TAKOTSUBO SYNDROME (TTS) CARDIOMYOPATHIE DE STRESS TDM ET IRM

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OBJECTIFS

- Connaître les aspects typiques et atypiques de la CMP de stress
- Reconnaître les complications secondaires
- Apports respectifs du scanner et de l'IRM dans cette pathologie

International Expert Consensus Document on Takotsubo Syndrome (Part I): Clinical Characteristics, Diagnostic Criteria, and Pathophysiology

European Heart Journal (2018) **39**, 2032–2046

International Expert Consensus Document on Takotsubo Syndrome (Part II): Diagnostic Workup, Outcome, and Management

European Heart Journal (2018) **39**, 2047–2062

Stress Cardiomyopathy Diagnosis and Treatment

JACC State-of-the-Art Review

EBAC
ABIM
CME MOC
ACCREDITED

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J Am Coll Cardiol 2018;72:1955–71

TAKOTSUBO / RAPPELS

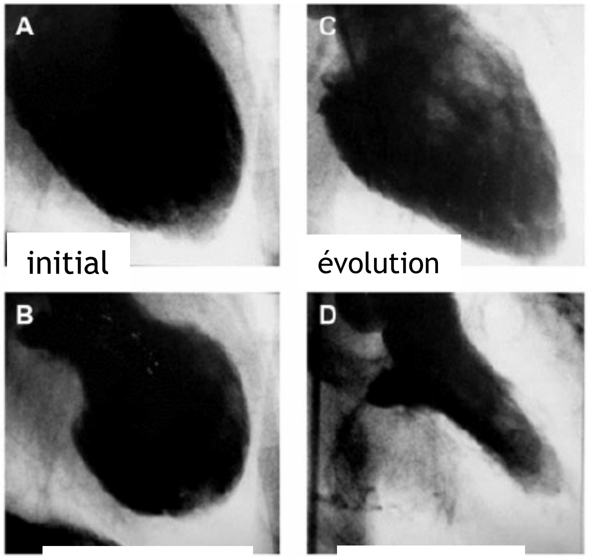
Syndrome d'anomalie transitoire supra-segmentaire de la cinétique VG (forme microvasculaire de SCA)

ballonisation apicale transitoire
Broken Heart syndrome, cardiomyopathie de stress
« Piège à poulpes » des japonais

- 1er cas: 1983 Hiroshima City Hospital
- 1ère série : 1990

TAKOTSUBO / RAPPELS

- Anomalie aigüe de la cinétique VG
  - non segmentaire
  - sans sténose coronaire responsable
  - Résolutive
  - Augmentation de troponine moins élevée que dans STEMI classique



diastole systole

1er cas
Dr Dote, cited in EHJ 2018

TAKOTSUBO / RAPPELS

- Environ 2% des SCA (9% si femme ménopausée)
- Prédominance féminine (90%)
- Age moyen 65 ans

- 80% après stress intense, (facteur familial ?)

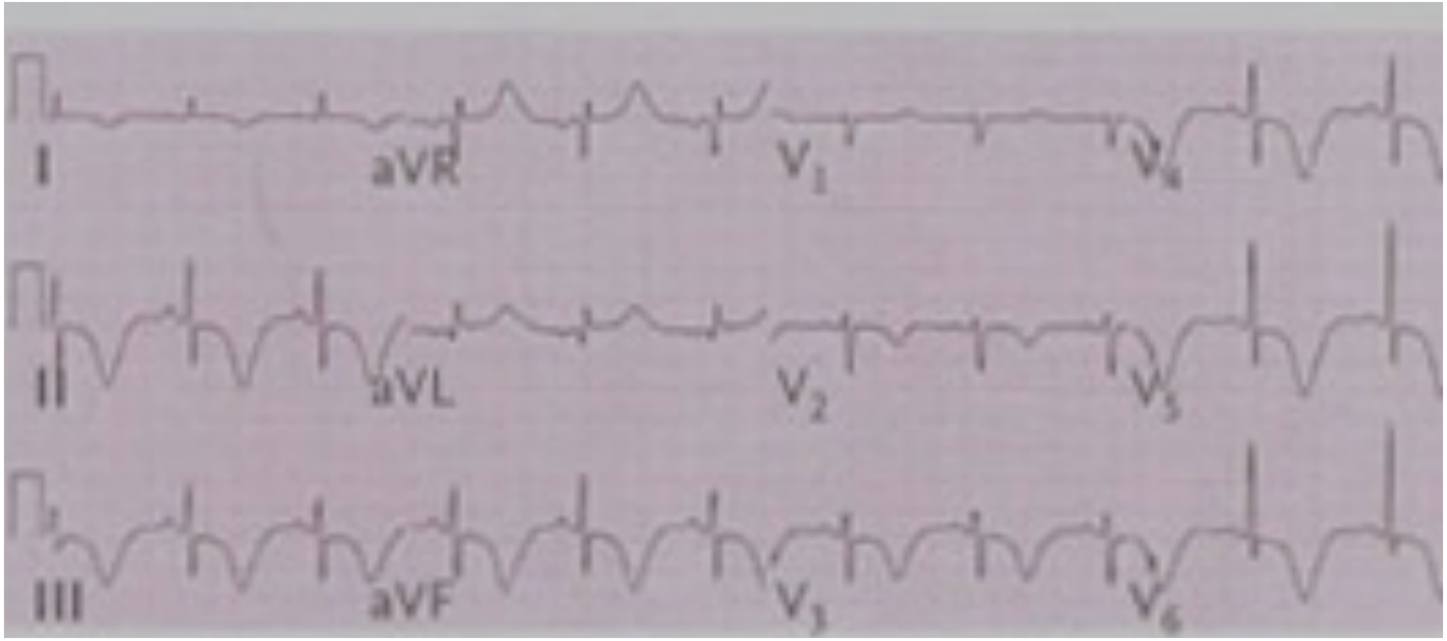
- 10% sous forme d'OAP ou de choc cardiogénique
- Récurrence 1.8% patient / an

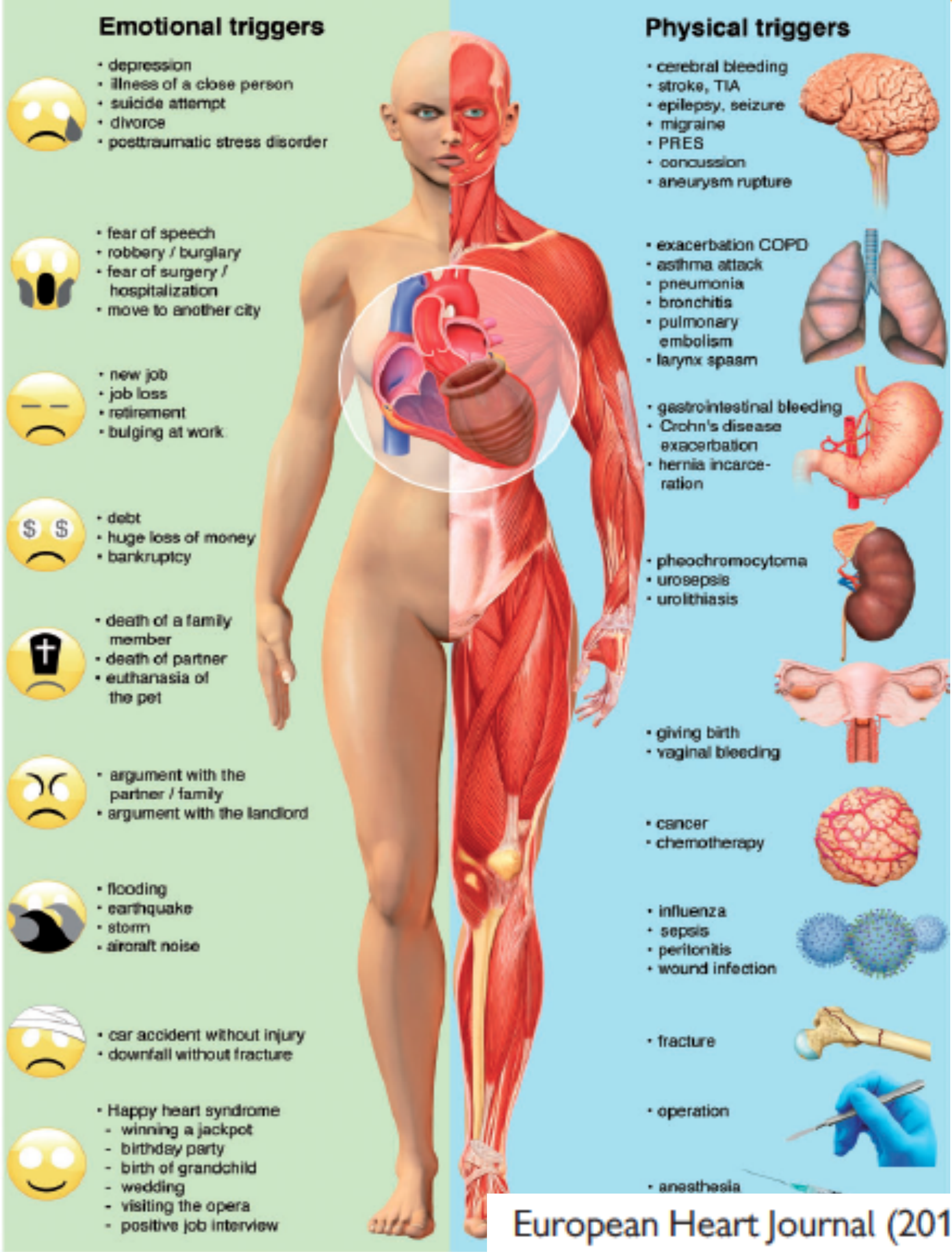
Mortalité hospitalière : au moins 5%

TAKOTSUBO / RAPPELS

ECG

SCA ST + ou ondes T négatives
souvent QT allongé
parfois onde Q transitoire


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6



Emotional triggers

- depression
- illness of a close person
- suicide attempt
- divorce
- posttraumatic stress disorder

- fear of speech
- robbery / burglary
- fear of surgery / hospitalization
- move to another city

- new job
- job loss
- retirement
- bulging at work

- debt
- huge loss of money
- bankruptcy

- death of a family member
- death of partner
- euthanasia of the pet

- argument with the partner / family
- argument with the landlord

- flooding
- earthquake
- storm
- aircraft noise

- car accident without injury
- downfall without fracture

- Happy heart syndrome
  - winning a jackpot
  - birthday party
  - birth of grandchild
  - wedding
  - visiting the opera
  - positive job interview

Physical triggers

- cerebral bleeding
- stroke, TIA
- epilepsy, seizure
- migraine
- PRES
- concussion
- aneurysm rupture

- exacerbation COPD
- asthma attack
- pneumonia
- bronchitis
- pulmonary embolism
- larynx spasm

- gastrointestinal bleeding
- Crohn's disease exacerbation
- hernia incarceration

- pheochromocytoma
- urosepsis
- urolithiasis

- giving birth
- vaginal bleeding

- cancer
- chemotherapy

- influenza
- sepsis
- peritonitis
- wound infection

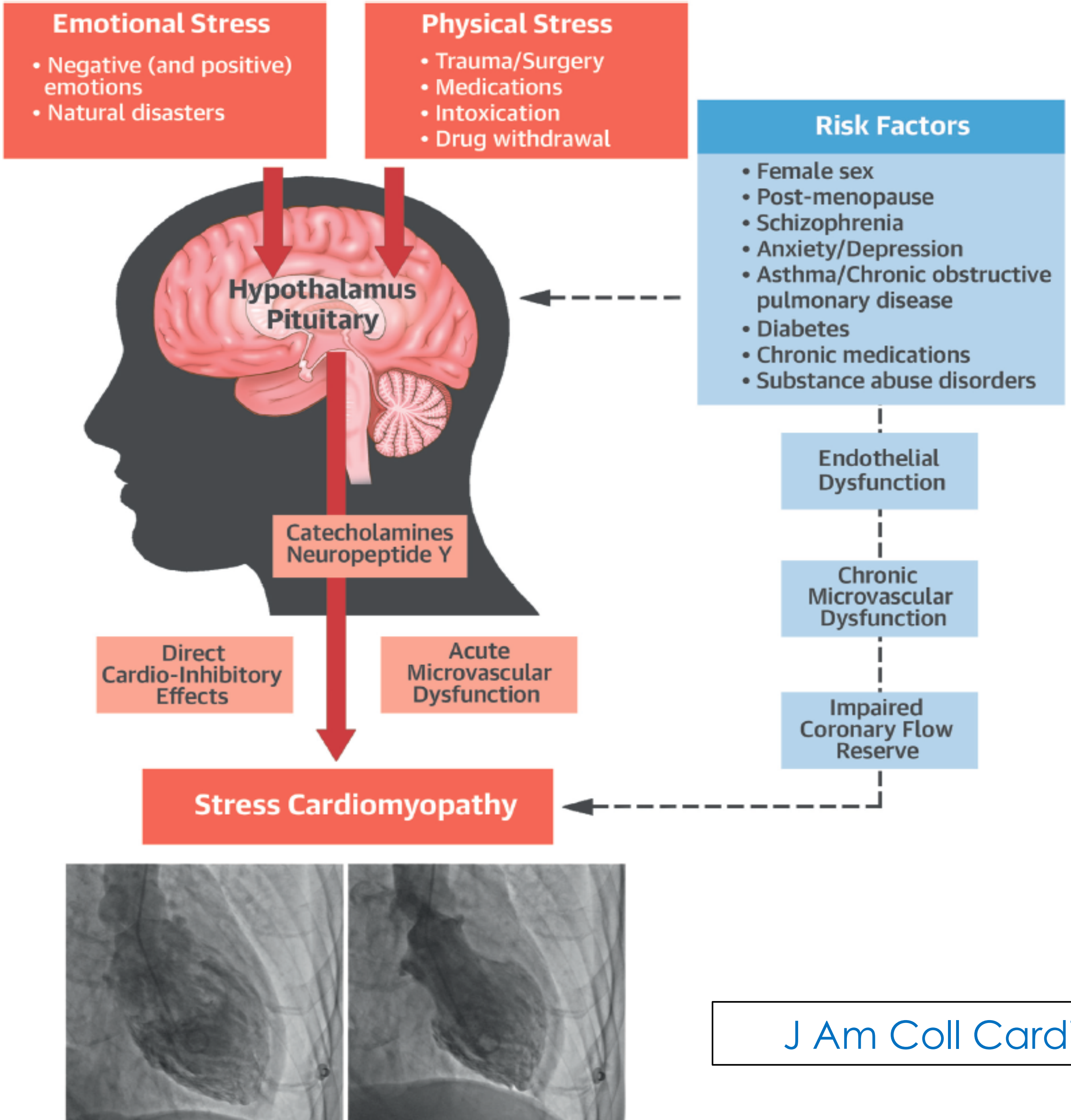
- fracture

- operation

- anesthesia

European Heart Journal (2018) **39**, 2032–2046

CENTRAL ILLUSTRATION Pathophysiology of Stress Cardiomyopathy



Emotional Stress
- Negative (and positive) emotions
- Natural disasters

Physical Stress
- Trauma/Surgery
- Medications
- Intoxication
- Drug withdrawal

Risk Factors
- Female sex
- Post-menopause
- Schizophrenia
- Anxiety/Depression
- Asthma/Chronic obstructive pulmonary disease
- Diabetes
- Chronic medications
- Substance abuse disorders

Hypothalamus
Pituitary

Catecholamines
Neuropeptide Y

Direct Cardio-Inhibitory Effects

Acute Microvascular Dysfunction

Endothelial Dysfunction

Chronic Microvascular Dysfunction

Impaired Coronary Flow Reserve

Stress Cardiomyopathy

J Am Coll Cardiol 2018;72:1955–71

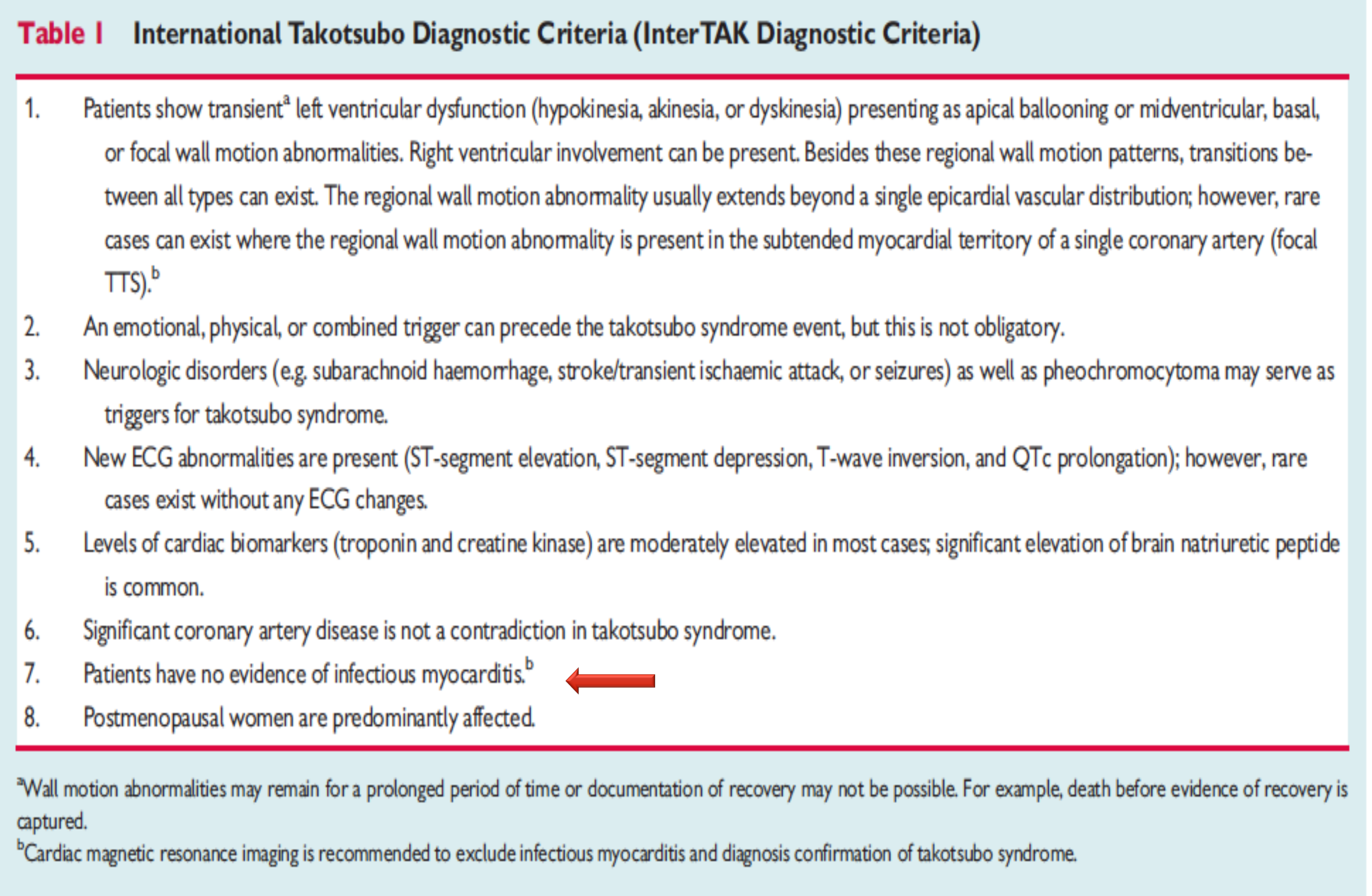


Table 1 International Takotsubo Diagnostic Criteria (InterTAK Diagnostic Criteria)

1. Patients show transient[a] left ventricular dysfunction (hypokinesia, akinesia, or dyskinesia) presenting as apical ballooning or midventricular, basal, or focal wall motion abnormalities. Right ventricular involvement can be present. Besides these regional wall motion patterns, transitions between all types can exist. The regional wall motion abnormality usually extends beyond a single epicardial vascular distribution; however, rare cases can exist where the regional wall motion abnormality is present in the subtended myocardial territory of a single coronary artery (focal TTS).[b]
2. An emotional, physical, or combined trigger can precede the takotsubo syndrome event, but this is not obligatory.
3. Neurologic disorders (e.g. subarachnoid haemorrhage, stroke/transient ischaemic attack, or seizures) as well as pheochromocytoma may serve as triggers for takotsubo syndrome.
4. New ECG abnormalities are present (ST-segment elevation, ST-segment depression, T-wave inversion, and QTc prolongation); however, rare cases exist without any ECG changes.
5. Levels of cardiac biomarkers (troponin and creatine kinase) are moderately elevated in most cases; significant elevation of brain natriuretic peptide is common.
6. Significant coronary artery disease is not a contradiction in takotsubo syndrome.
7. Patients have no evidence of infectious myocarditis.[b]
8. Postmenopausal women are predominantly affected.

[a] Wall motion abnormalities may remain for a prolonged period of time or documentation of recovery may not be possible. For example, death before evidence of recovery is captured.

[b] Cardiac magnetic resonance imaging is recommended to exclude infectious myocarditis and diagnosis confirmation of takotsubo syndrome.

European Heart Journal (2018) **39**, 2032–2046

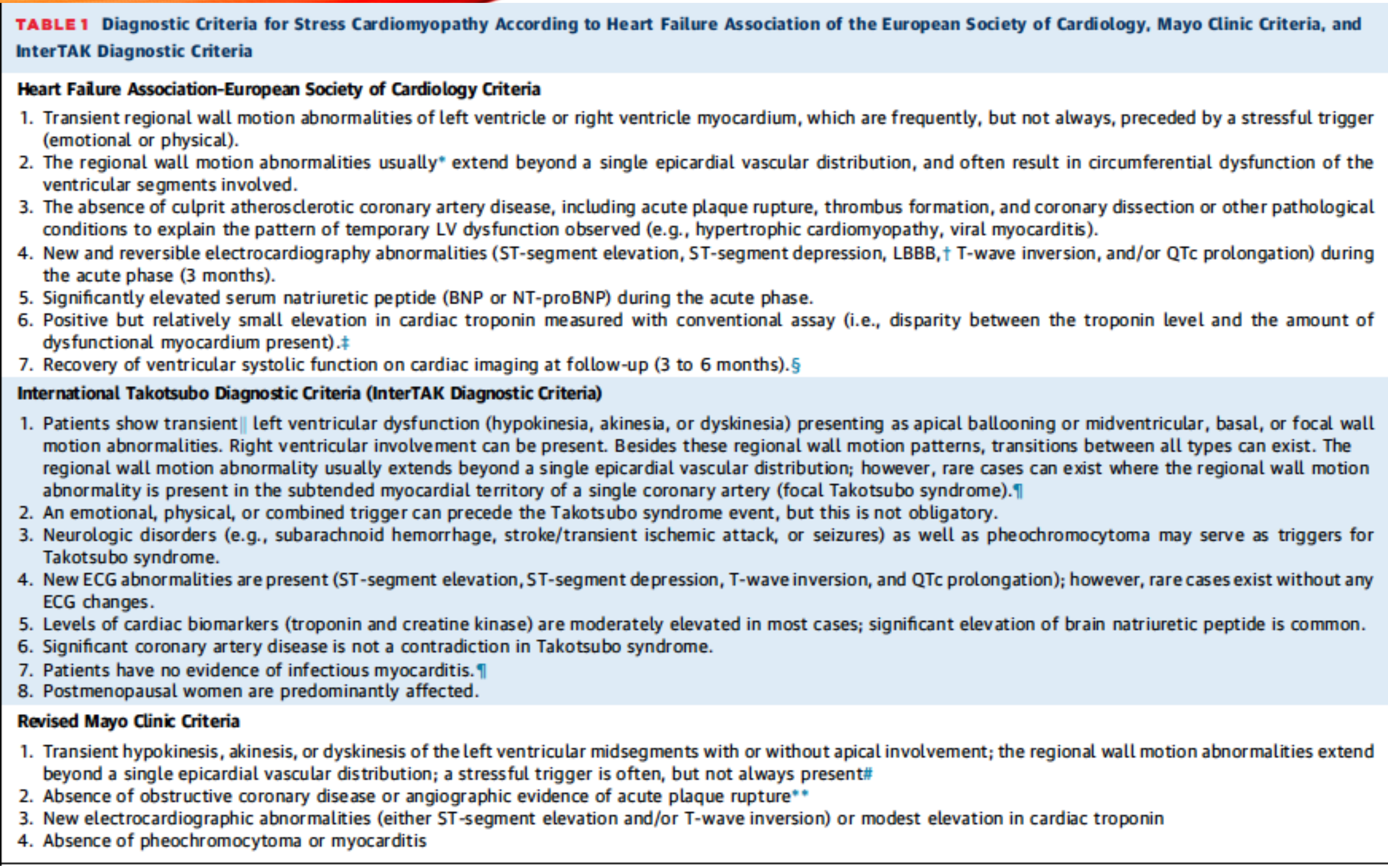


TABLE 1 Diagnostic Criteria for Stress Cardiomyopathy According to Heart Failure Association of the European Society of Cardiology, Mayo Clinic Criteria, and InterTAK Diagnostic Criteria

Heart Failure Association–European Society of Cardiology Criteria

1. Transient regional wall motion abnormalities of left ventricle or right ventricle myocardium, which are frequently, but not always, preceded by a stressful trigger (emotional or physical).
2. The regional wall motion abnormalities usually[*] extend beyond a single epicardial vascular distribution, and often result in circumferential dysfunction of the ventricular segments involved.
3. The absence of culprit atherosclerotic coronary artery disease, including acute plaque rupture, thrombus formation, and coronary dissection or other pathological conditions to explain the pattern of temporary LV dysfunction observed (e.g., hypertrophic cardiomyopathy, viral myocarditis).
4. New and reversible electrocardiography abnormalities (ST-segment elevation, ST-segment depression, LBBB,[†] T-wave inversion, and/or QTc prolongation) during the acute phase (3 months).
5. Significantly elevated serum natriuretic peptide (BNP or NT-proBNP) during the acute phase.
6. Positive but relatively small elevation in cardiac troponin measured with conventional assay (i.e., disparity between the troponin level and the amount of dysfunctional myocardium present).[‡]
7. Recovery of ventricular systolic function on cardiac imaging at follow-up (3 to 6 months).[§]

International Takotsubo Diagnostic Criteria (InterTAK Diagnostic Criteria)

1. Patients show transient[||] left ventricular dysfunction (hypokinesia, akinesia, or dyskinesia) presenting as apical ballooning or midventricular, basal, or focal wall motion abnormalities. Right ventricular involvement can be present. Besides these regional wall motion patterns, transitions between all types can exist. The regional wall motion abnormality usually extends beyond a single epicardial vascular distribution; however, rare cases can exist where the regional wall motion abnormality is present in the subtended myocardial territory of a single coronary artery (focal Takotsubo syndrome).[¶]
2. An emotional, physical, or combined trigger can precede the Takotsubo syndrome event, but this is not obligatory.
3. Neurologic disorders (e.g., subarachnoid hemorrhage, stroke/transient ischemic attack, or seizures) as well as pheochromocytoma may serve as triggers for Takotsubo syndrome.
4. New ECG abnormalities are present (ST-segment elevation, ST-segment depression, T-wave inversion, and QTc prolongation); however, rare cases exist without any ECG changes.
5. Levels of cardiac biomarkers (troponin and creatine kinase) are moderately elevated in most cases; significant elevation of brain natriuretic peptide is common.
6. Significant coronary artery disease is not a contradiction in Takotsubo syndrome.
7. Patients have no evidence of infectious myocarditis.[¶]
8. Postmenopausal women are predominantly affected.

Revised Mayo Clinic Criteria

1. Transient hypokinesis, akinesis, or dyskinesis of the left ventricular midsegments with or without apical involvement; the regional wall motion abnormalities extend beyond a single epicardial vascular distribution; a stressful trigger is often, but not always present[#]
2. Absence of obstructive coronary disease or angiographic evidence of acute plaque rupture[**]
3. New electrocardiographic abnormalities (either ST-segment elevation and/or T-wave inversion) or modest elevation in cardiac troponin
4. Absence of pheochromocytoma or myocarditis

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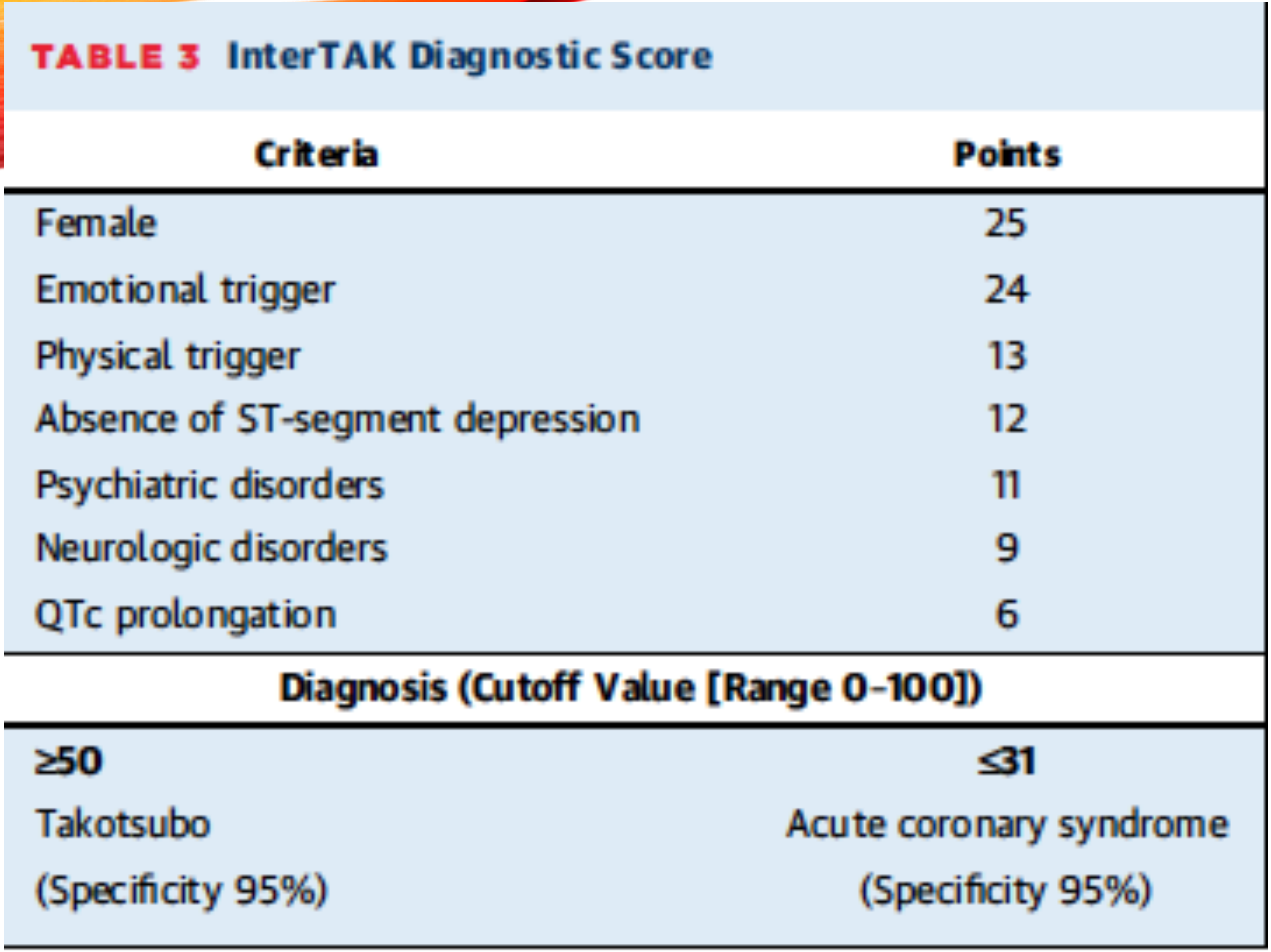
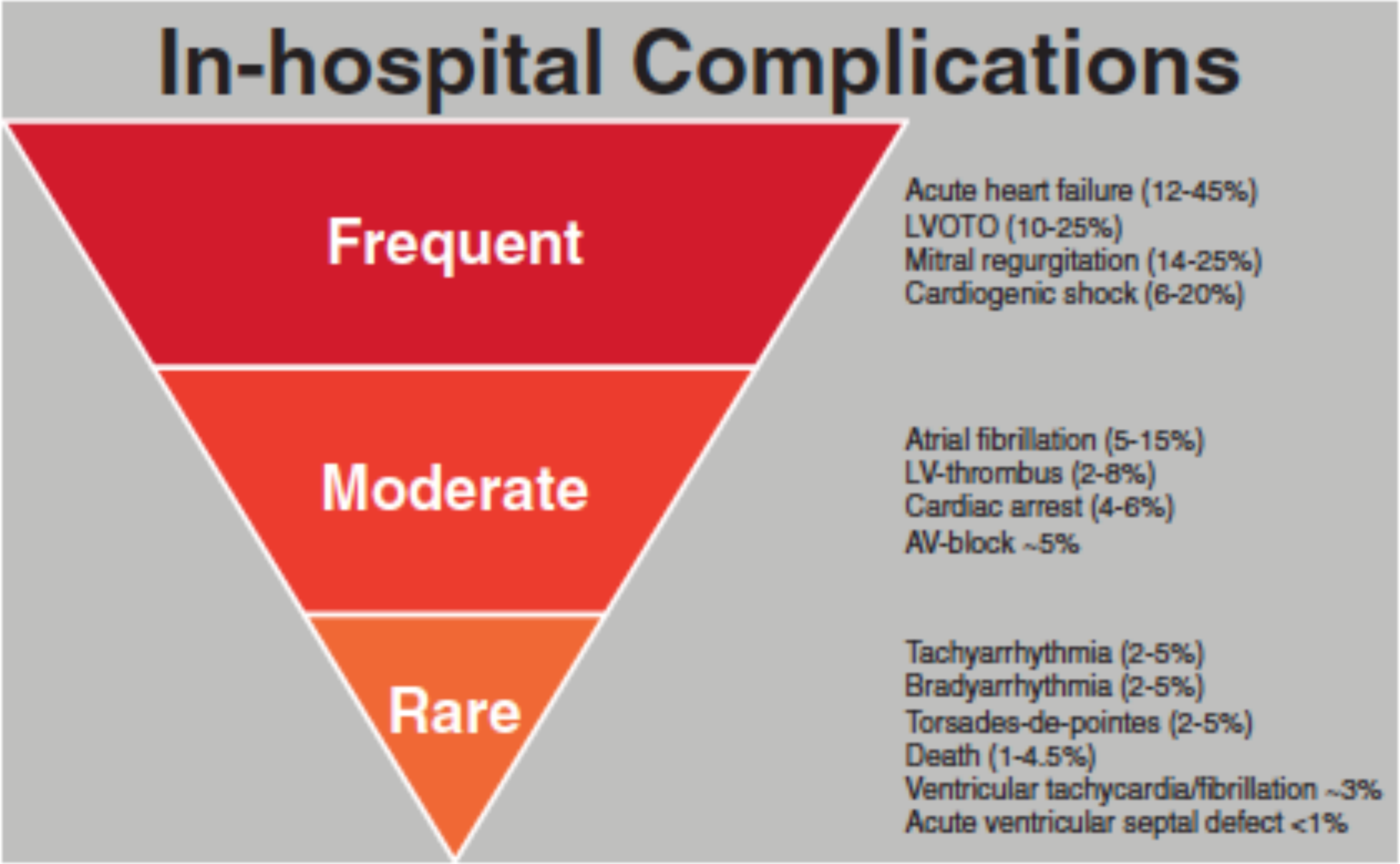


TABLE 3 **InterTAK Diagnostic Score**

Criteria	Points
Female	25
Emotional trigger	24
Physical trigger	13
Absence of ST-segment depression	12
Psychiatric disorders	11
Neurologic disorders	9
QTc prolongation	6
Diagnosis (Cutoff Value [Range 0-100])	
≥50	**≤31**
Takotsubo	Acute coronary syndrome
(Specificity 95%)	(Specificity 95%)



In-hospital Complications

Frequent

Acute heart failure (12-45%)
LVOTO (10-25%)
Mitral regurgitation (14-25%)
Cardiogenic shock (6-20%)

Moderate

Atrial fibrillation (5-15%)
LV-thrombus (2-8%)
Cardiac arrest (4-6%)
AV-block ~5%

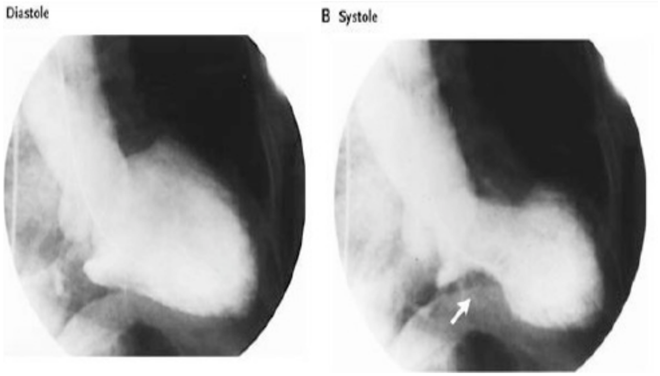
Rare

Tachyarrhythmia (2-5%)
Bradyarrhythmia (2-5%)
Torsades-de-pointes (2-5%)
Death (1-4.5%)
Ventricular tachycardia/fibrillation ~3%
Acute ventricular septal defect <1%

TAKOTSUBO / IMAGERIE

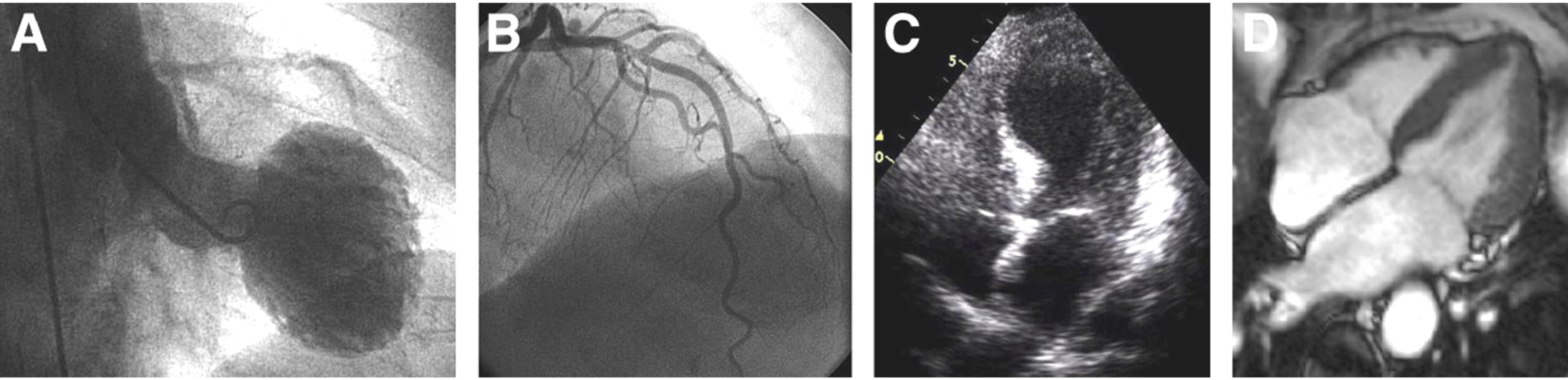
L'écho coeur est le premier examen à réaliser et à répéter pour l'évolution et les complications

- ETT et / ou Ventriculographie (en l'absence de thrombus apical)
  - Akinésie ou hypokinésie apicale sévère avec base hyperkinétique



- Coronarographie
  - Absence de sténose coronaire angiographique pouvant expliquer l'anomalie de cinétique

TAKOTSUBO / ASPECT TYPIQUE



Femme ménopausée douleur thoracique aiguë après décès familial , SCA ST +. Décision d’angioplastie primaire. Ventriculographie typique de Tako Tsubo, absence de lésion coronaire. Obstruction sous aortique en ETT sur hyperkinésie de la base et akinésie apicale; Aspect normal de l’IRM 3mois plus tard.

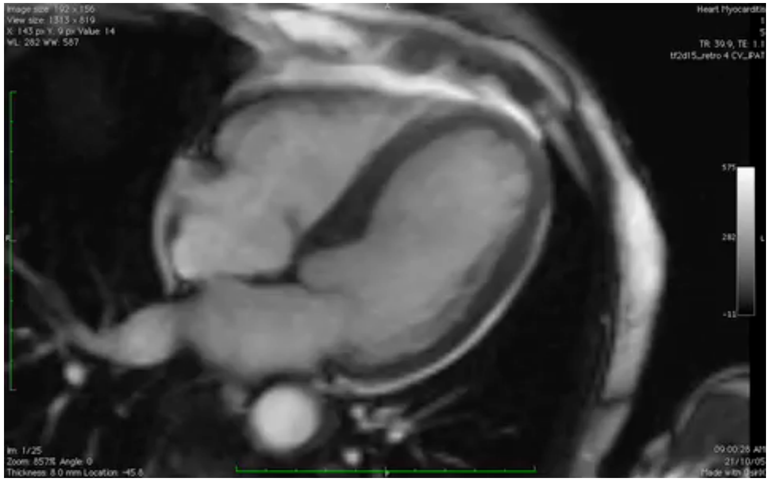
Crean, A
JACC Img 2009

TAKOTSUBO ET IRM

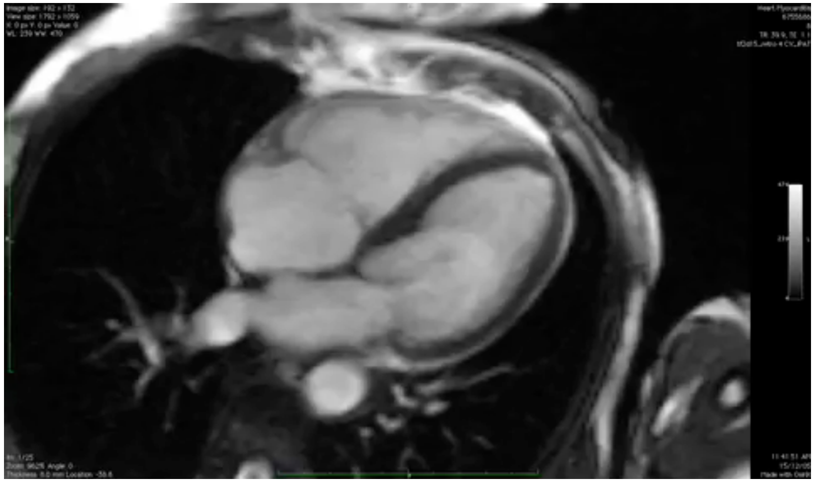
- **Critères diagnostiques de Takotsubo:**
  - Trouble de cinétique non segmentaire
  - Récupération rapide
  - Œdème myocardique à la phase aiguë (IRM pondérée T2)
  - Absence de cicatrice myocardique en IRM temps tardif post gadolinium ou discret réhaussement tardif moins étendu que l'anomalie cinétique et moins dense que dans un STEMI habituel

TAKOTSUBO ET IRM

Aspect typique de Tako Tsubo



24h après admission pour SCA avec absence de sténose coronaire.

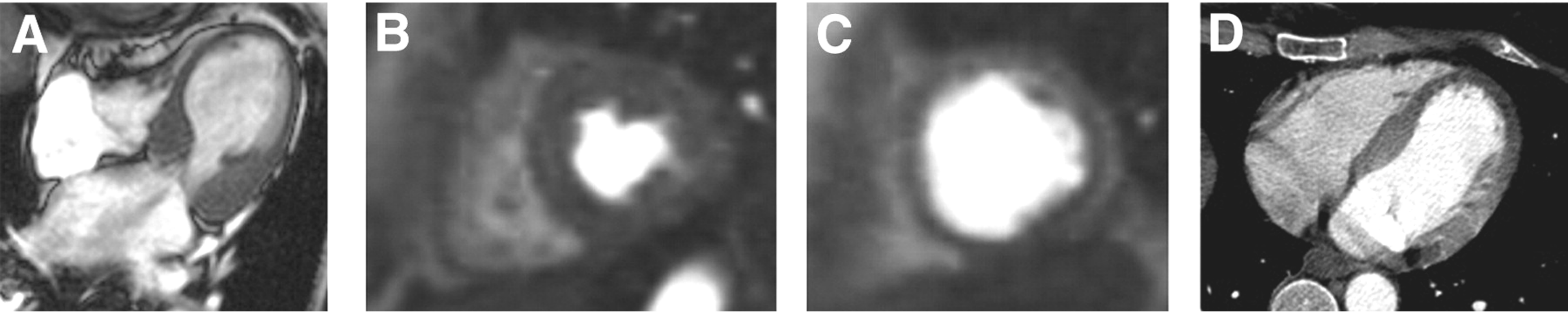


1 mois après.

IRM séquence Ciné

Friedrich MG
JACC Img 2008

TAKOTSUBO ET IRM



ETT

Base

IRM de perfusion

Apex

TDM

Akinésie apicale
Parois apicales fines

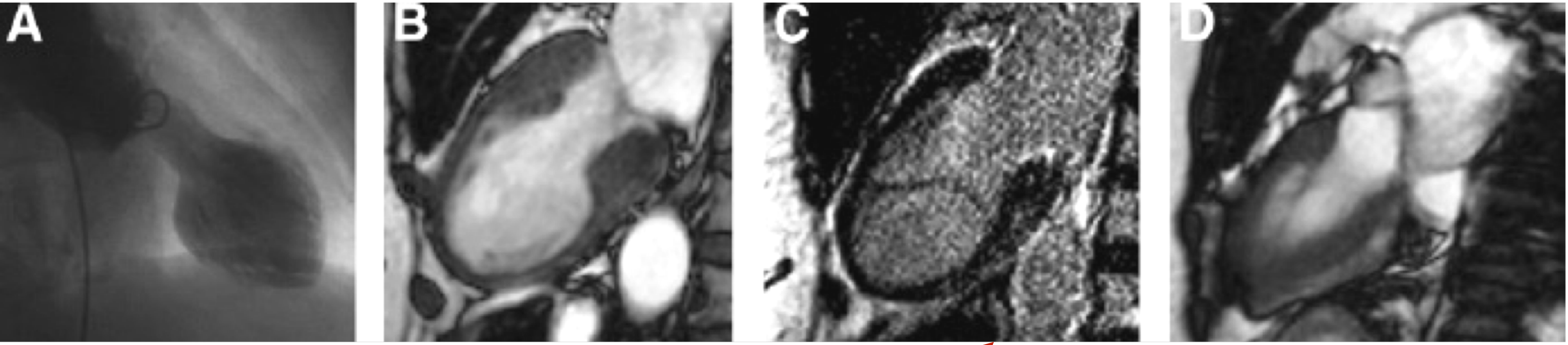
hypoperfusion

hypodensité apicale
en phase aiguë

inconstant

Crean A. JACC Img 2009

TAKOTSUBO ET IRM



Ventriculographie
ballonisation apicale

IRM à 3 mois
Récupération

IRM précoce:
ballonisation apicale absence de réhaussement tardif

Crean A. JACC Img 2009

TAKOTSUBO ET IRM

- Série de 256 patients, IRM 93%
  - Prospective, 2005-2010
  - 7 centres européens et nord américains
  - 11% d'hommes, 17 % de femmes < 55 ans
  - facteur déclenchant émotionnel intense: 2/3

- 4 types de ballonisation :
  - Apicale pour 82 % des patients
  - Biventriculaire dans 34 % des cas
  - Médiane dans 17 % des cas
  - Basale dans 1 % des cas.

Forme plus sévère
A rechercher !!

+ fréquentes si patient jeune

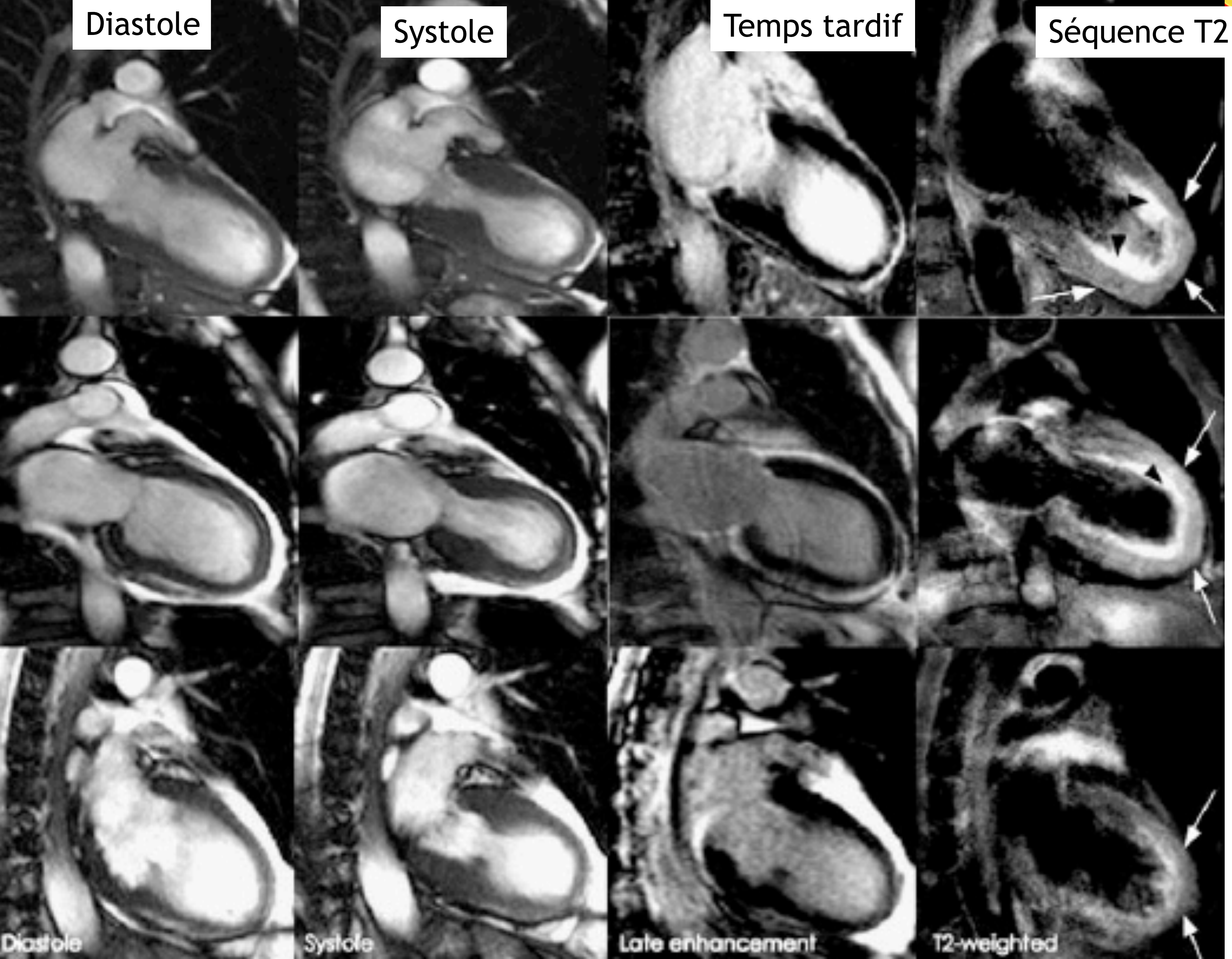
Eitel I. *JAMA* 2011 ; 306 : 277-86.

TAKOTSUBO ET IRM

- IRM en séquence T2
  - Hypersignal / œdème myocardique
  - Épaississement systolique inversement proportionnel au signal en T2

  - Rapporté chez 82% des patients (Leurent G, Int J Cardiol 2009)

Abdel-Haty H
Int J Cardiol 2007



Diastole

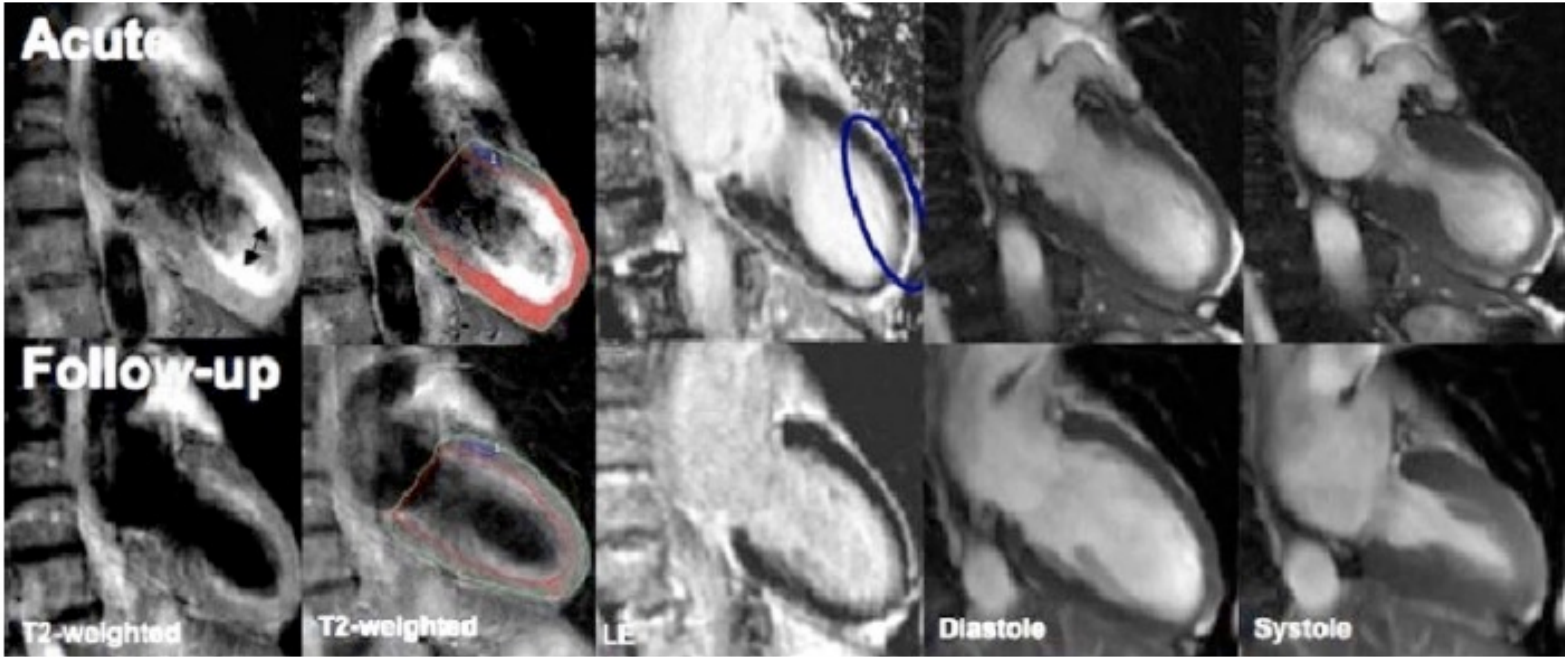
Systole

Temps tardif

Séquence T2

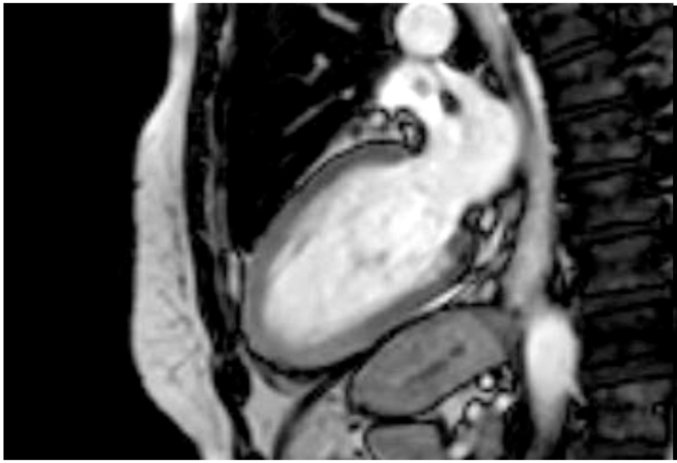
Diastole
Systole
Late enhancement
T2-weighted

TAKOTSUBO ET IRM

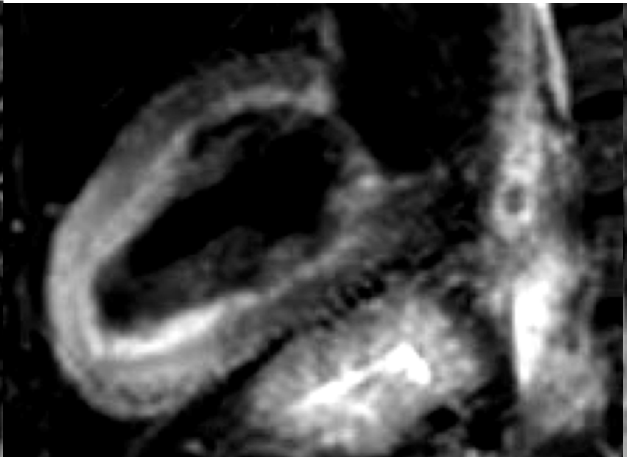

Acute
Follow-up
T2-weighted
T2-weighted
LE
Diastole
Systole

Abdel-Haty H
Int J Cardiol 2007

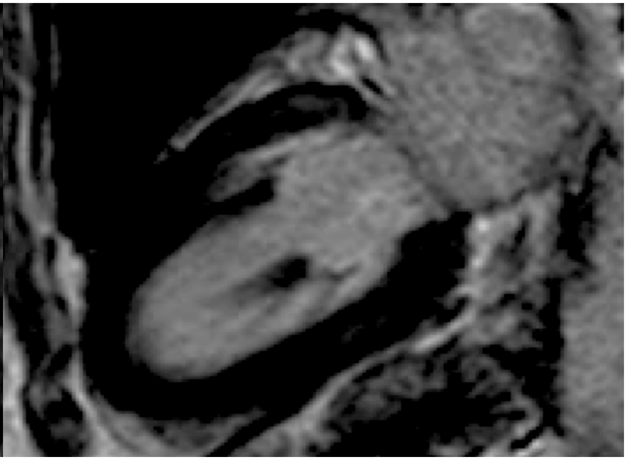
TAKOTSUBO ET IRM



Ciné IRM précoce
ballonisation apicale



IRM séquence STIR
Œdème à prédominance apicale



Temps tardif
Pas de réhaussement

Genée O
UCRB Orléans

SÉQUENCES IRM / DOULEUR THORACIQUE

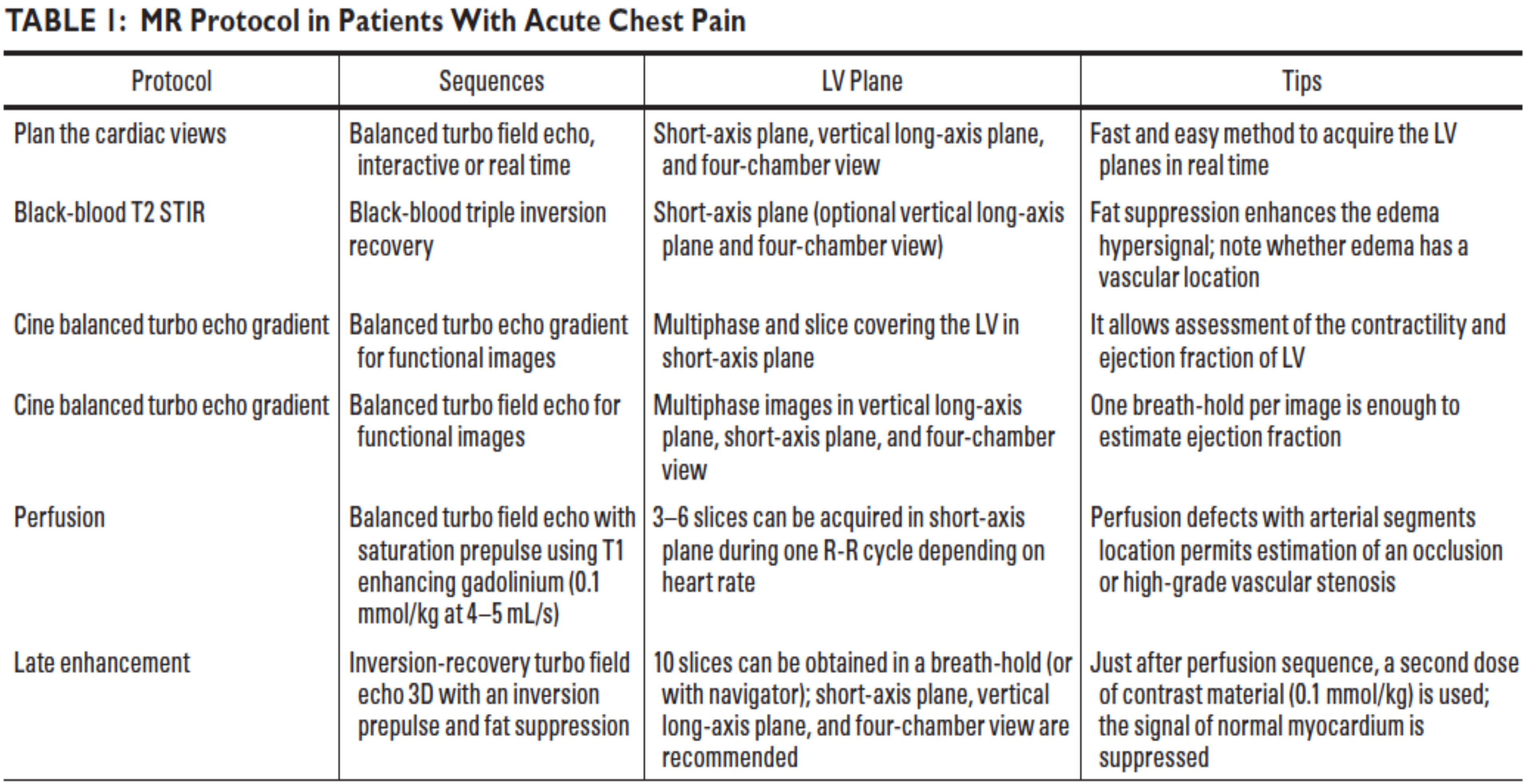
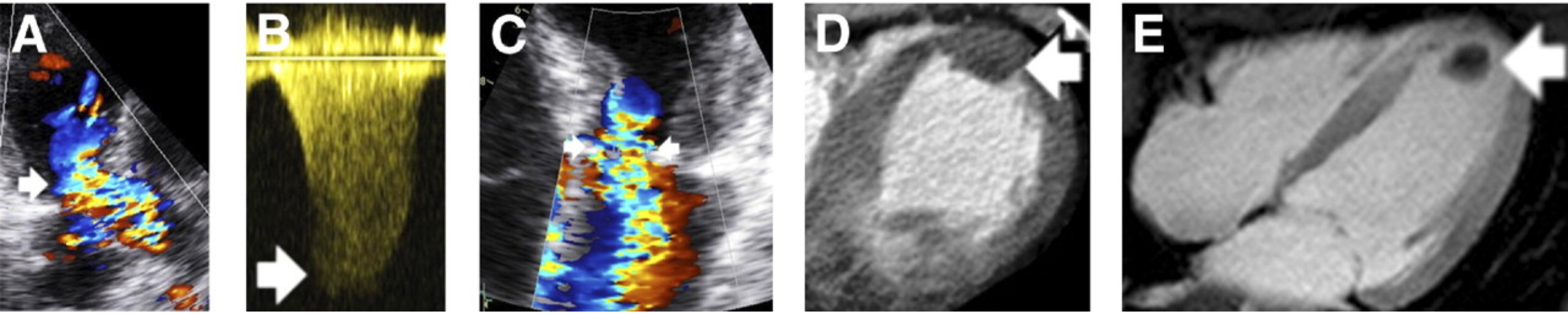


TABLE 1: MR Protocol in Patients With Acute Chest Pain

Protocol	Sequences	LV Plane	Tips
Plan the cardiac views	Balanced turbo field echo, interactive or real time	Short-axis plane, vertical long-axis plane, and four-chamber view	Fast and easy method to acquire the LV planes in real time
Black-blood T2 STIR	Black-blood triple inversion recovery	Short-axis plane (optional vertical long-axis plane and four-chamber view)	Fat suppression enhances the edema hypersignal; note whether edema has a vascular location
Cine balanced turbo echo gradient	Balanced turbo echo gradient for functional images	Multiphase and slice covering the LV in short-axis plane	It allows assessment of the contractility and ejection fraction of LV
Cine balanced turbo echo gradient	Balanced turbo field echo for functional images	Multiphase images in vertical long-axis plane, short-axis plane, and four-chamber view	One breath-hold per image is enough to estimate ejection fraction
Perfusion	Balanced turbo field echo with saturation prepulse using T1 enhancing gadolinium (0.1 mmol/kg at 4–5 mL/s)	3–6 slices can be acquired in short-axis plane during one R-R cycle depending on heart rate	Perfusion defects with arterial segments location permits estimation of an occlusion or high-grade vascular stenosis
Late enhancement	Inversion-recovery turbo field echo 3D with an inversion prepulse and fat suppression	10 slices can be obtained in a breath-hold (or with navigator); short-axis plane, vertical long-axis plane, and four-chamber view are recommended	Just after perfusion sequence, a second dose of contrast material (0.1 mmol/kg) is used; the signal of normal myocardium is suppressed

Fernandez Perez GC. AJR 2010

TAKOTSUBO / COMPLICATIONS



Obstruction sous aortique

Fuite mitrale sévère avec SAM

Thrombus apical

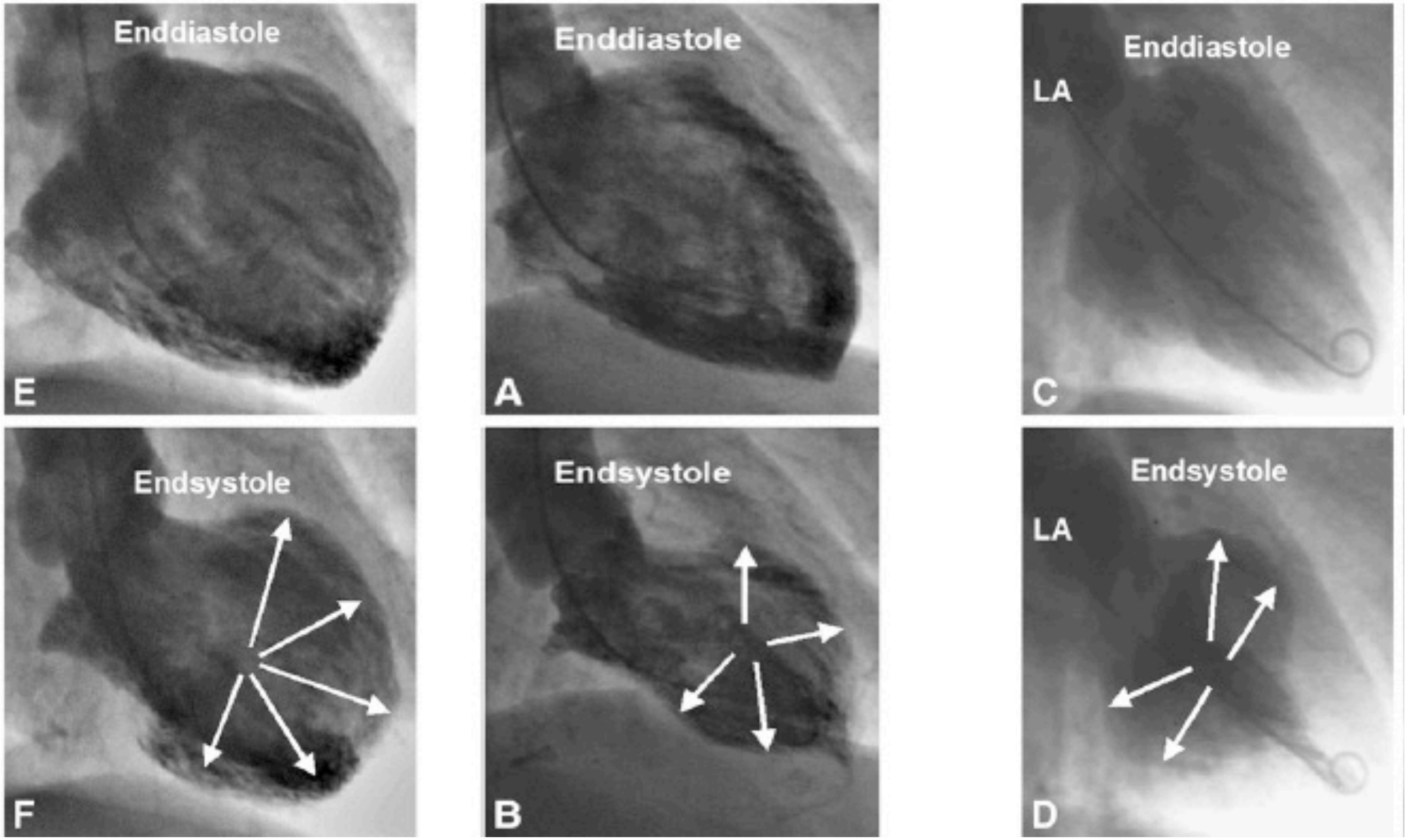
Crean A. JACC Img 2009

Thrombus apical : 5% des cas
dysfonction ventriculaire droite transitoire 38%
Revue systématique de 176 cas
Leurent G, Int J Cardiol 2009

TAKOTSUBO: FORMES ATYPIQUES

- Par la localisation de l’ akinésie
- Par l’ existence de réhaussement tardif

TAKOTSUBO: FORMES ATYPIQUES



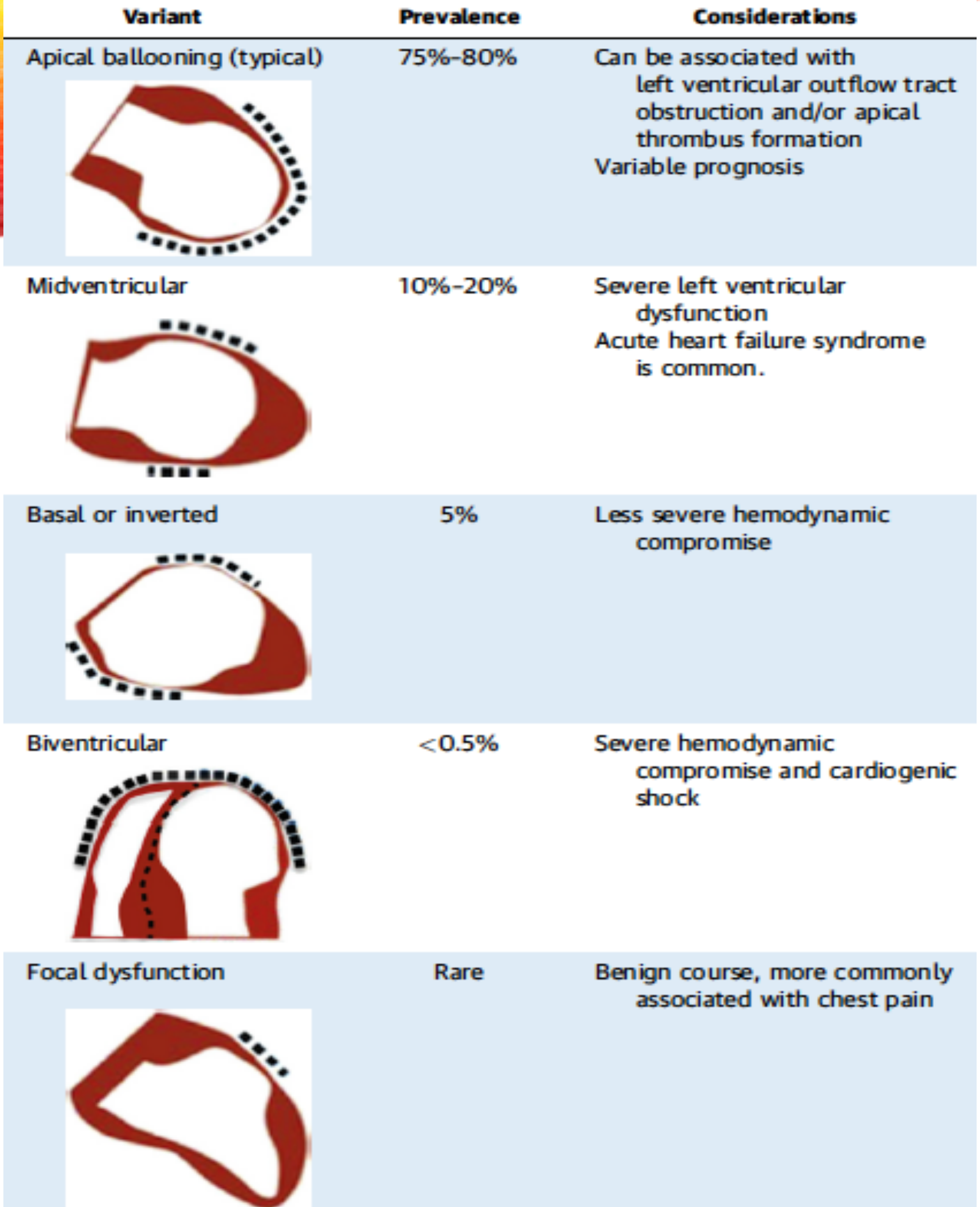
Forme typique

Forme médioventriculaire

Forme « inversée »

Enddiastole
E
Endsystole
F
Enddiastole
A
Endsystole
B
Enddiastole
LA
C
Endsystole
LA
D

Haghi D. Int J Cardiol 2006



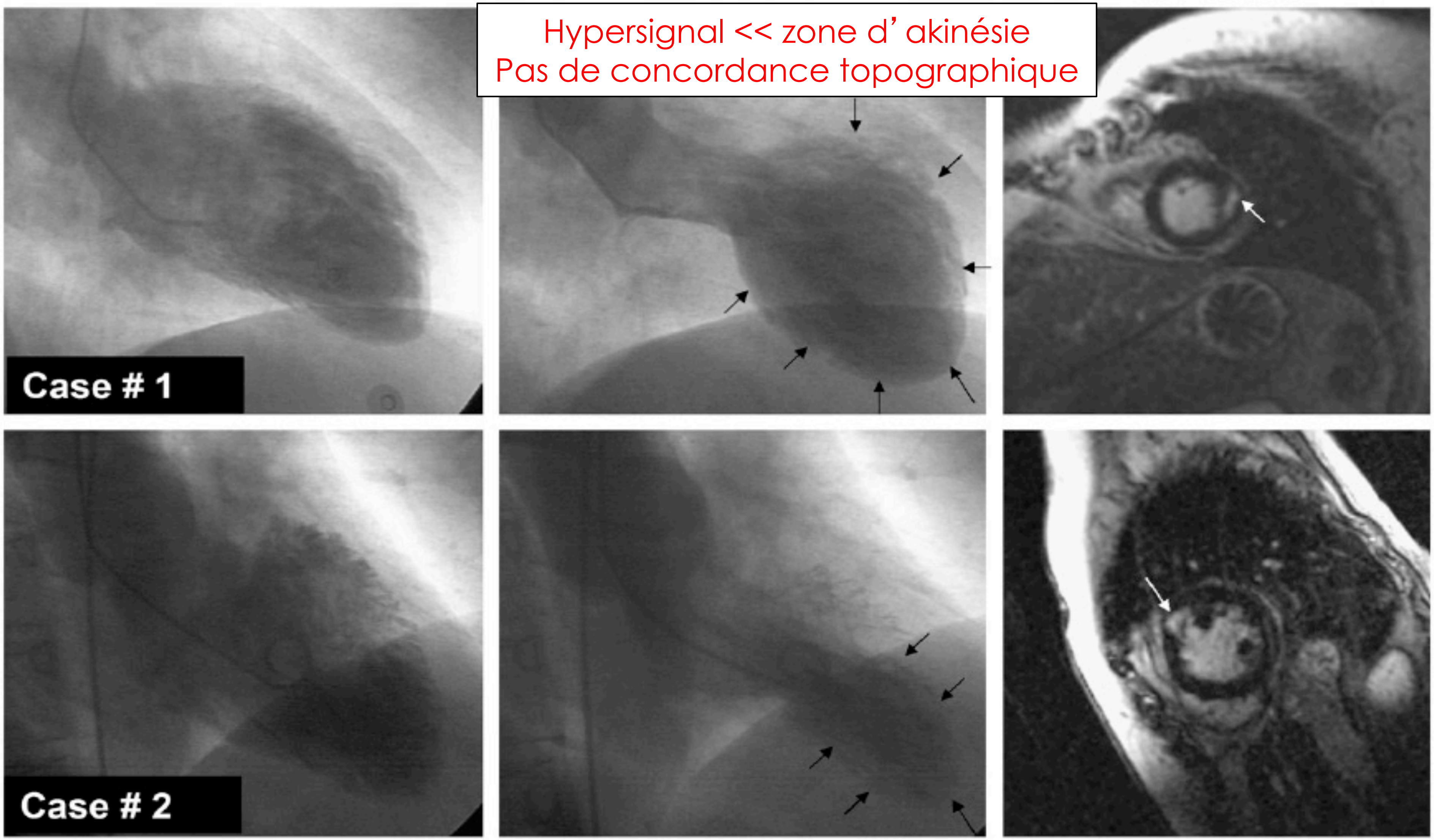
Variant	Prevalence	Considerations
Apical ballooning (typical)	75%-80%	Can be associated with left ventricular outflow tract obstruction and/or apical thrombus formation Variable prognosis
Midventricular	10%-20%	Severe left ventricular dysfunction Acute heart failure syndrome is common.
Basal or inverted	5%	Less severe hemodynamic compromise
Biventricular	<0.5%	Severe hemodynamic compromise and cardiogenic shock
Focal dysfunction	Rare	Benign course, more commonly associated with chest pain

J Am Coll Cardiol 2018;72:1955–71

Bellera M. Int J Cardiol 2010

RÉHAUSSEMENT TARDIF ET TAKOTSUBO

Hypersignal << zone d’akinésie
Pas de concordance topographique



RÉHAUSSEMENT TARDIF ET TAKOTSUBO

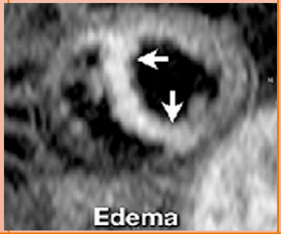
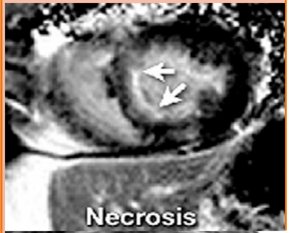
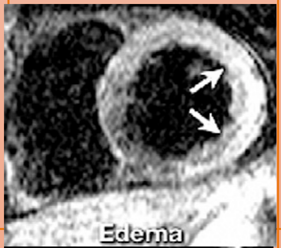
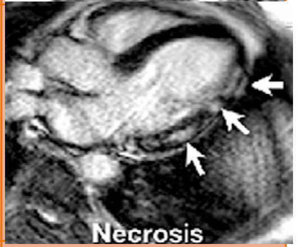
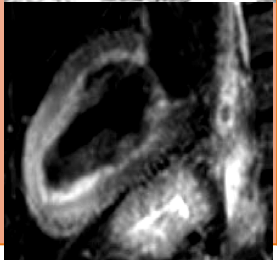
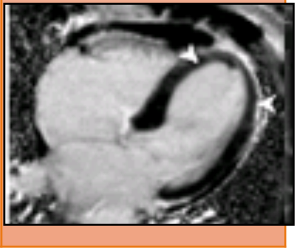
Bellera M. Int J Cardiol 2010

- 20 Takotsubo (1 homme)
  - 4 / décès d'un proche
  - 2 / conflit avec un proche
  - 2 / annonce de diagnostic médical
- IRM à 11 +/- 9 mois pour 16 patients
- Réhaussement tardif: 3 cas
  - Pic de troponine plus élevé (10 vs 3)
  - Même FEVG initiale et même récupération
  - 2 sur 3 patients admis en OAP ou choc cardiogénique

RÉHAUSSEMENT TARDIF ET TAKOTSUBO

- Série de 20 patients de Hamilton-Craig (JACC 2010)
  - Réhaussement dans 10 cas
  - Aspect ischémique ou myocardite
- Réhaussement et Takotsubo
  - Erreur de diagnostic ou méconnaissance?
  - Artefact ?
  - Mécanismes complexes associés ?
  - Biopsies: 4 études avec des myocytes nécrosés et de la fibrose interstitielle en cas de takotsubo
  - Augmentation significative du collagène intramyocardique en cas de Takotsubo notamment si LGE + (Rolf A, EHJ 2009)

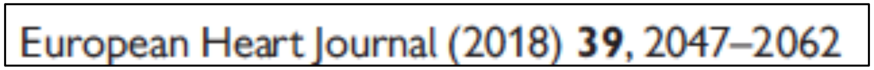
SÉMIOLOGIE IRM

	Séquence ciné	Séquence en T2		Temps tardif	
IDM	Anomalie segmentaire	oedème (surtout si récent)		Réhaussement segmentaire sous endocardique ou transmural	
Myocardite	Anomalie +/- segmentaire	oedème (surtout si récent)		Réhaussement focal ou multiple sous épicardique ou intra mural	
Takotsubo	Hypokinésie apicale supra segmentaire	oedème		Pas de réhaussement en général	

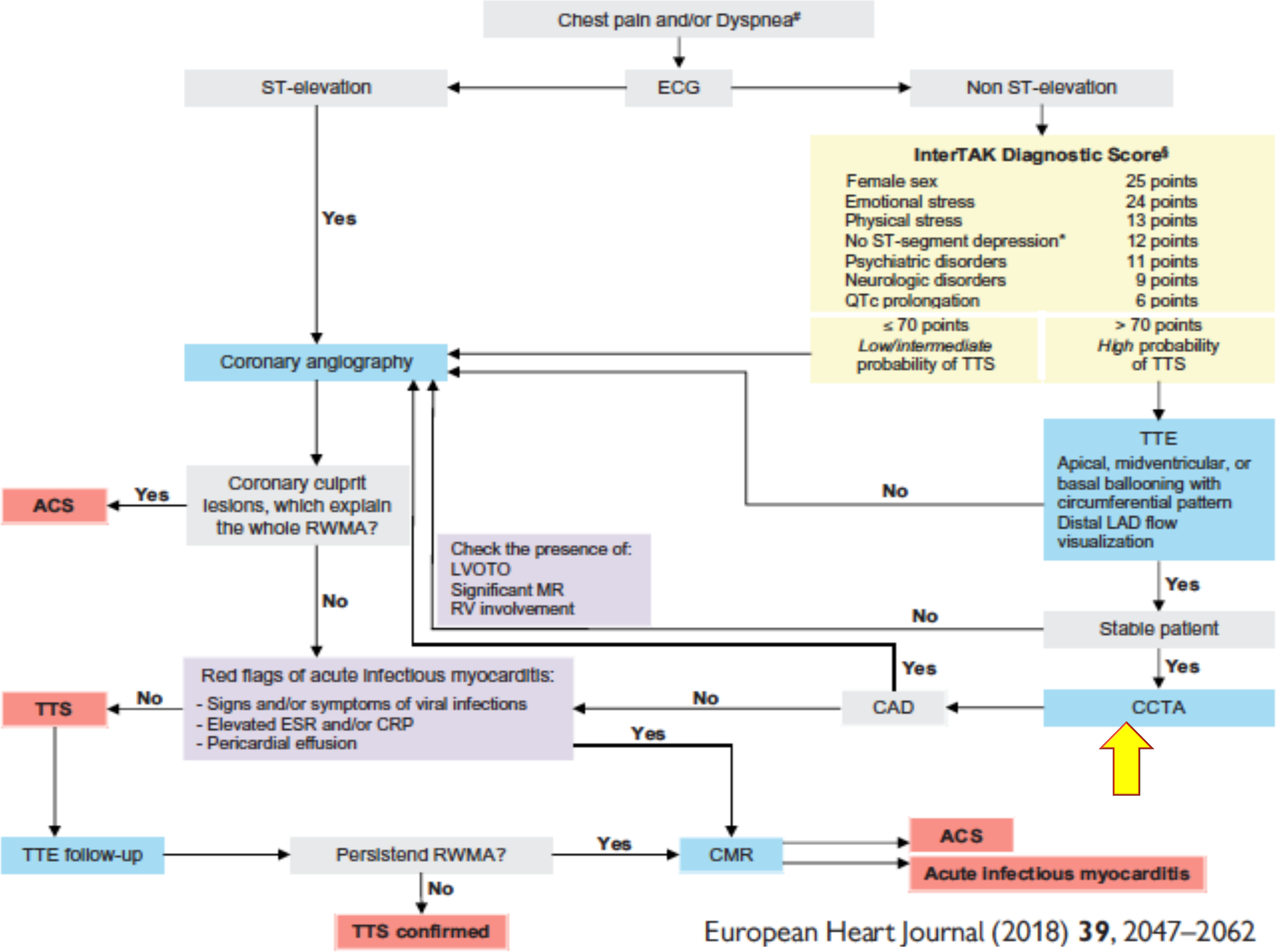
TAKOTSUBO ET SCANNER

- TDM
  - Analyse des coronaires ++
  - Analyse de la cinétique segmentaire en acquisition retrospective si écho non contributive
  - Intérêt si hypoéchogène et CI à l’IRM et pas de ventriculographie
  - **Ne s’adresse qu’aux formes typiques de Takotsubo et aux formes non ST+**

J Am Coll Cardiol 2018;72:1955–71



European Heart Journal (2018) **39**, 2047–2062



Chest pain and/or Dyspnea#

ECG

ST-elevation

Non ST-elevation

InterTAK Diagnostic Score§

Female sex	25 points
Emotional stress	24 points
Physical stress	13 points
No ST-segment depression*	12 points
Psychiatric disorders	11 points
Neurologic disorders	9 points
QTc prolongation	6 points

≤ 70 points
Low/intermediate
probability of TTS

> 70 points
High probability
of TTS

Yes

Coronary angiography

Coronary culprit lesions, which explain the whole RWMA?

Yes

ACS

No

TTE
Apical, midventricular, or basal ballooning with circumferential pattern
Distal LAD flow visualization

No

Yes

Check the presence of:
LVOTO
Significant MR
RV involvement

No

Stable patient

Yes

Yes

Red flags of acute infectious myocarditis:
- Signs and/or symptoms of viral infections
- Elevated ESR and/or CRP
- Pericardial effusion

No

TTS

No

CAD

CCTA

Yes

TTE follow-up

Persistend RWMA?

Yes

CMR

ACS

Acute infectious myocarditis

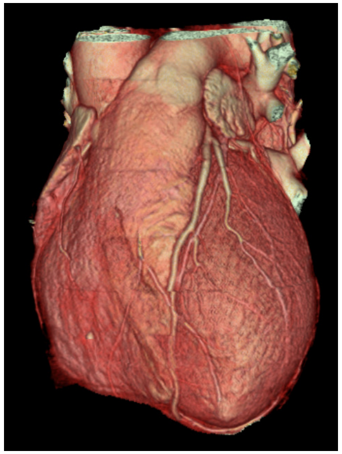
No

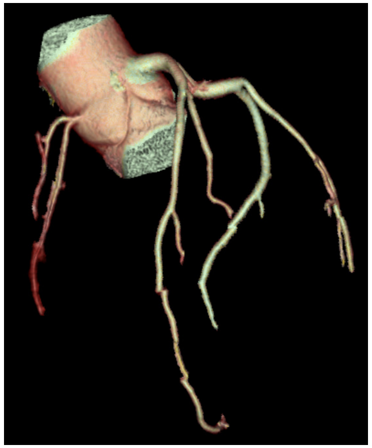
TTS confirmed

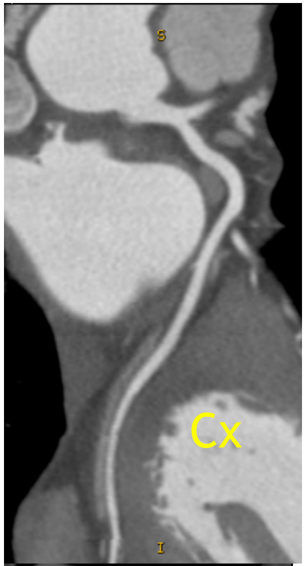
European Heart Journal (2018) **39**, 2047–2062

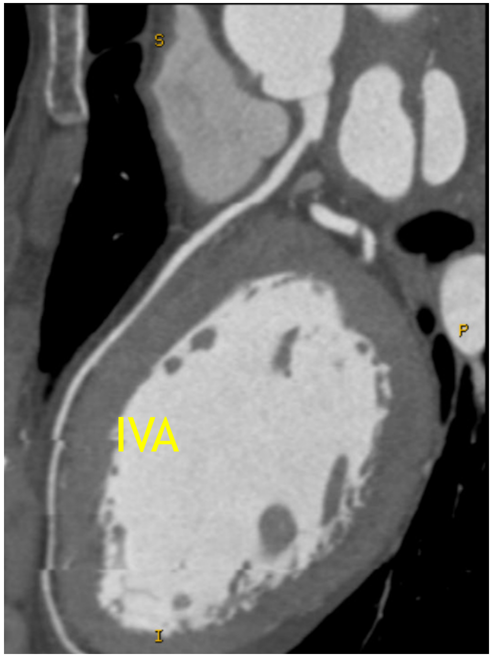
TAKOTSUBO / TDM EXEMPLE 1

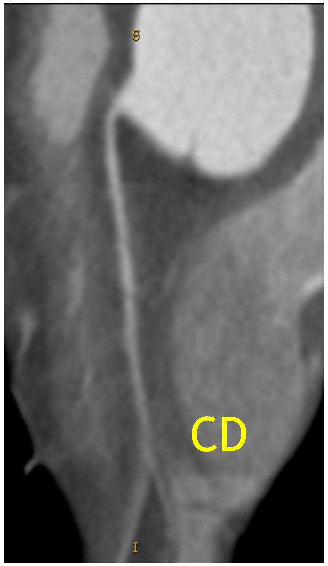
Femme 55 ans douleur thoracique angineuse post stress (anniversaire !!), ondes T négatives en apical, hypokinésie apicale ETT

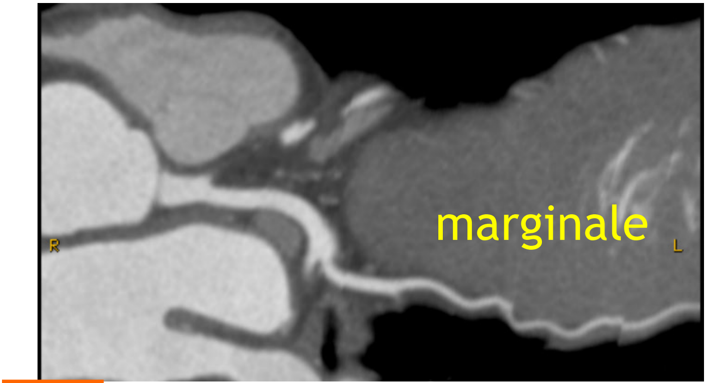


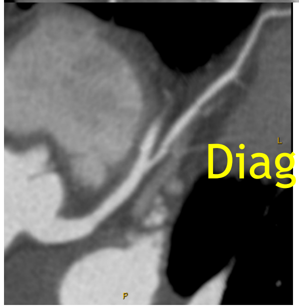




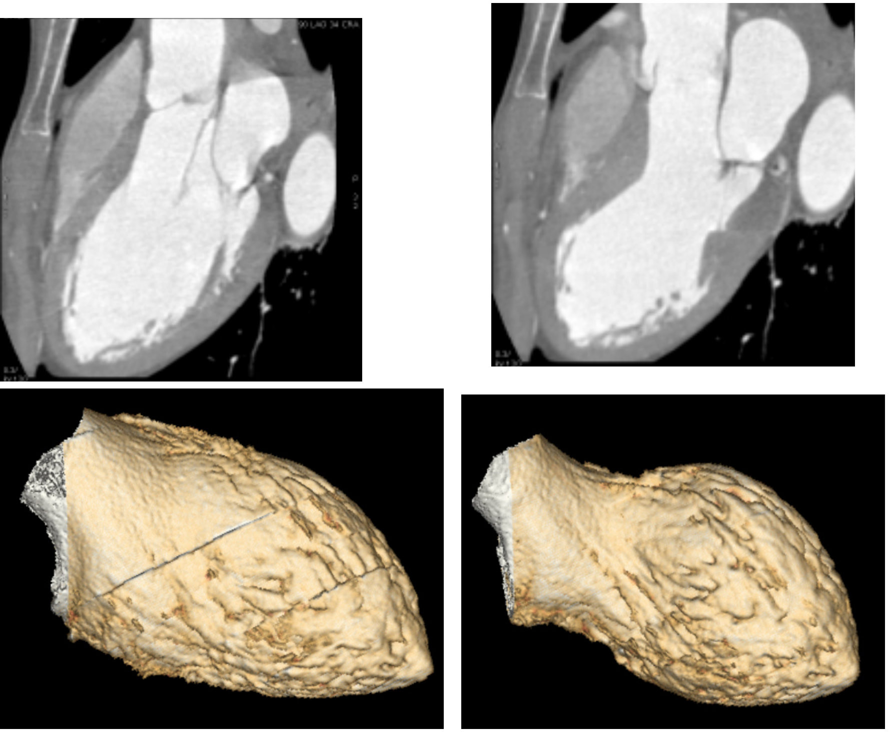





R
marginale
L



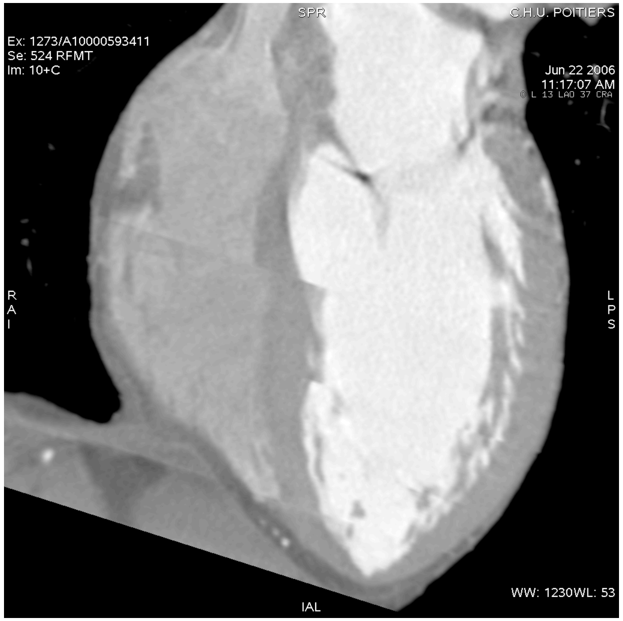
TAKOTSUBO / TDM EXEMPLE 1



Diastole

Systole

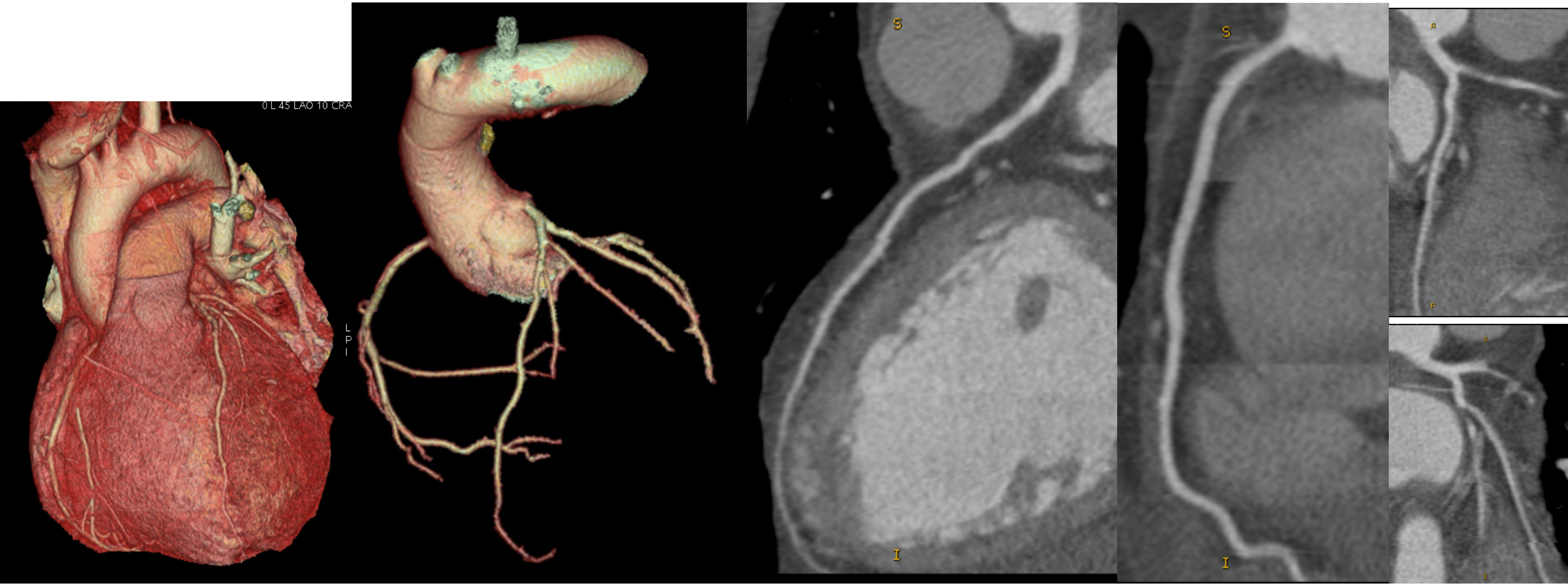
VG diastole 179 ml
VG systole 119 ml
FEVG = 34%


SPR
C.H.U. POITIERS
Ex: 1273/A10000593411
Se: 524 RFMT
Im: 10+C
Jun 22 2006
11:17:07 AM
L 13 LAO 37 CRA
R
A
I
L
P
S
WW: 1230WL: 53
IAL

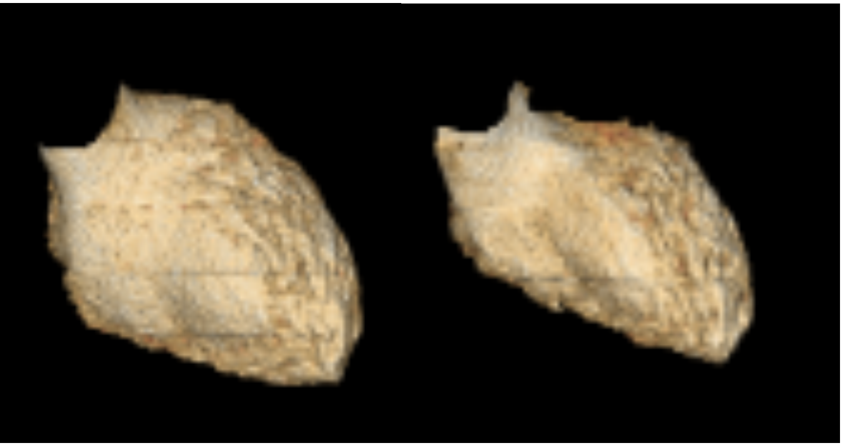
Récupération de la cinétique en 8 jours en faveur d’un Takotsubo

TAKOTSUBO / TDM EXEMPLE 2

Homme 46 ans plaie thoracique antérieure sup G par arme blanche
Hypokinésie anteroapicale, FEVG 38% en ETT

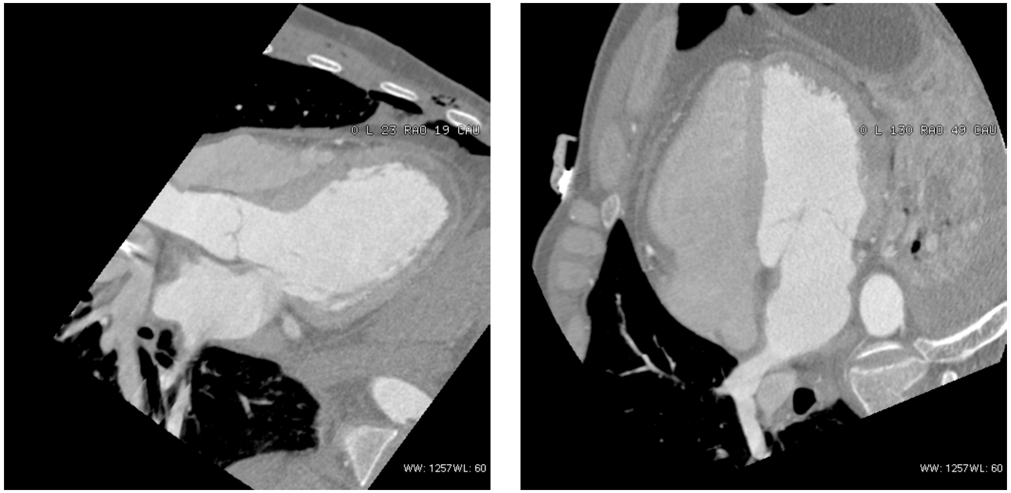

0 L 45 LAO 10 CRA
L
P
I
S
I
S
I
A
P
S
I

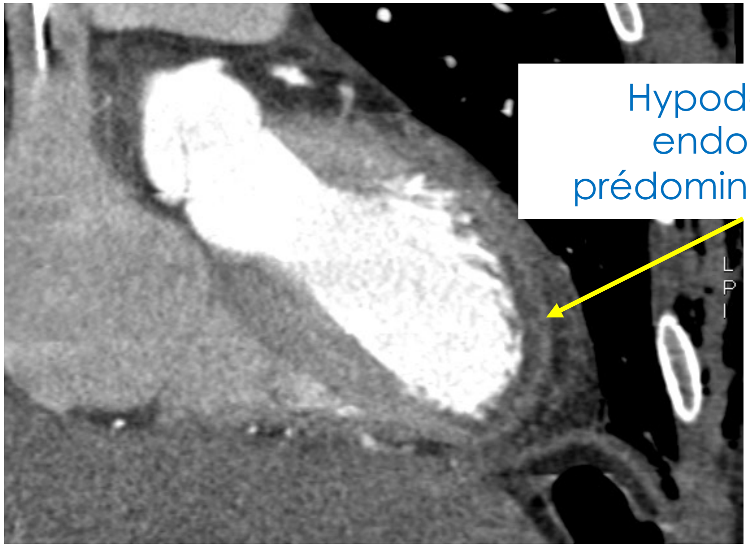
TAKOTSUBO / TDM EXEMPLE 2



Diastole Systole

FEVG = 36%

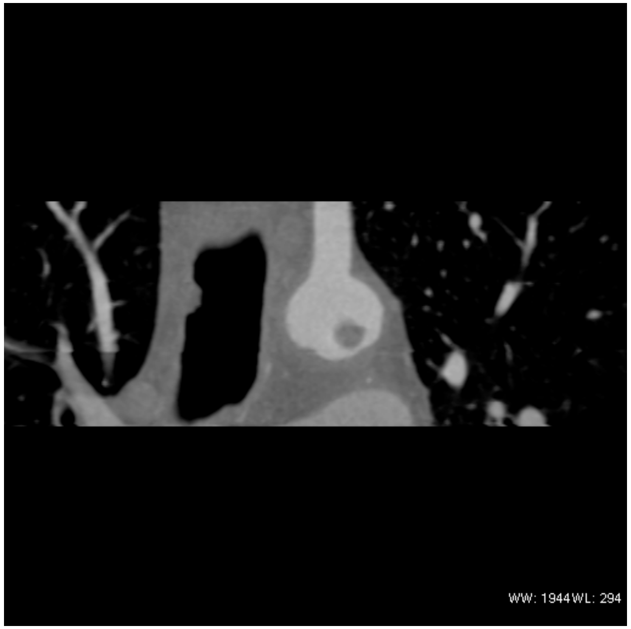

0 L 23 RAO 19 CAU
WW: 1257WL: 60
0 L 130 RAO 49 CAU
WW: 1257WL: 60

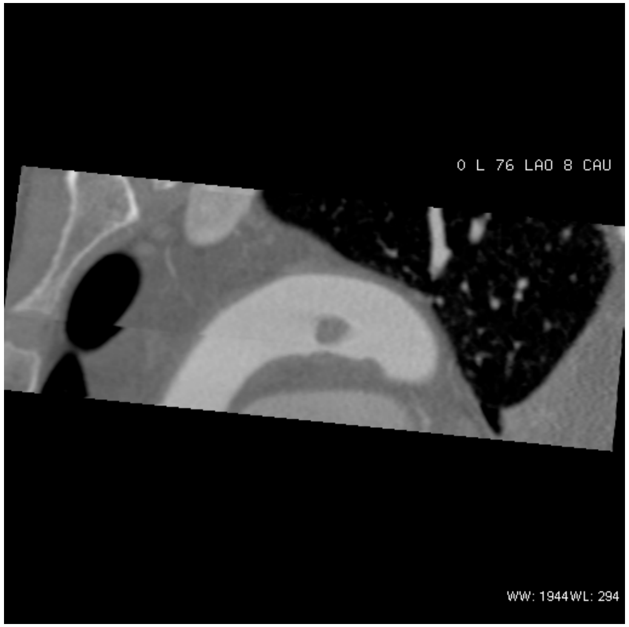


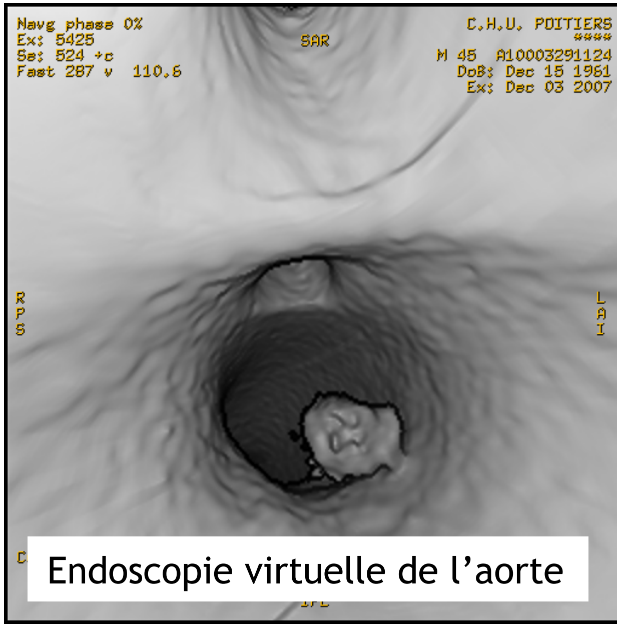
Hypodensité sous endocardique prédominant en systole

TAKOTSUBO / TDM EXEMPLE 2

Plaie de la crosse aortique par arme blanche
avec thrombus ou déchirure intimale


WW: 1944 WL: 294


0 L 76 LAO 8 CAU
WW: 1944 WL: 294


Navg phase 0%
Ex: 5425
Se: 524 +c
Fast 287 v 110.6
SAR
C.H.U. POITIERS
####
M 45 A10003291124
DoB: Dec 15 1961
Ex: Dec 03 2007
R
P
S
L
A
I
C

Endoscopie virtuelle de l'aorte

Récupération de la cinétique VG en 15 jours
après traitement chirurgical de la lésion aortique

POINTS CLÉS

- Fréquent. Terrain + circonstances évocatrices
- Complications et récurrences fréquentes
- Echo en 1ere intention: anomalie de cinétique évocatrice.
- Évaluation des coronaires nécessaire (coronaro si ST+)
- Possibilité de TDM pour vérifier l’ absence de sténose coronaire si tableau évocateur et patient stable (non ST+)
- IRM pour Dc différentiel avec Myocardite
- Pas de réhaussement tardif ou minime et n’expliquant pas l’anomalie de cinétique initiale