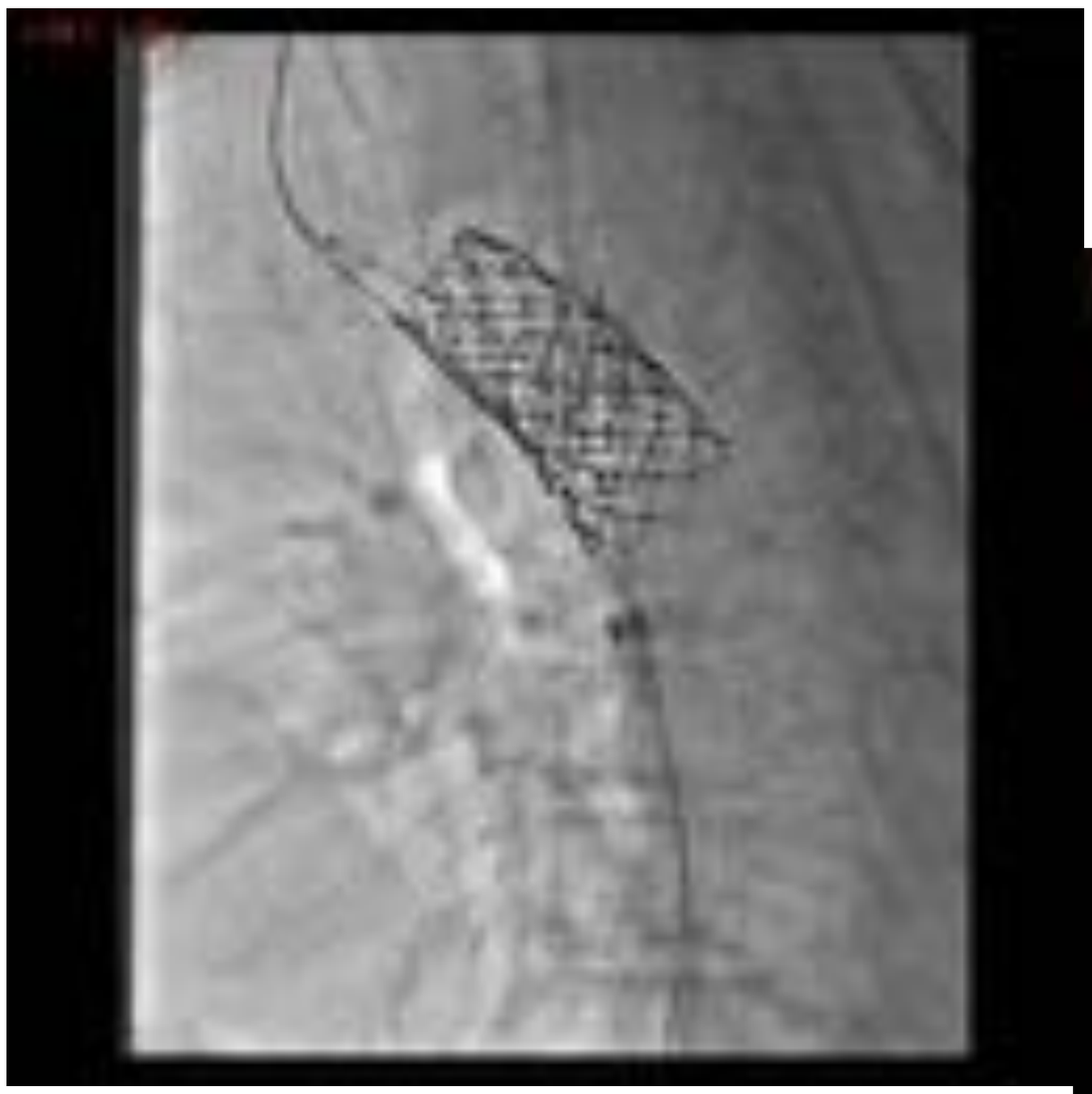


Coarctation néonatale: sauvetage par stenting



Coarctation native vieillie chez une malade Turner





Suivi à vie

- accès
- hypertension artérielle persistante
- dilatation aorte ascendante (biscuspidie)
- anévrismes (suivi échographique insuffisant)
- épreuve d’effort
- recoarctation, fracture de stent
- Croissance, recoarctation

Comparison of Surgical, Stent, and Balloon Angioplasty Treatment of Native Coarctation of the Aorta

An Observational Study by the CCISC
(Congenital Cardiovascular Interventional Study Consortium)

Forbes et al. JACC 2011

Table 2 Baseline Characteristics

	Surgery (n = 72)	Balloon (n = 61)	Stent (n = 217)	p Value (2-Sided)
Age, yrs	10.0 ± 9.7	9.0 ± 8.0	16.6 ± 10.9	<0.001*
Age range, yrs	0.1/58.6	0.4/42.5	2.2/74.3	
Weight, kg	35 ± 24	30 ± 21	55 ± 24	<0.001*
Male	69%	64%	69%	0.750
Pre-intervention right-arm SBP, mm Hg	137 ± 19	138 ± 23	143 ± 21	0.061

Moins de complications immédiates avec les stents versus chirurgie et angioplastie seule

Table 3 Acute Outcomes

	Surgery (n = 72)	Balloon (n = 61)	Stent (n = 217)	p Value (2-Sided)
Post-intervention right-arm SBP, mm Hg	123 ± 13	118 ± 15	135 ± 15	0.002*
Discharge ULG	7.7 ± 18.2	10.3 ± 12.9	4.9 ± 13.2	0.032
Discharge ULG <10 mm Hg	64%	56%	76%	0.011*
Discharge ULG <15 mm Hg	73%	69%	82%	0.101
Post-intervention catheterization SBP gradient	NA	12.4 ± 12.2	4.8 ± 8.6	<0.001*
% increase in coarctation measurement post-intervention	NA	135%	172%	0.008*
Any complications	18.1%†	9.8%	2.3%	<0.001*
Aortic wall injury	UK‡	9.8%	0.0%	<0.001*
Dissection/intimal tear	UK‡	9.8%	0.0%	
Aneurysm	UK‡	0.0%	0.0%	
Balloon rupture	NA	0.0%	0.5%	
Stent migration	NA	n/a	1.4%	
Femoral	UK‡	0.0%	0.5%	
Atrial fibrillation	3%	0%	0%	
Severe/prolonged hypertension	3%	0%	0%	
Length of stay, days	6.4/5.0	3.6/1.0	2.4/1.0	<0.001*

Table 4 Short-Term Follow-Up Outcomes

Outcomes	Surgery (n = 52)	Balloon (n = 37)	Stent (n = 125)	p Value (2-Sided)
Age at follow-up, yrs	12.1 ± 10.9	10.4 ± 9.2	17.2 ± 10.1	<0.001†
Weight at follow-up, kg	41.3 ± 30.6	34.4 ± 22.4	59.3 ± 21.9	<0.001†
Normal SBP*	84.6%	72.2%	87.2%	0.096
Antihypertensive medications	40%	16%	41%	0.019†

Table 6 Intermediate Follow-Up Outcomes

	Surgery (n = 23)	Balloon (n = 25)	Stent (n = 77)	p Value (2-Sided)
Age at follow-up	15.0 ± 11.2	12.9 ± 6.5	18.3 ± 9.8	0.035†
Weight at follow-up	57.4 ± 22.4	40.3 ± 16.2	60.8 ± 18.6	<0.001†
Normal SBP*	96%	72%	82%	0.092
Antihypertensive medications	13%	16%	31%	0.130

Table 7 Intermediate Follow-up Outcomes by Integrated Imaging

	Surgery (n = 16)	Balloon (n = 16)	Stent (n = 56)	p Value (2-Sided)
Any complications*	25.0%	43.8%	12.5%	0.020‡
Aortic wall injury	12.5%	43.8%	7.1%	0.003‡
Dissection/intimal tear	0.0%	6.3%	1.8%	0.598
Aneurysm	12.5%	43.8%	5.4%	<0.001
Coarct:Dao ratio, mean	0.98	0.79	0.80	0.011‡
Coarct:Dao ratio ≥0.6	88%	93%	89%	1.000
Any reobstruction	18.8%	18.8%	14.3%	0.923
Mild†	6.3%	18.8%	12.5%	
Moderate	6.3%	0%	1.8%	
Severe	6.3%	0%	0%	

Dans le suivi, meilleurs résultats HD avec la chirurgie ou les stents vs angioplasties
Stents plus haut taux de réintervention planifié
End to end non faisable à partir de 8 ans

Table 8 Reintervention

	Surgery (n = 72)	Balloon (n = 61)	Stent (n = 217)
Patients with reintervention	4	6	44
Patients with planned procedures	0	2	35
Patients with unplanned procedures	4	4	9
Time to first planned reintervention, yrs	NA	1.43 ± 1.70	1.14 ± 1.15
Time to first unplanned reintervention, yrs	2.24 ± 2.23	1.28 ± 1.43	2.84 ± 1.43

Balloon Dilatation and Stenting for Aortic Coarctation
A Systematic Review and Meta-Analysis

Maximilian Salcher, MSc; Huseyin Naci, PhD; Tyler J. Law, MD; Titus Kuehne, MD;
Stephan Schubert, MD; Marcus Kelm, MD; on behalf of Cardioproof Consortium*

Circ Cardiovasc Interv. 2016;9:e003153

- Méta-analyse
- Supériorité du stenting pour diminuer le gradient
- Tendance à moins d'évènements indésirables graves pendant l'hospitalisation avec le stent qu'avec la dilatation seule

En pratique: stenting dès que l'enfant a un poids suffisant pour mettre un stent qui peut être redilaté

Comparison Between Covered and Bare Cheatham-Platinum Stents for Endovascular Treatment of Patients With Native Post-Ductal Aortic Coarctation

Immediate and Intermediate-Term Results

Bahram Sohrabi, MD,* Peiman Jamshidi, MD,*† Alireza Yaghoubi, MD,* Afshin Habibzadeh, MD,* Yashar Hashemi-aghdam, MD,‡ Araz Moin, MD,‡ Babak Kazemi, MD,* Samad Ghaffari, MD,* Mohammad Reza Abdolahzadeh Baghayi, MD,* Khalil Mahmoody, MD§

Table 4. Clinical Findings During Follow-Up Between Groups

	Bare CP (n = 60)	Covered CP (n = 60)	p Value
Recurrent coarctation	4 (6.7)	0 (0)	NS
Pseudoaneurysm in aortic segment at 12-month follow-up	0	2 (3.3)	NS
Total mortality	1 (1.7)	0	NS

Values are n (%).
Abbreviations as in Table 2.

120 patients
CoA natives serrées
Diamètre zone coarctée 3.5 mm
Pas de différence stent couvert et stent nu

Covered Stents for Coarctation of the Aorta

Treating the Interventionalist or the Patient?*

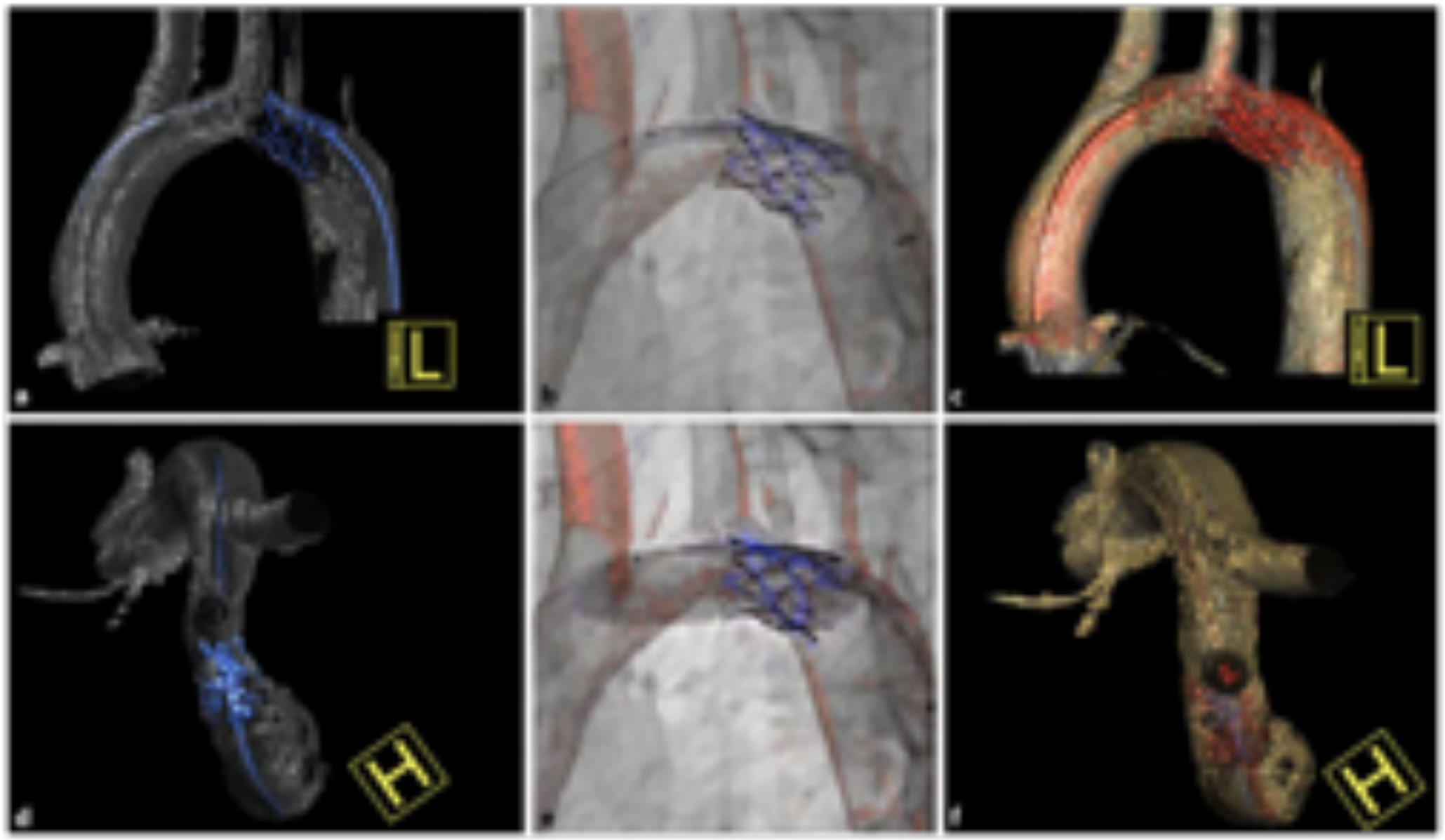
Ziyad M. Hijazi, MD, MPH,
Damien P. Kenny, MB, MD

Patients à haut risque uniquement
Patients >40 ans
Quasi interruption
Turner

Safety and efficacy of stenting for aortic arch hypoplasia in patients with coarctation of the aorta

E. G. Warmerdam · G. J. Krings · T. A. Meijs · A. C. Franken · B. W. Driesen · G. T. Sieswerda · F. J. Meijboom · P. A. F. Doevendans · M. M. C. Molenschot · M. Voskuil

Neth Heart J, Nov 2019



Coarctation néonatale

- Choc cardiogénique: dilatation au ballon

Pediatr Cardiol (2007) 28:183–192
DOI 10.1007/s00246-006-0074-4

ORIGINAL ARTICLE

Stent Angioplasty: An Effective Alternative in Selected Infants with Critical Native Aortic Coarctation

Coarctation néonatale

Coarctation native

- première intention: traitement chirurgical
- thérapie de sauvetage (bas débit, défaillance ventriculaire gauche): dilatation (stenting si échec)

Recoarctation

- première intention: dilatation au ballon
- stenting très rarement, après discussion avec le chirurgien

Coarctation de l’enfant (< 20kg)

première intention: traitement chirurgical

Coarctation native

dilatation si CI chirurgicale

première intention dilatation au ballon

Recoarctation

si échec de dilatation ou complication: stenting

Coarctation de l’aorte (> 20kg)

Stenting (redilatable à un diamètre d’aorte d’adulte)

Coarctation native: stent couvert ou nu

Recoarctation: stent nu

Obstacles du coeur droit

Sténose valvulaire pulmonaire

Tétralogie de Fallot extrême

Cerclage de l’artère pulmonaire

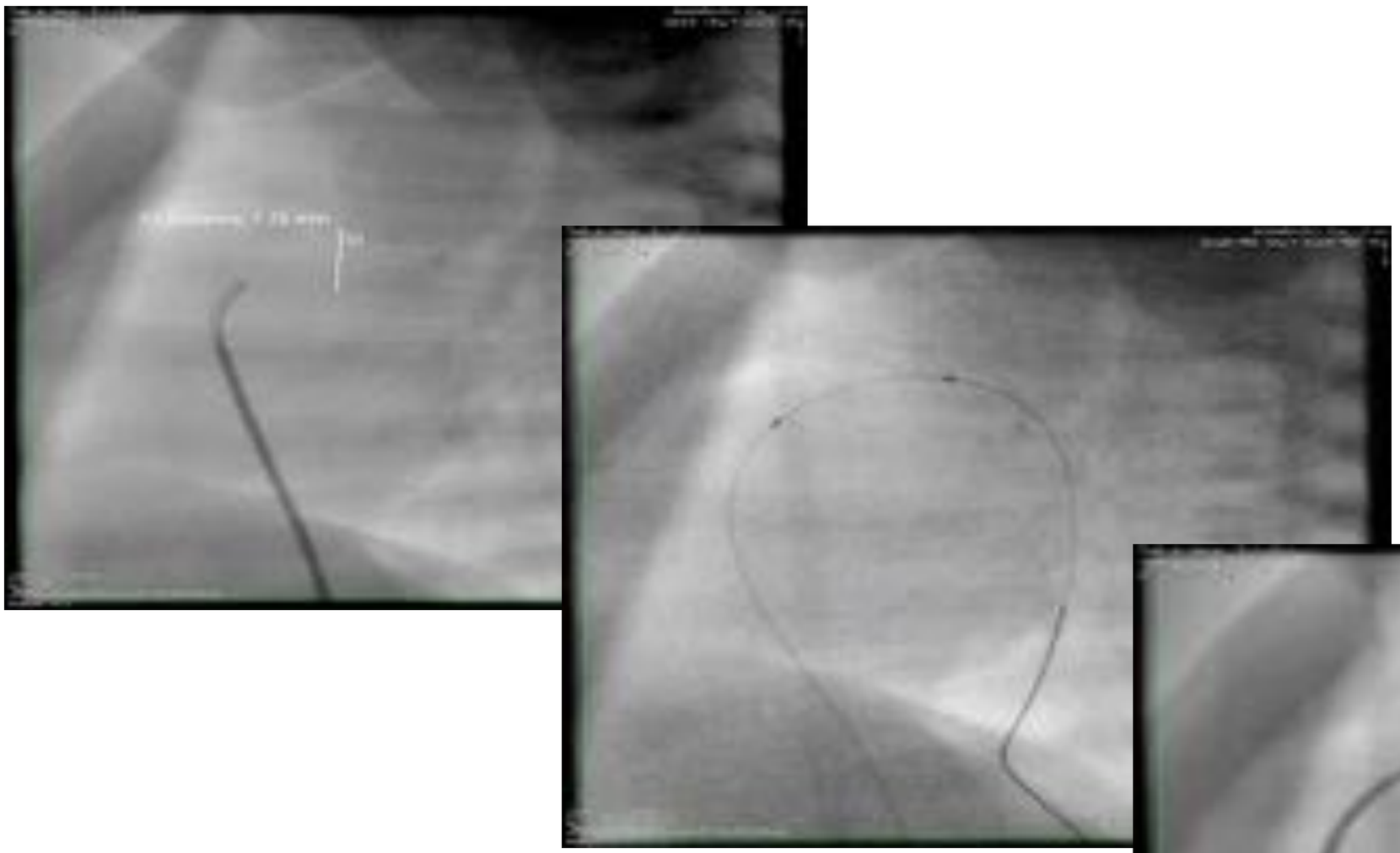
Sténose des artères pulmonaires

Revalvulation pulmonaire

Sténose valvulaire pulmonaire

- Dilatation au ballon: Gold standard
- Indication: SVP critique, gradient max > 40 mmHg
- Diamètre du ballon jusqu’à 120% de l’anneau
- Excellent résultat immédiat et à long terme
- Mauvais résultat chez les Noonan de par la dysplasie valvulaire pulmonaire et l’obstacle supravalvulaire

Sténose valvulaire pulmonaire



Long-Term Outcomes of Balloon Valvuloplasty for Isolated Pulmonary Valve Stenosis

- 213 patients
- 103 patients dans l'étude
- 7% seconde dilatation valvulaire
- 15% chirurgie pour SVP ou augmenter le débit pulmonaire
- 3% chirurgie pour fuite pulmonaire symptomatique (16 +/- 22 ans)

Atrésie pulmonaire à septum intact

- Si le ventricule droit est exploitable: bonne taille du VD
  bonne taille de la tricuspide
- Si la circulation coronaire n'est pas VD dépendante

Le ventricule droit peut être décomprimé: la valve pulmonaire doit être perforée puis dilatée

Procédure d’ouverture d’APSI

Procédure d’ouverture d’APSI

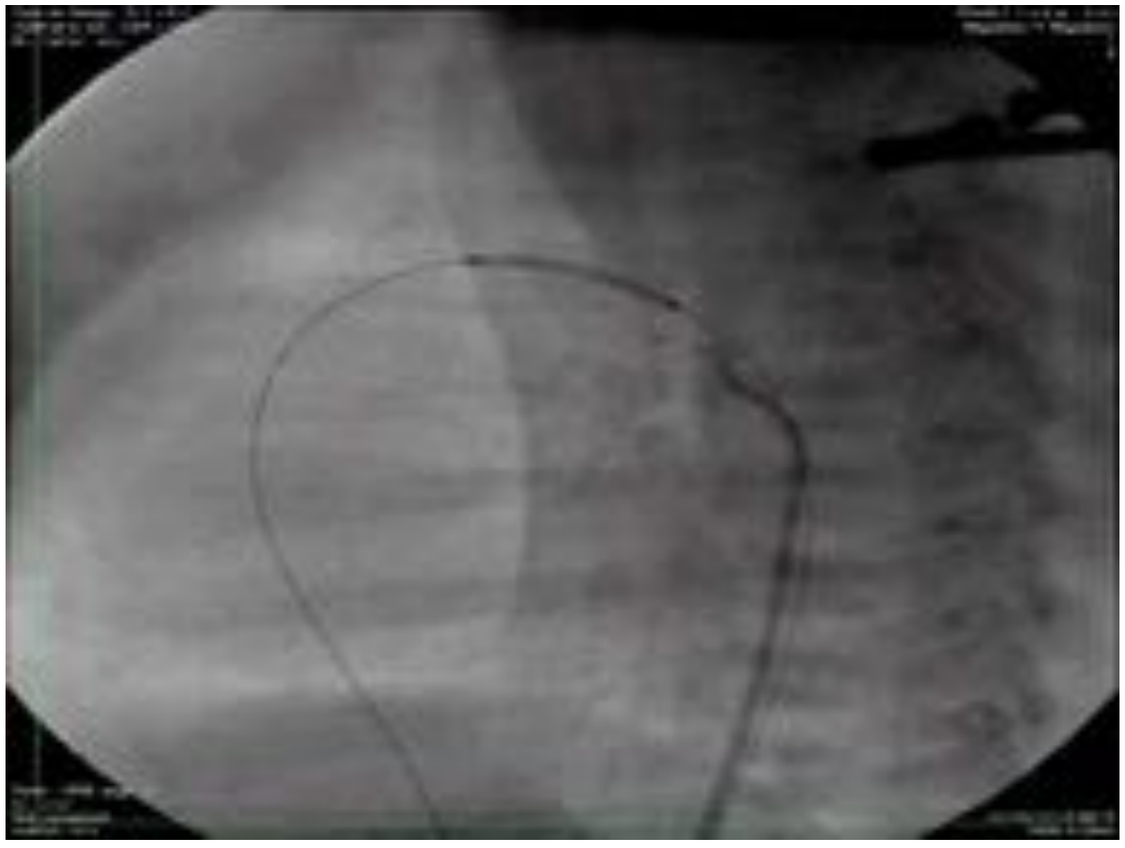
APSI – suivi de la perforation

- Trouble de compliance du ventricule droit
- Prostaglandines parfois plusieurs jours
- Si plus long: stenting du canal ou BTS

En cas de stenting du canal: arrêt des prostaglandines plusieurs heures avant la procédure pour que le canal soit restrictif et que le stent puisse être placé

Possible de prédire si il faudra stenter le canal artériel: Z-score de la tricuspide. On peut décider d’ouvrir la voie droite et de stenter le canal dans le même temps.

Images du stenting du canal



Images du stenting du canal

Pediatr Cardiol (2014) 35:22–29
DOI 10.1007/s00246-013-0733-1

ORIGINAL ARTICLE

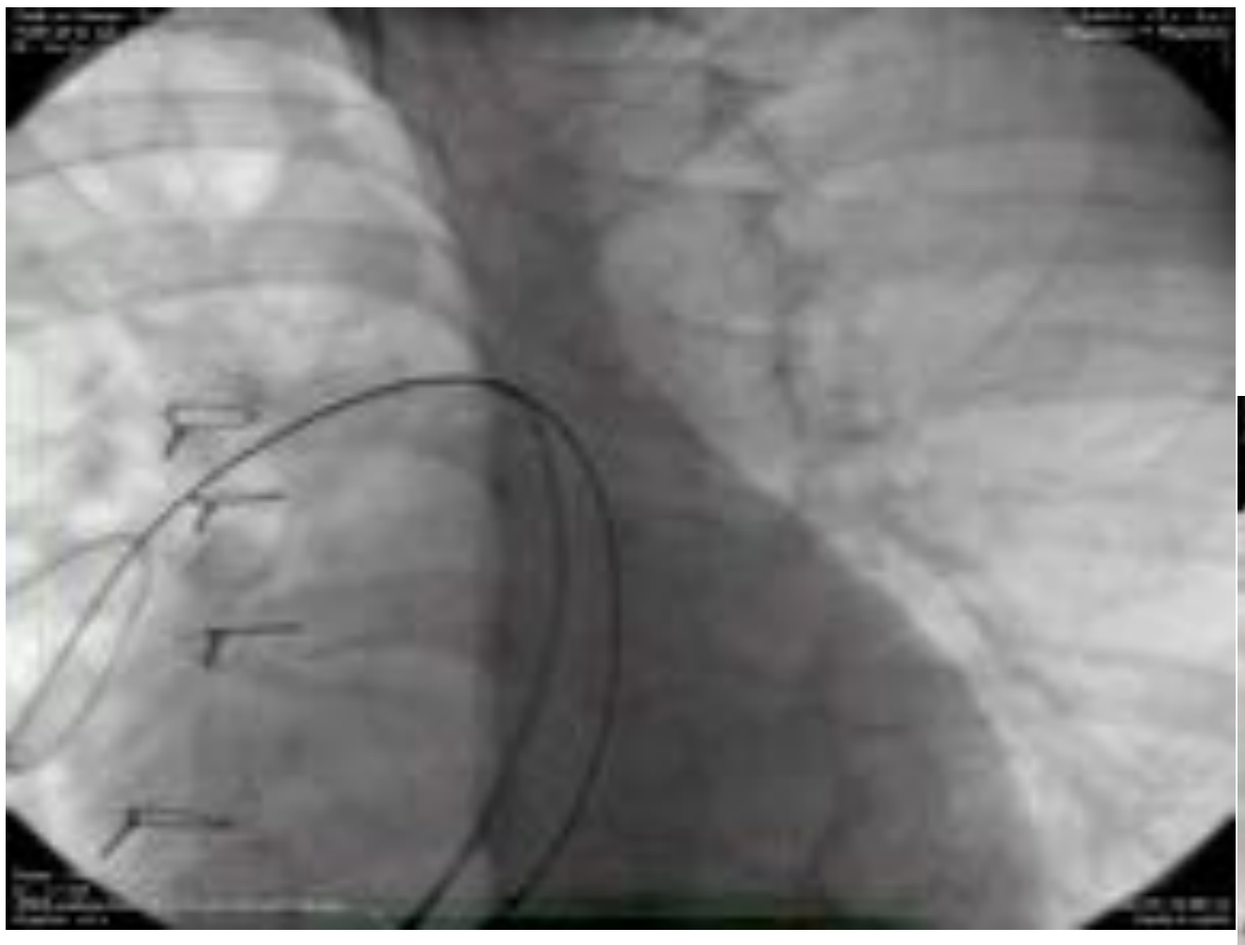
Outcomes and Predictors of Reintervention in Patients With Pulmonary Atresia and Intact Ventricular Septum Treated With Radiofrequency Perforation and Balloon Pulmonary Valvuloplasty

- 23 patients avec radiofréquence
- 50% BTS ou stenting du canal
- 50% seconde dilatation de la voie droite
- 30% pas d'autre geste
- Tricuspide Z score < 0.7: BTS ou stent canal
- Gradient résiduel > 20 mm Hg: seconde dilatation

Sténoses des branches pulmonaires

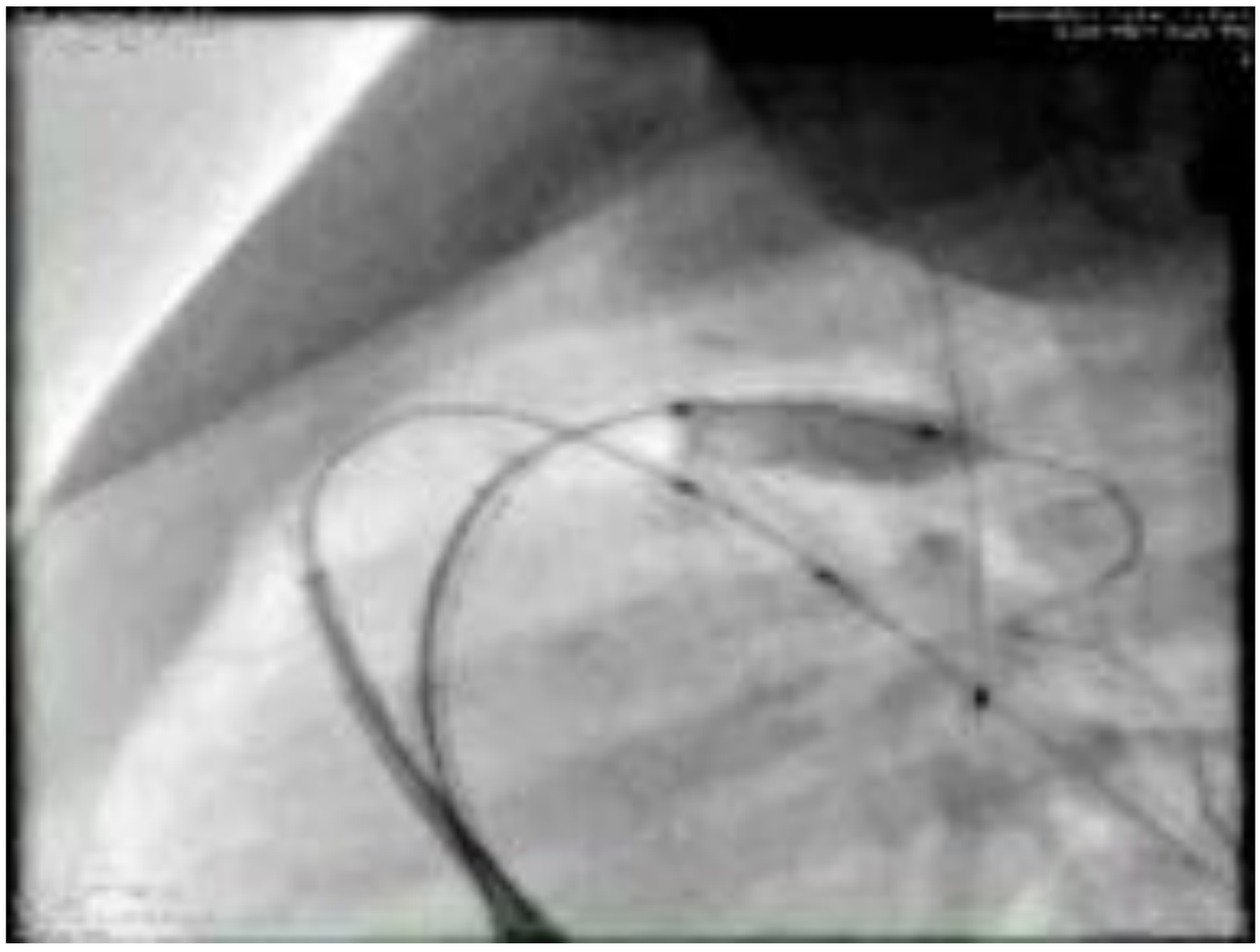
- Distalité difficilement accessible par voie chirurgicale
- Parfois après plasties chirurgicales
- Sténoses multiples ou uniques
- Angioplastie seule mauvais résultats
- Angioplastie seule réservée aux petits enfants
- Stenting direct traitement de choix
- Stents redilatables
- Stents biorésorbables

Sténose de l’AP gauche post Fallot

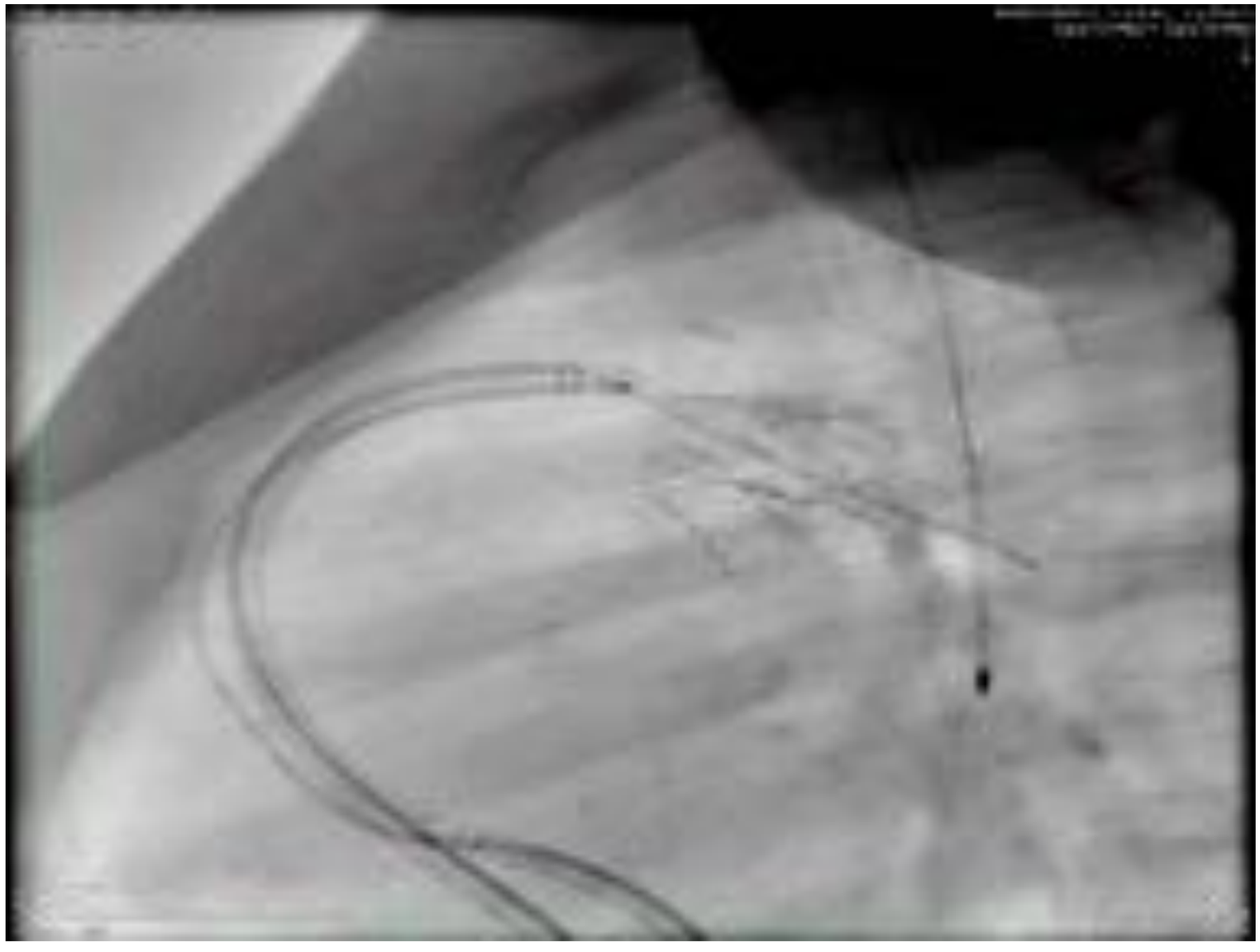


Sténose complexe de la bifurcation

Sténose complexe de la bifurcation: kissing



Sténose complexe de la bifurcation: kissing

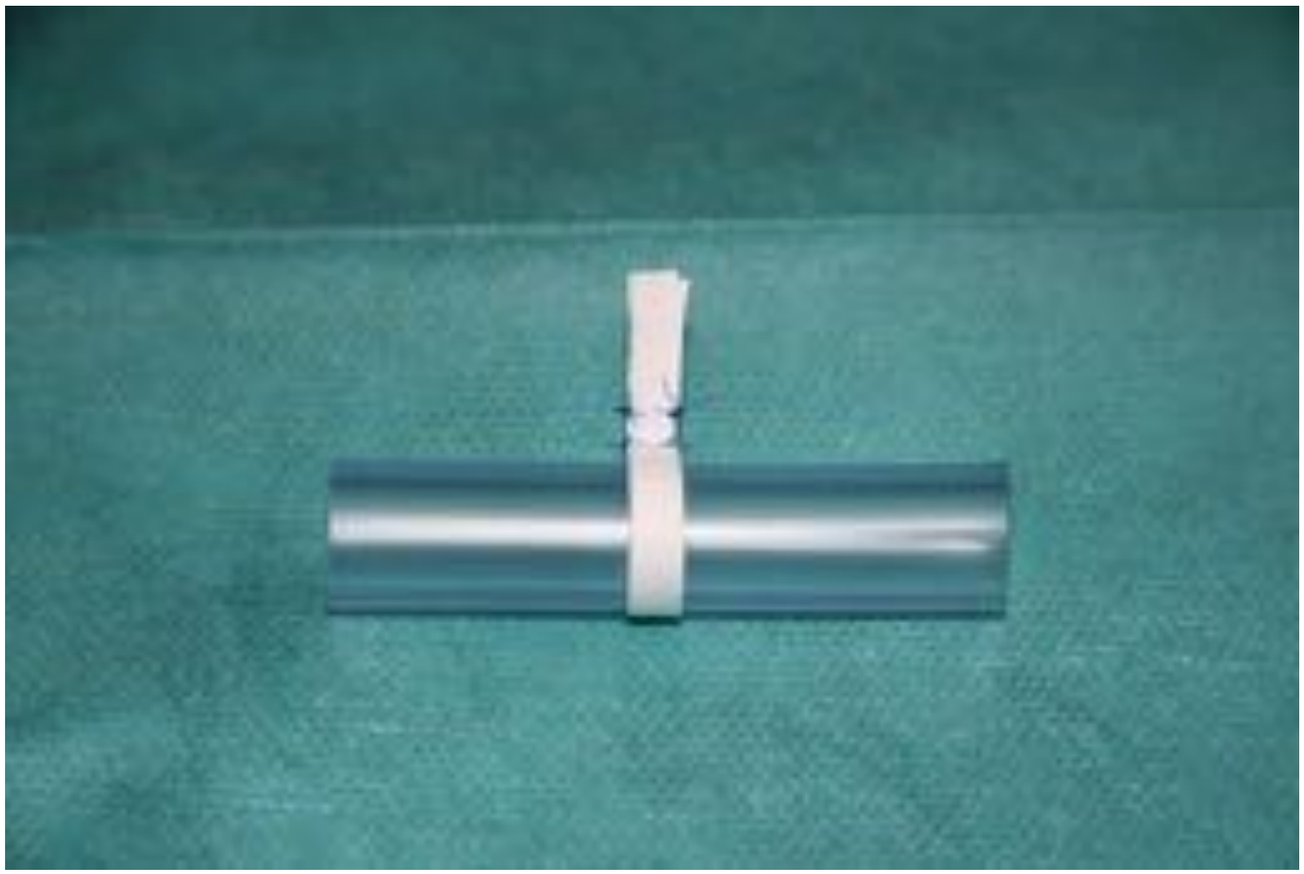


Tétralogie de Fallot extrême

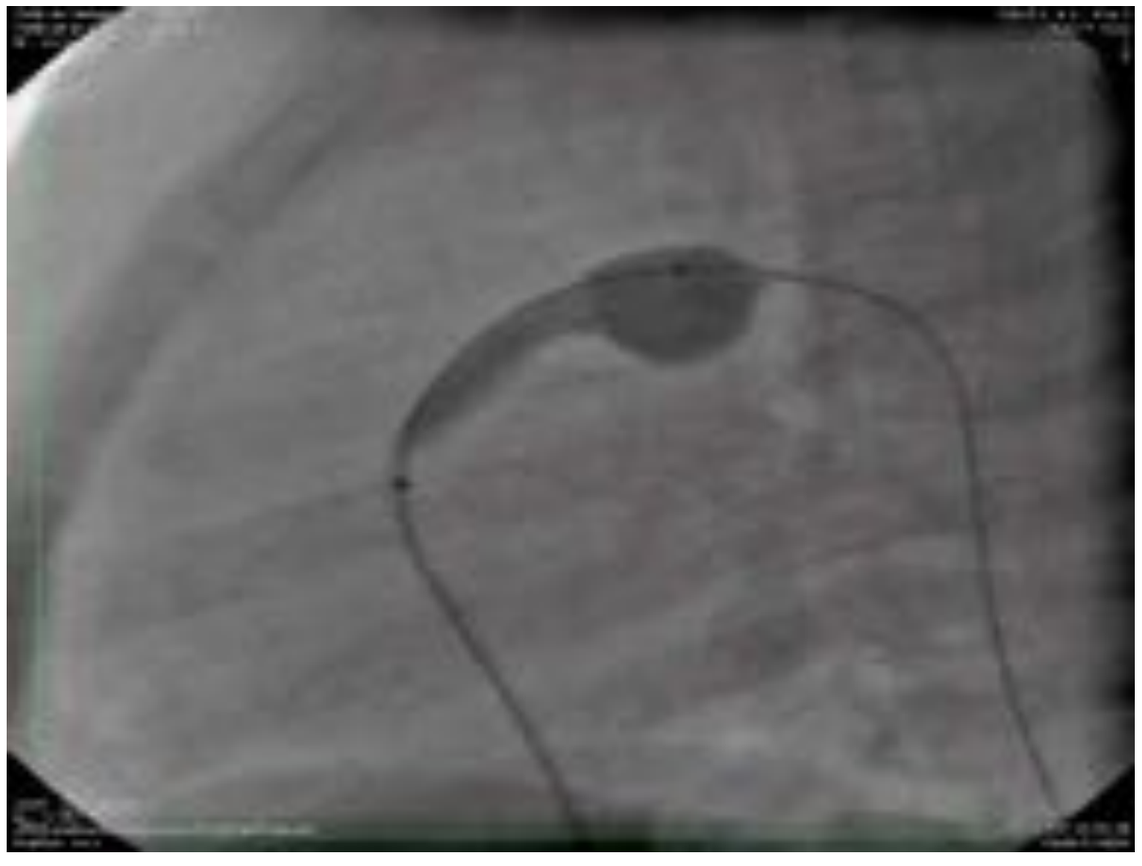
- En alternative au BTS ou à l’ouverture VD-AP
- Dilatation valvulaire pulmonaire
- Stenting de la voie VD-AP

Stenting de la voie VD-AP

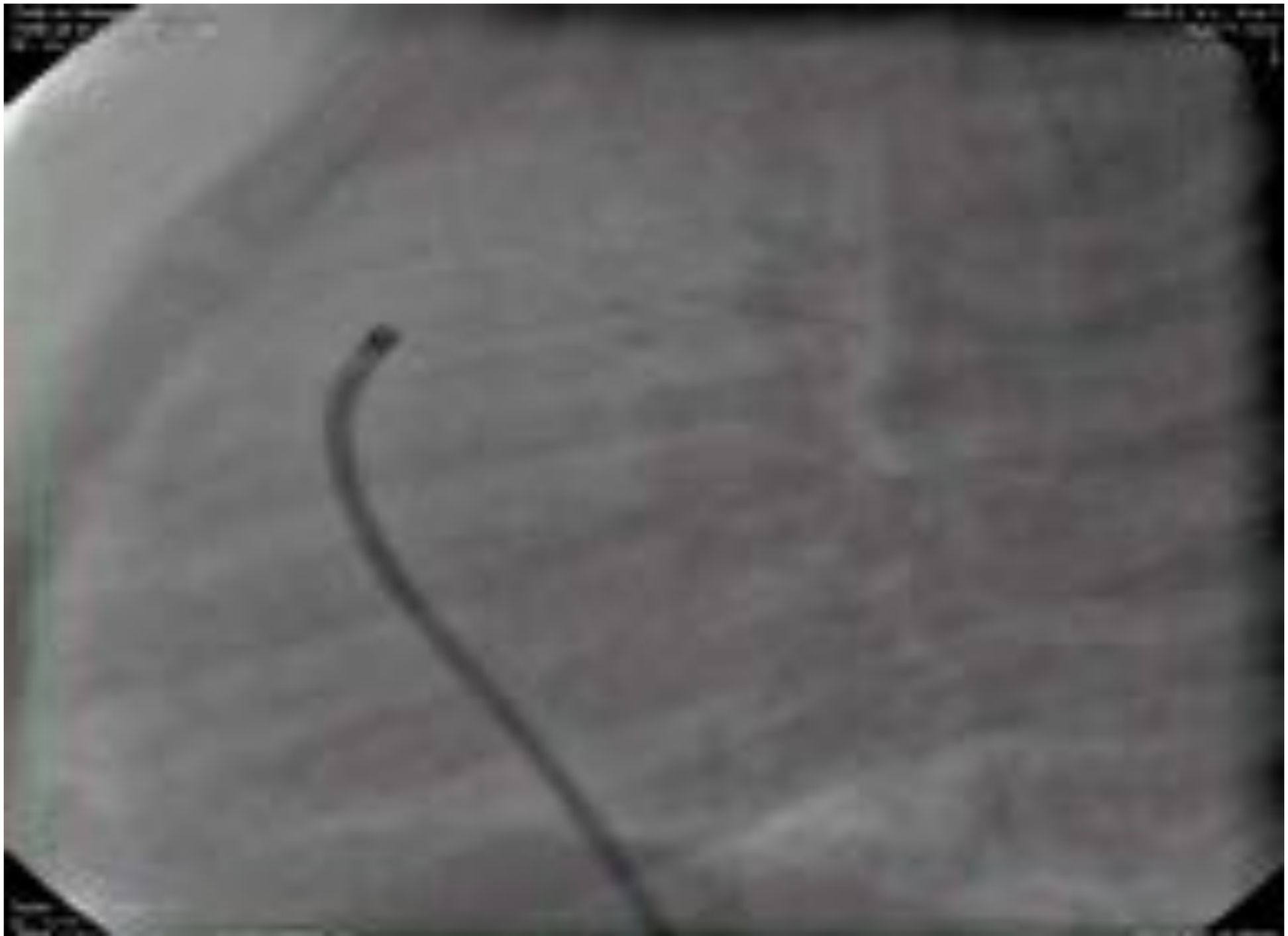
Cerclage dilatable



Cerclage pulmonaire dilatable



Cerclage dilatable post dilatation

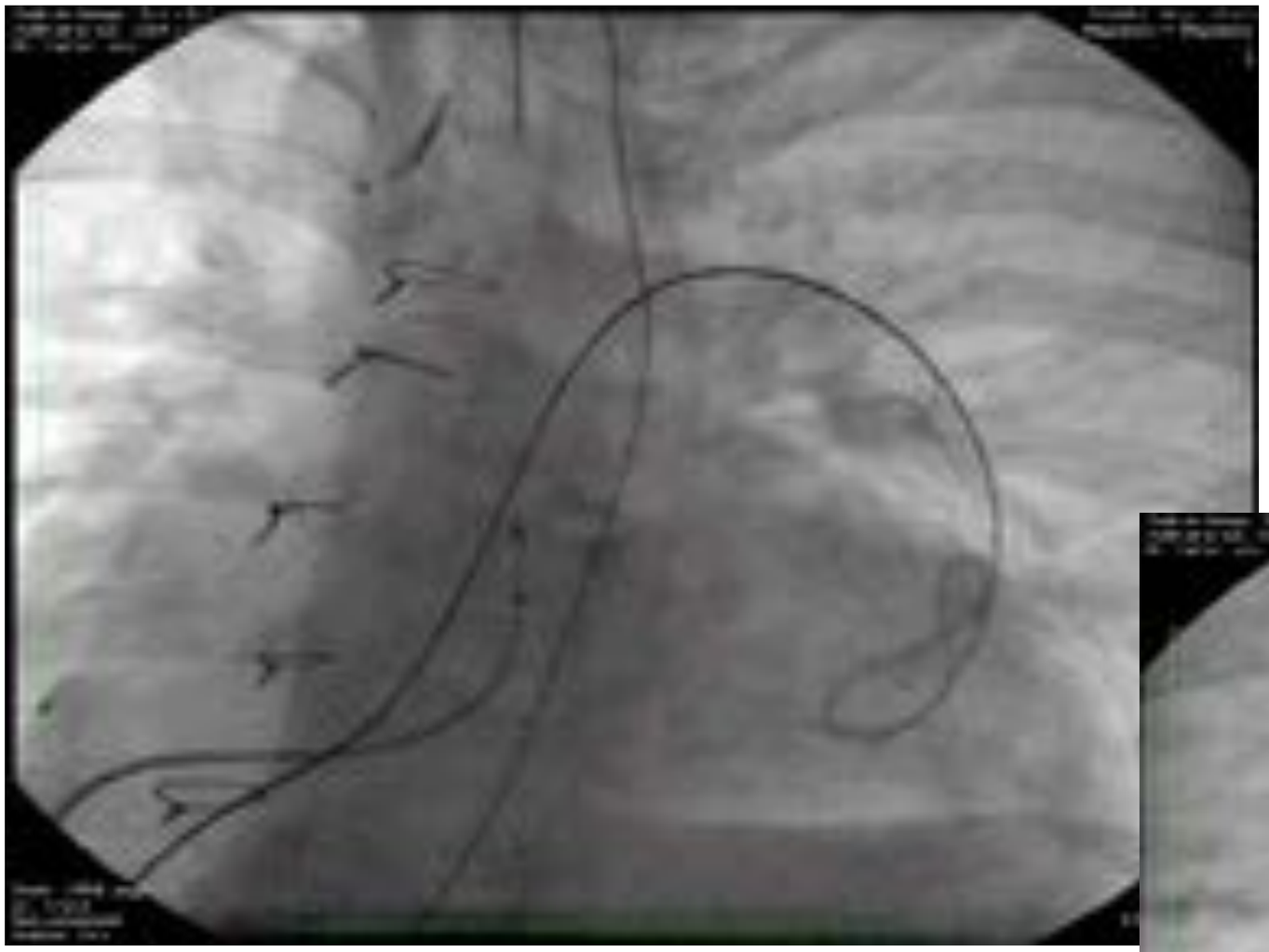


Stenting de la voie droite

- Cures chirurgicales avec mise en place de tube entre le ventricule droit et les artères pulmonaires
- Dégradation plus ou moins rapide des conduits (sténose et fuite)
- Mise en place d'un stent nu permet de lever l'obstacle et d'augmenter la longévité des conduits
- Création ou majoration de la fuite pulmonaire

- Encore d'application chez les enfants petits

Stenting de la voie droite



Attention à la rupture de conduit
Attention au risque de compression coronaire

Valvulation percutanée

- 2000: première valvulation pulmonaire percutanée
- Augmenter la durée de vie des conduits mis en place chirurgicalement
- Généralisation de la technique
- 2 substrats valvulaires:

La valve Mélody^{TM} Medtronic

La valve Sapien ^{TM} Edwards

La fabuleuse histoire

2000
Première valvulation percutanée pulmonaire
Mélody

2002
TAVI

2012
Première endocardite

2006
Marquage CE Mélody

2011
Edwards Sapien

2012
Valvulation voies natives

Substrats valvulaires

Valve Mélody

Valve Sapien

Technique standardisée

- Pour diminuer les complications per procédurales

- Pour améliorer le résultat à long terme

Un peu de littérature

CLINICAL RESEARCH

Percutaneous pulmonary valve implantation: two-centre experience with more than 100 patients

Circulation

American Heart Association

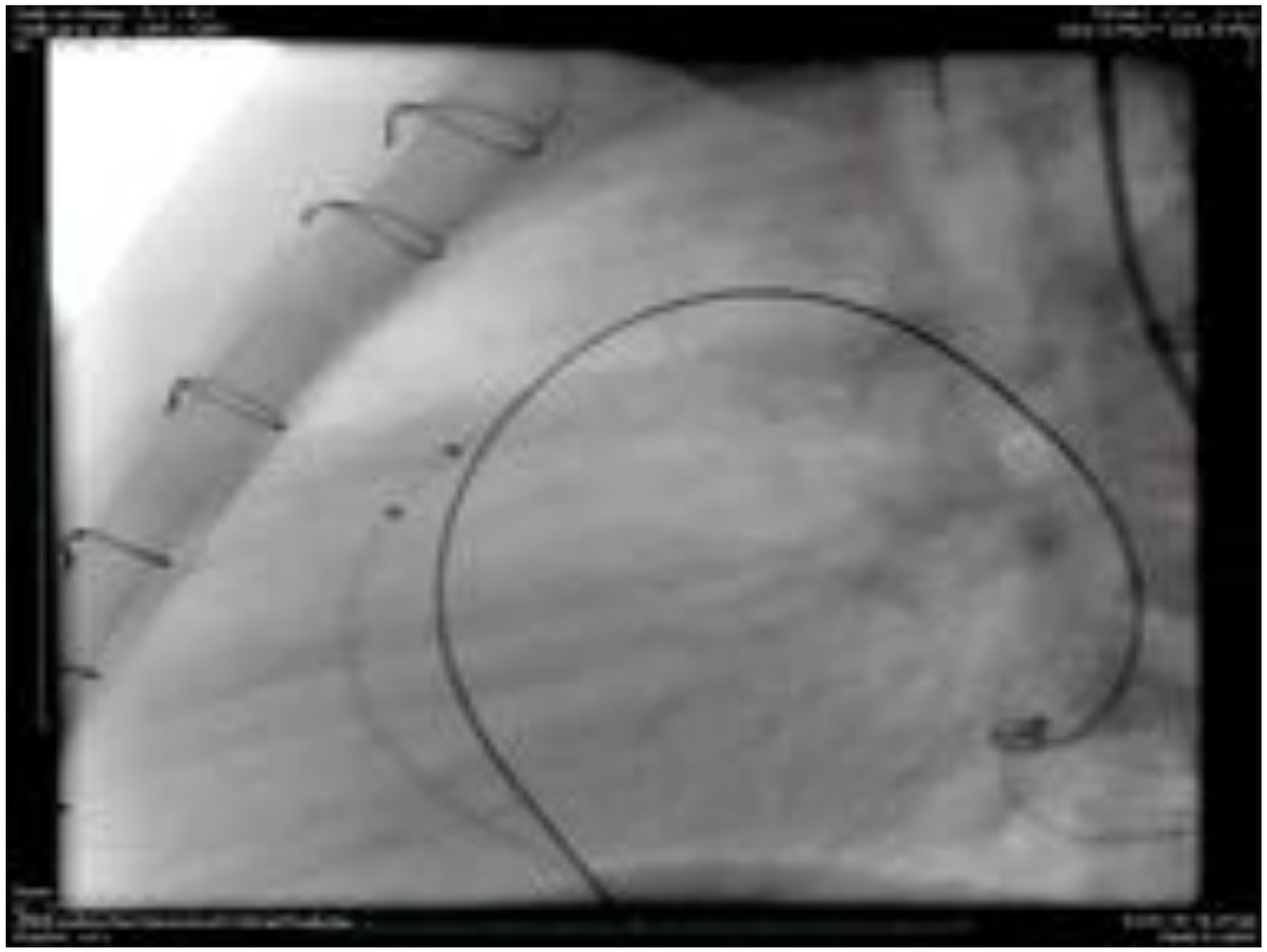
Valvulation pulmonaire

- Standardisation de la technique
- Complications: comment les éviter
- La compression coronaire
- La rupture de conduit

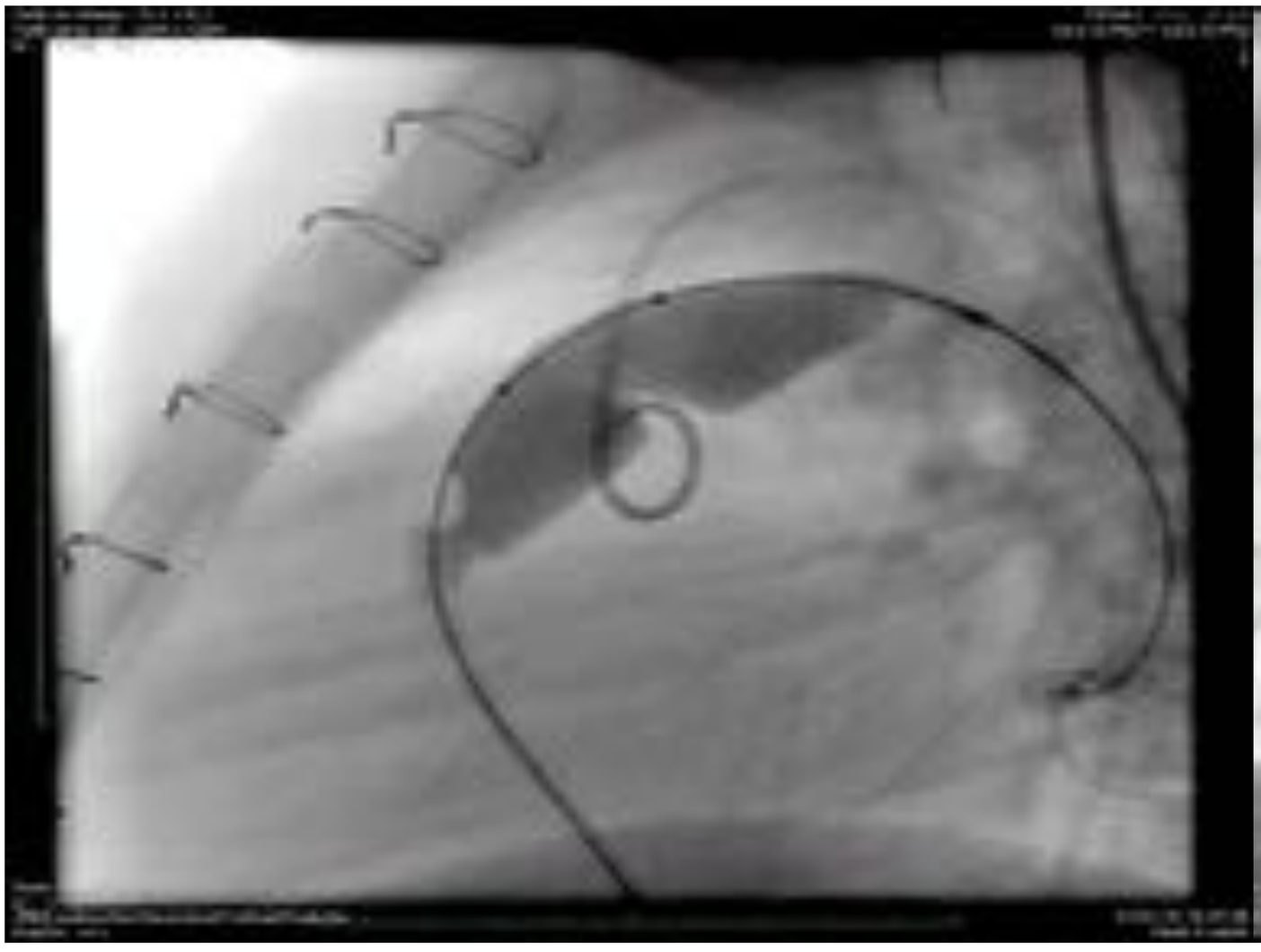
- Endocardites
- Voies droites complexes: courtes, larges, sténose de la bifurcation

Importance du pré stenting

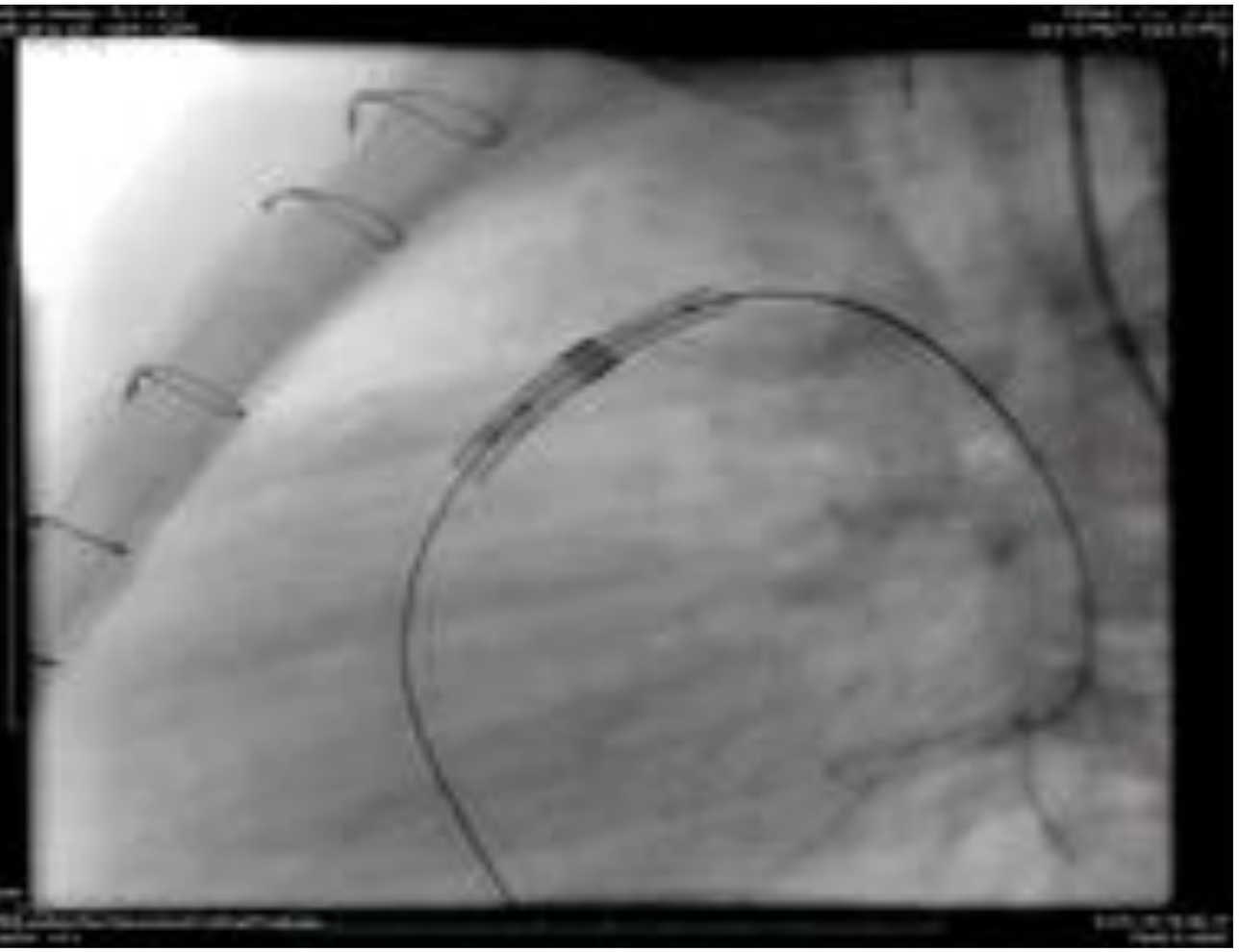
Valvulation step by step

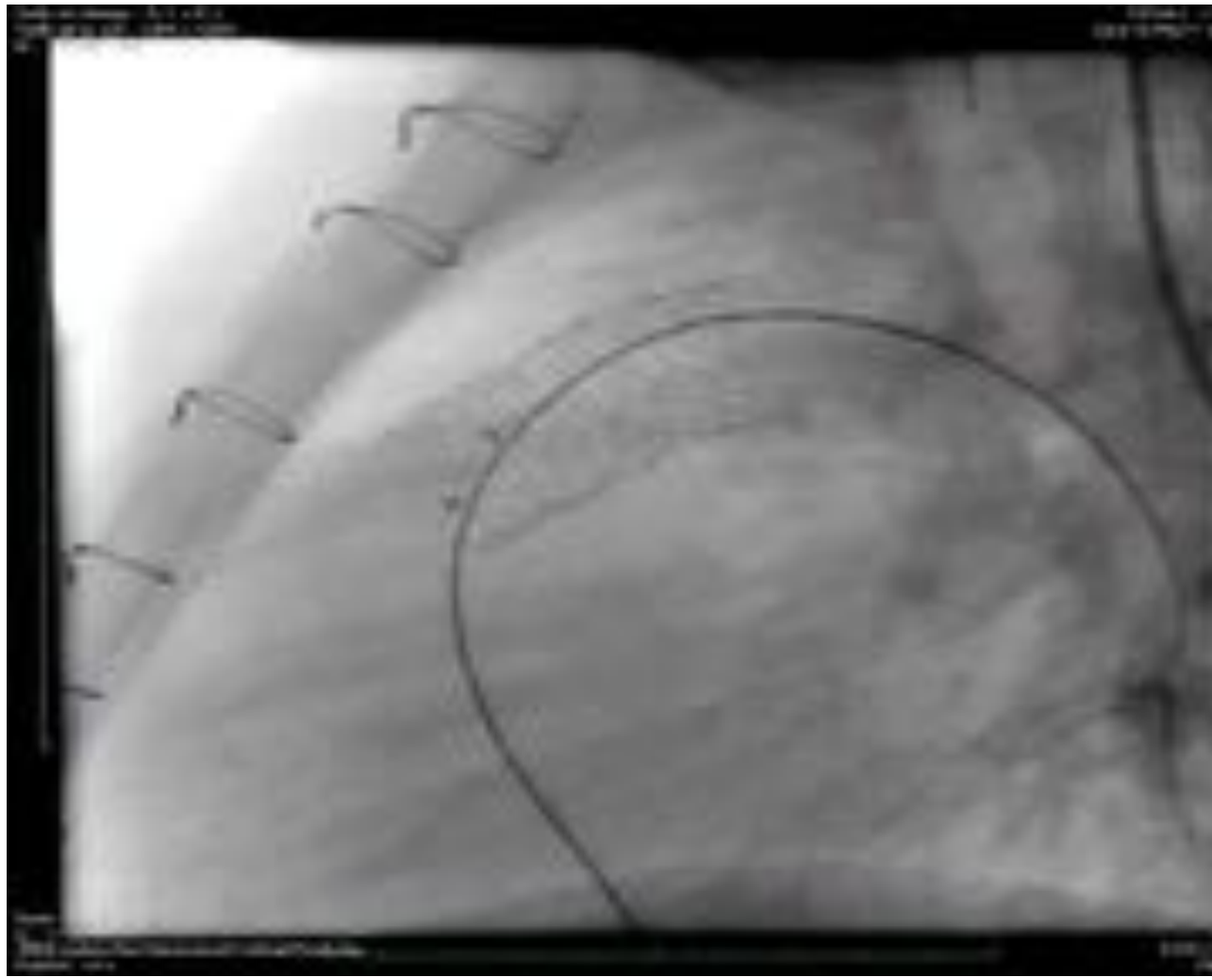


Step by step

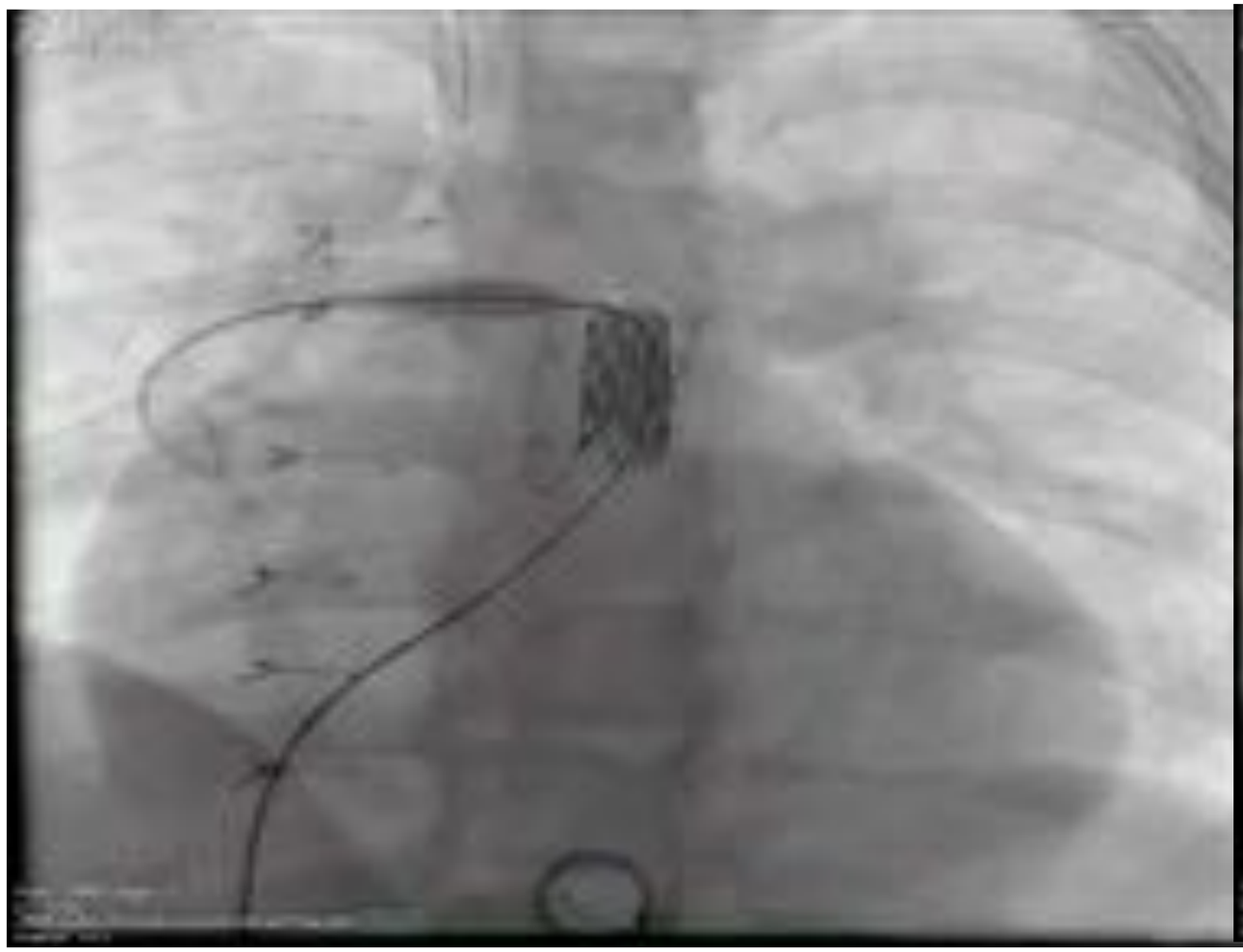


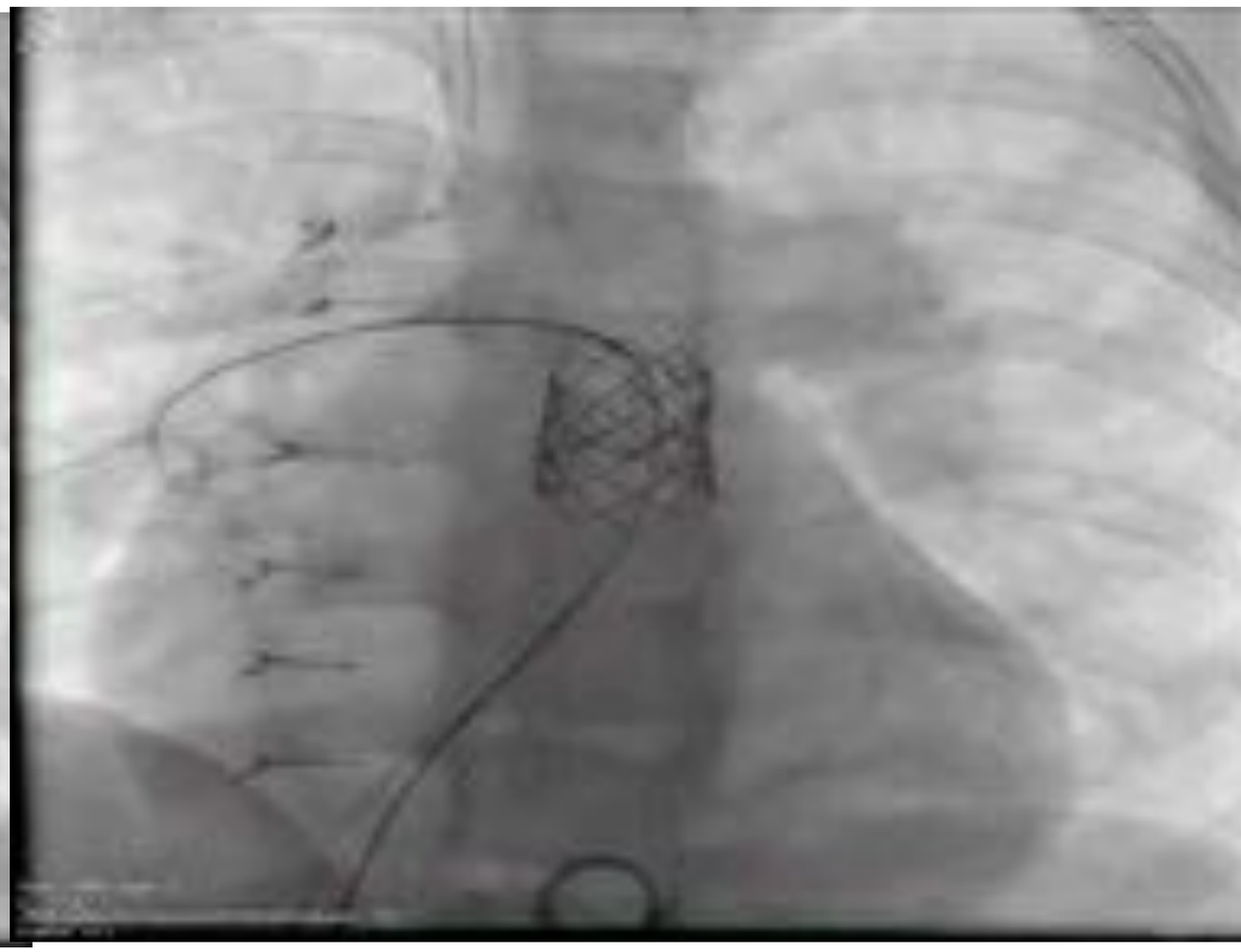
Step by step



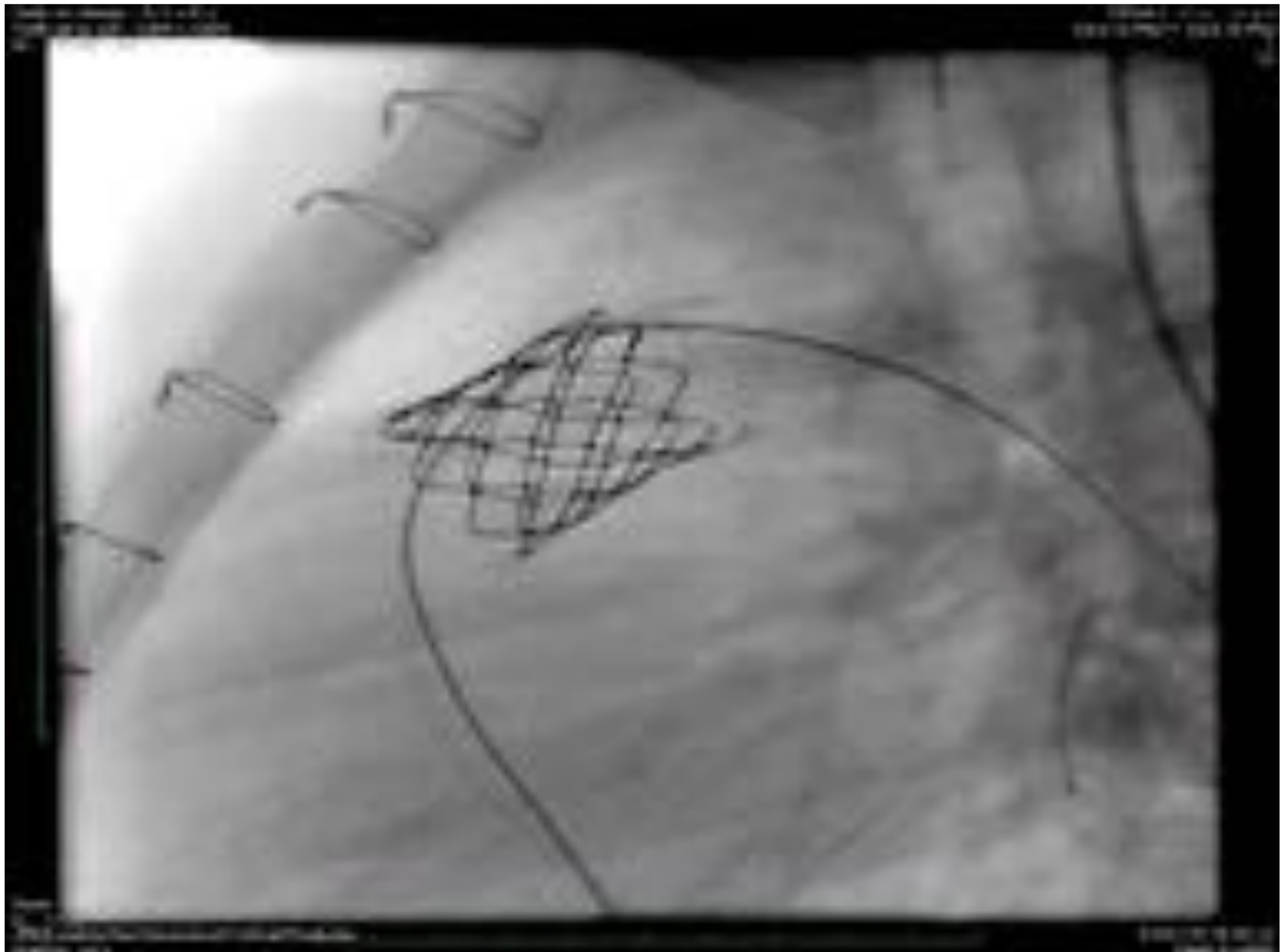


Step by step

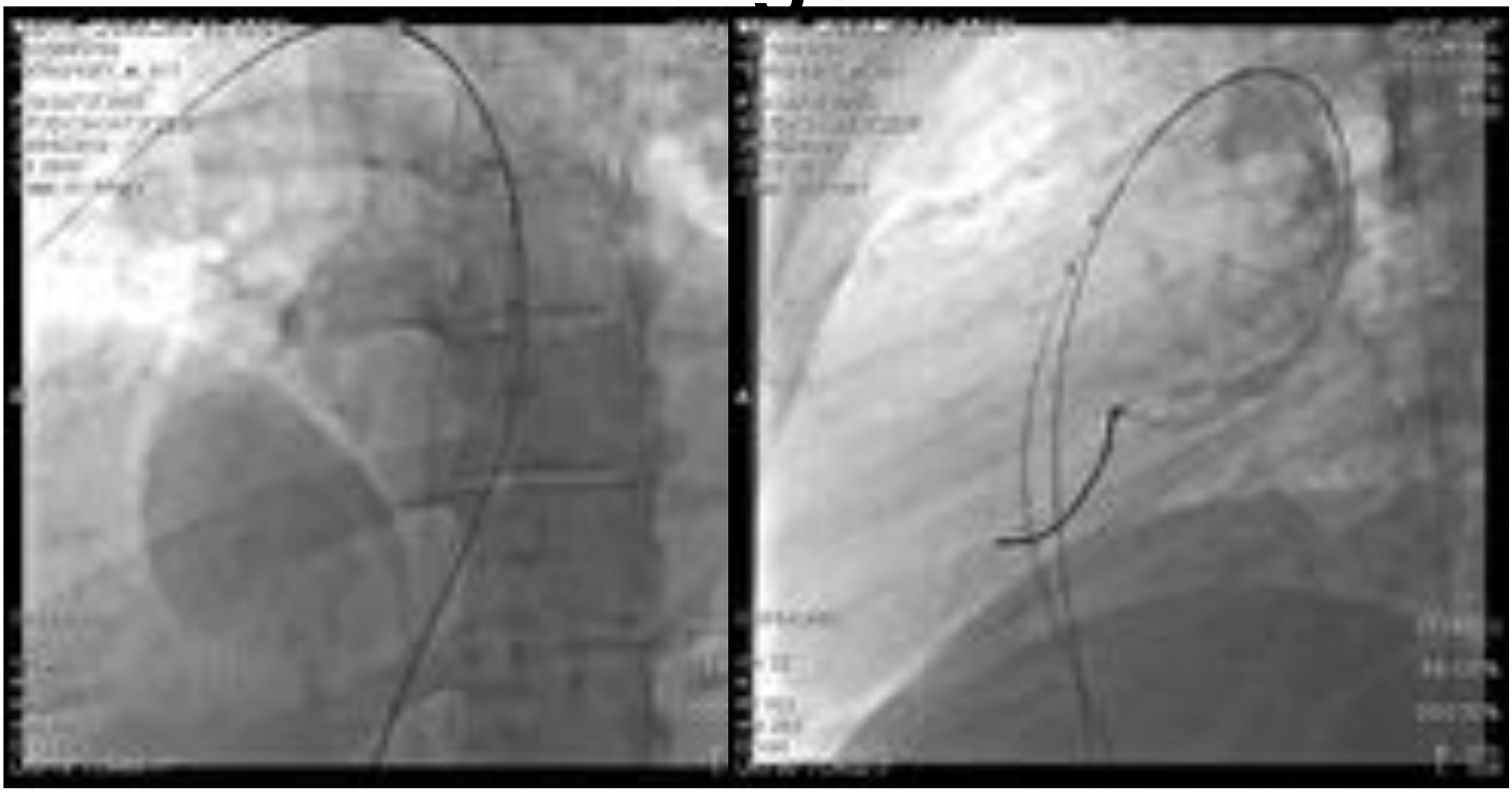




Final step

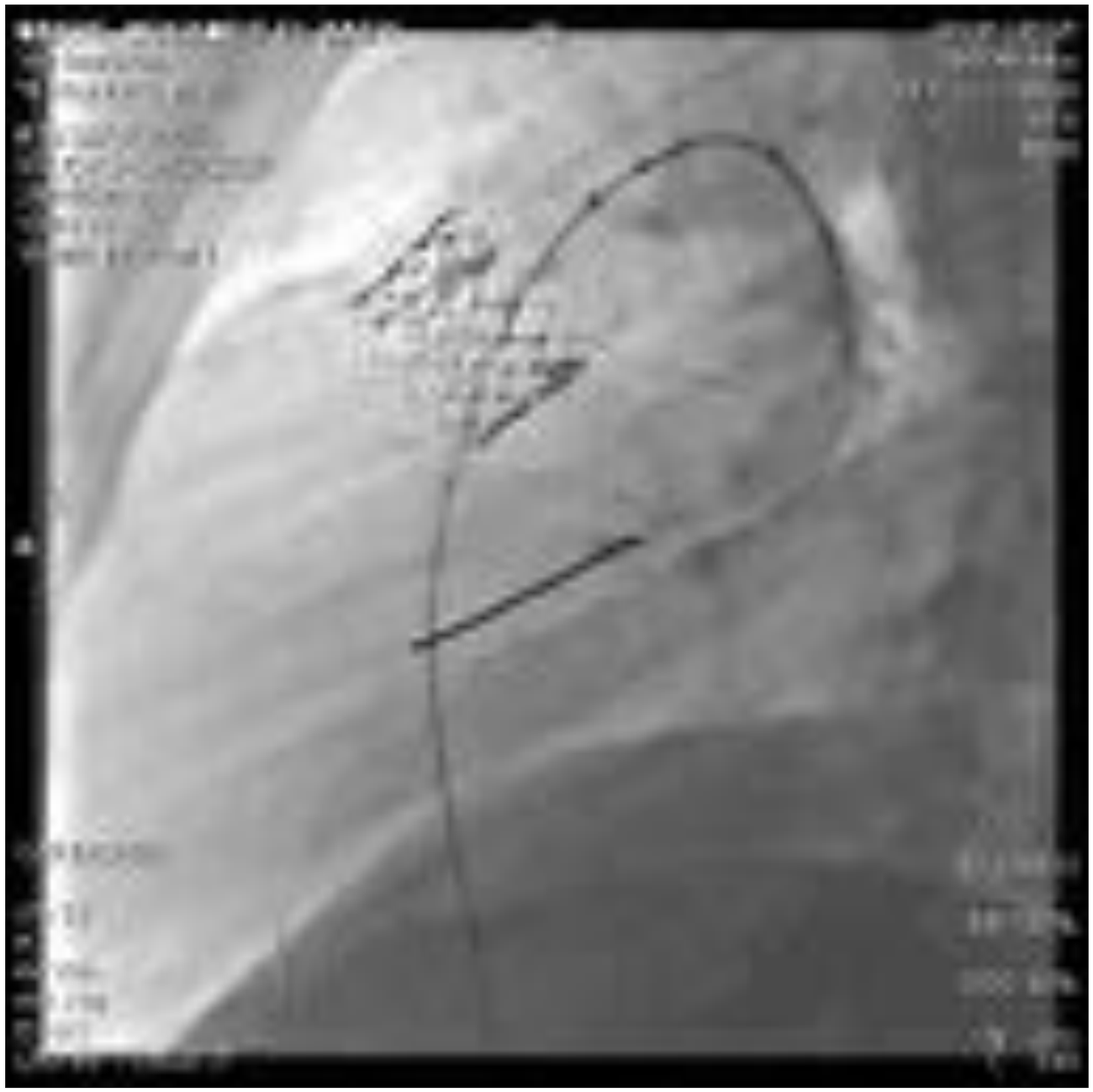


Valvulation de voie native large

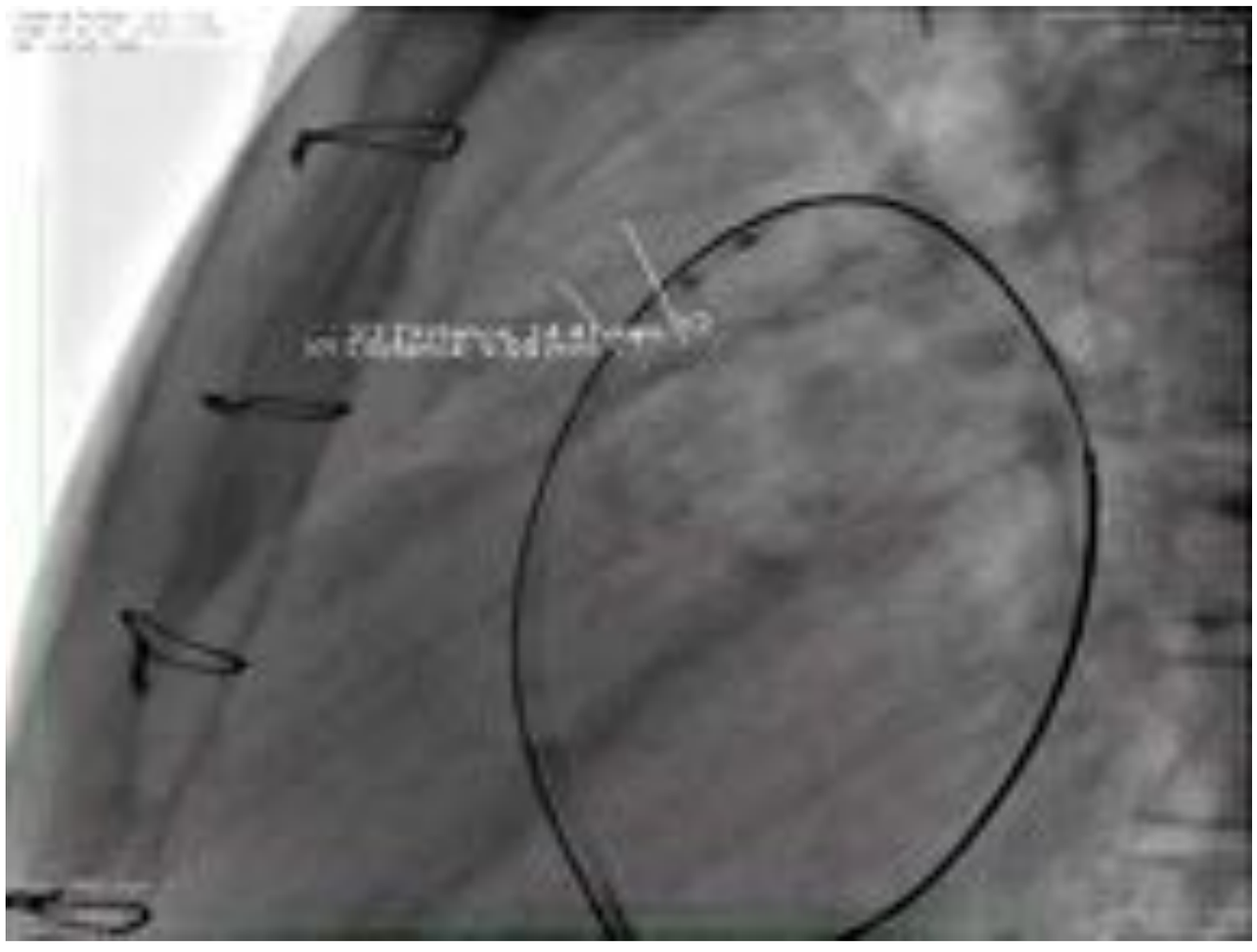


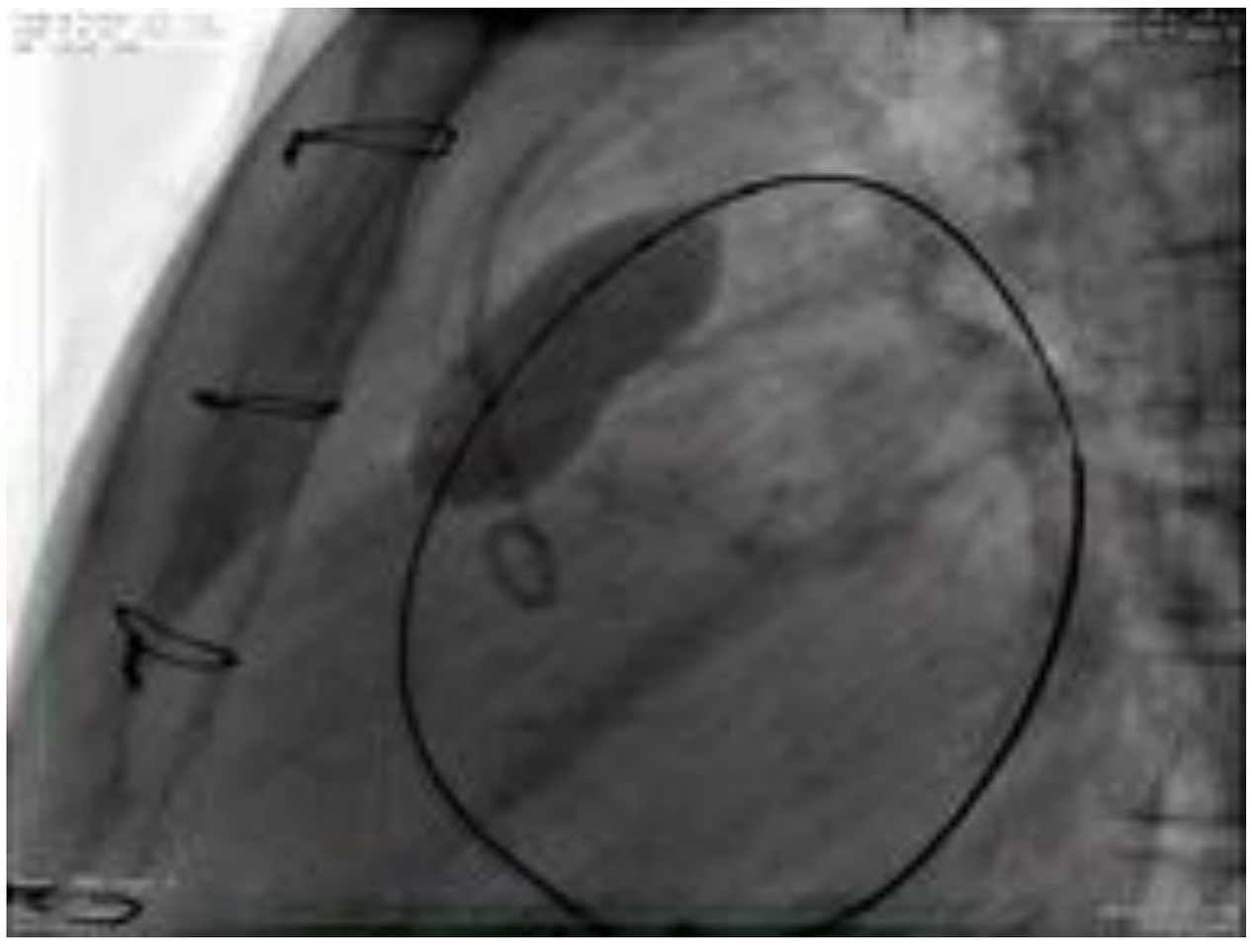
Pre-stenting

Mise en place d’une Valve Edwards

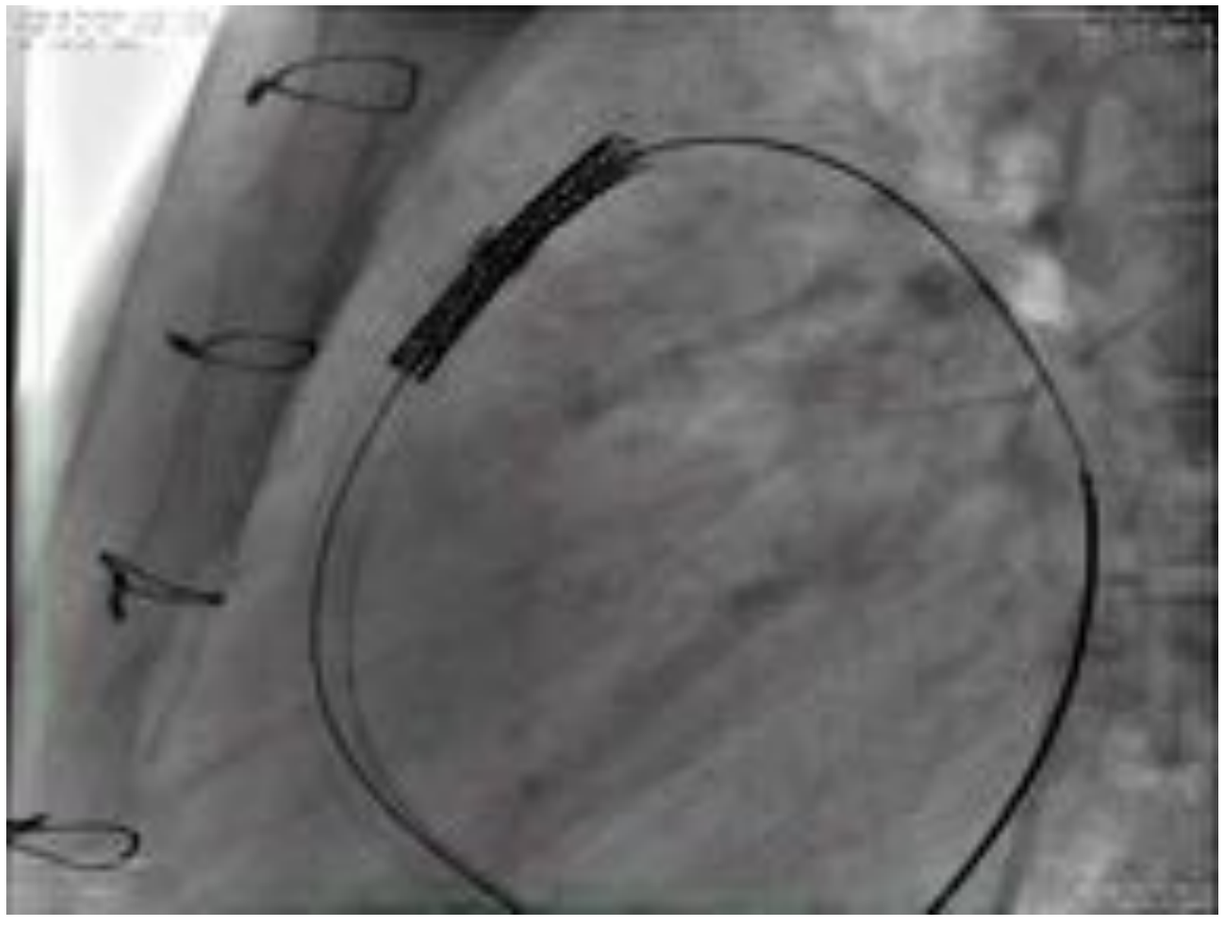


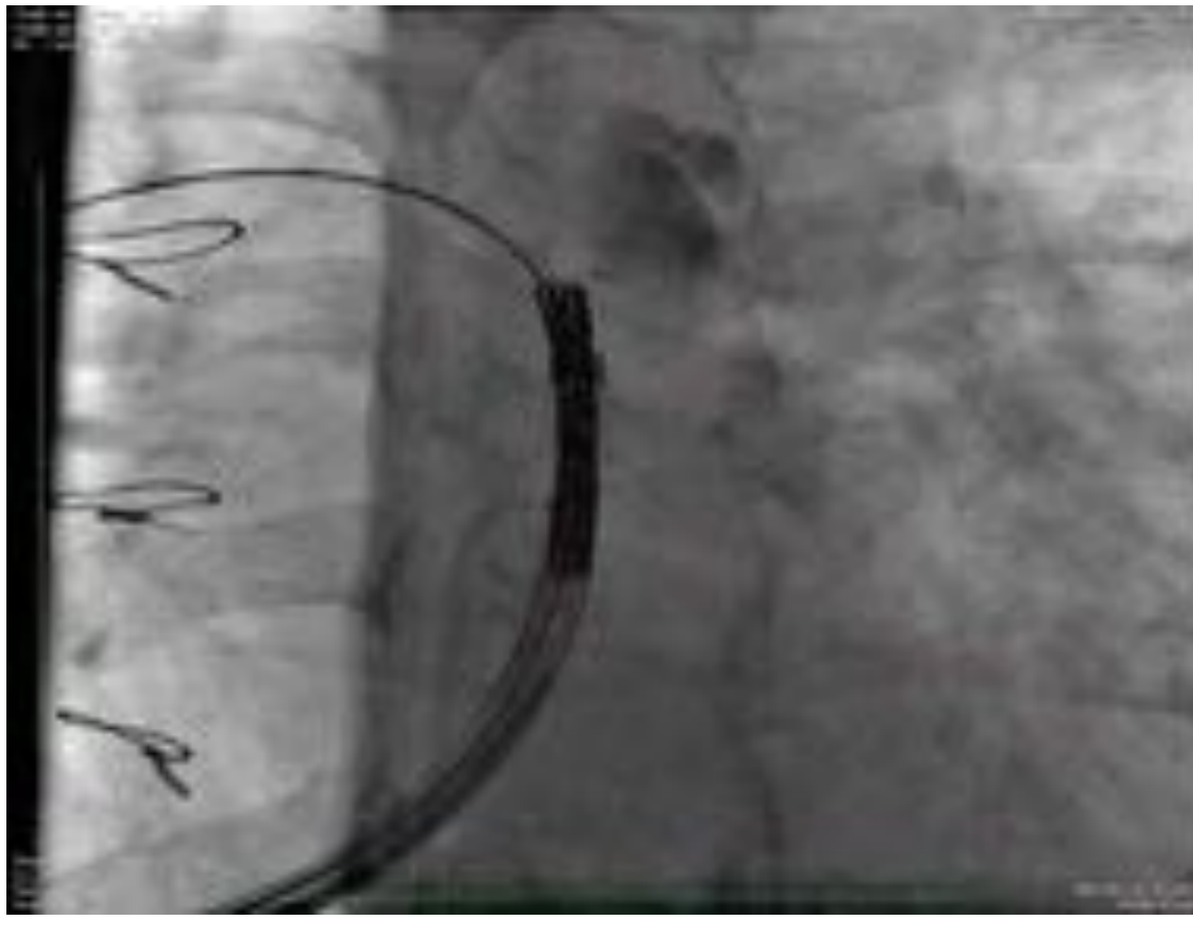
Complications potentielles
Rupture de conduit





Rupture de conduit





Compromis

Pour éviter les compressions coronaires, il faut un dépistage agressif avec un test au ballon au bon diamètre

MAIS le test au ballon est le moment où l'on rompt ou déchire le conduit

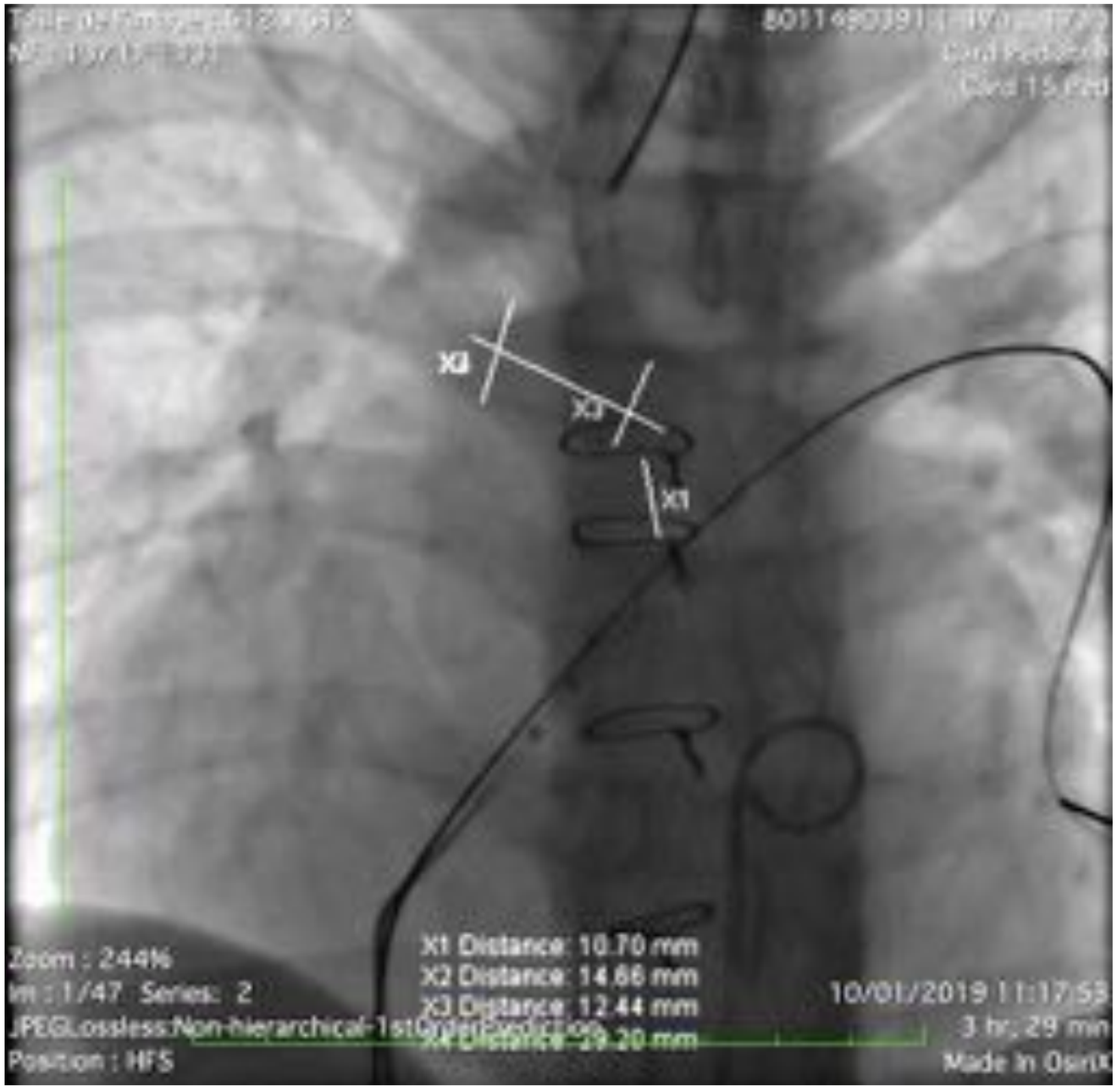
Le compromis:

être prudent avec les conduits calcifiés, petits

dilatation progressive

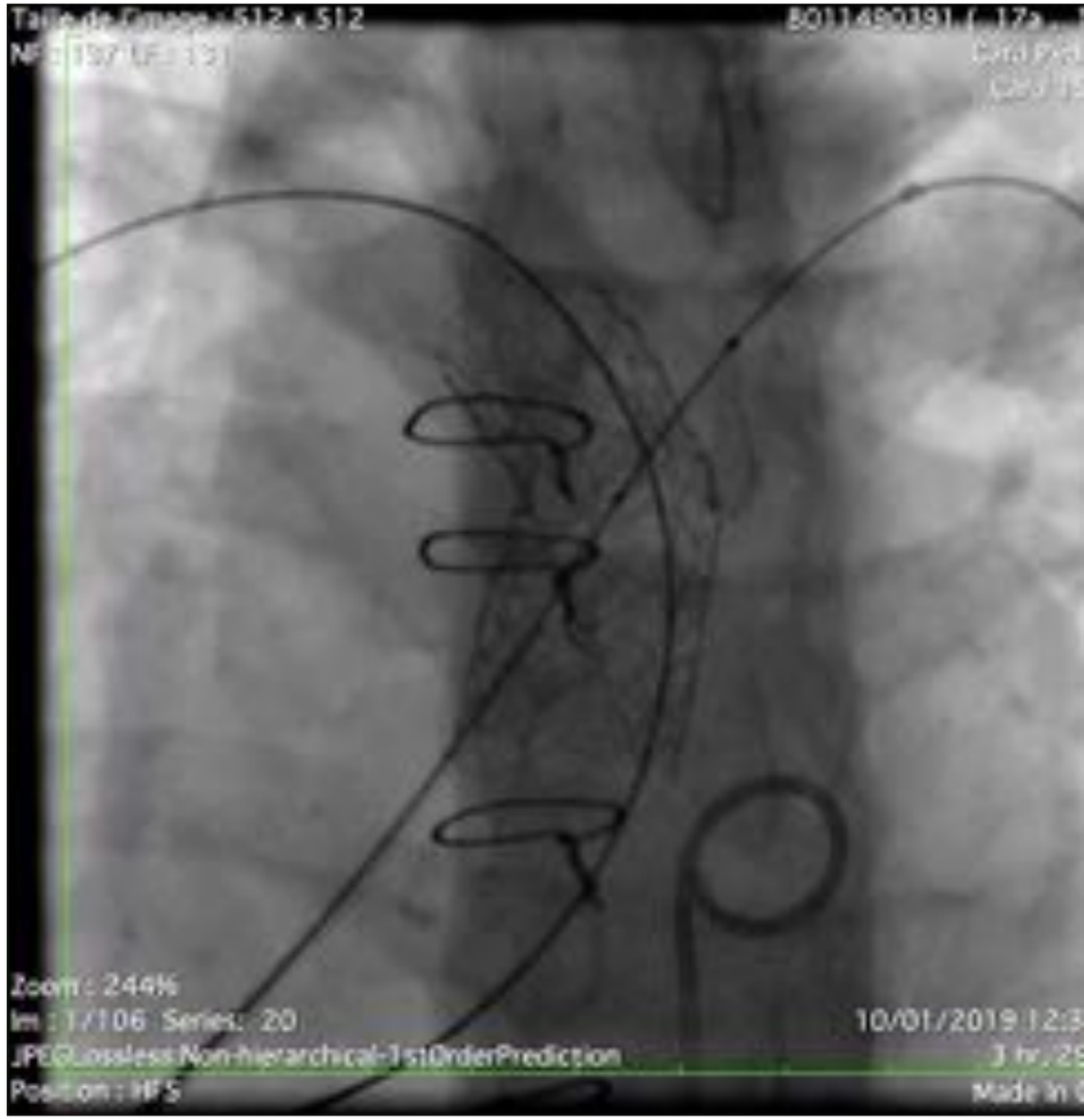
si les coronaires sont à distances dans plusieurs incidences et conduit fragile, pas de dilatation excessive

Techniques plus complexes
Sténose de la bifurcation



Suite


X1
X1 Distance: 18.65 mm
Zoom : 244%
Im : 1/47 Series: 16
JPEGLossless:Non-hierarchical-1stOrderPrediction
Position : HFS


Zoom : 244%
Im : 1/106 Series: 20
JPEGLossless:Non-hierarchical-1stOrderPrediction
Position : HFS

Fin


e de l'image : 512 x 512
8011490391 (17a , 17a)
Card Pédiatrie
Card 15 Ped
: 131
m : 244%
1/28 Series: 21
Lossless:Non-hierarchical-1stOrderPrediction
tion : HFS
10/01/2019 13:29:00
3 hr, 29 min
Made in Osirix


Taille de l'image : 512 x 512
NF : 137 UF : 131
8011490391 (17a , 17
Card Pédia
Card 15 P
Zoom : 244%
Im : 1/56 Series: 24
JPEGLossless:Non-hierarchical-1stOrderPrediction
Position : HFS
10/01/2019 13:35
3 hr, 29
Made in Os

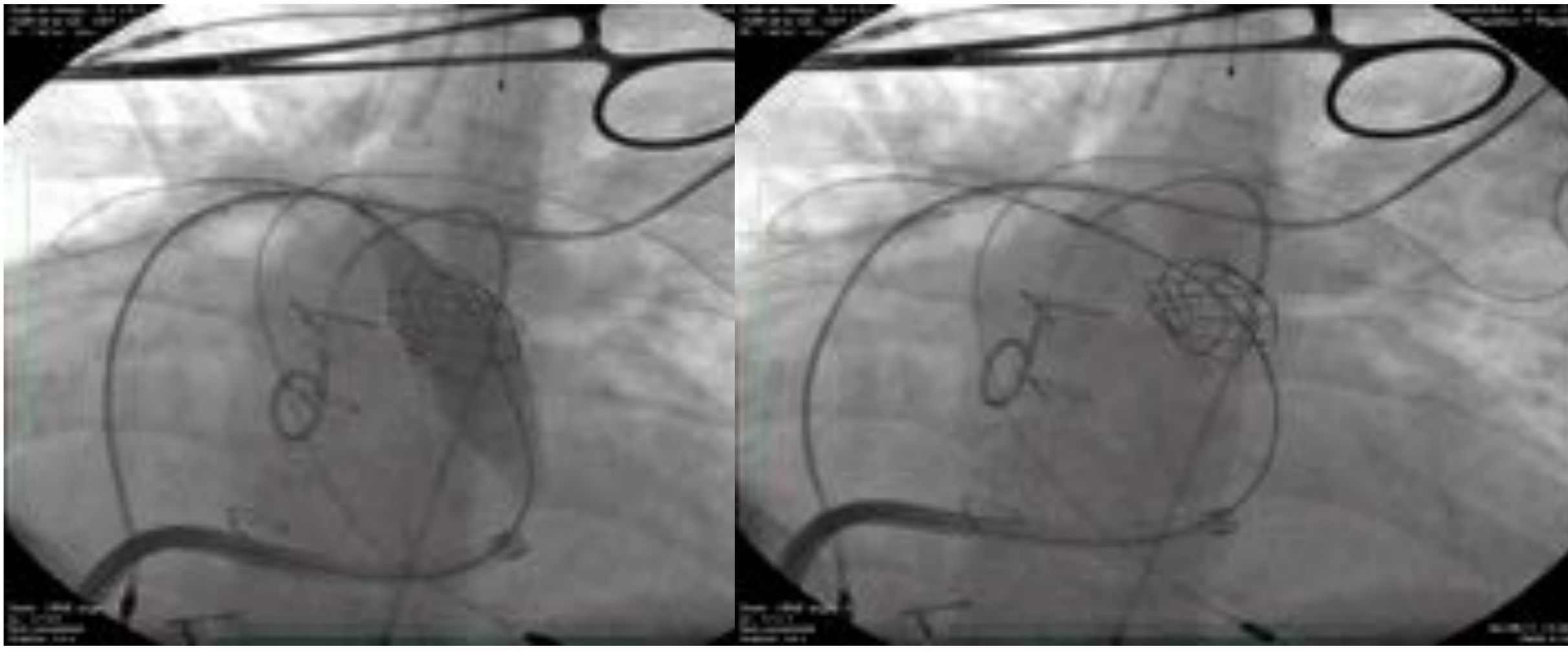
Compression coronaire

Rescue surgery following percutaneous pulmonary valve implantation[1,2,3]

Martin Rostsky[1], Victor Tsang[1,2], Johannes Nordmeyer[3], Carin Van Doorn[1], Alessandra Frigiola[1], Sachin Khambadkone[1], Marc R. de Leval[1], Philipp Bonhoeffer[1]

[1] London Unit, Great Ormond Street Hospital for Children, NHS Trust, Great Ormond Street, WC1N 3JH London, United Kingdom

Compression coronaire



Endocardites de la Mélody

Atypical malignant late infective endocarditis of Melody valve

Paris, France

Circulation

American Heart Association

Endocardites des valves Mélody

- Complication préoccupante
- Mortalité chez les premiers patients car délai de prise en charge et méconnaissance de la complication
- Actuellement: fréquence plus élevée qu'avec les substituts chirurgicaux mais mortalité diminuée
- Mortalité reste importante avec les Staph doré

- Importance capitale de la prévention et de l'éducation

Incidence différente d'IE entre Sapiens et Mélodys
1 article (Hasoët et al)
D'autres études en cours

Valve in valve

Indications

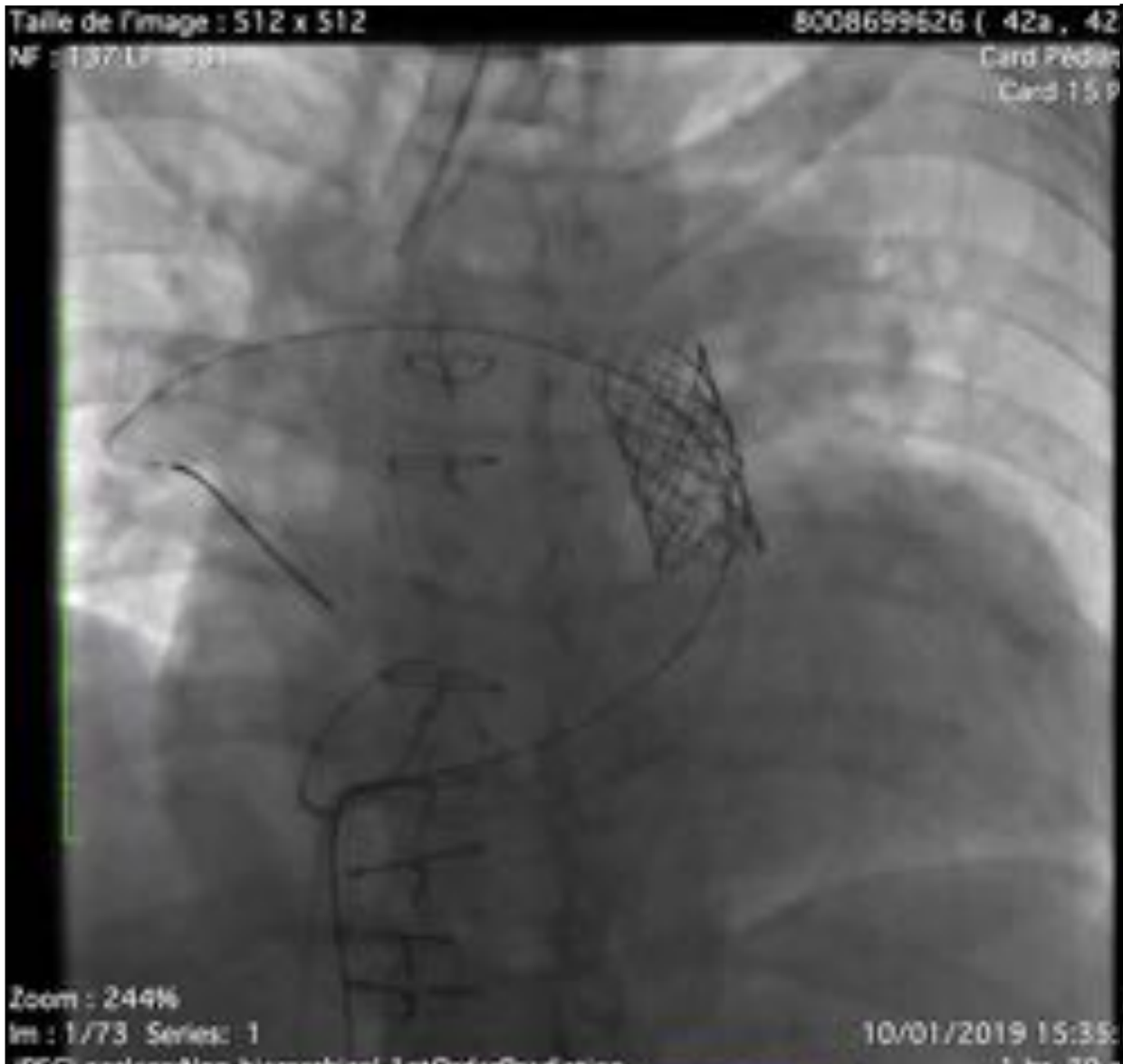
Croissance de l’enfant

Fracture de Mélody

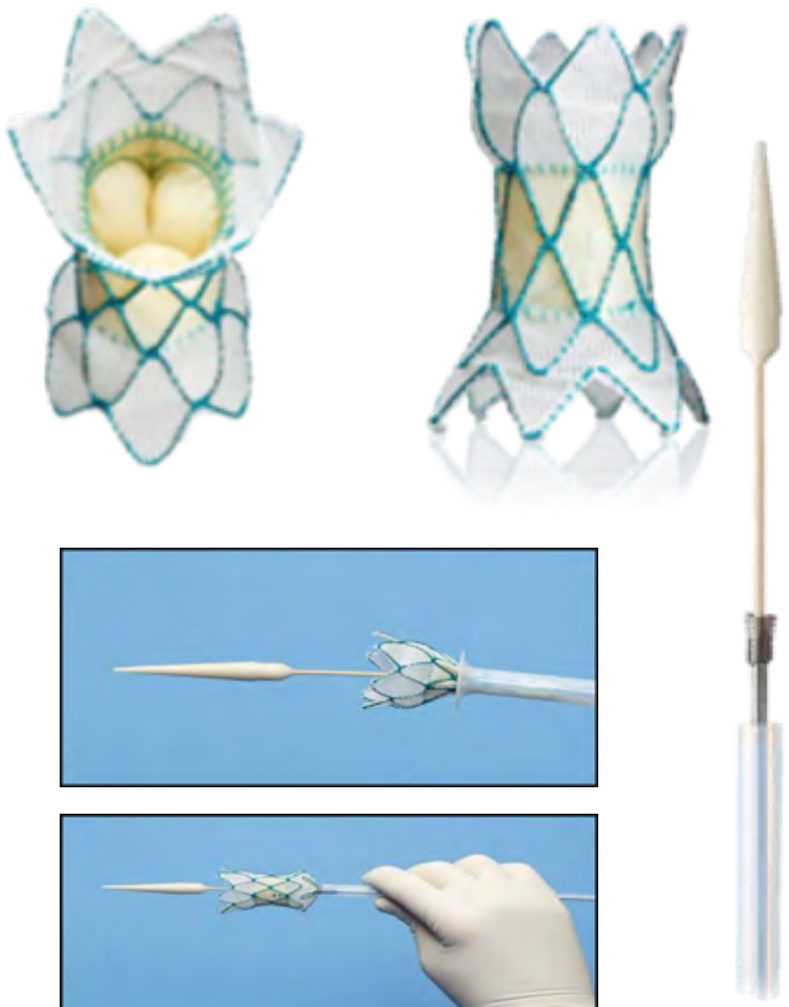
Endocardite

Registre européen actuellement

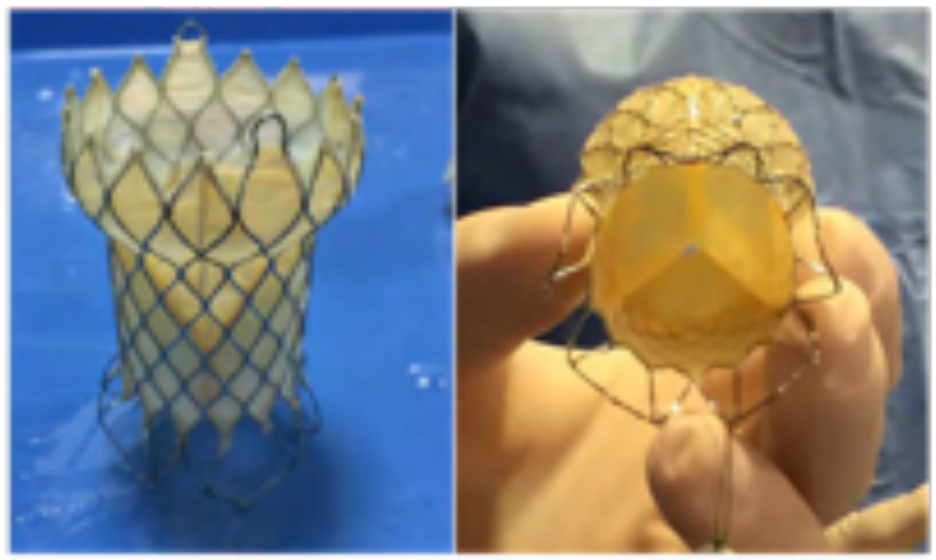
Valve in valve post endocardite

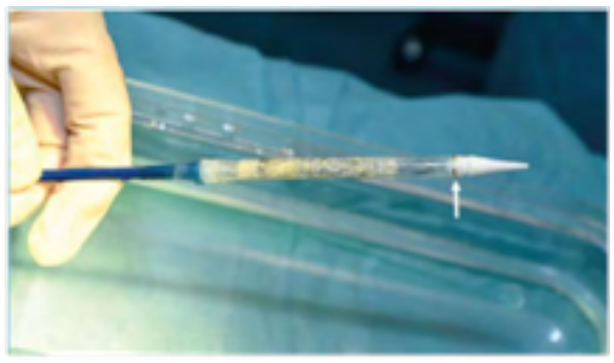


Autres substituts



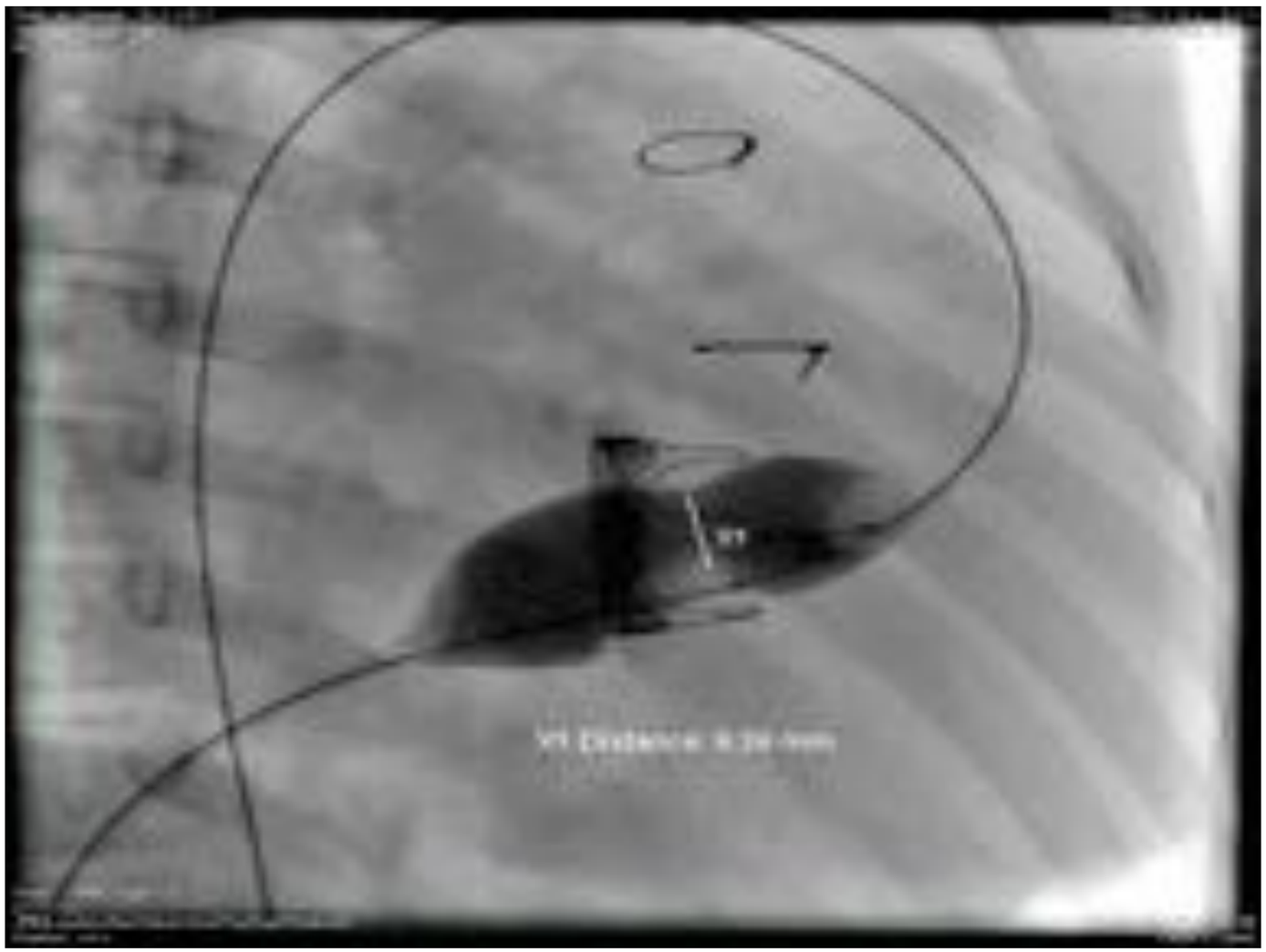
Harmony valve
Medtronic





P venus valve
Medtech

Valvulation tricuspide



Procédures hybrides

- Intérêt de combiner plusieurs techniques-savoir faire et les forces des 2 techniques

- Procédure hybride par définition: Norwood hybride

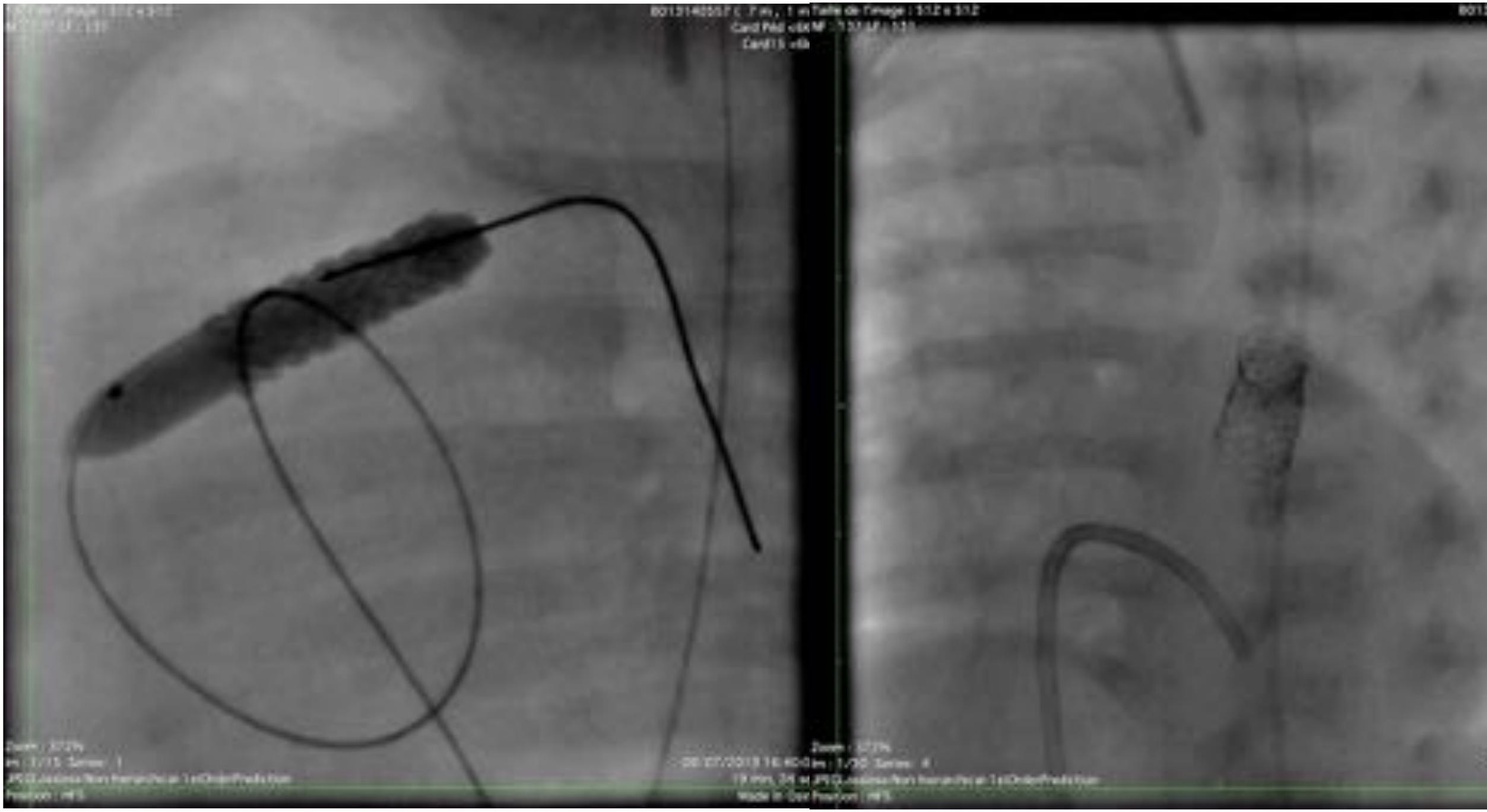
- Procédure hybride pour l’accès vasculaire: dénudation et abord artériel chirurgical

- Procédure hybride par sternotomie

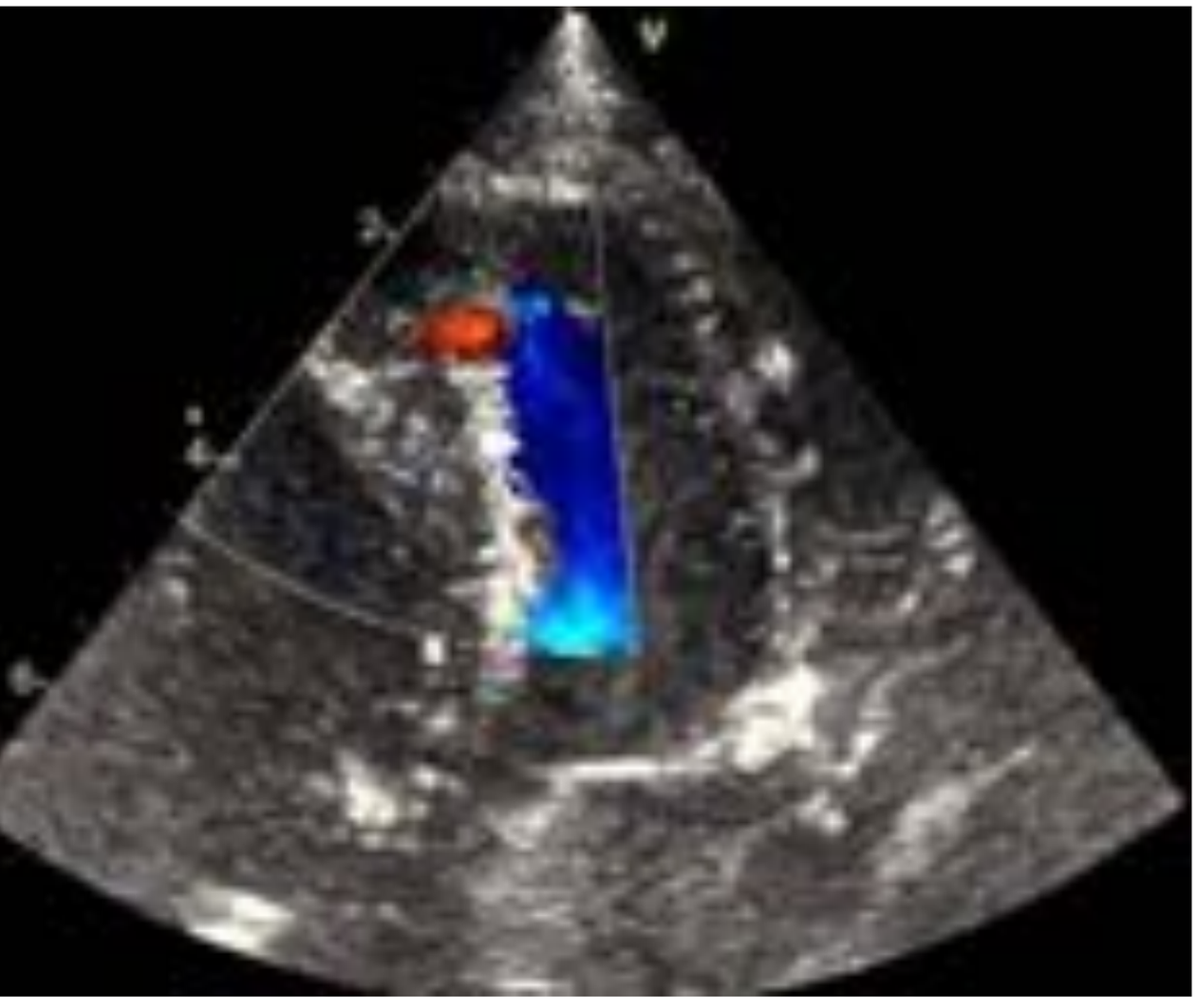
Hybride voie droite

Hybride voie droite

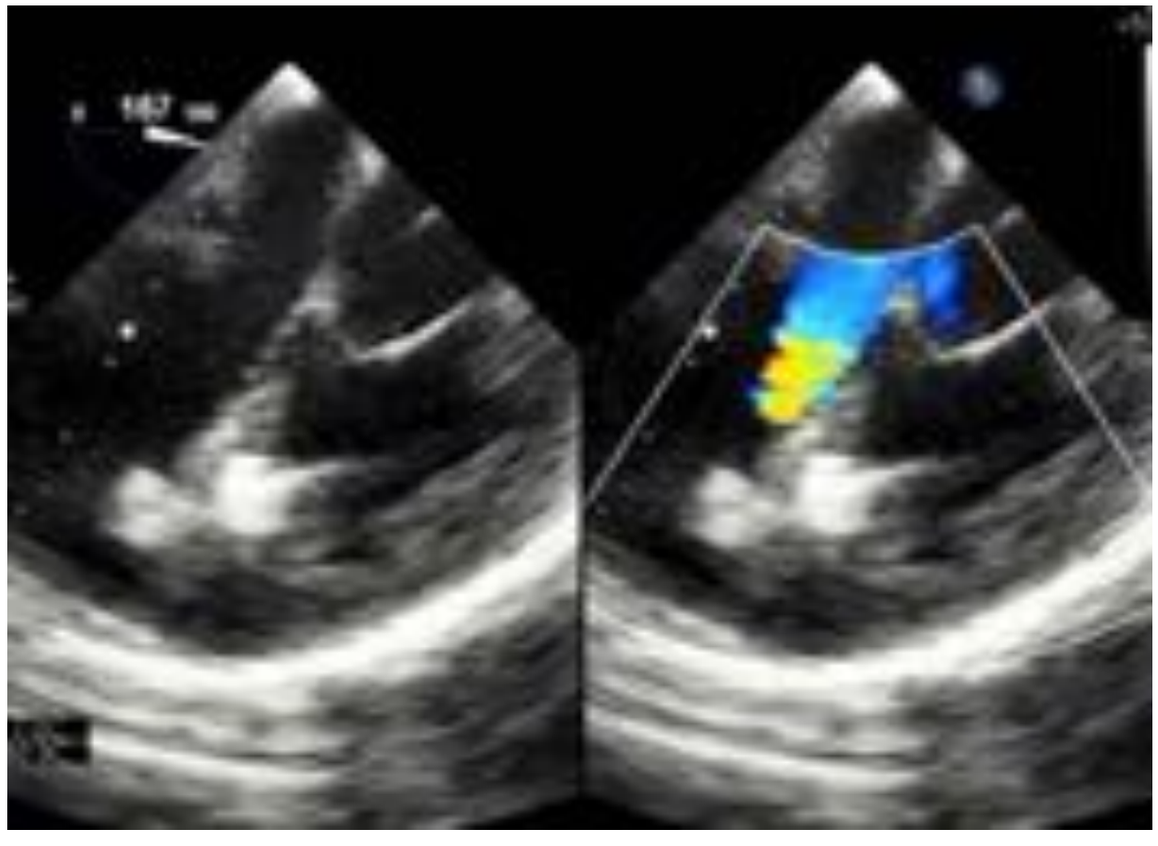
1 mois plus tard, prise de 600 gr



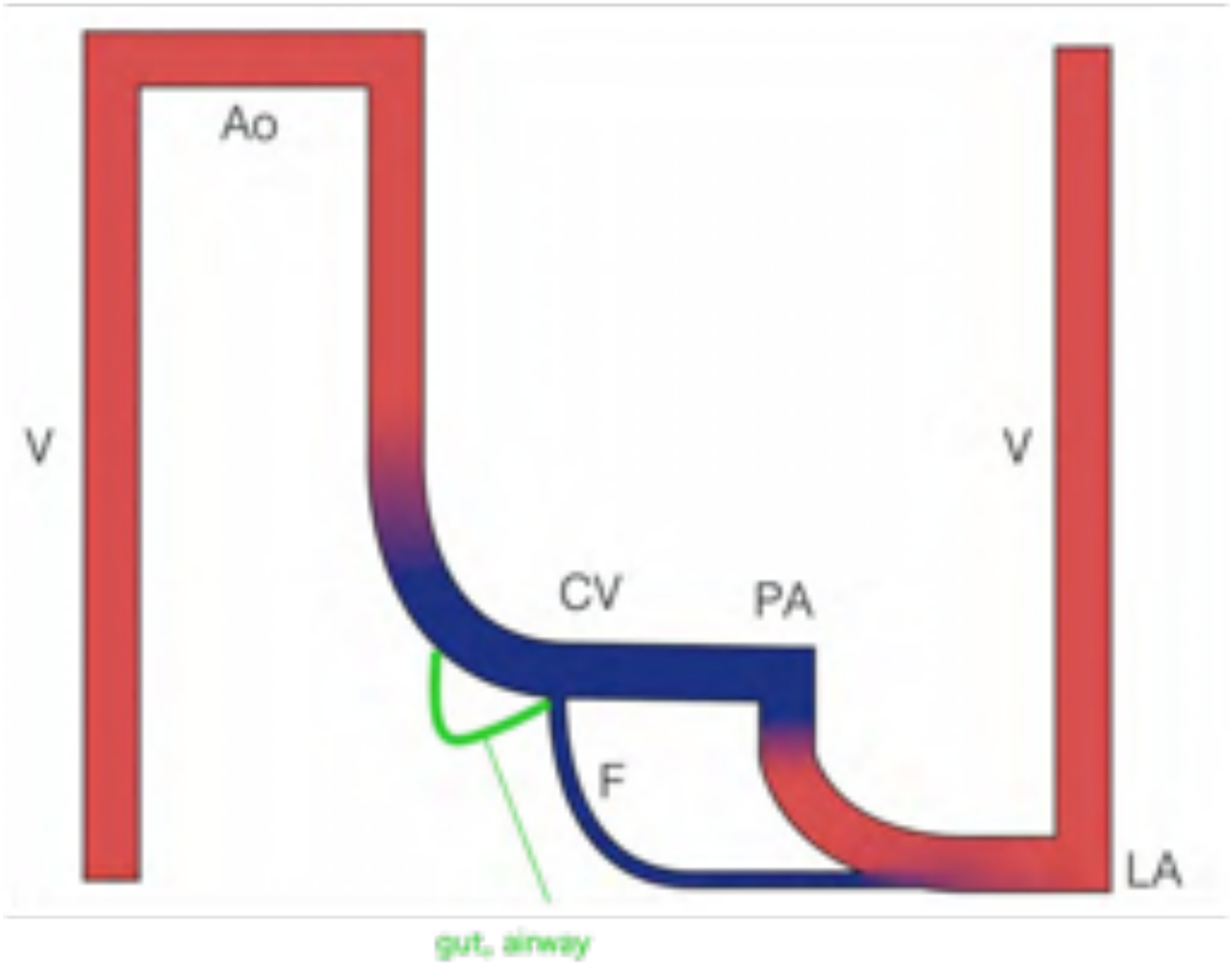
Fermeture CIV hybride

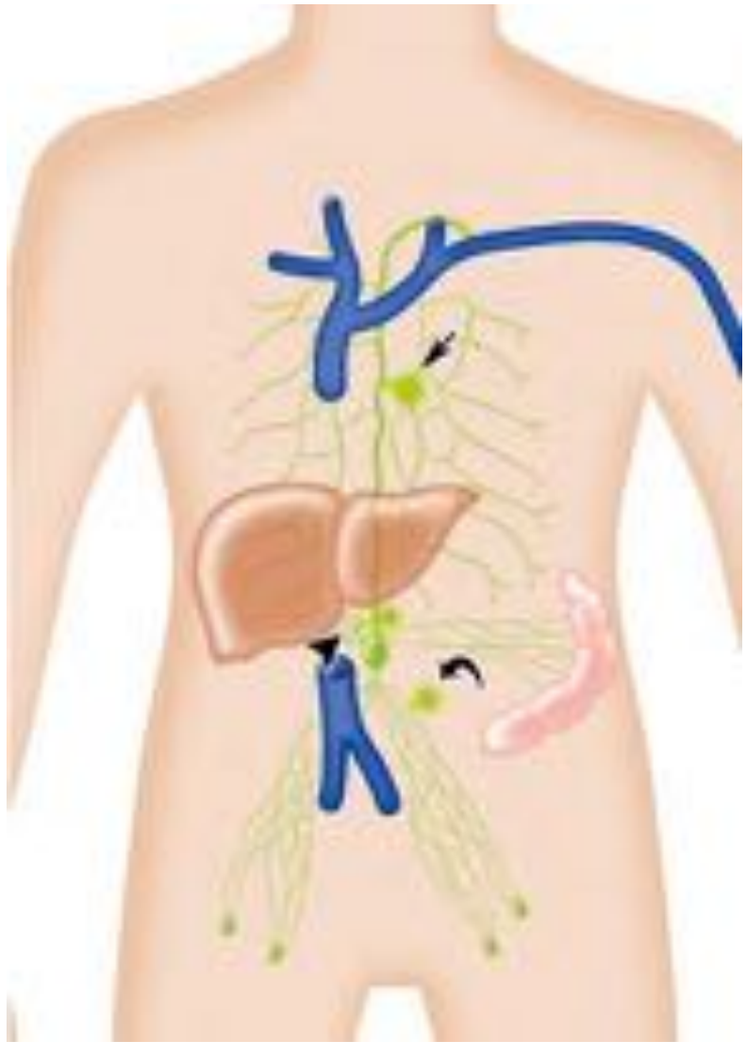


Fermeture CIV hybride



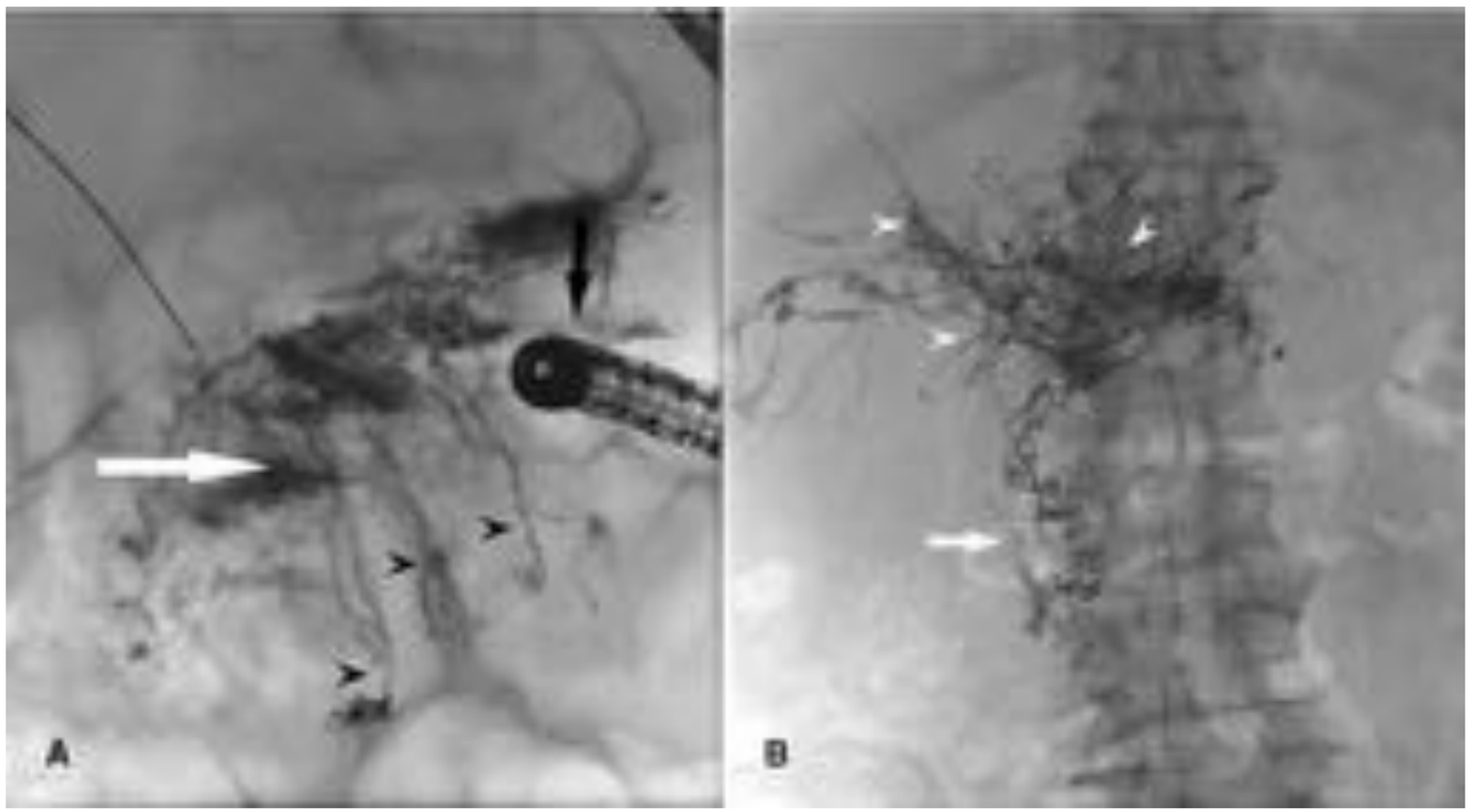
Et la lymphe





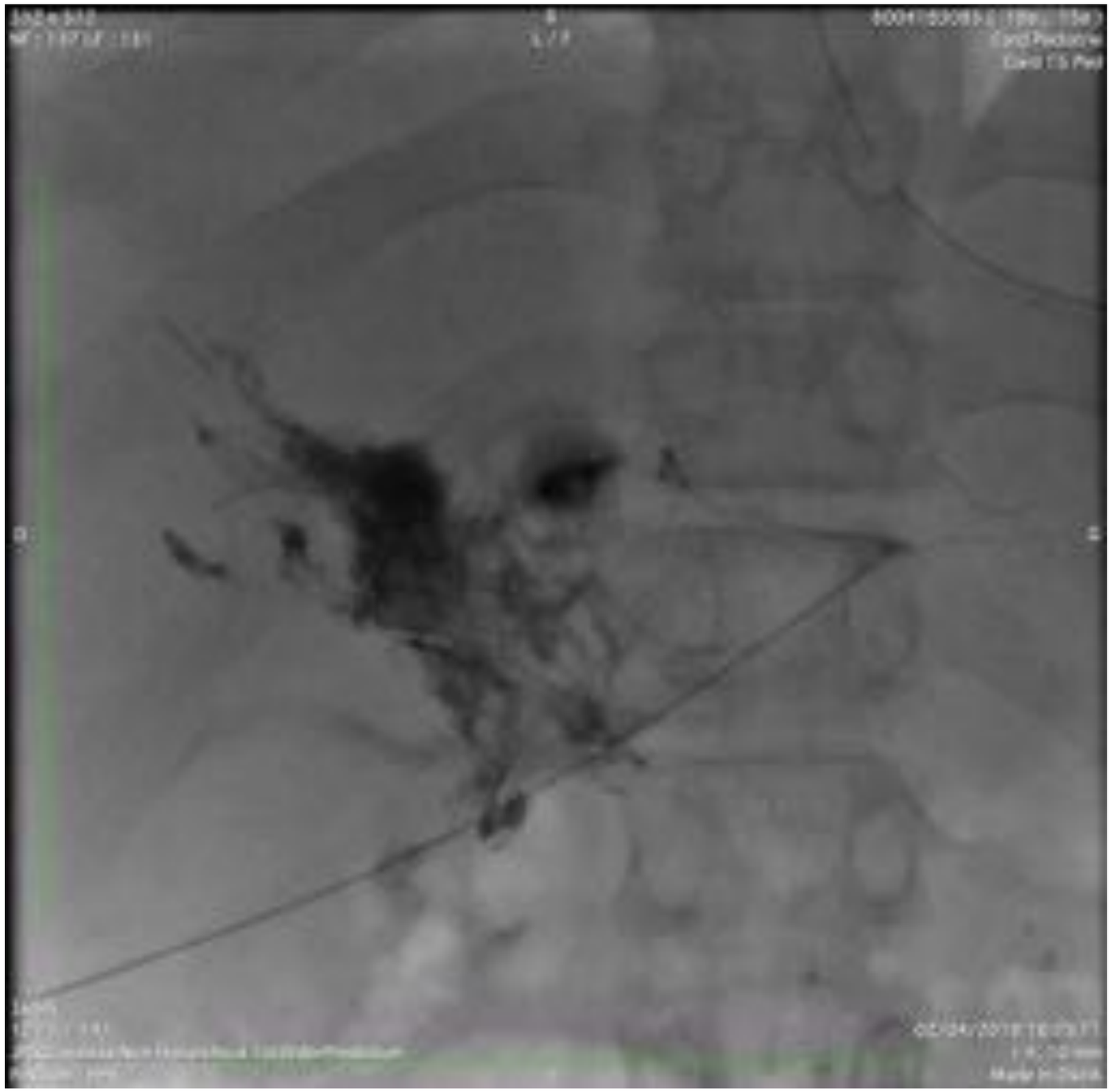
Marc Gewillig

Embolisation lymphatiques hépatiques

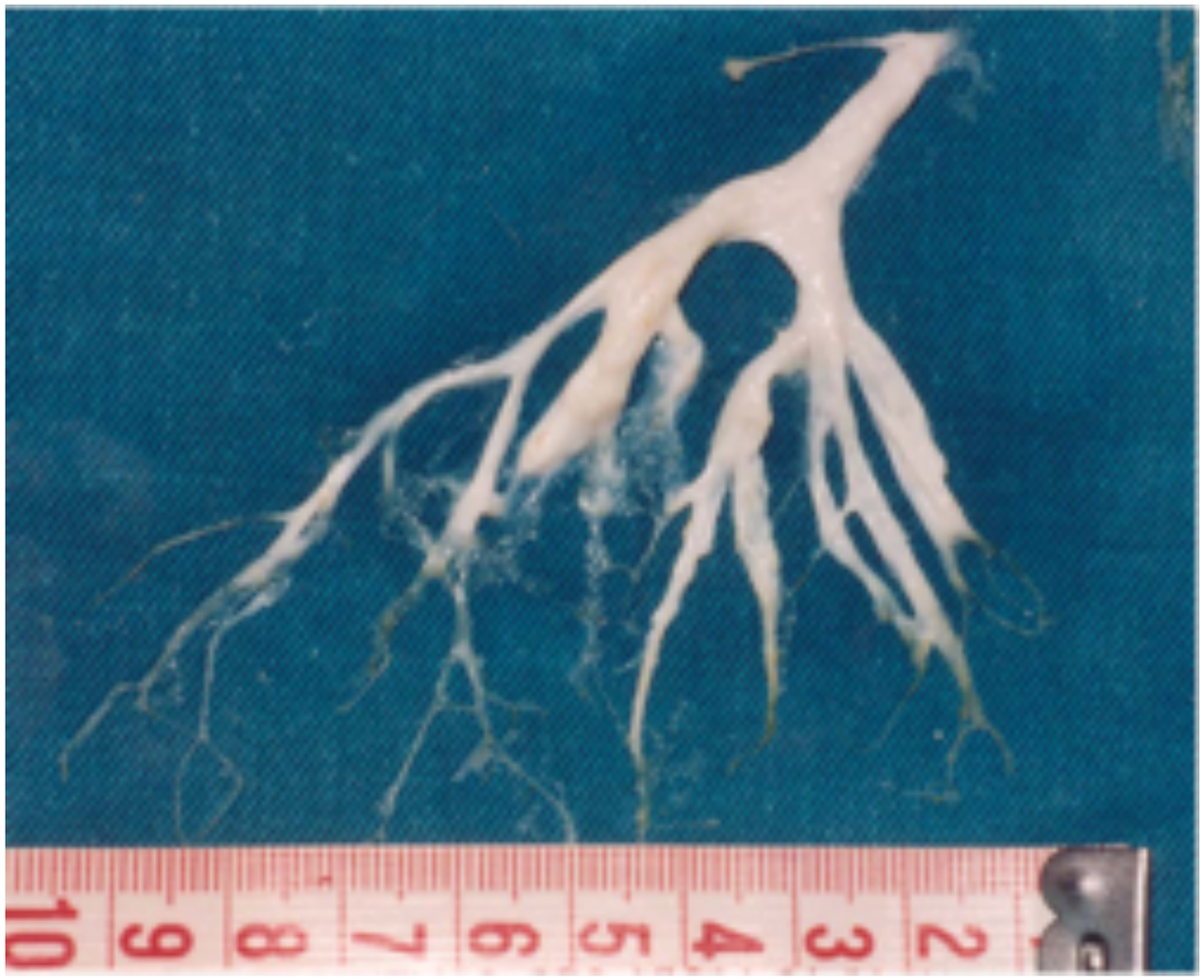


Itkin and Nadolski, Cardiovas Intervent Radiol. 2018

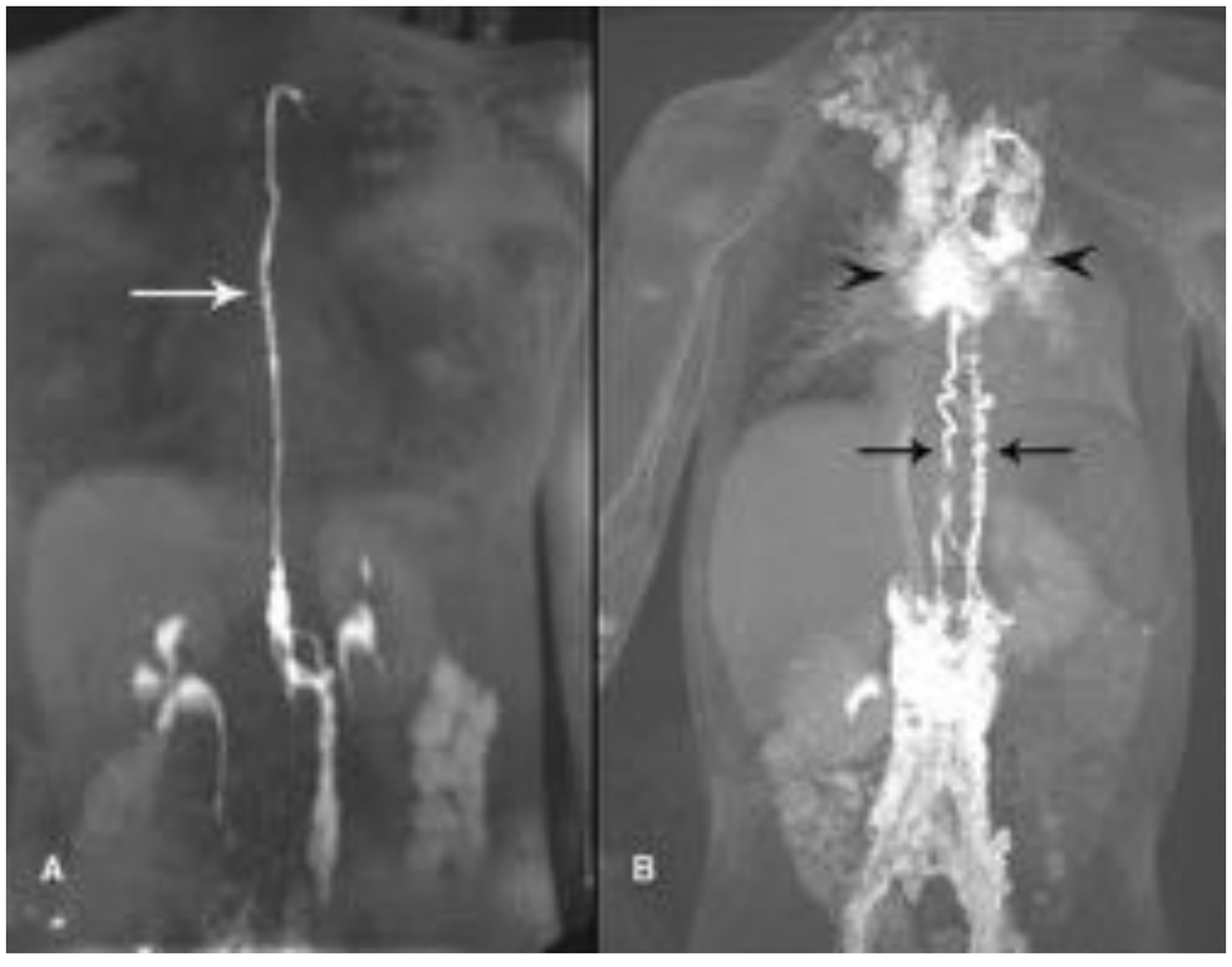
Embolisation hépatique



Bronchite plastique

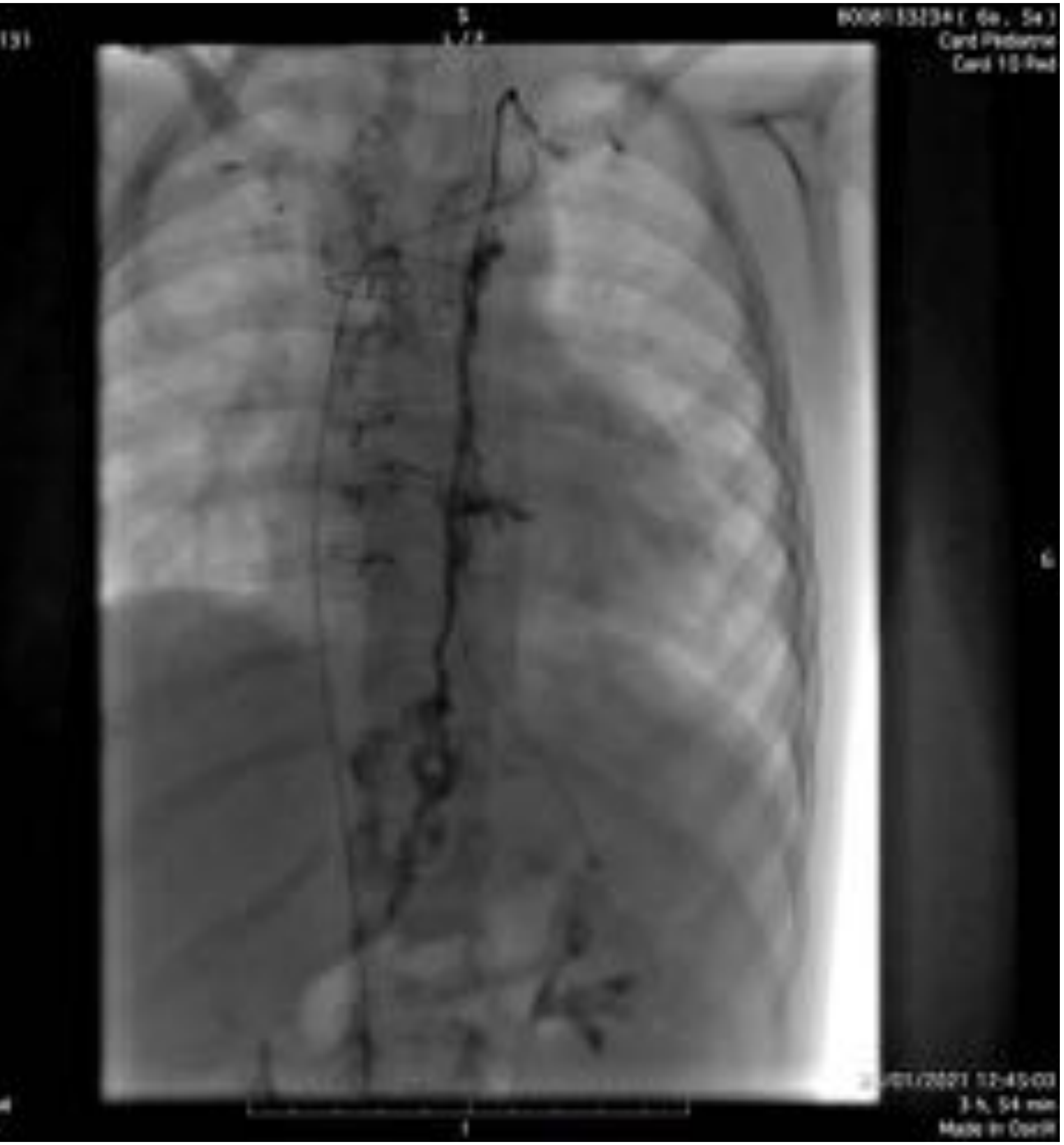


Bronchite plastique



Itkin and Nadolski, Cardiovas Intervent Radiol. 2018

Bronchite plastique



Futur

- Réducteur d’infundibulum prévalvulation
- Prothèses biorésorbable
- Procédures sans rayons RX, échoguidage, IRM

Conclusions

- Traitement de nombreuses lésions par voie endovasculaire
- Coexistence de la chirurgie et du cathétérisme pour les mêmes malades
- Excellents résultats du cathétérisme qui est moins invasif
- Connaître les complications potentielles
- Savoir les éviter et les traiter
- Nouvelles perspectives