Contre-pulsion intra-aortique (CPIA): ses principes, ses indications

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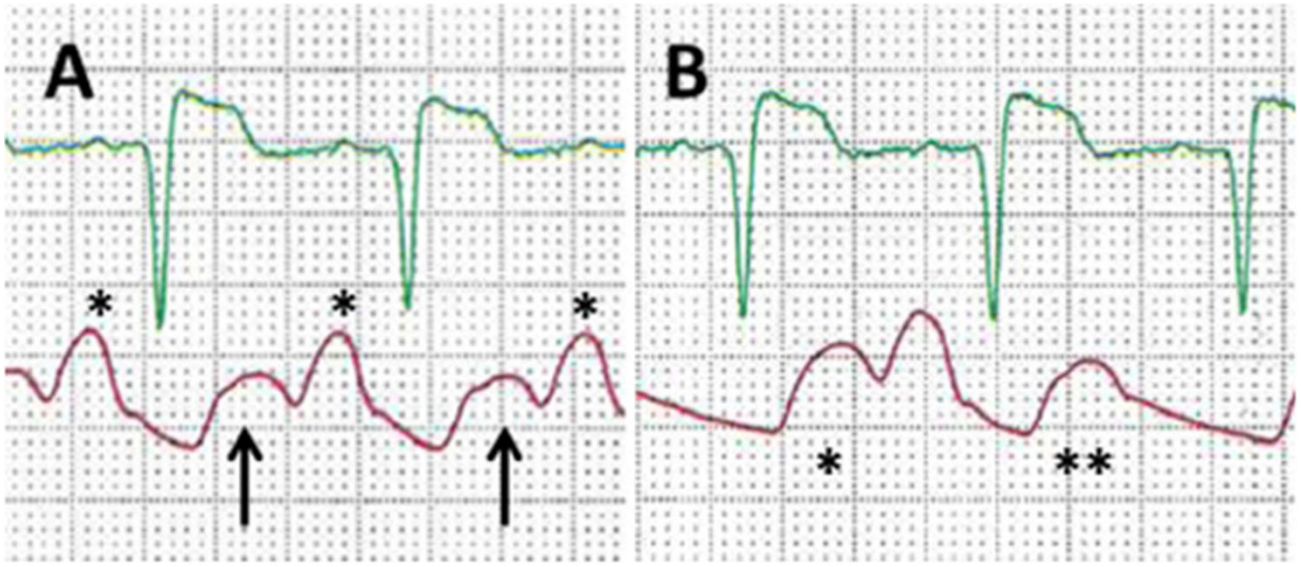
CHU de Bordeaux

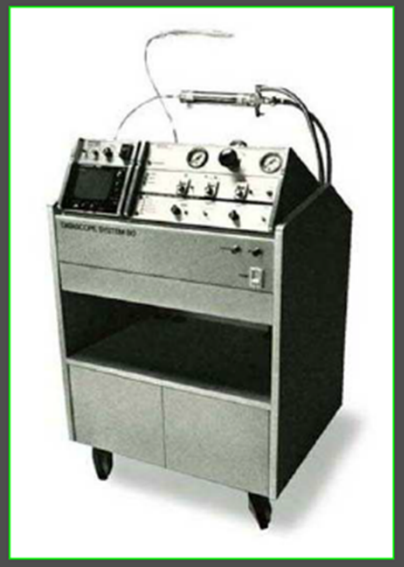
Définition

- Dispositif temporaire de soutien circulatoire mis en place de manière invasive par voie fémorale, via un désilet 8F, dans l'aorte descendante sous contrôle scopique.
- 1ère application clinique en 1968 pour un diagnostic de choc cardiogénique (Dr Kantrowitz)



Histoire

History:



1962 Animal studies

Moulopoulos et al. Am Heart J 1962;63:669-675

1968 First clinical description in shock

Kantrowitz et al. JAMA 1968;203:135-140

1973 Hemodynamic effects in shock, Mortality unchanged

Scheidt et al. NEJM 1973;288:979-984

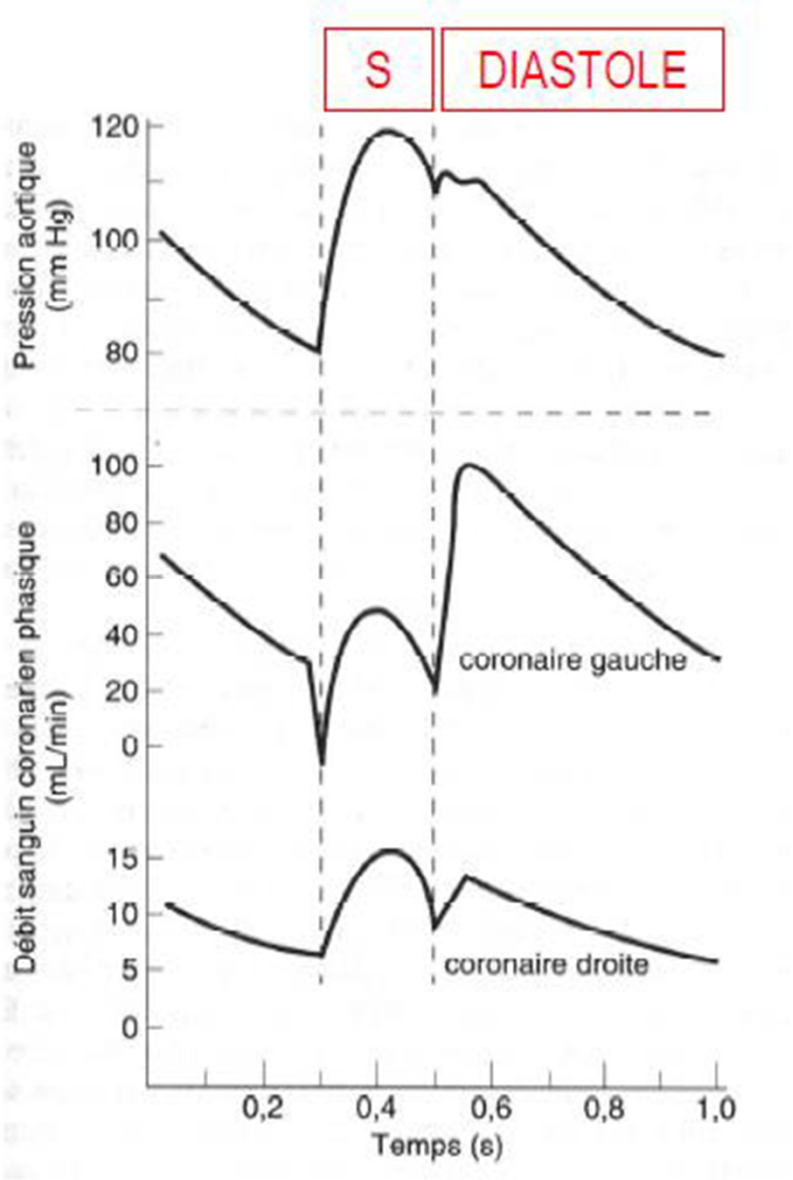
> 40 years > 1 Million patients treated, low complication rate, Benchmark registry

Ferguson et al. JACC 2001;38:1456-1462

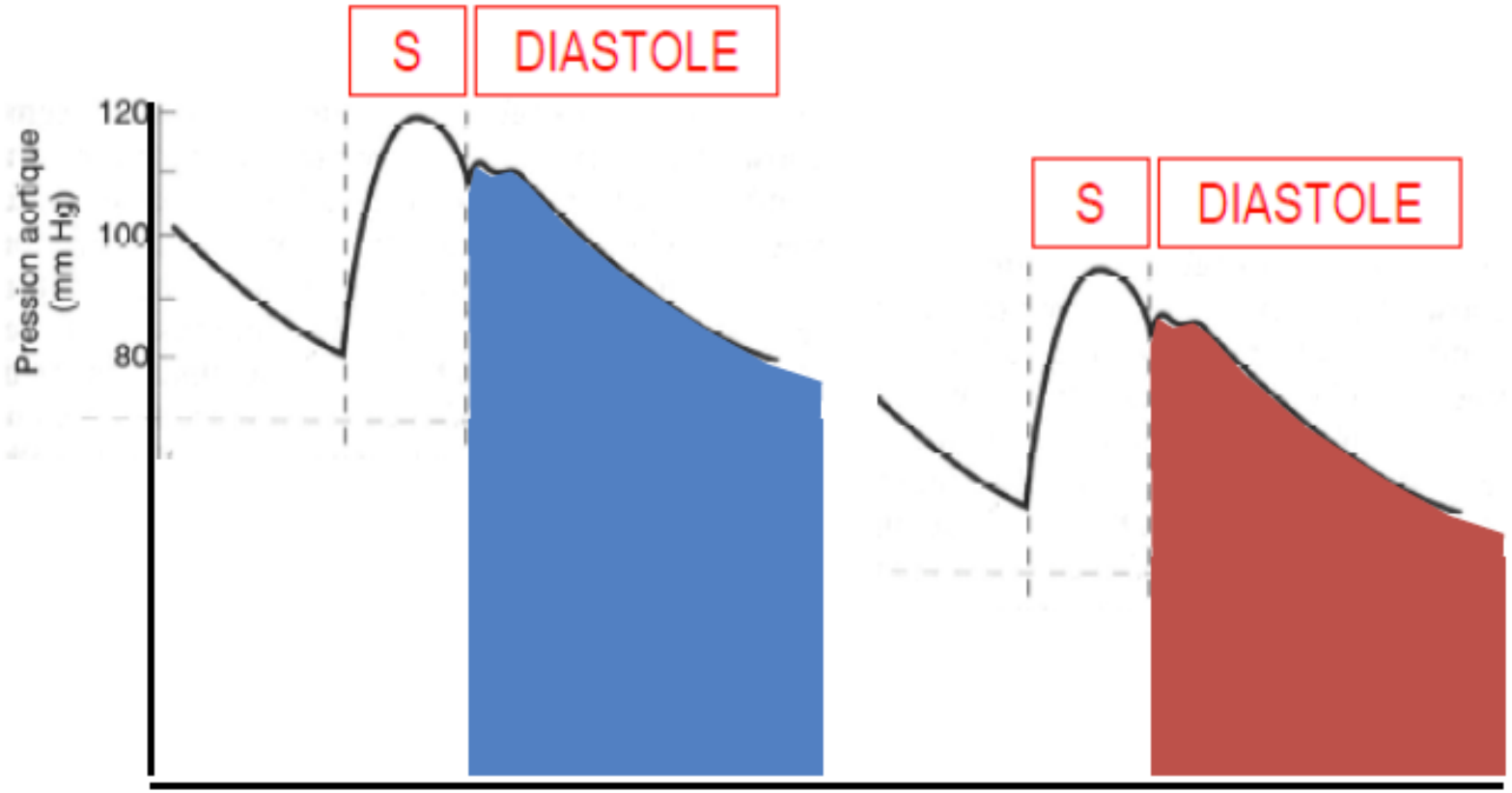
- La perfusion d'une coronaire se fait

<u>en diastole</u>

<u>et surtout pour l'artère coronaire gauche</u>

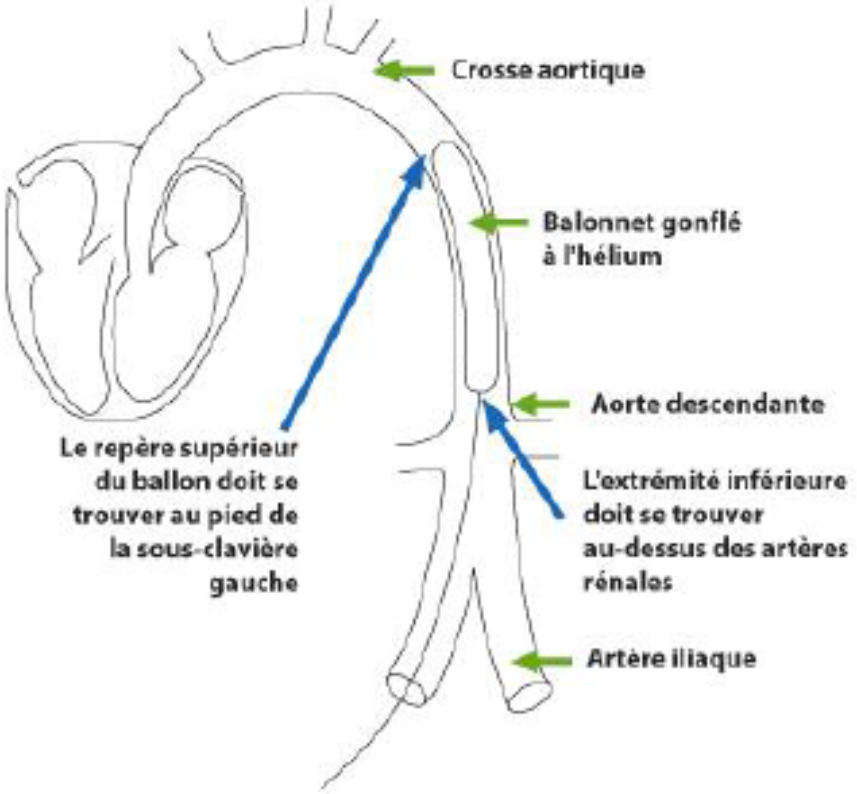


Choc cardiogénique

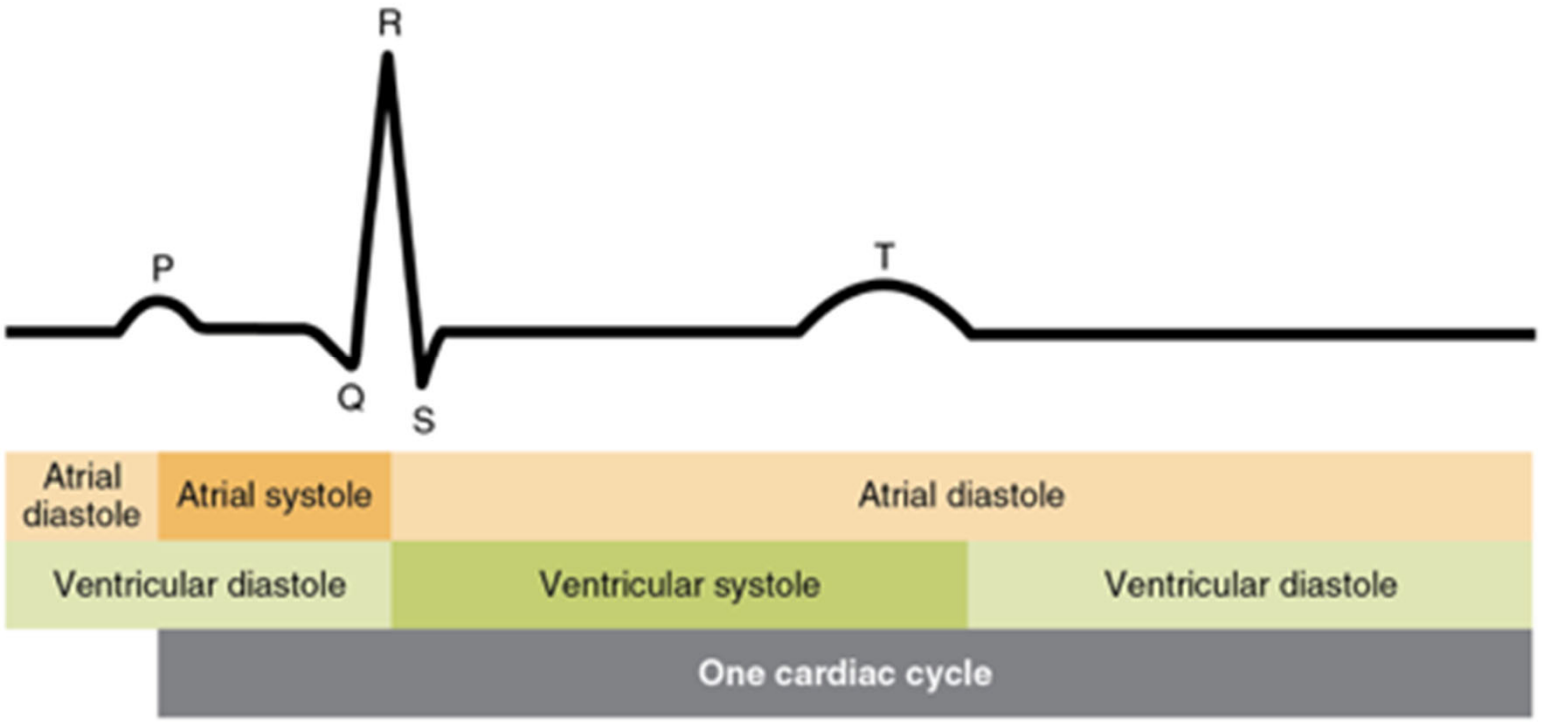


Fonctionnement

- Ballon en Silicone de 30 ou 40 cc (++)
- Hélium
- Synchronisation sur l'ECG pour
  - Se gonfler en début de diastole
  - Se dégonfler (de manière active) avant le début de la systole



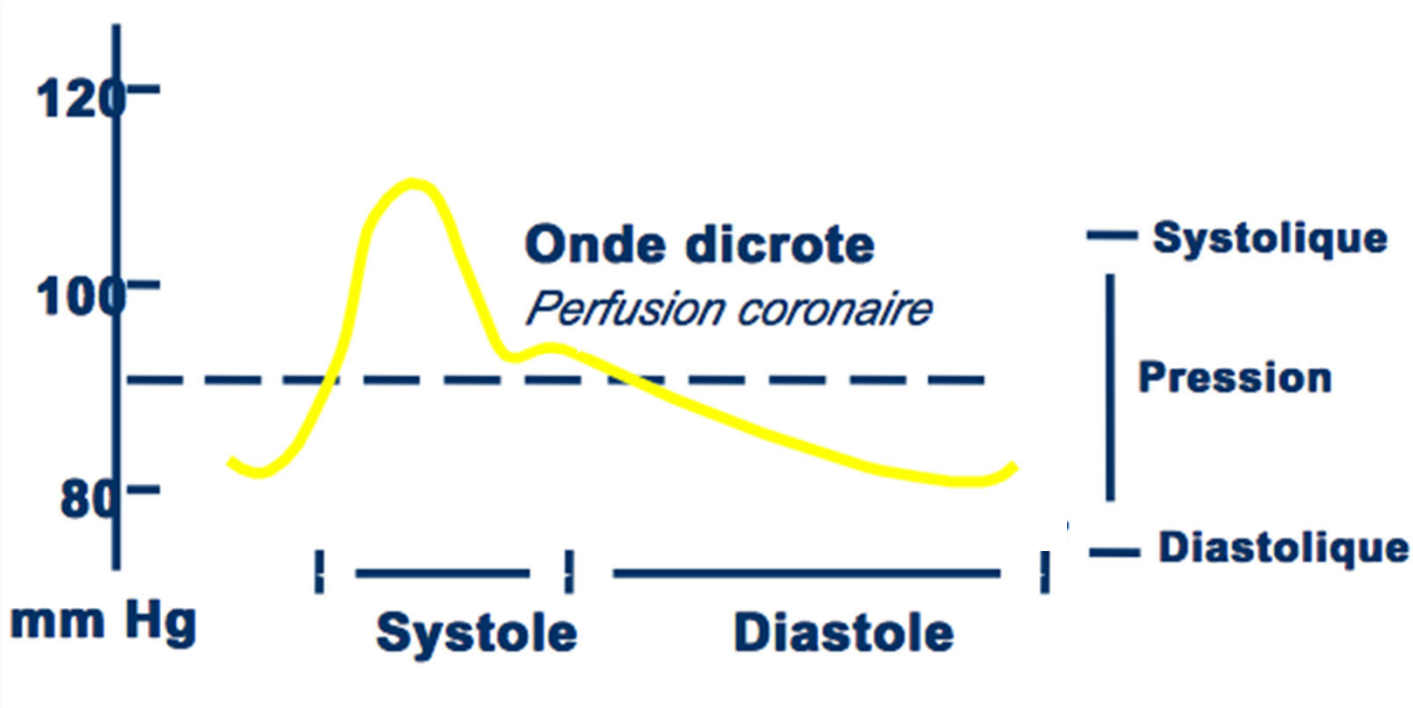
Le cycle cardiaque



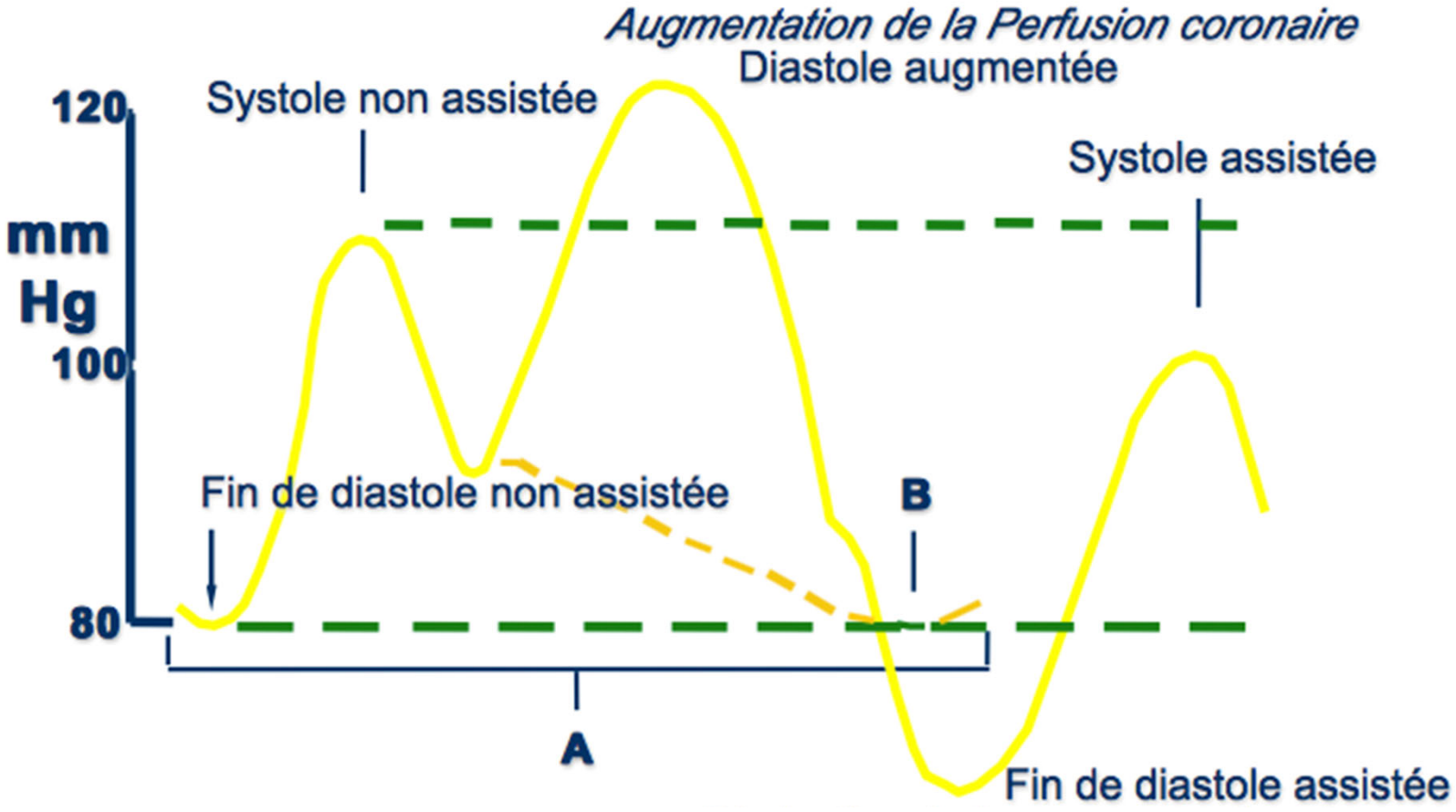
- L'impulsion électrique précède l'activité mécanique

Fonctionnement

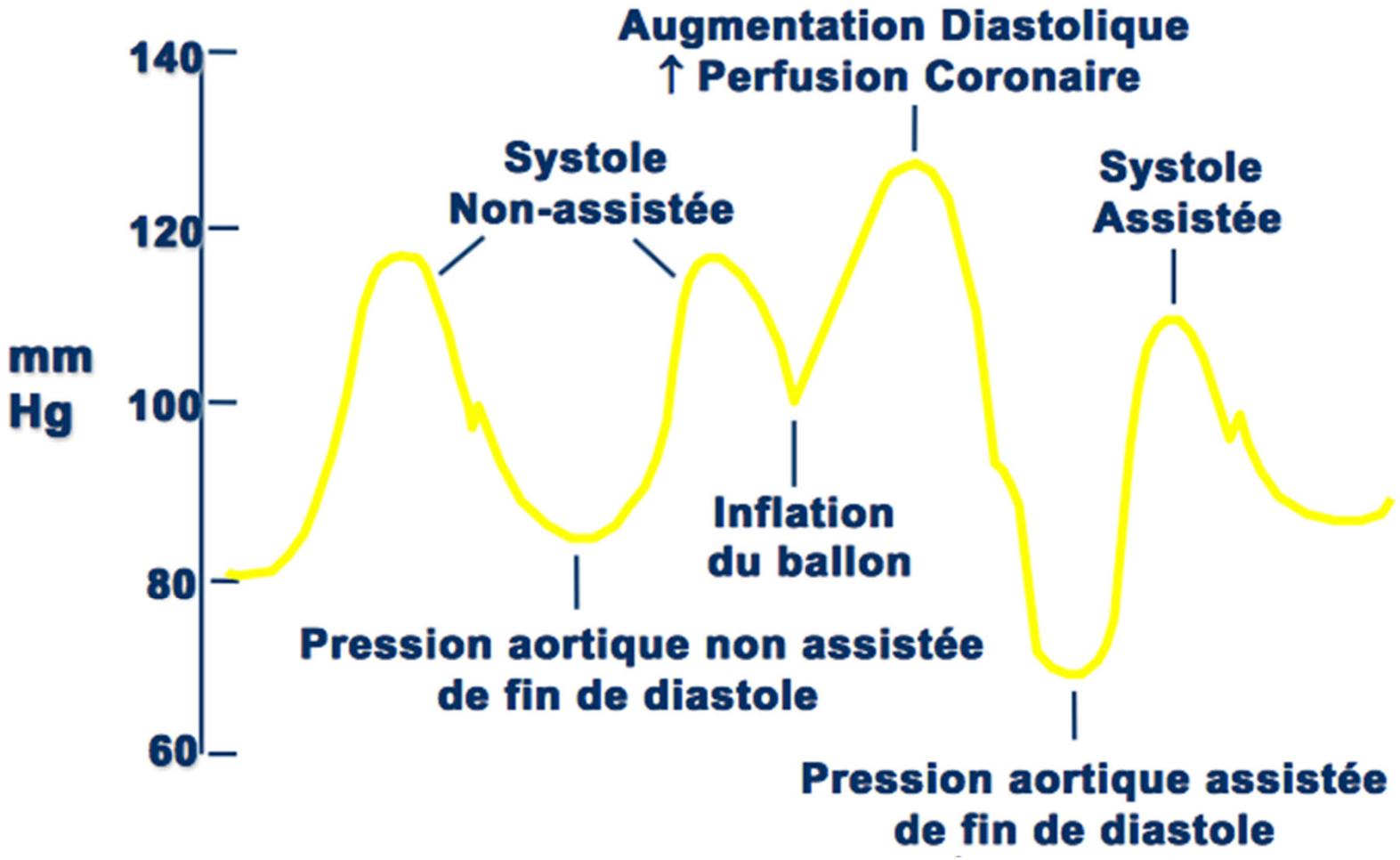
- Pression artérielle moyenne
- Indicateur de la perfusion périphérique
- Améliorée par la CPIA



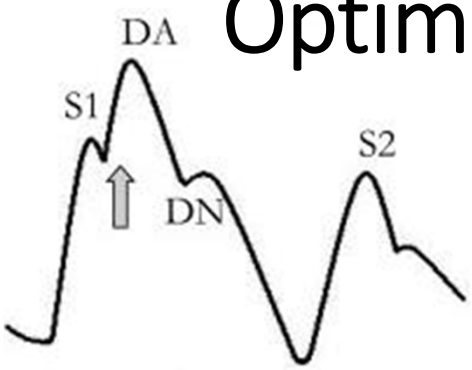
Fonctionnement



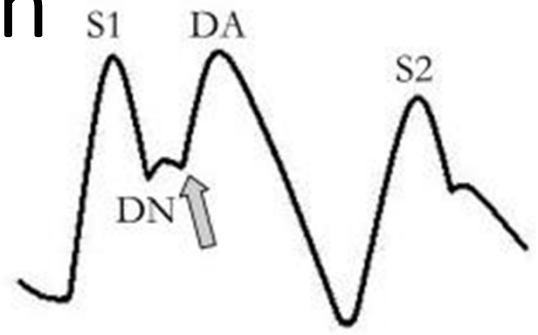
Fonctionnement



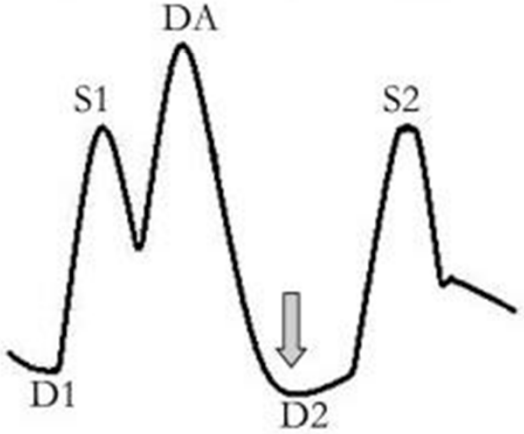
Optimisation



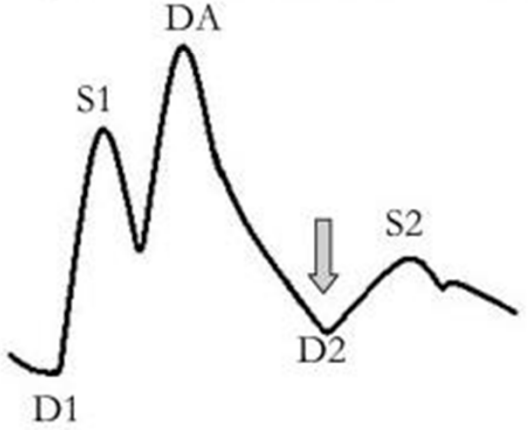
Early Inflation– rapid rise in diastolic pressure with dicrotic notch after IABP deflation; causes increased afterload.



Late inflation– prolonged dip before a decreased diastolic augmentation reduces effectiveness.



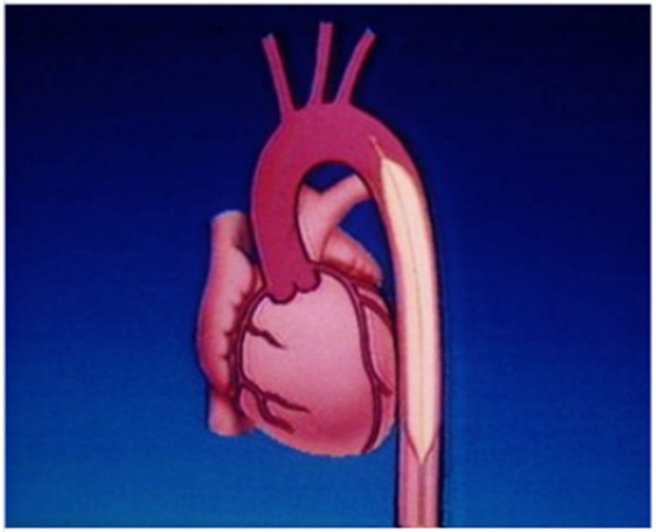
Early deflation– prolonged dip of assisted end-diastolic pressure and no decrease in assisted systolic pressure; no afterload reduction.



Late deflation- the assisted end-diastolic pressure is higher than the unassisted end-diastolic pressure; causes increased afterload.

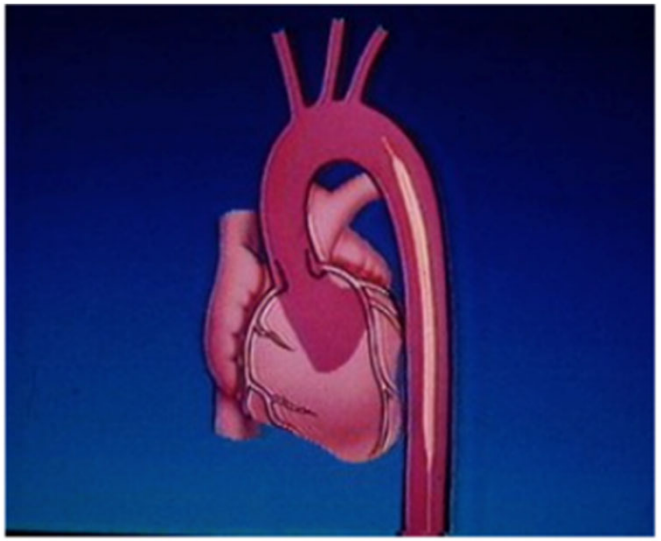
Quel Gain?

- Augmentation de la pression aortique diastolique
- Amélioration du débit de perfusion coronaire
- Augmentation de l'apport en O_2



GONFLAGE du ballon

- Diminution de la pression artérielle systolique
- Diminution de la résistance contre lequel le cœur travaille
- Diminution de la consommation en O_2



DEGONFLAGE du ballon

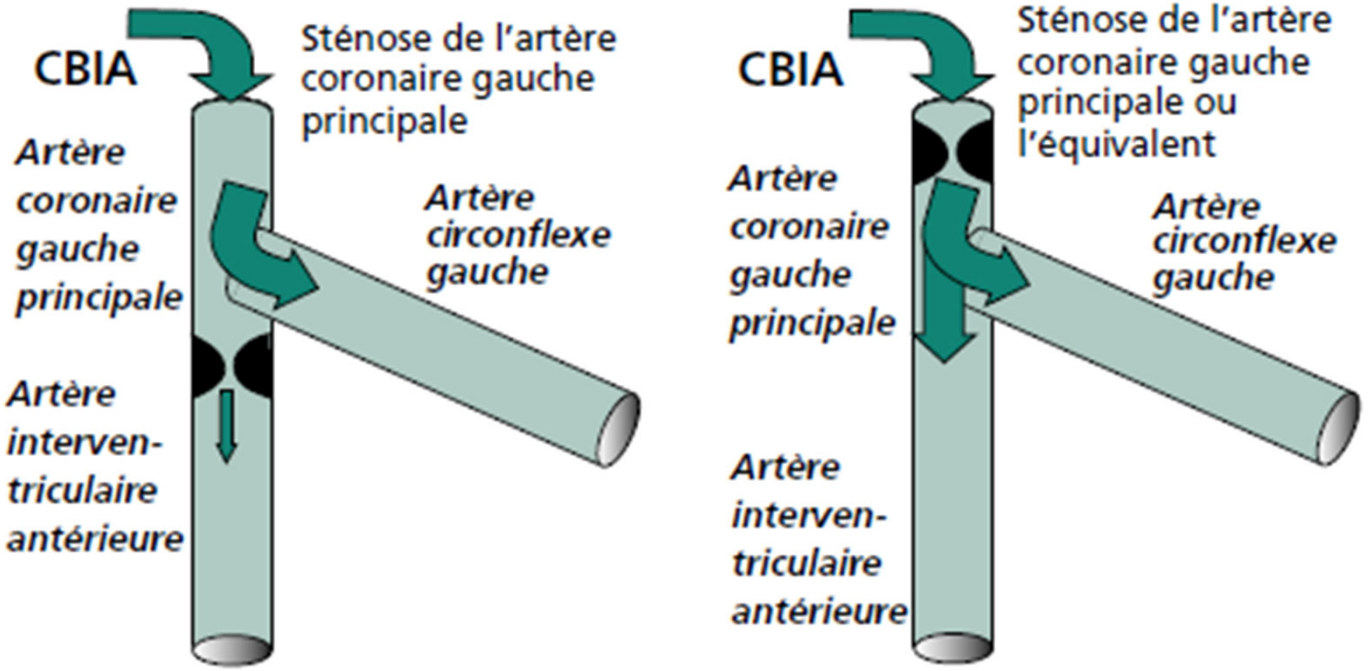
Quel Gain?

- Cela dépend
  - de la fréquence cardiaque
  - du volume du ballon

  - de la sténose coronaire

Le problème de la sténose coronaire

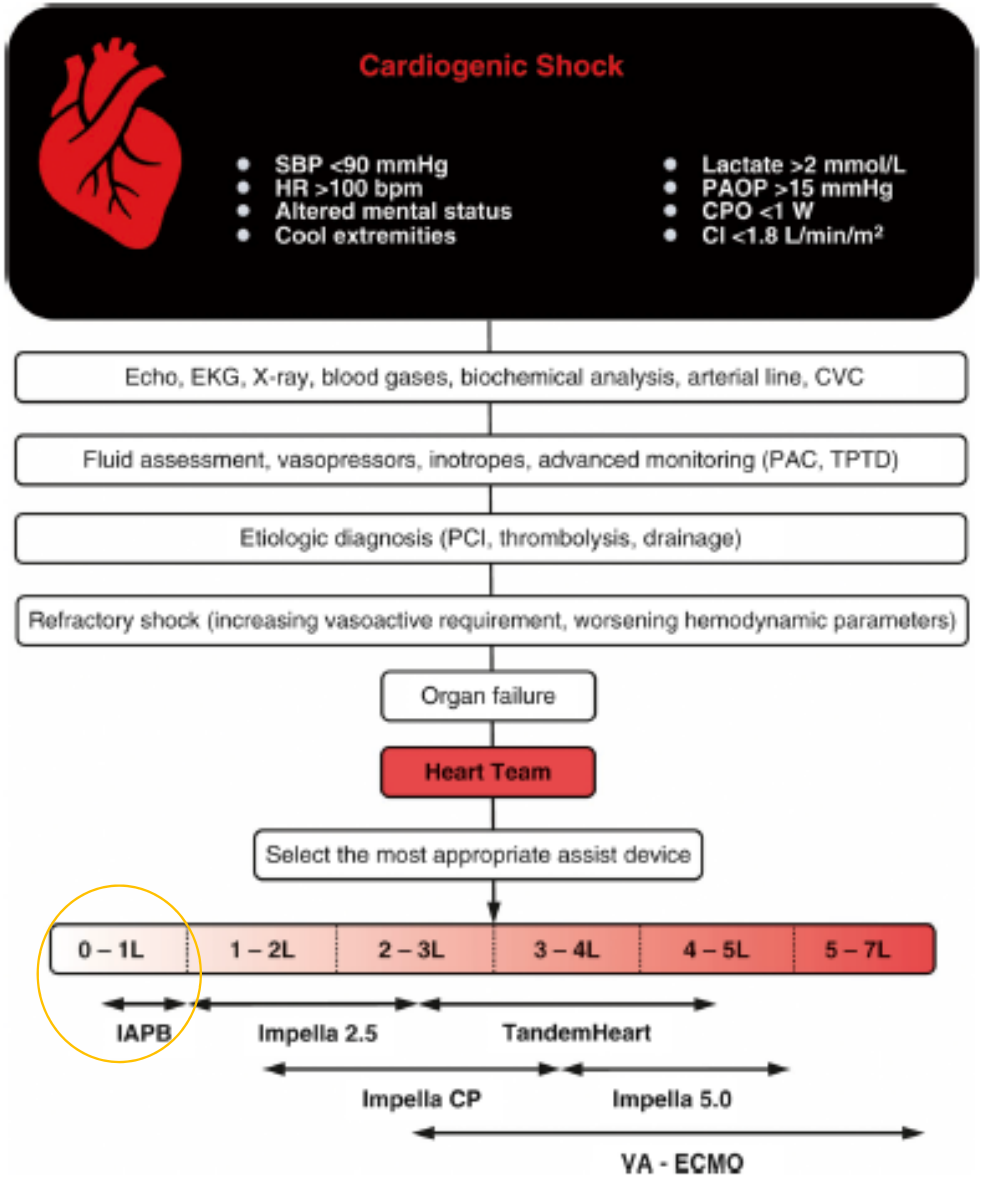
- Il faut l'enlever



- par angioplastie ou par pontage aorto-coronarien

Quel Gain?

Augmentation du débit cardiaque d'environ 0.5 L/min



Hajjar LA et al. Crit Care 2019;23:76

Les indications

- Choc cardiogénique dans un contexte de syndrome coronarien aigu
  - lésion isolée de l'IVA proximale (atteinte mono-tronculaire)
  - « Pré-choc »: patient « limite / borderline » sur le plan hémodynamique avec faible dose concomitante d'amines vasopressives

- Angioplastie protégée / « High risk PCI »

- Infarctus du ventricule droit

Gerbaud E et al. Arch Cardiovasc Dis 2020; 113:276-284

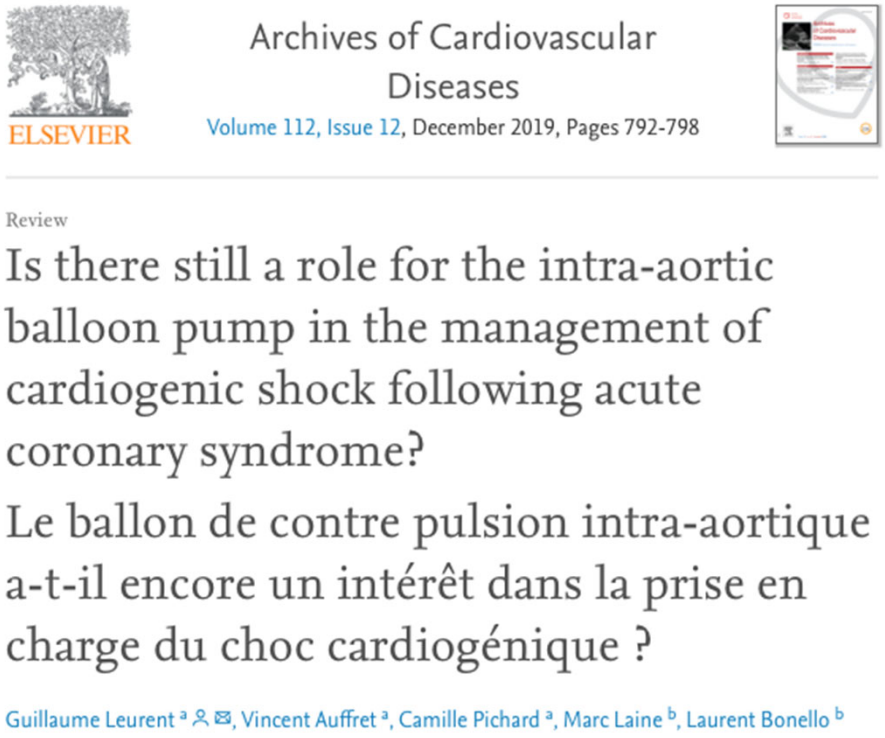
Les indications

- Réduire la post-charge du ventricule gauche
- Augmenter le volume d'éjection systolique effectif en diminuant le shunt G>D ou en diminuant le volume régurgitant mitral

- Pré-chirurgie cardiaque
  - pontages aorto-coronariens (tronc commun)
  - insuffisance mitrale
  - communication interventriculaire

- Période « post-opératoire » de chirurgie cardiaque

- Décharge ECMO



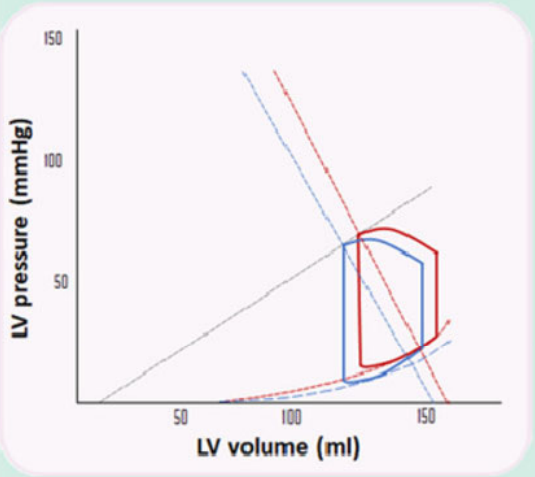
Leurent G et al. Arch Cardiovasc Dis 2019; 112:792-798

CHU BDX CENTRE HOSPITALIER UNIVERSITAIRE BORDEAUX

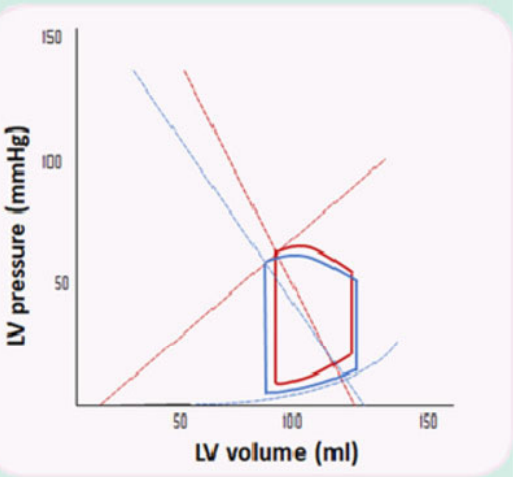
Intra-Aortic balloon pump for acute decompensated heart failure complicated by cardiogenic shock

Cardiogenic Shock related to

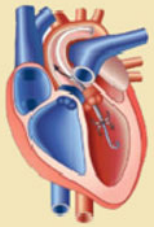
Acute Decompensated Heart Failure **VS** **Acute Myocardial Infarction**



- LV end diastolic pressure
- Wall Stress
- Mixed Venous Saturation
- Improved pH due to better acid-base equilibrium
- Different Cardiac Power Output at baseline



IABP



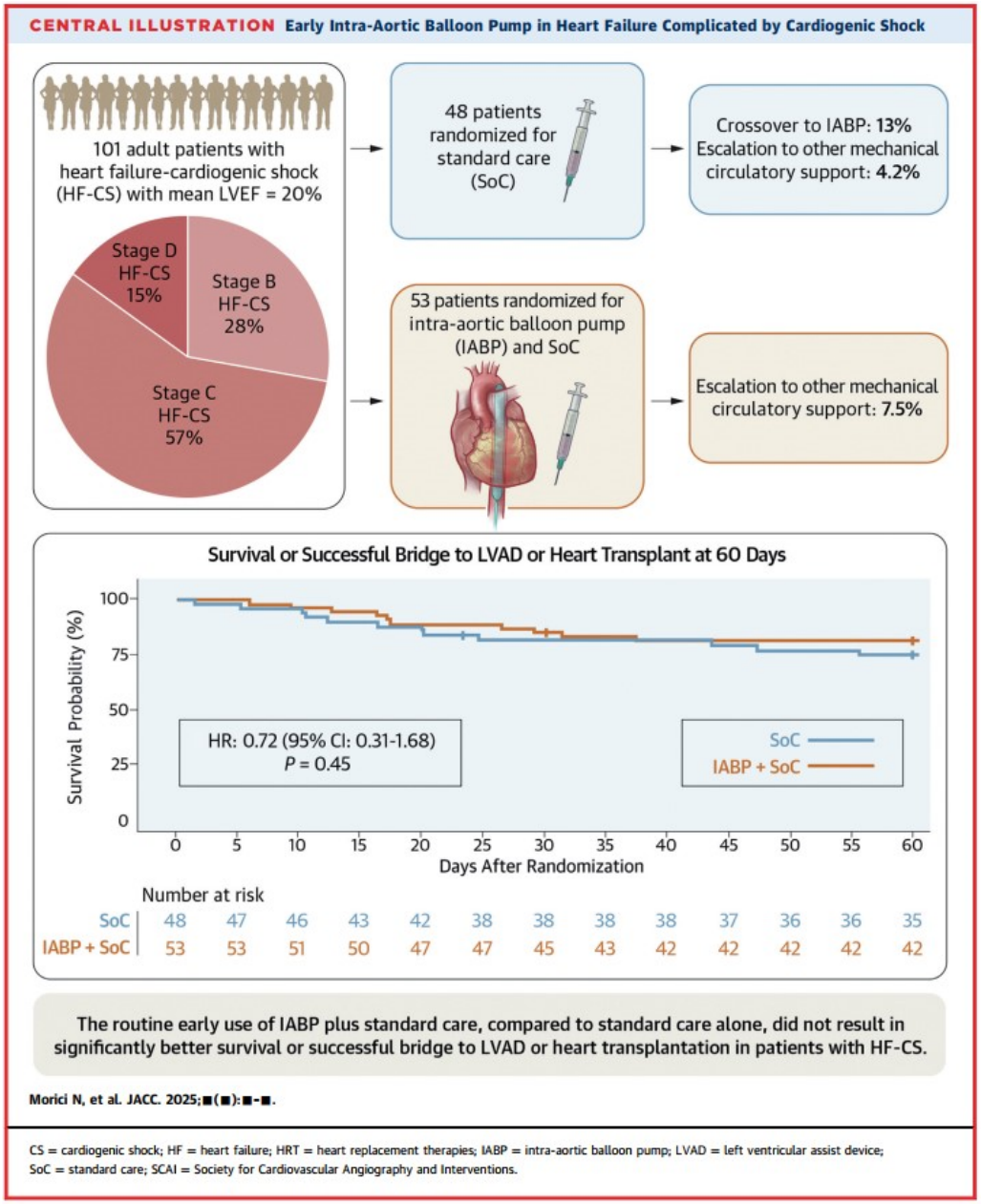
Hemodynamic Benefits through:

- Incresing diastolic aortocoronary pressure *(diastolic pressure time index, DTI)*
- Reducing myocardial oxygen demand *(tension time index, TTI)*
- Increasing Buckber index *(DTI/TTI)*
- Increasing Cardiac Output
- Improving ventriculo-arterial coupling
- Improving Right Ventricular function
- Direct action on Mitral valve anatomy and physiology

Hemodynamic Effects hampered by tachyarrhytmias -> optimize triggering (autopilot mode reccommended)

Morici N et al. J Cardiac Failure 2022; 28:1202-1216
Brown MA et al. J Am Heart Assoc. 2021 Aug 3; 10(15): e019376.

Altshock-2 trial was stopped because of futility



Les contre-indications

- Insuffisance aortique

- Syndrome douloureux aortique, dissection, hématome de paroi, anévrysme aortique…

- Accès artériel membre inférieur insuffisant

- « Relative »: Les tachycardies

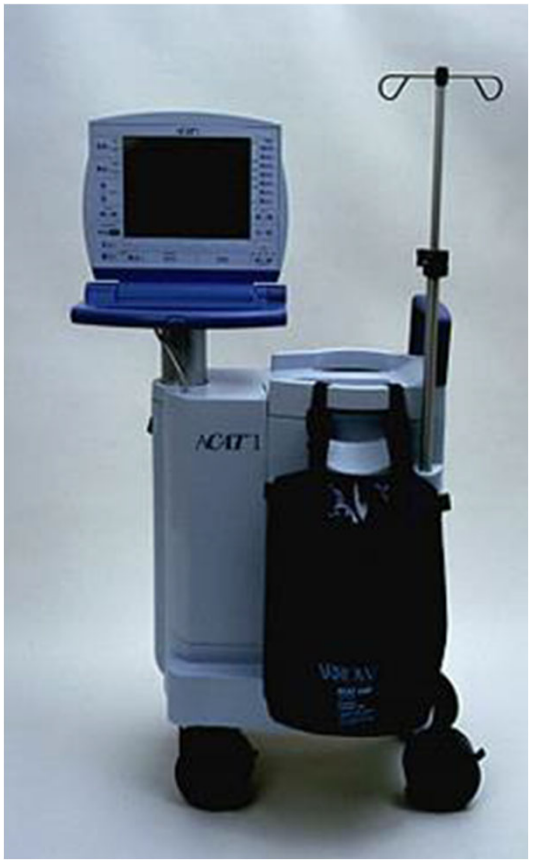
Les recommendations dans le STEMI

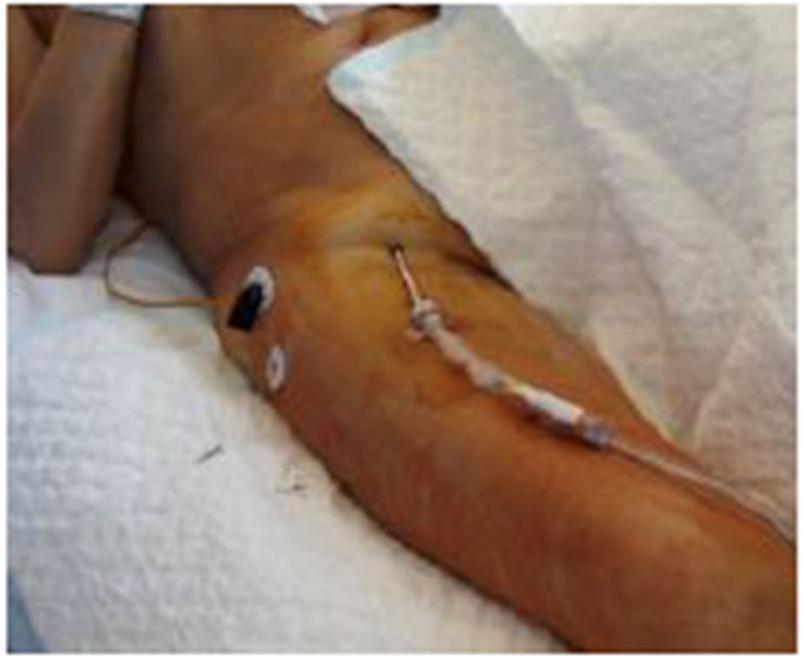
Intra-aortic balloon pumping should be considered in patients with haemodynamic instability/cardiogenic shock due to mechanical complications.	IIa	C
Short-term mechanical support[c] may be considered in patients in refractory shock.	IIb	C
Routine intra-aortic balloon pumping is not indicated.[177,437]	III	B

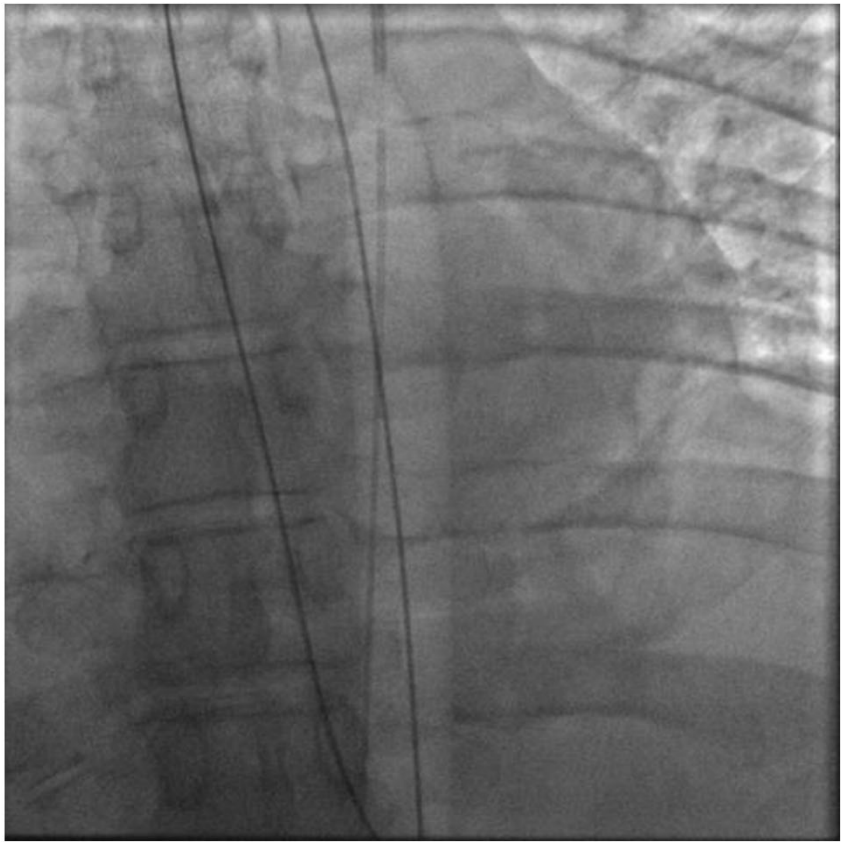
[C] Percutaneous cardiac support devices, ECLS, and ECMO

Ibanez S et al. Eur Heart J 2018; 39:119-177

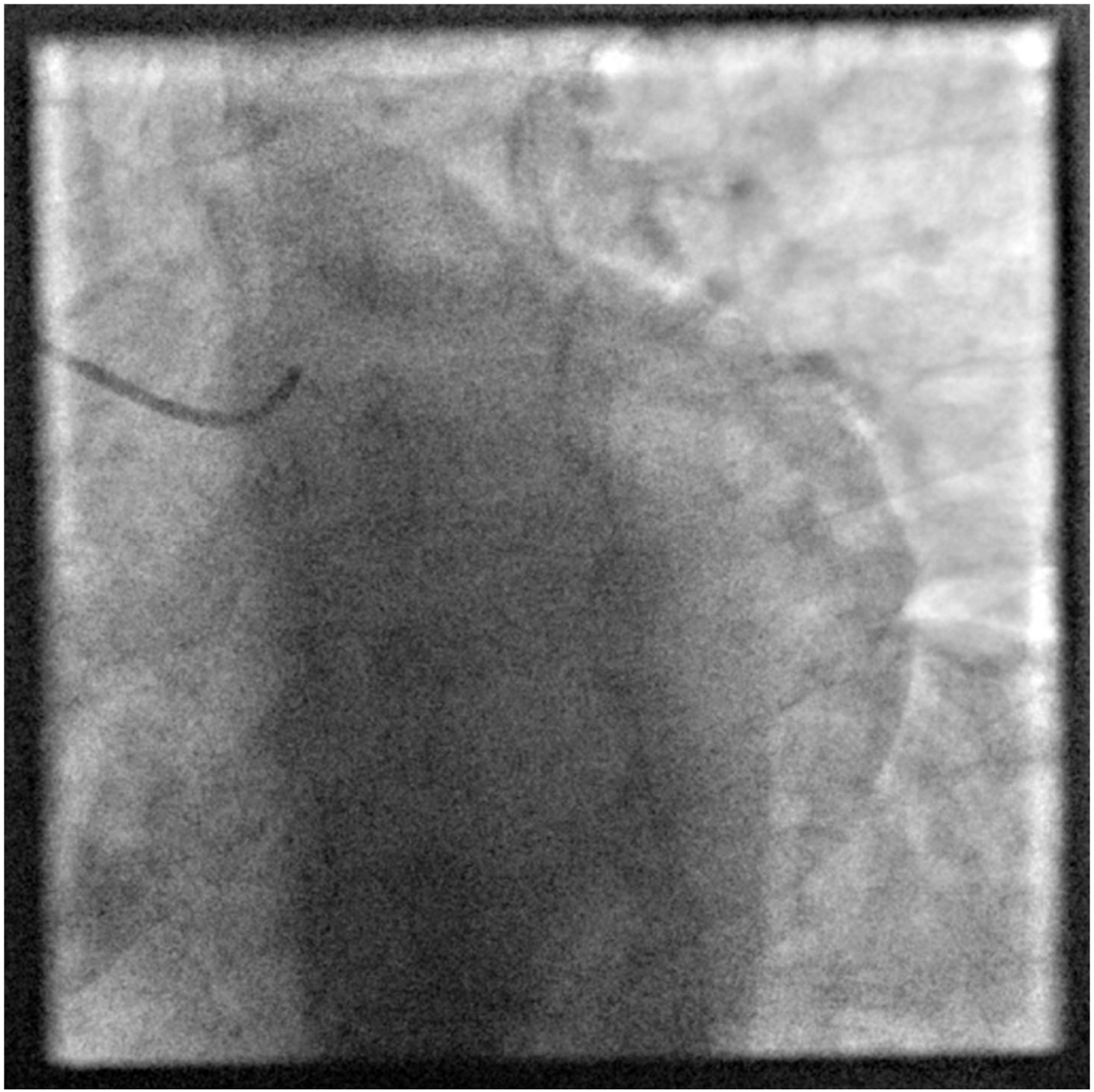
Images de BPCIA

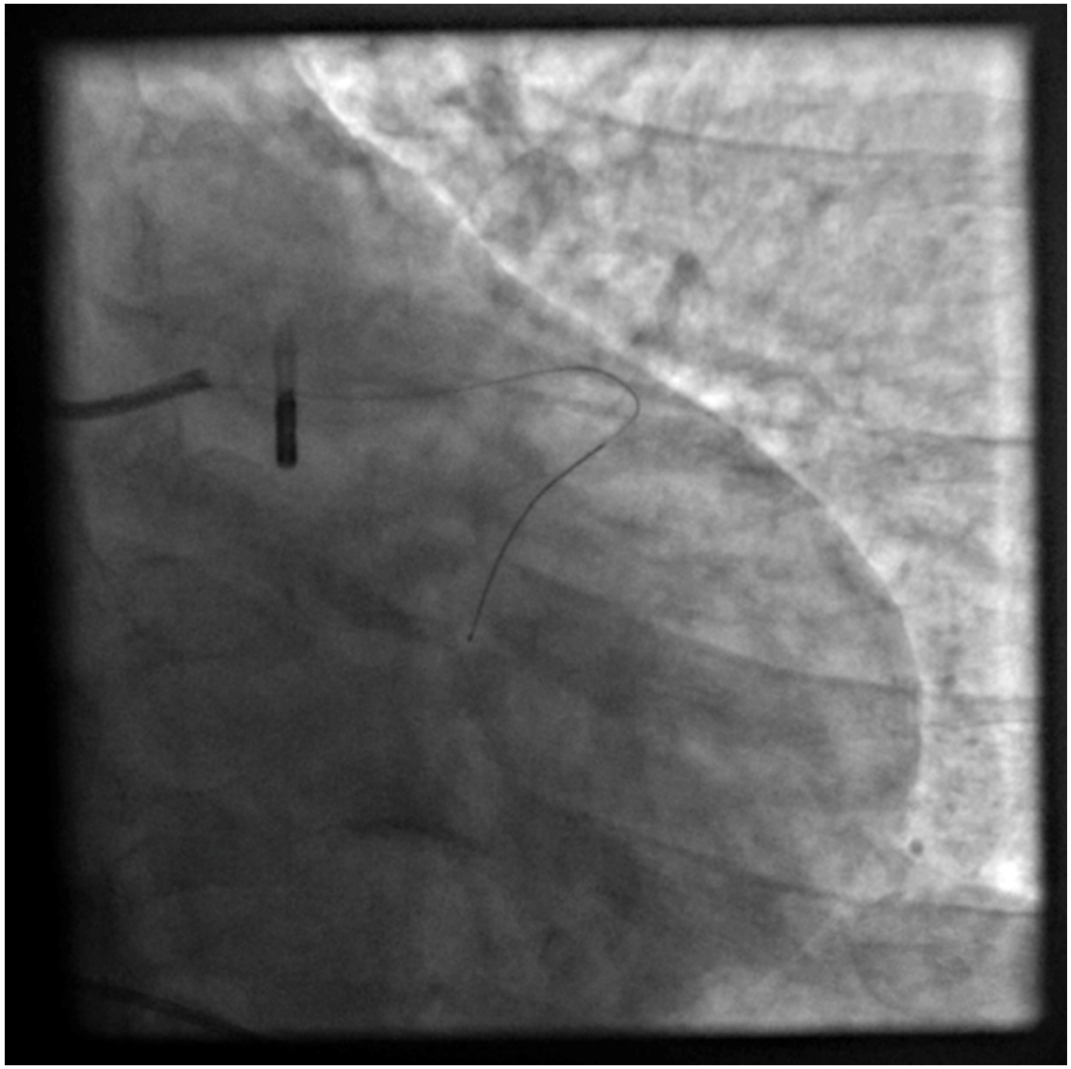


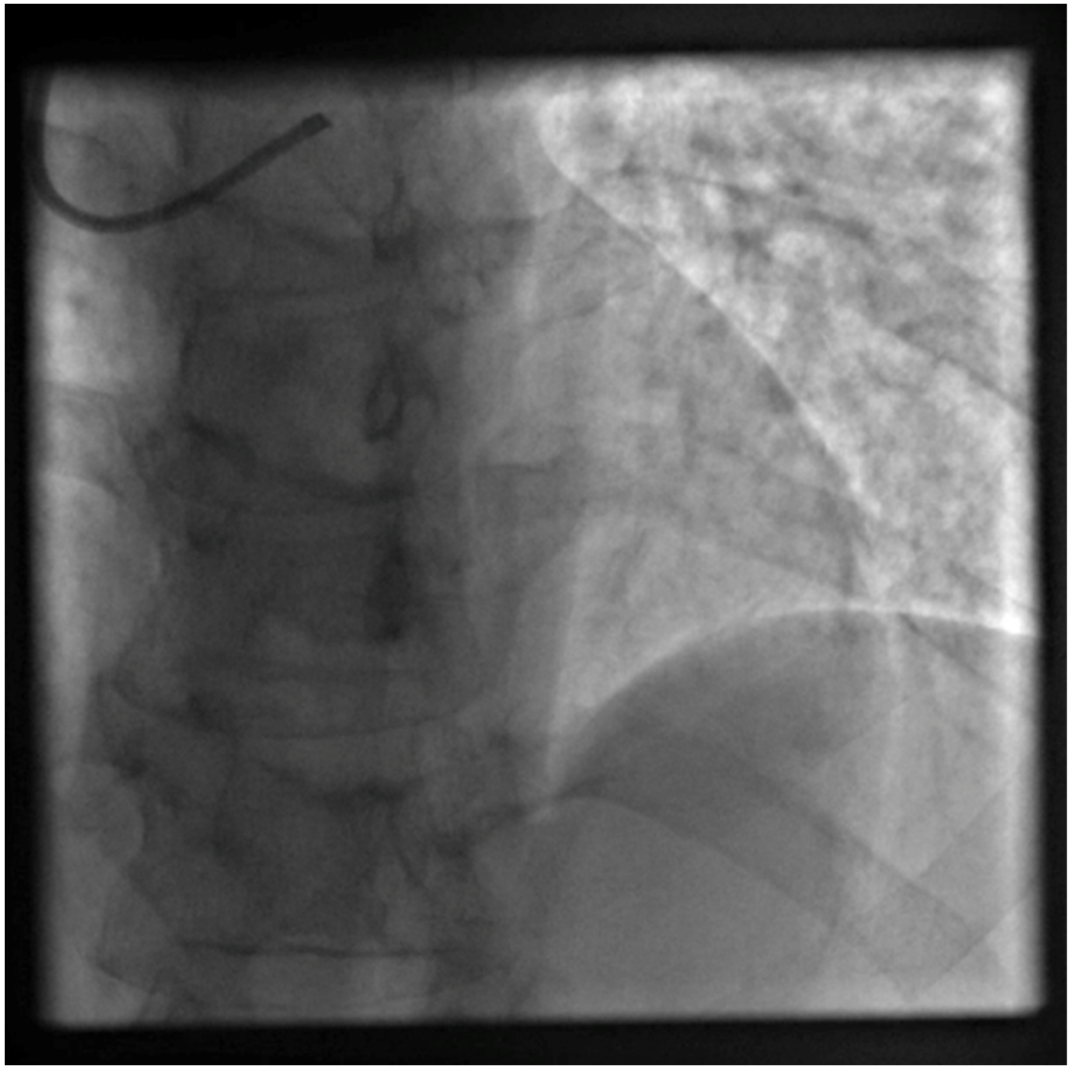




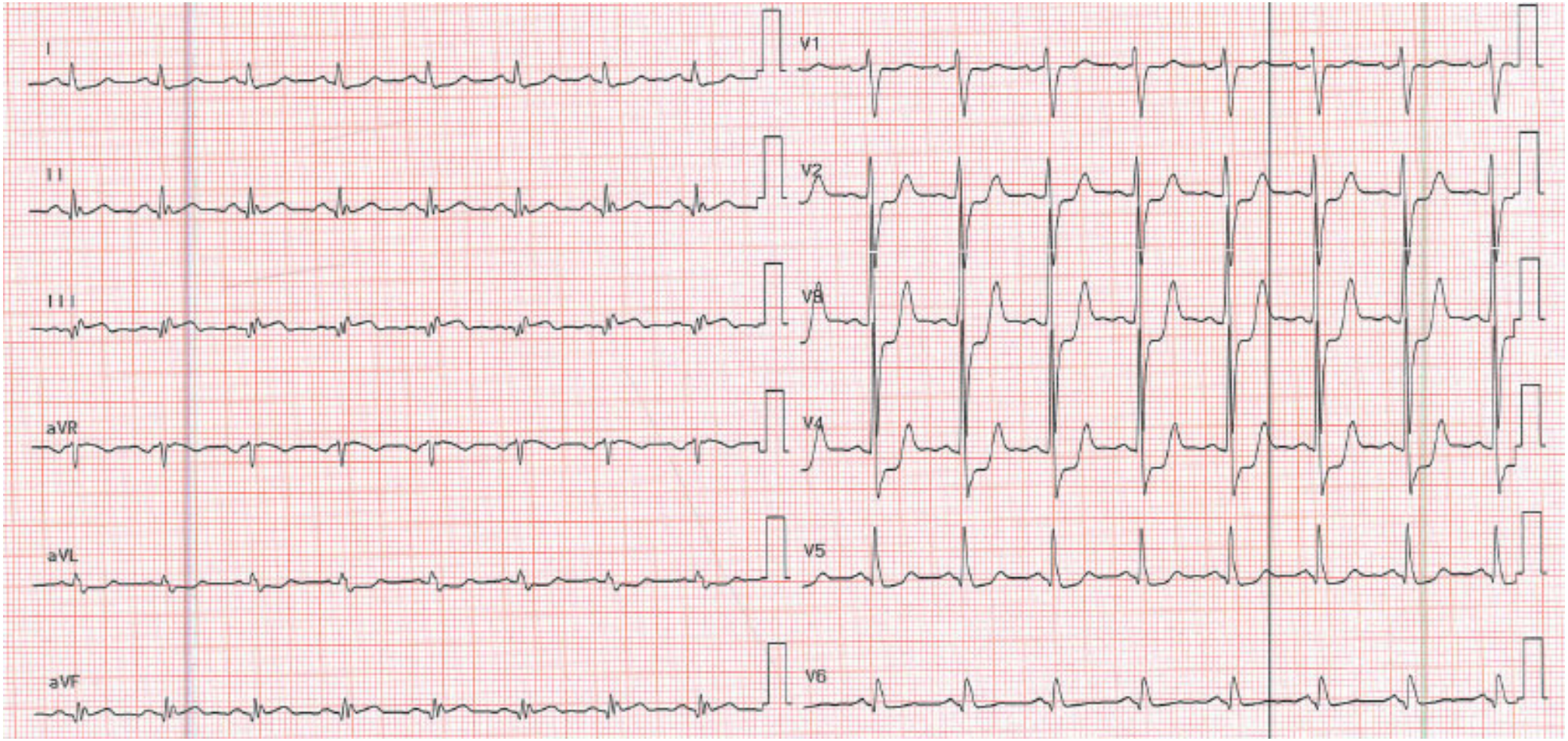
Héparinothérapie IVSE durant l'utilisation avec un objectif d'héparinémie / Activité anti Xa (HNF): 0,3-0,4 UI/mL

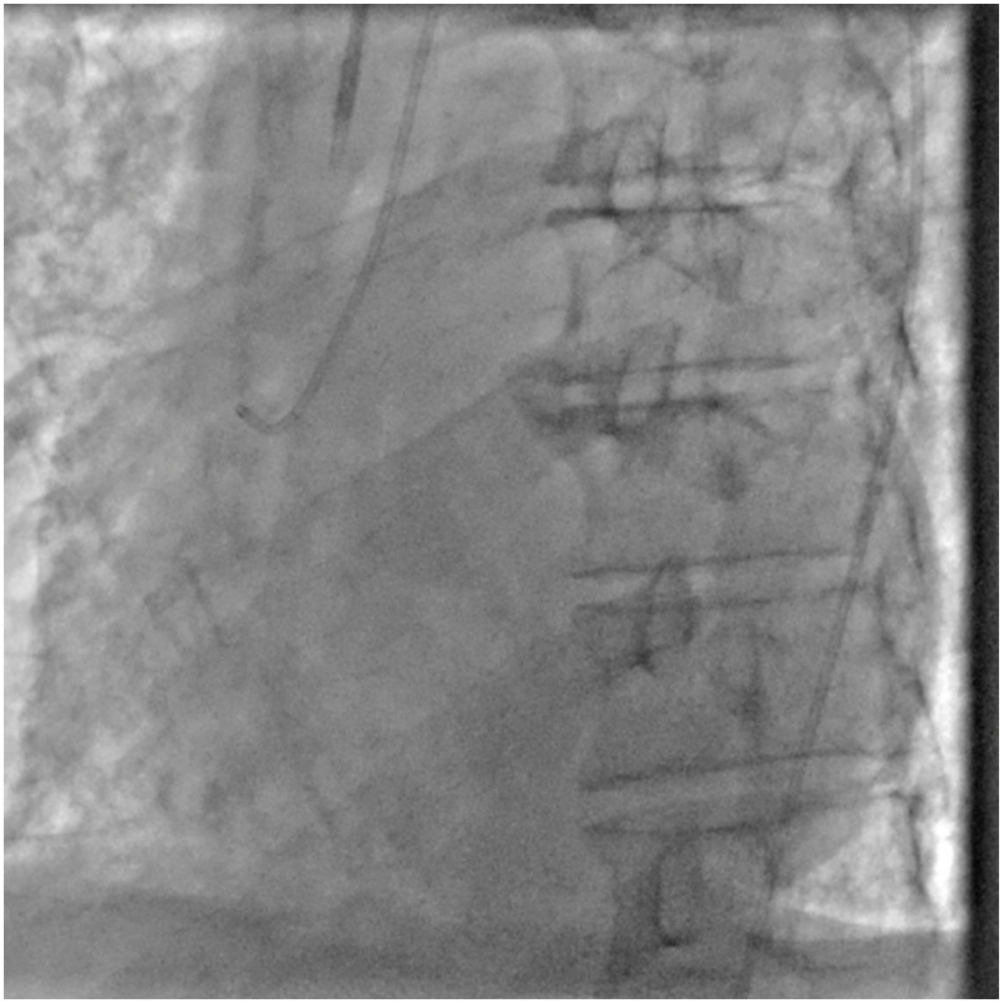


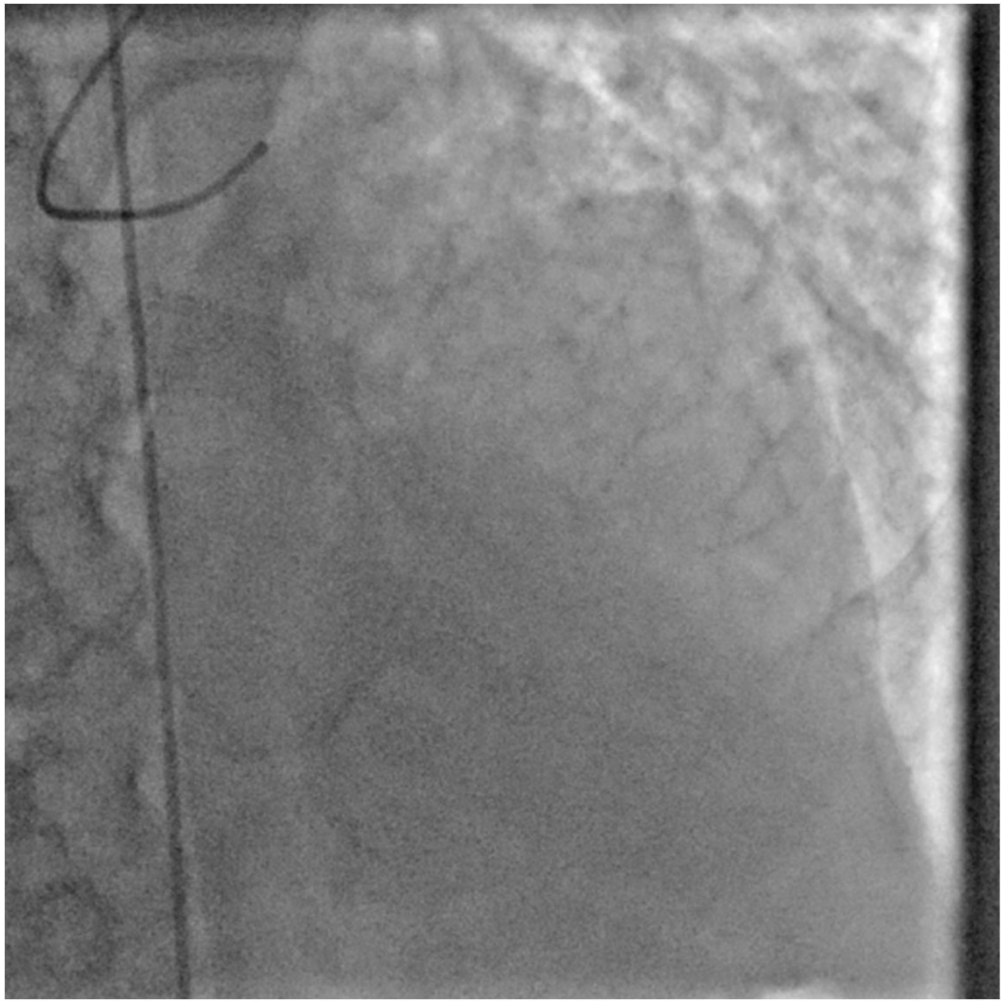


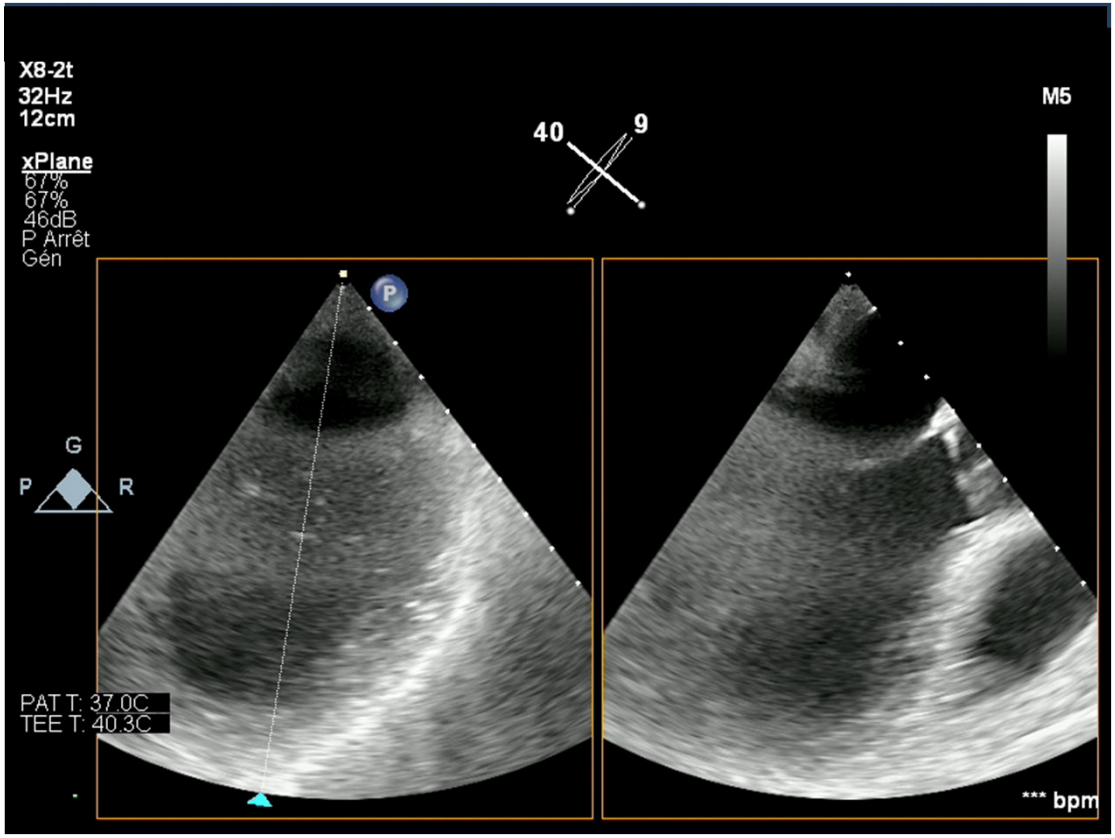


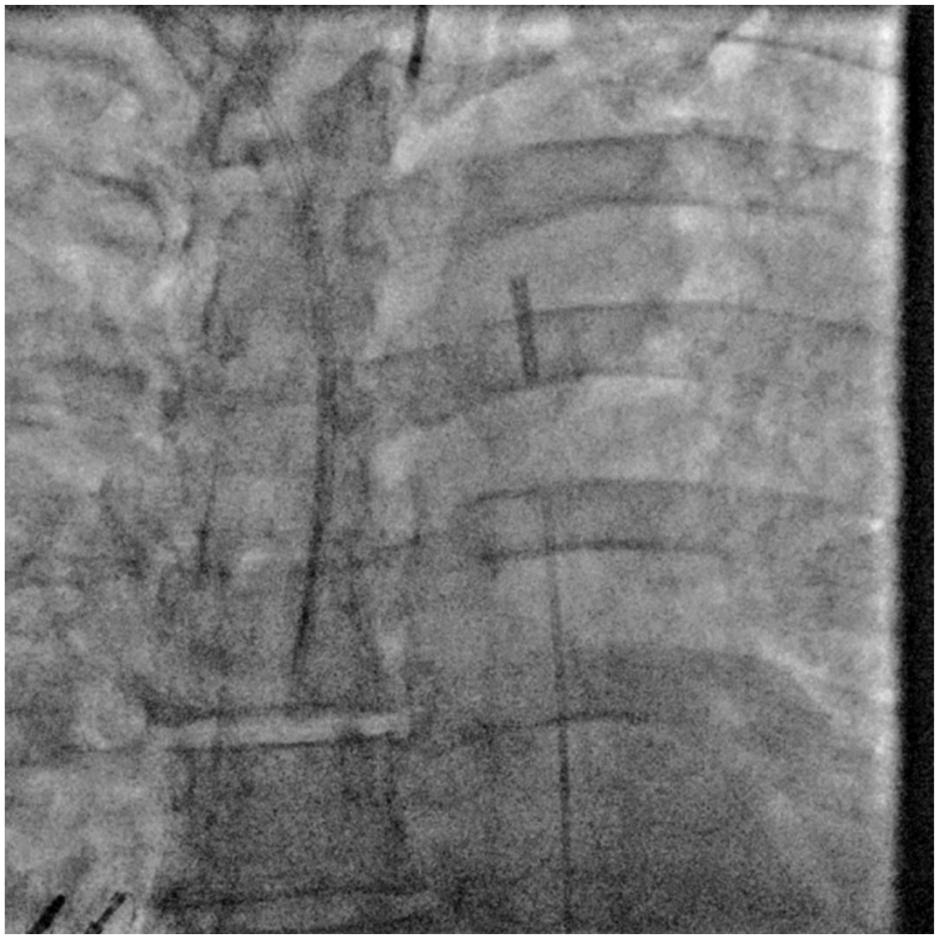
Infarctus inférieur tardif



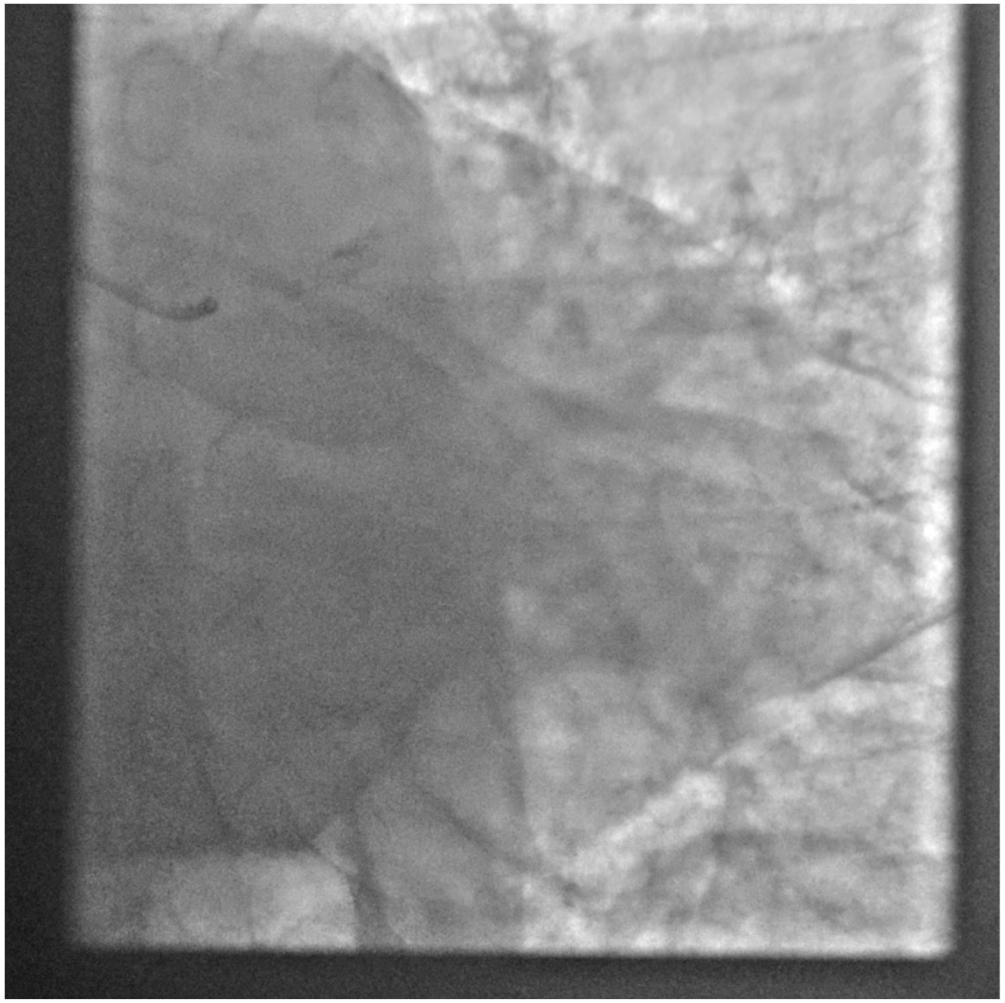


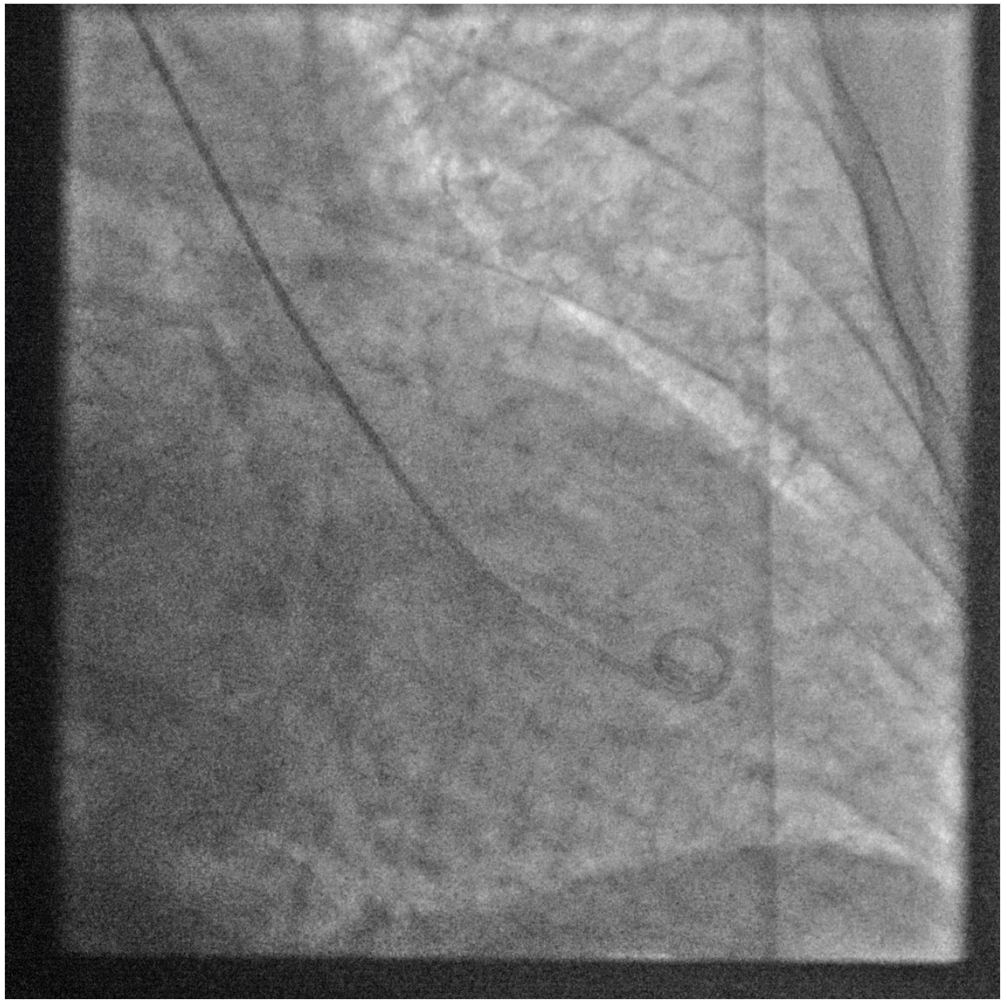


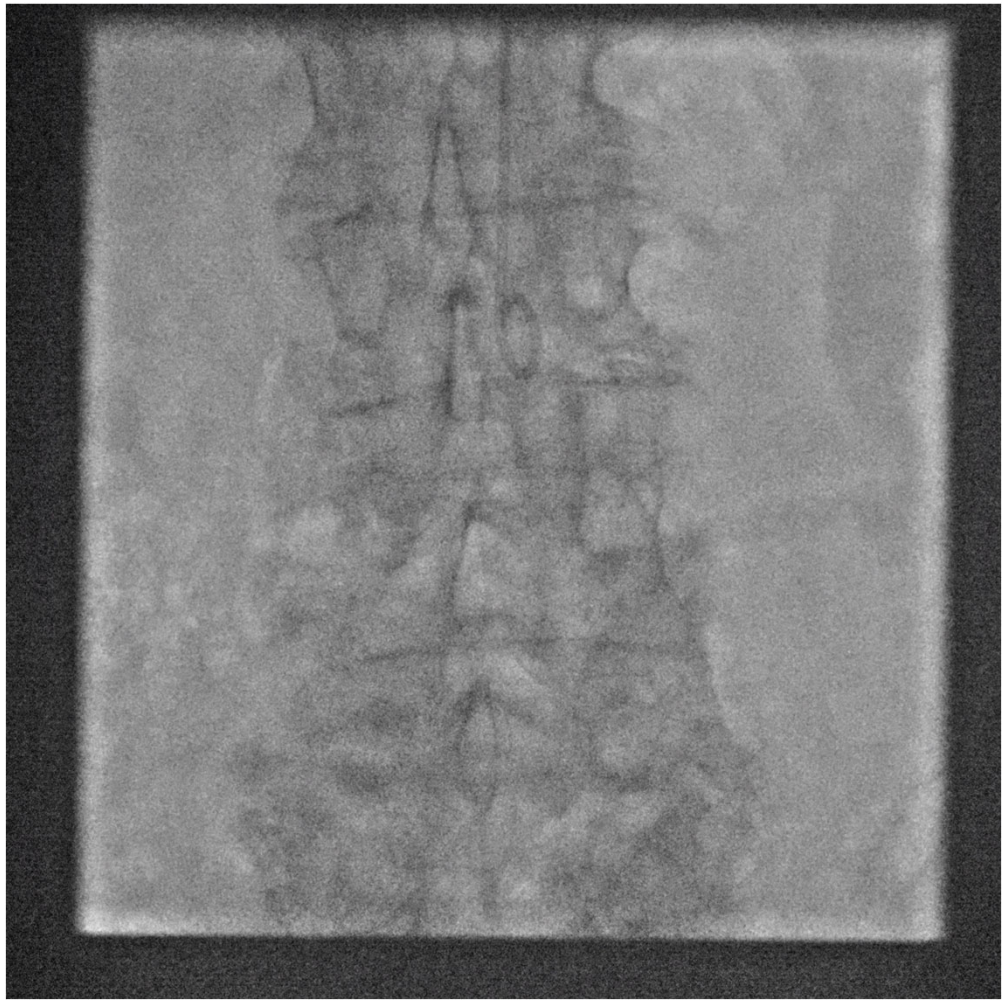


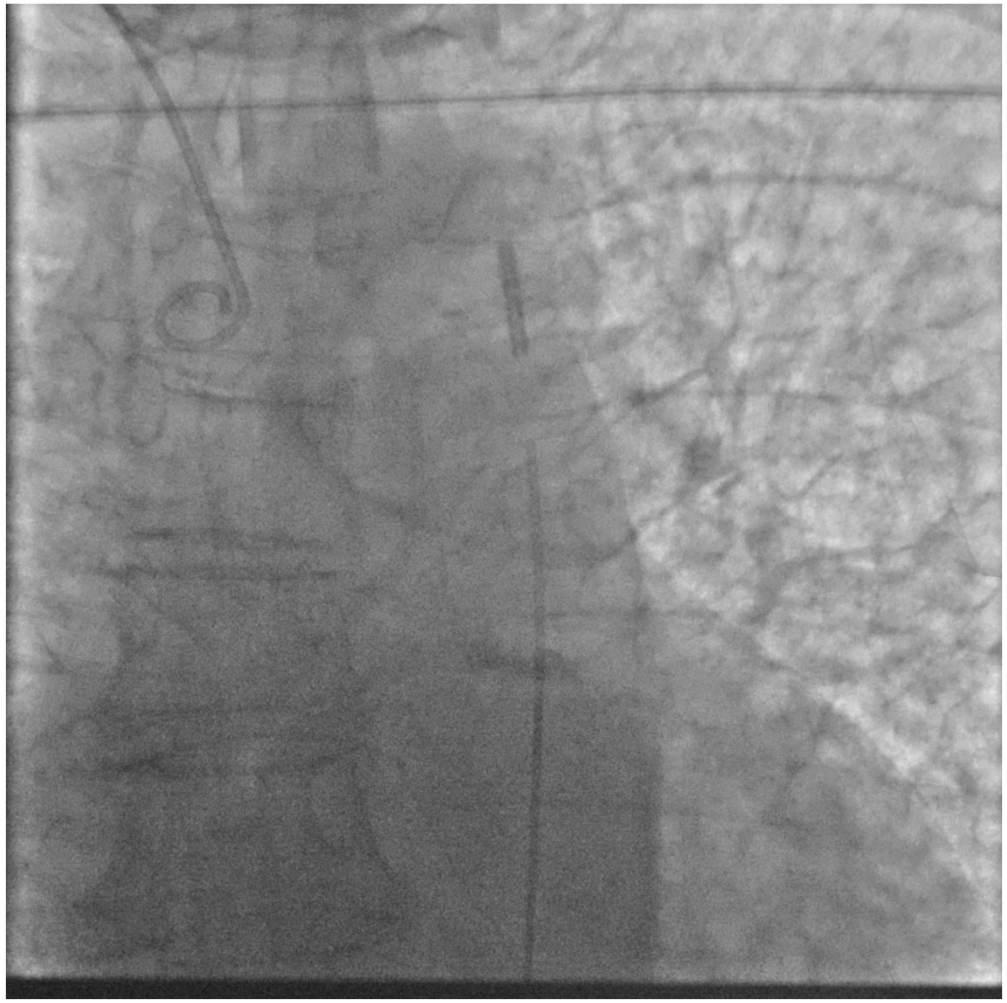


Rupture partielle de pilier









Surveillance

- Surveillance
  - clinique: point de ponction, membre inférieur, transit, diurèse
  - biologique: anticoagulation, hémoglobine, plaquettes, lactates artériels
  - radiologique: radiographie pulmonaire de face

- Les Traitements
  - anticoagulation
  - anxiolytiques

- La console
  - pas d'arrêt prolongé
  - optimisation de l'inflation
  - présence de fuites
  - niveau d'hélium

Effets secondaires

- Thrombopénie
- Thrombose artérielle
- Hypoperfusion rénale, mésentérique, ou du membre inférieur

⚠ douleur abdominale chez le (la) patient(e) porteur d'une CPIA

Sevrage et retrait

⚠ Dispositif transitoire! A enlever dès que possible!

- Sevrage progressif

(1 inflation tous les 2 cycles cardiaques puis 1 inflation tous les 4 cycles cardiaques)

- Arrêt de l'héparinothérapie 1 heure avant

- Soit préclosing à la pose

- Soit compression manuelle fémorale (30 minutes) sous couvert d'antalgiques

Randomized comparison of intraaortic balloon counterpulsation versus optimal medical therapy in addition to early revascularization in acute myocardial infarction complicated by cardiogenic shock

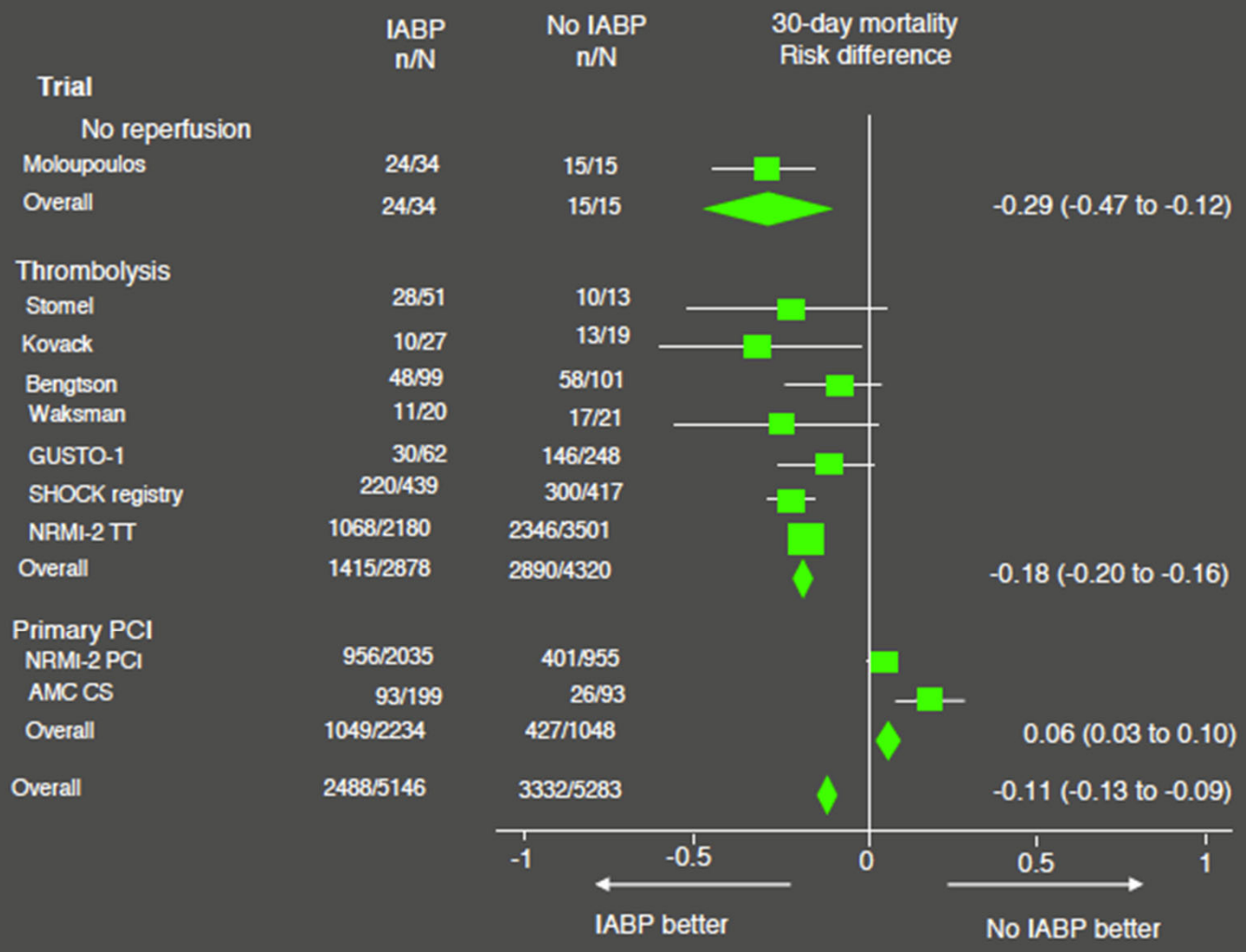
Holger Thiele, MD
Uwe Zeymer, MD; Franz-Josef Neumann, MD; Miroslaw Ferenc, MD; Hans-Georg Olbrich, MD; Jörg Hausleiter, MD; Gert Richardt, MD; Marcus Hennersdorf, MD; Klaus Empen, MD; Georg Fuernau, MD; Steffen Desch, MD; Ingo Eitel, MD; Rainer Hambrecht, MD; Jörg Fuhrmann, MD; Michael Böhm, MD; Henning Ebelt, MD; Steffen Schneider, PhD; Gerhard Schuler, MD; Karl Werdan, MD

on behalf of the **IABP-SHOCK II Trial** Investigators

University of Leipzig – Heart Center

Background

Mortality IABP vs no IABP - Metaanalysis



Sjauw et al. Eur Heart J 2009;30:459-468

Methods

Study Sites and Organisation

IABP SHOCK II

DSMB:

Kurt Huber
Ferenc Follath
Bernhard Maisch
Johannes Haerting

Steering committee:

Holger Thiele
Karl Werdan
Uwe Zeymer
Gerhard Schuler

Support + Patronage:

DEUTSCHE GESELLSCHAFT FÜR KARDIOLOGIE - HERZ- UND KREISLAUFFORSCHUNG e.V.
GERMAN CARDIAC SOCIETY

Deutsche Herzstiftung

ALKK

DFG Deutsche Forschungsgemeinschaft

Methods

Statistical Methodology

IABP SHOCK II

Sample Size

- Estimated 12% absolute difference in survival rates
- Sequential statistical design with 2 interim analyses (33% and 66% of patients)
- Significance level 0.0005 at 1st or 0.014 at 2nd interim analysis.
  Final analysis at α-level 0.044 → 564 patients
- To compensate losses in follow-up and putative center effect → 600 patients

Primary Study Endpoint:

30-day all-cause mortality

Secondary Study Endpoints:

- Hemodynamic parameters (mean BP, heart rate pre and post revascularization)
- Serum-lactate (every 8 h for 48 h)
- SAPS-2 Score
- Serial creatinine-level and creatinine-clearance (Cockcroft-Gault-formula)
- Inflammatory reaction (CRP)

Process of care

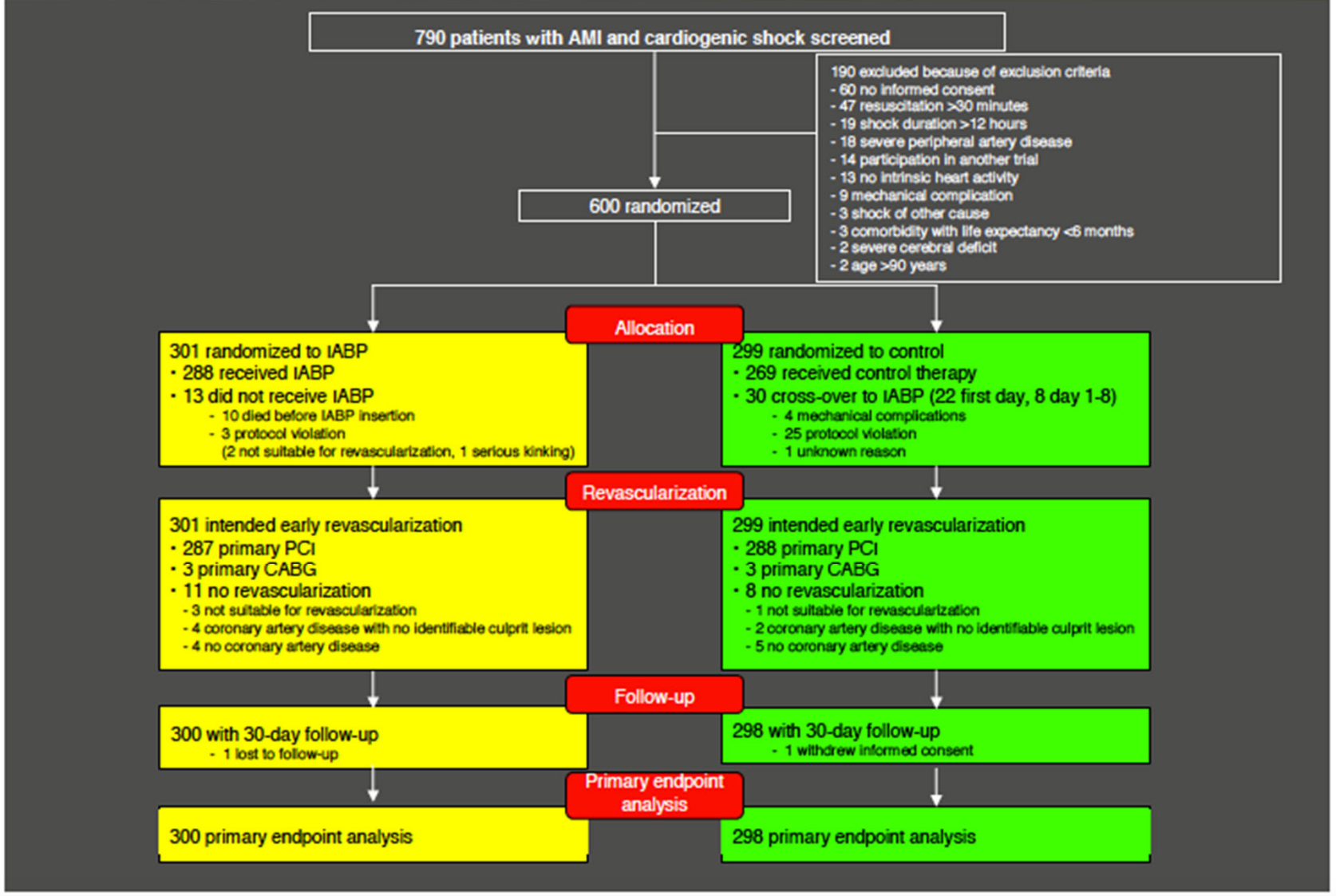
- Time until hemodynamic stabilization
- Catecholamine dose and duration
- Requirement for LVAD-implantation or HTx
- Requirement for renal replacement therapy
- Length of ICU-stay
- Length of mechanical ventilation
- Mortality after 6 and 12 months

Thiele et al. Am Heart J 2012;163:938-45

Results

Trial Flow and Treatment

IABP SHOCK II RANDOMIZED CLINICAL TRIAL



Results

Patient Characteristics

IABP SHOCK II

		IABP (n=301)	Control (n=299)
Age (years); median (IQR)		70 (58-78)	69 (58-76)
Male sex; n (%)		202 (67.1)	211 (70.6)
Current Smoking; n/total (%)		96/295 (32.5)	108/299 (36.1)
Hypertension; n/total (%)		213/296 (72.0)	199/299 (66.6)
Hypercholesterolemia; n/total (%)		122/295 (41.4)	105/299 (35.1)
Diabetes mellitus; n/total (%)		105/297 (35.4)	90/299 (30.1)
Body mass index (kg/m²); median (IQR)		27.5 (24.7-30.1)	26.9 (24.7-29.4)
Prior myocardial infarction; n/total n (%)		71/300 (23.7)	61/299 (20.4)
Prior PCI; n/total n (%)		63/299 (21.1)	52/299 (17.4)
Prior CABG; n/total (%)		20/300 (6.7)	12/299 (4.0)
Fibrinolysis < 24 h before randomization; n/total (%)		28/301 (9.3)	20/299 (6.7)
STEMI/LBBB; n/total (%)		200/300 (66.7)	212/298 (71.1)
NSTEMI; n/total (%)		96/300 (32.0)	81/298 (27.2)
Resuscitation before randomization; n/total (%)	V	127/301 (42.2%)	143/299 (47.8)
Signs of impaired organ perfusion; n/total (%)			
Altered mental status		215/300 (71.7)	232/299 (77.6)
Cold, clammy skin and extremities		257/300 (85.7)	245/299 (81.9)
Oliguria		90/300 (30.0)	99/299 (33.1)
Serum lactate >2.0 mmol/l		226/300 (75.3)	218/298 (73.2)
Creatinine clearance (ml/min); median (IQR)		60.7 (43.4-86.6)	56.8 (39.7-78.1)
Infarct related artery; n/total (%)			
LAD		132/293 (45.1)	121/293 (41.3)
LCX		55/293 (18.8)	57/293 (19.5)
RCA		73/293 (24.9)	79/293 (27.0)
Left main		26/293 (8.9)	28/293 (9.6)
Bypass graft		7/293 (2.4)	8/293 (2.7)
Multivessel disease; n/total (%)		235/296 (79.4)	228/293 (77.9)
Left ventricular ejection fraction (%); median (IQR)	V	35 (25-45)	35 (25-45)

Results

Treatment + Process of Care Outcomes

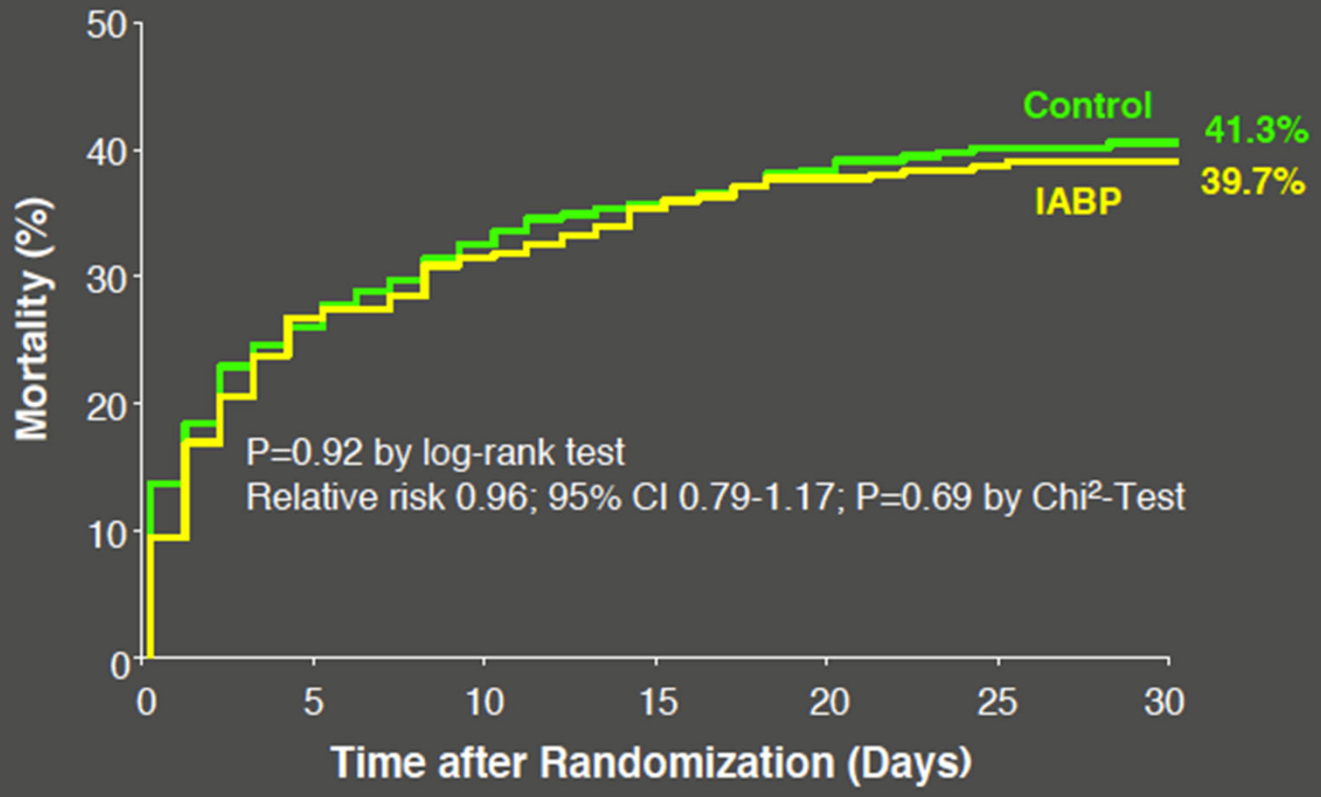
IABP SHOCK II

Variable	IABP (n=301)	Control (n=299)	p
Primary PCI; n/total (%)	287/301 (95.3)	288/299 (96.3)	0.55
Stent implanted; n/total (%)	273/301 (90.7)	266/299 (89.0)	0.48
Drug-eluting stent; n/total (%)	126/301 (41.9)	123/299 (41.1)	0.86
Immediate PCI of non-culprit lesions; n/total (%)	90/301 (29.9)	81/299 (27.1)	0.45
Immediate bypass surgery; n/total (%)	8/301 (2.7)	10/299 (3.3)	0.62
Staged bypass surgery; n/total (%)	3/301 (1.0)	4/299 (1.3)	0.72
Active left ventricular assist device; n/total (%)	11/301 (3.7)	22/299 (7.4)	0.053
Mild hypothermia; n/total (%)	106/301 (35.2)	120/299 (40.1)	0.21
Mechanical ventilation; n/total (%)	240/301 (79.7)	252/299 (84.3)	0.15
Duration of mechanical ventilation (days); median (IQR)	3.0 (1.0-8.0)	3.0 (1.0-8.0)	0.44
Duration of intensive care treatment (days); median (IQR)	6.0 (3.0-12.0)	6.0 (3.0-13.0)	0.34
Renal replacement therapy; n/total (%)	62/301 (20.6)	47/299 (15.7)	0.12
Antiplatelets and anticoagulation; n/total (%)	293/299 (98.0)	284/298 (95.3)	0.07
Aspirin	216/299 (72.2)	206/298 (69.1)	0.40
Clopidogrel	80/299 (26.8)	76/298 (25.5)	0.73
Prasugrel	19/234 (8.1)	15/228 (6.6)	0.52
Ticagrelor*	138/299 (46.2)	143/298 (48.0)	0.63
Glycoprotein IIb/IIIa-inhibitors	288/299 (96.3)	275/298 (92.3)	0.03
Unfractionated heparin	60/299 (20.1)	59/298 (19.8)	0.94
Low molecular weight heparin	29/299 (9.7)	36/298 (12.1)	0.34
Bivalirudin			
Catecholamines (µg/kg per minute); median (IQR)			
Dopamine	4.1 (2.9-7.7)	4.2 (3.6-8.3)	0.76
Norepinephrine	0.3 (0.1-1.2)	0.4 (0.1-1.1)	0.73
Epinephrine	0.3 (0.1-1.3)	0.3 (0.2-1.4)	0.59
Dobutamine	10.2 (4.9-20.6)	9.0 (4.8-17.6)	0.25
Duration of catecholamines (days), median (IQR)	3.0 (1.0-5.0)	3.0 (1.0-6.0)	0.81
Time to hemodynamic stabilization (days); median (IQR)	3.0 (1.0-5.0)	3.0 (1.0-6.0)	0.50

Results

Primary Study Endpoint (30-Day Mortality)

IABP SHOCK II

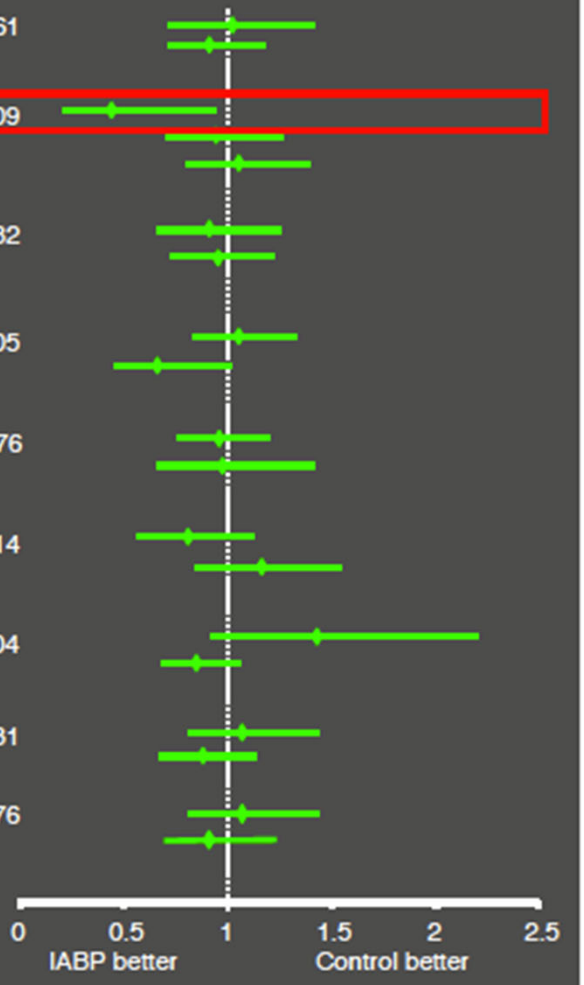


Results

Subgroups (30-Day Mortality)

IABP SHOCK II

Baseline Variable	N	30-Day Mortality (%) IABP	30-Day Mortality (%) Control	Relative Risk (95% CI)	P-Value for Interaction
Female	187	44.4	43.2	1.03 (0.74-1.43)	0.61
Male	411	37.3	40.5	0.92 (0.72-1.18)	
Age <50 years	70	19.4	44.1	0.44 (0.21-0.95)	0.09
Age 50-75 years	334	34.6	36.5	0.95 (0.71-1.27)	
Age >75 years	194	53.7	40.0	1.07 (0.81-1.41)	
Diabetes	195	42.9	46.7	0.92 (0.67-1.26)	0.82
No diabetes	399	37.2	38.9	0.96 (0.74-1.23)	
Hypertension	410	42.9	40.4	1.06 (0.84-1.34)	0.05
No hypertension	183	28.9	43.0	0.67 (0.45-1.01)	
STEMI/LBBB	412	41.0	42.9	0.96 (0.77-1.21)	0.76
NSTEMI	177	37.5	38.3	0.98 (0.67-1.43)	
Anterior STEMI	216	35.4	43.7	0.81 (0.58-1.13)	0.14
Non-anterior STEMI	196	48.3	42.2	1.16 (0.85-1.57)	
Previous infarction	131	47.9	33.3	1.44 (0.93-2.21)	0.04
No previous infarction	466	37.3	43.3	0.86 (0.69-1.07)	
Hypothermia	226	48.1	44.2	1.09 (0.82-1.44)	0.31
No hypothermia	372	35.1	39.3	0.89 (0.68-1.16)	
Blood pressure <80 mmHg	161	50.7	46.4	1.09 (0.79-1.50)	0.76
Blood pressure ≥80 mmHg	432	35.9	39.2	0.92 (0.72-1.17)	



Summary + Conclusions

IABP SHOCK II

- IABP support in cardiogenic shock is safe without significant inherent complications.
- However, IABP support did not reduce 30-day mortality in this large, randomized, multicenter trial in cardiogenic shock patients complicating myocardial infarction undergoing early revascularization.
- The primary study endpoint results are supported by a lack of benefit in secondary endpoints.

Conclusion

- Encore largement utilisé quand pas d'autre système disponible !

- Garde un « potentiel intérêt » dans certaines indications

➢ Patient jeune, IVA proximale, « pré-choc »

➢ Complications mécaniques de l'infarctus

➢ Pré ou post- chirurgie cardiaque