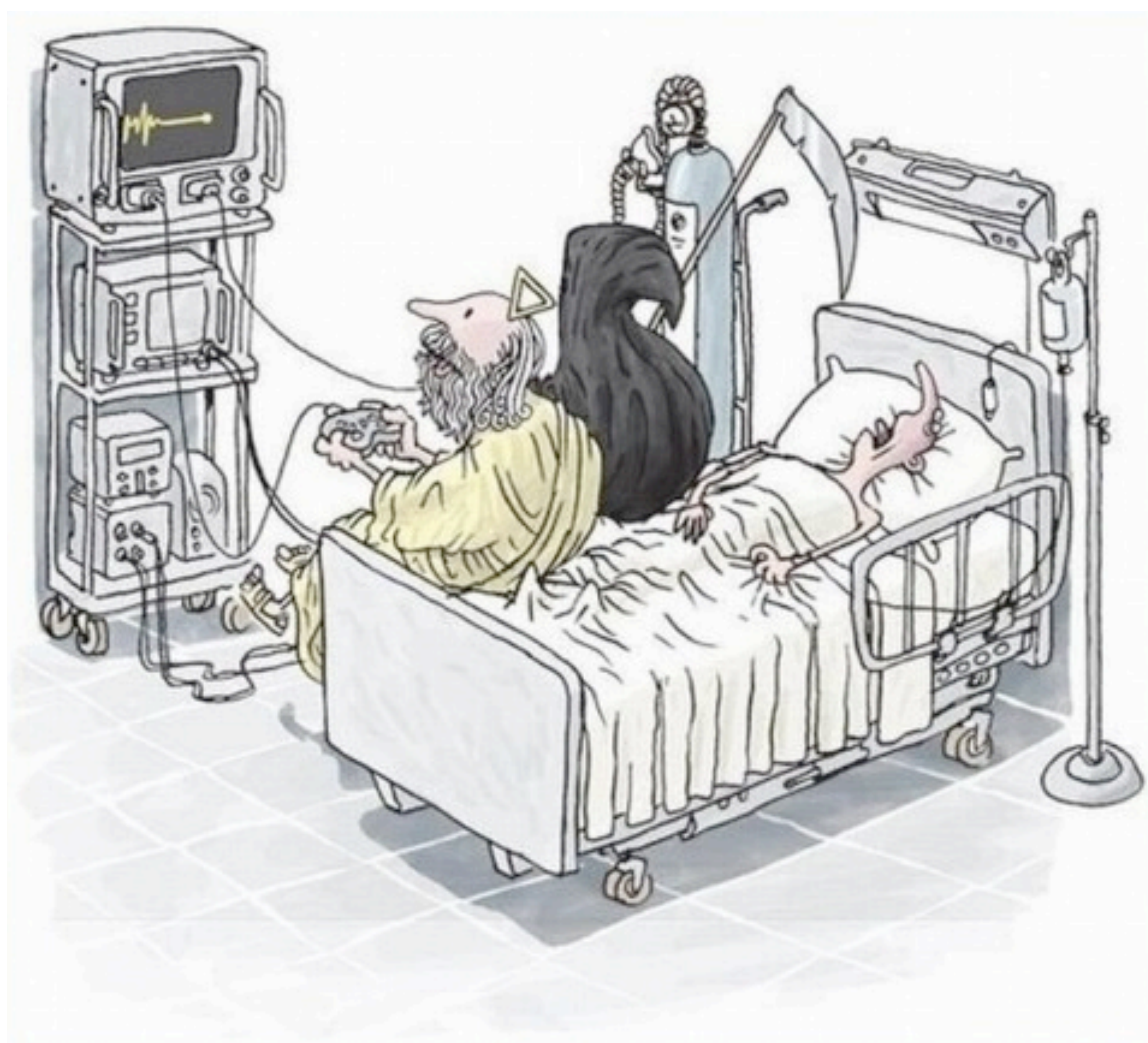




Epuration extra-rénale aux soins intensifs

Indications, méthodes et complications

Dr Vincent Bourquin - service de néphrologie - <http://nephrohug.com>



**La dialyse aux soins
intensifs est-elle
fréquente ?**

Acute Renal Failure in Critically Ill Patients: A multinational, Multicenter Study

“In this multinational study the period prevalence of ARF requiring RRT in the ICU was between 5% and 6% and was associated with high hospital mortality.”

29'269 critically ill patients

Source: Uchino et coll. JAMA 2005

“The **mortality rate** in subjects without renal failure was 7% compared with 34% in the corresponding subjects with renal failure. Renal failure appears to increase the risk of developing **severe nonrenal complications** that lead to death and should not be regarded as a treatable complication of serious illness.”

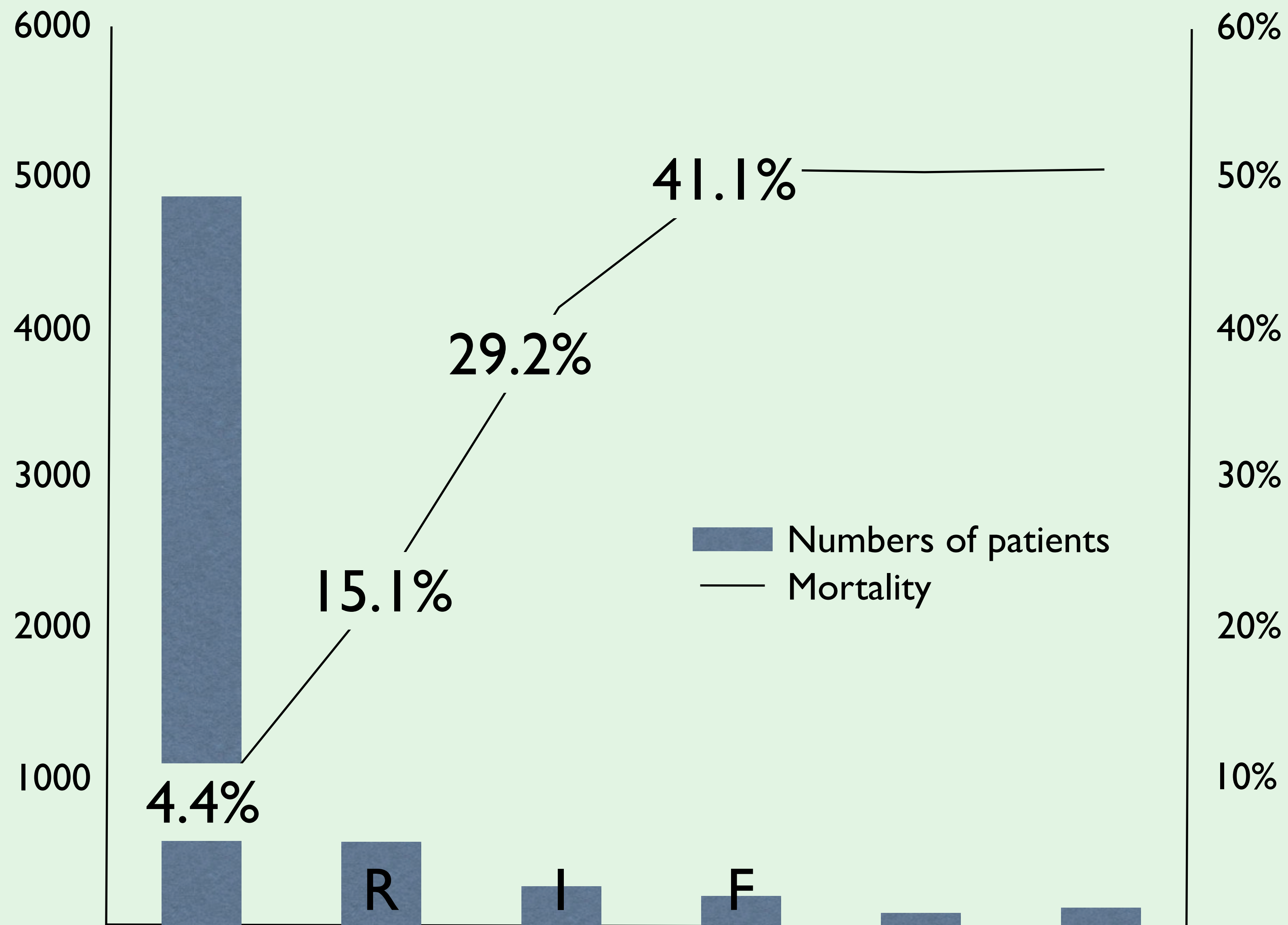
16'248 inpatients undergoing radiocontrast procedures

Source: Uchino et coll. JAMA 2005

Metabolic	Cardiovascular	Gastrointestinal	Neurologic	Hematologic	Infectious
Hyperkalemia	Pulmonary edema	Nausea	Neuromuscular	Anemia	Pneumonia
Metabolic acidosis	Arrhythmias	Vomiting	Irritability	Bleeding	Wound infections
Hyponatremia	Pericarditis	Malnutrition	Asterixis		Intravenous line infections
Hypocalcemia	Pericardial effusion	Gastritis	Seizures		Septicemia
Hyperphosphatemia	Hypertension	Gastrointestinal ulcers	Mental status changes		Urinary tract infection
Hypermagnesemia	Myocardial infarction	Gastrointestinal bleeding	Somnolence		
Hyperuricemia	Pulmonary embolism	Stomatitis or gingivitis	Coma		
	Pneumonitis	Parotitis or pancreatitis			

Complications of ARF

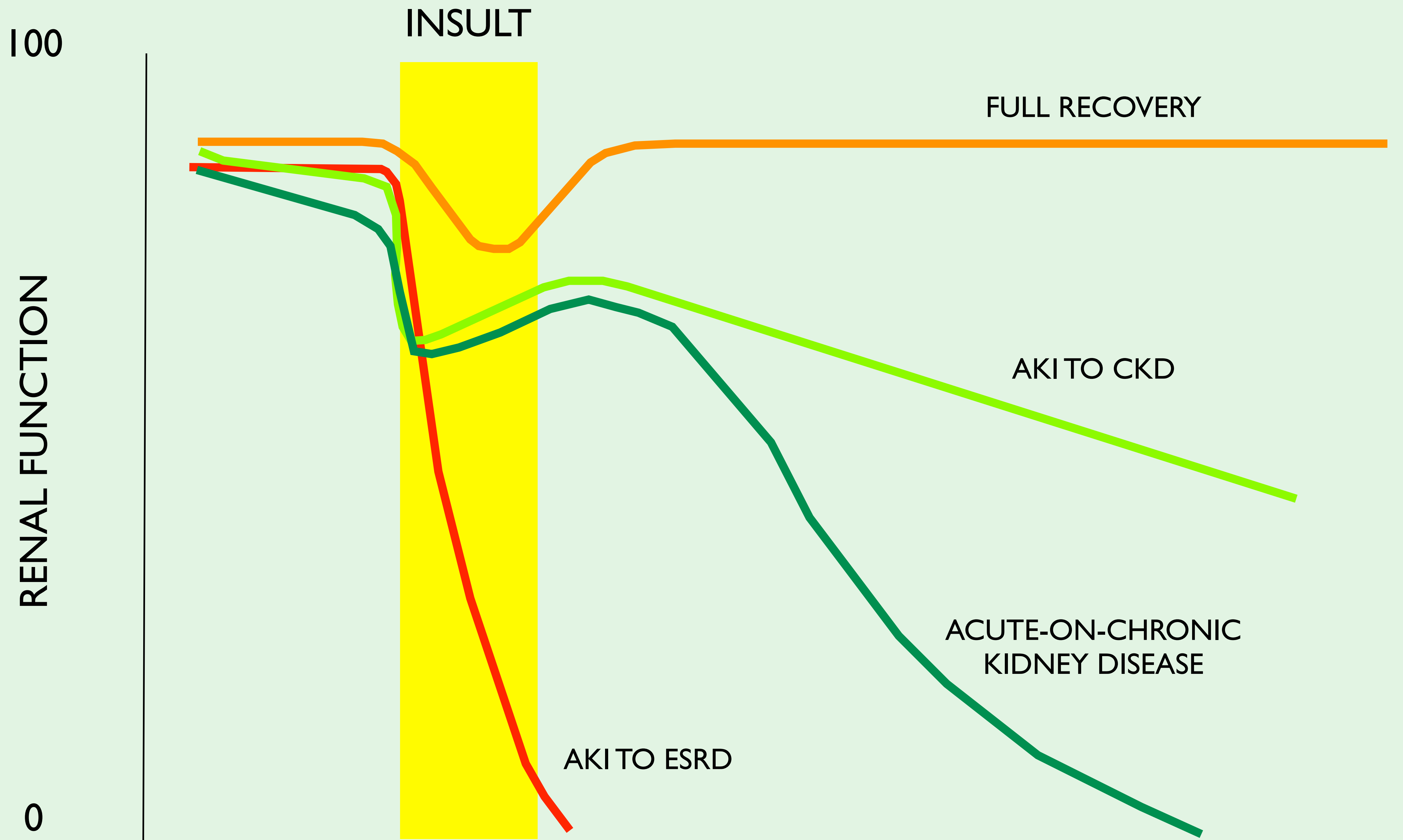
Source: Uchino et coll. JAMA 2005



20'126 patients, 14.7% required ICU admission

Source: Uchino et coll. Crit Care Med 2006

**Est-ce grave d'être
dialysé aux soins
intensifs ?**



“AKI carries implication for long-term renal function (RF) even in patients without pre-existing renal dysfunction. Ageing, co-morbidities and RF at discharge are determinants of the long-term functional outcome.”

187 patients surviving AKI retrospectively reviewed for 10 years

Source: Ponte et coll. Nephrology Dialysis Transplantation 2008

**Comment protéger la
fonction rénale aux soins
intensifs ?**

Auriculin Anaritide Acute Renal Failure Study Group

“The administration of anaritide did not improve the overall rate of dialysis-free survival in critically ill patients with acute tubular necrosis.

However, anaritide may improve dialysis-free survival in patients with oliguria and may worsen it in patients without oliguria who have acute tubular necrosis.”

504 critically ill patients with ATN

Source: Allgren et coll. N Engl J Med 1997

Australian and New Zealand Intensive Care Society (ANZICS) Clinical Trials Group

“Administration of low-dose dopamine by continual intravenous infusion to critically ill patients at risk of renal failure does not confer clinically significant protection from renal dysfunction.”

328 patients admitted to 23 ICUs

Source: Bellomo et coll. Lancet 2000

Fenoldopam mesylate in early acute tubular necrosis: a double-blind, placebo-controlled RCT.

“Fenoldopam does not reduce the incidence of death or dialysis therapy in intensive care unit patients with early ATN.”

155 patients with early ATN

Source: Tumlin et coll. Am J Kidney Dis 2005

High-Dose Flurosemide in Acute Renal Failure Study Group

“High-dose furosemide helps maintain urinary output, but does not have an impact on the survival and renal recovery rate of patients with established ARF.”

338 patients with ARF requiring dialysis therapy

Source: Cantarovich et coll. Am J Kidney Dis 2004

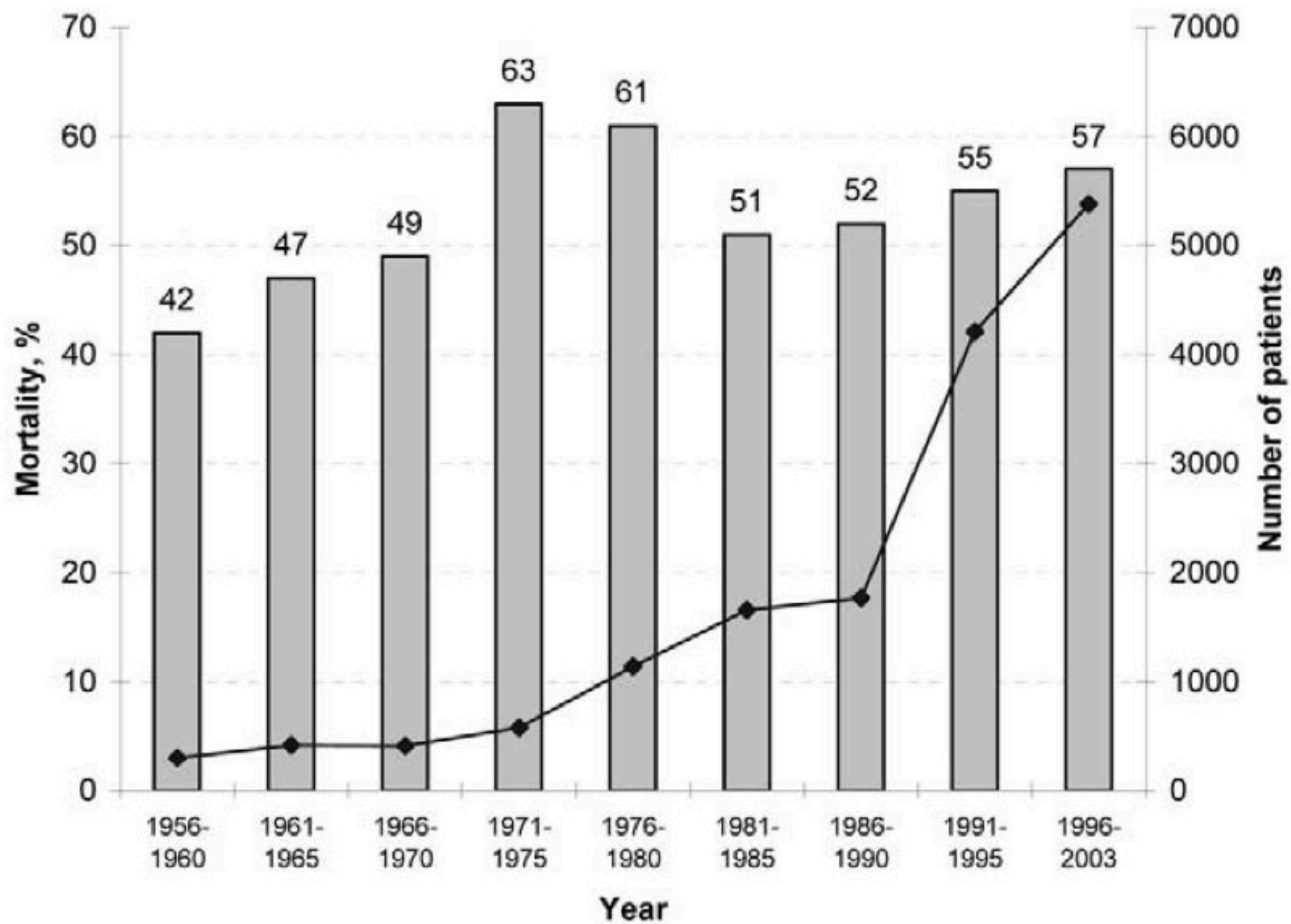
**Est-ce que la mortalité
liée à l'IRA a diminué ?**

Has mortality from acute renal failure decreased? A systematic review of the literature.

“Despite technical progress in the management of acute renal failure over the last 50 years, mortality rates seem to have remained unchanged at around 50%.”

Review of 80 articles

Source: Ympa et coll. Am J Med 2005



Source: Ympa et coll. Am J Med 2005

Pourtant !

“Among patients hospitalized with AKI, **weekend admission is associated with a higher risk for death compared with admission on a weekday.** The risk for death with admission on a weekend for AKI was more pronounced in smaller hospitals.”

963'730 admissions with a diagnosis of AKI

Source: James et coll. J Am Soc Nephrol 2010

“Despite the lack of evidence based success, good care makes a differences. We just don’t know what that “good care” looks like.”

Source: www.pbfluids.com

“Without evidence we are left to wander with only our clinical sense to guide us: avoid hypotension, maintain urine flow, avoid renal toxins, maintain electrolyte balance and maintain fluid balance.”

Source: www.pbfluids.com

Quand faut-il dialyser ?

Acidose métabolique (pH < 7.0)

A

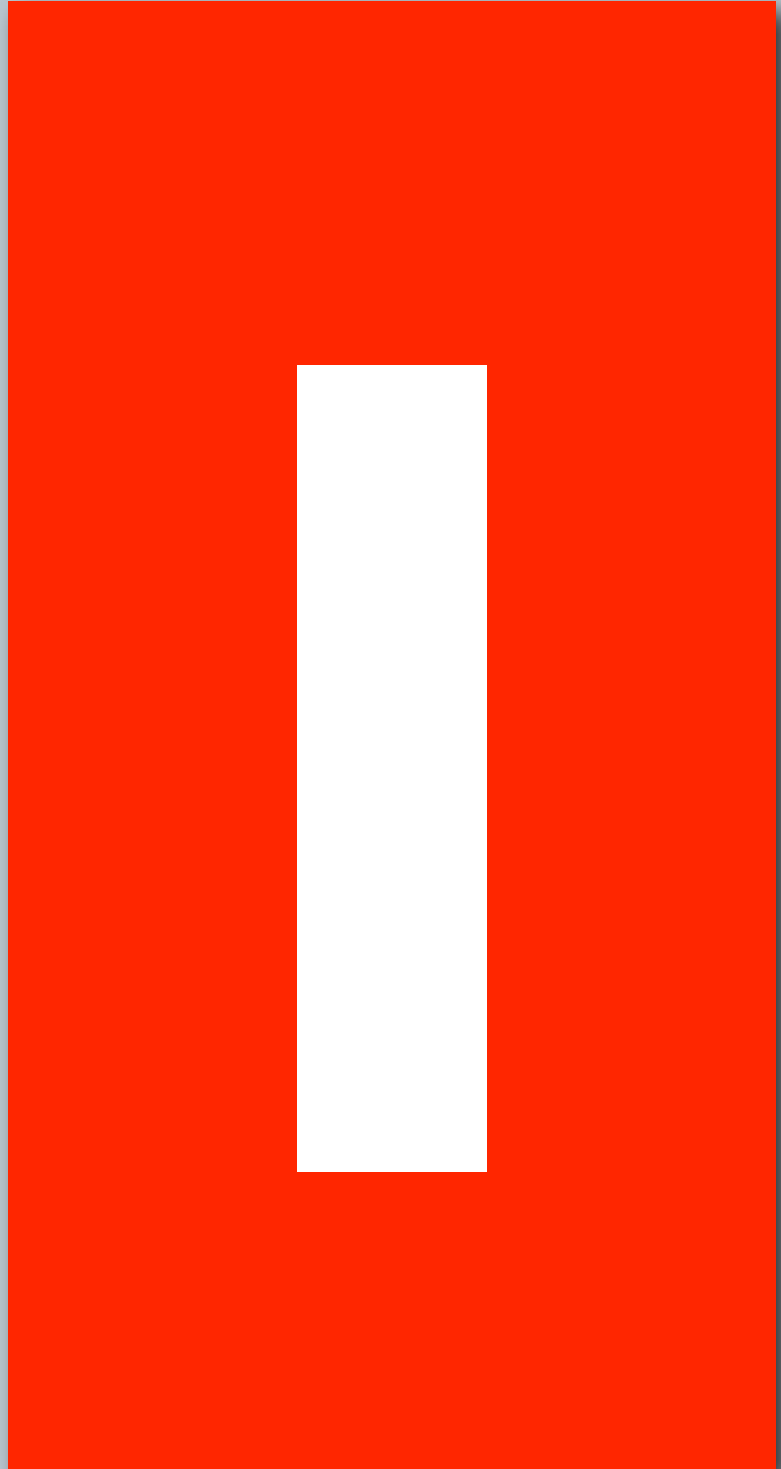
CID-BASE

Hyperkaliémie ($K^+ > 6.5 \text{ mmol/l}$)
Dysnatrémie sévère

E

LECTROLYTES

Toxine(s) dialysable(s)



INTOXICATIONS

SURCHARGE VOLEMIQUE

Oedème pulmonaire

Oligurie (< 200 ml sur 12h)

Anurie (< 50 ml sur 12h)

A large, bold, white capital letter 'O' is centered within a solid red rectangular background.

VERLOAD

Urémie (nausées, prurit, asthénie)

Neuropathie, myopathie

Encéphalopathie

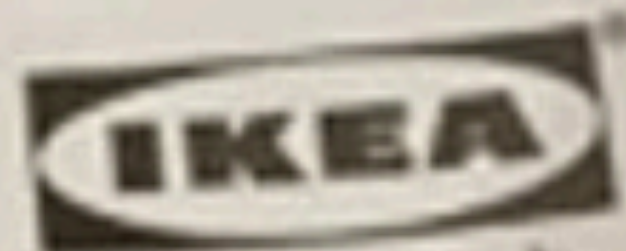
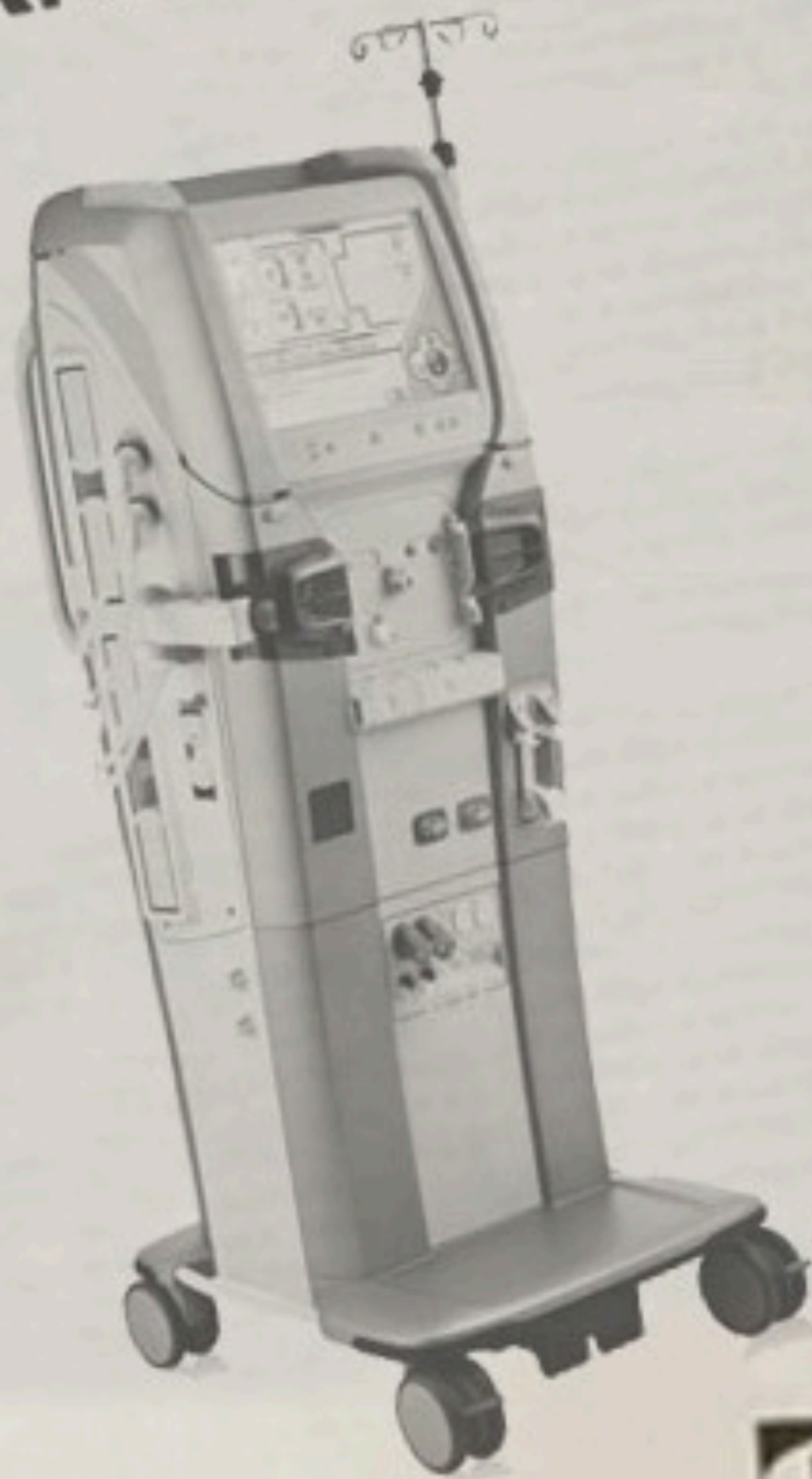
Péricardite

A large, bold, white capital letter 'U' is centered within a solid red rectangular background.

REMIE

**Comment dialyser aux
soins intensifs ?**

 **GAMBRO**



Design and Quality
IKEA of Sweden

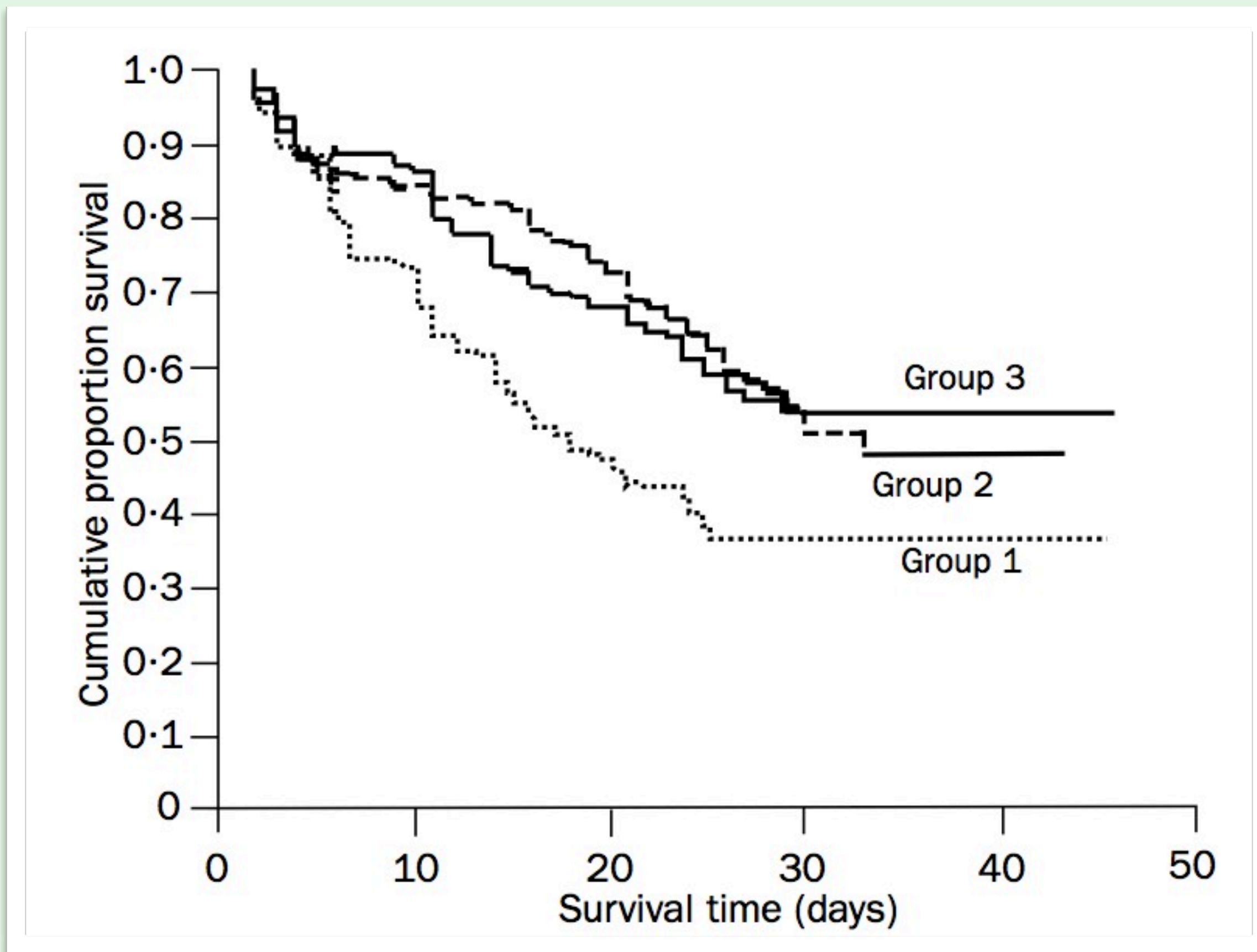
Daily hemodialysis and the outcome of acute renal failure

“Daily hemodialysis resulted in better control of uremia, fewer hypotensive episodes during hemodialysis, and more rapid resolution of acute renal failure than did conventional hemodialysis.”

160 patients with ARF daily or conventional intermittent HD

Source: Schiffl et coll. N Engl J Med 2002

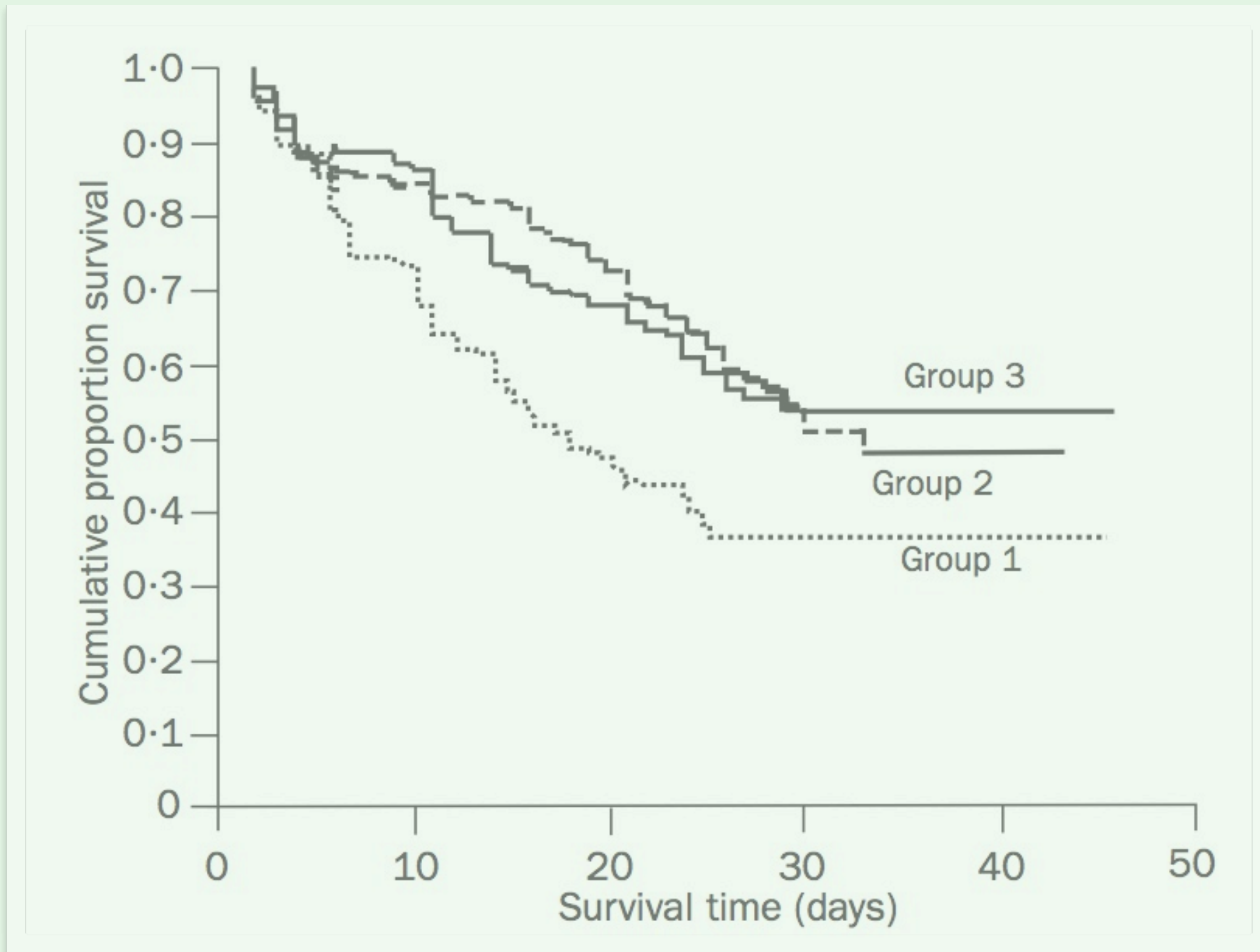
Effects of different doses in CVVH on outcomes of ARF: a prospective randomised trial



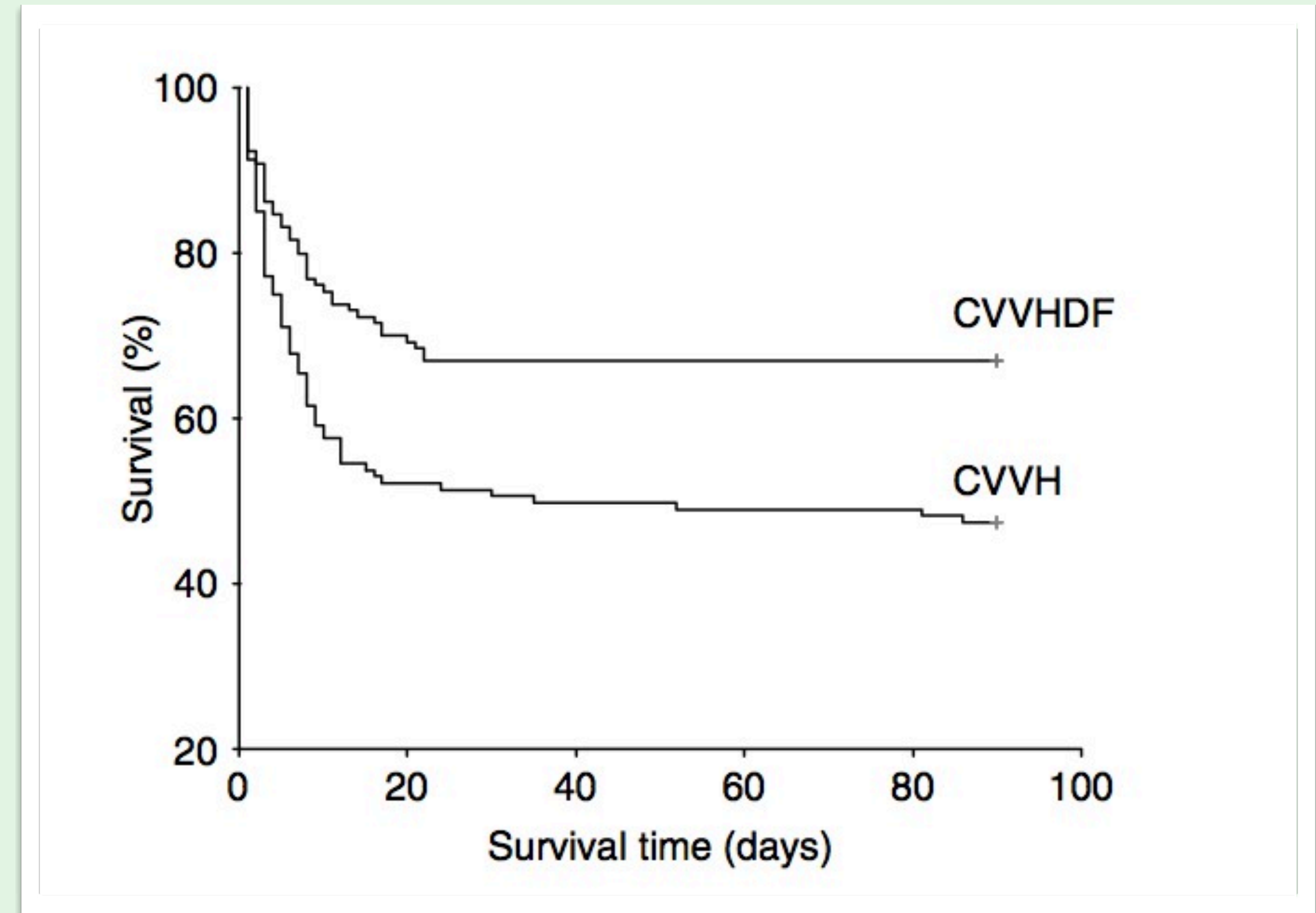
20 vs 35 vs 45 ml/kg/h

Source: Ronco et coll Lancet 2000

Adding a dialysis dose to continuous hemofiltration increases survival in patients with ARF



20 vs 35 vs 45 ml/kg/h



25 vs 42 ml/kg/h

Source: Saudan et coll. Kidney Int 2006

Randomized controlled trials comparing CRRT dose in the ICU

Study	Type	n	Comparison	Mortality	Mortality end point	Comment
RENAL (2009)	Multicenter RCT	1'508	40 ml/kg per h vs 25 ml/l per h post-dilution CVVHDF	45% vs 45% (P = ns)	Day 90	-
ATN (2008)	Multicenter RCT	1'124	35 ml/kg per h vs 20 ml/kg per h pre-dilution CVVHDF	54% vs 52% (P = ns)	Day 60	CRRT/SLEDD vs IHD
Tolwani et al. (2008)	Single center RCT	200	20 ml/kg per h vs 35 ml/kg per h pre-dilution CVVHDF	56% vs 49% (P = ns)	ICU discharge or day 30	-
Saudan et al. (2006)	Single center RCT	204	CVVHF (1-2.5 l/h) vs CVVHDF (1-2.5 l/h HF + 1-1.5 l/h HD)	59% vs 39% (P = 0.0005)	Day 28	Addition of HD to HF (as HDF vs HF alone)
Bouman et al. (2002)	Two-center RCT	106	CVVHF 72-96 l per day early vs 24-36 l per day early vs late	26% vs 31% (P = ns) vs 25% (P = ns)	Day 30	Combined trial of dose and timing
Ronco et al. (2000)	Single center RCT	425	20 ml/kg per h vs 35 ml/kg per h vs 45 ml/kg per h post-dilution CVVHF	41% vs 57% vs 58% (P < 0.02 for 20 vs 35 and 45)	Day 15	Unorthodox mortality outcome

Source: Prowle et al. Nat. Rev. Nephrol 2010

CRRT dose

A resolve issue in favor of conventional dosing (target effluent flow rate **20-25 ml/kg per h**)

CRRT versus IHD

Consensus in favor of CRRT in hemodynamically unstable critically ill patients, but without formal evidence

Timing of CRRT

Unresolved issue that requires further research

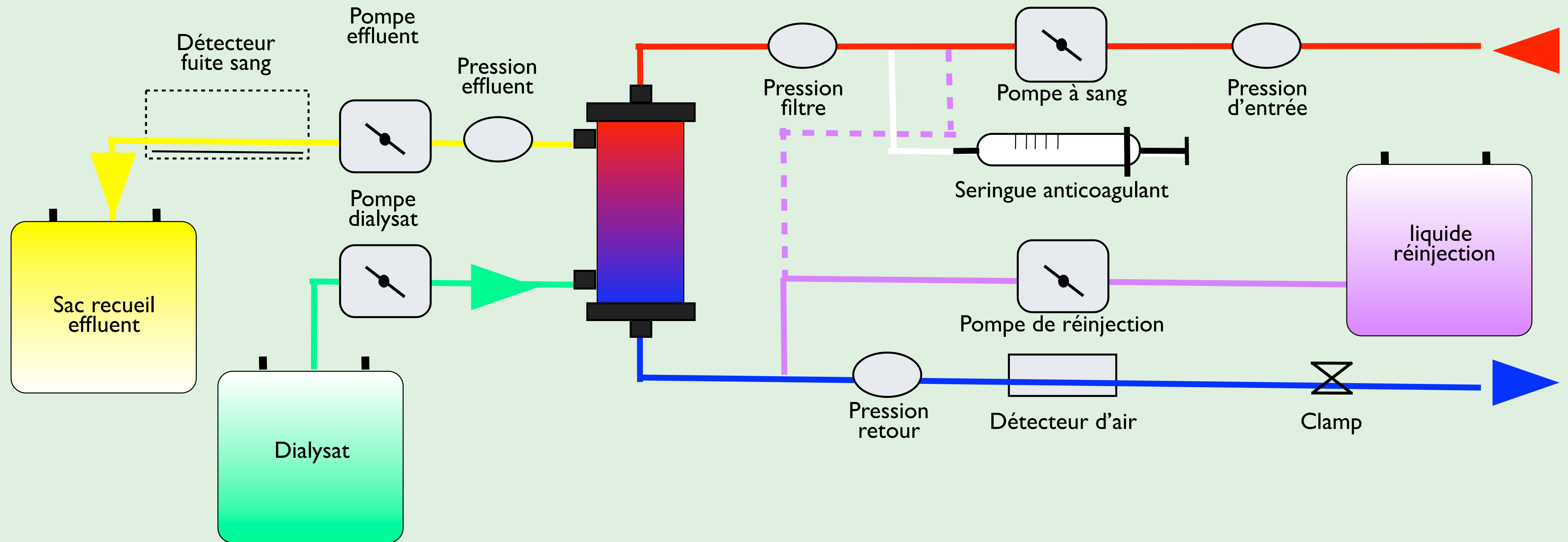
CRRT outcomes

Unresolved issue; studies to date may have been tooo focused on mortality over renal recovery and other patient-centred outcomes

CRRT modality

Unresolved issue - CRRT modalities might be equivalent

Source: Prowle et al. Nat. Rev. Nephrol 2010





Liquide de substitution

Hémosol®

Na^+ 140 mmol/l

Ca^{2+} 1.75 mmol/l

Mg^{2+} 0.5 mmol/l

Cl^- 109.5 mmol/l

lactate $^-$ 3 mmol/l

HCO_3^- 32 mmol/l



pauvre en lactate, sans potassium

“The degree of correction of acidosis during hemofiltration was determined by patient outcome in patients treated with **lactate- and bicarbonate-based buffer solutions**, but not in patients receiving acetate-buffered solution.”

132 critically ill patients with ARF and CVVH

Source: Heering et coll. Intensive Care Med 1999

“Continuous venovenous hemofiltration with dialysis **cannot mask lactate overproduction**, and its blood concentration remains a reliable marker of tissue oxygenation in patients receiving this renal replacement technique.”

Filter lactate clearance accounted for < 3%

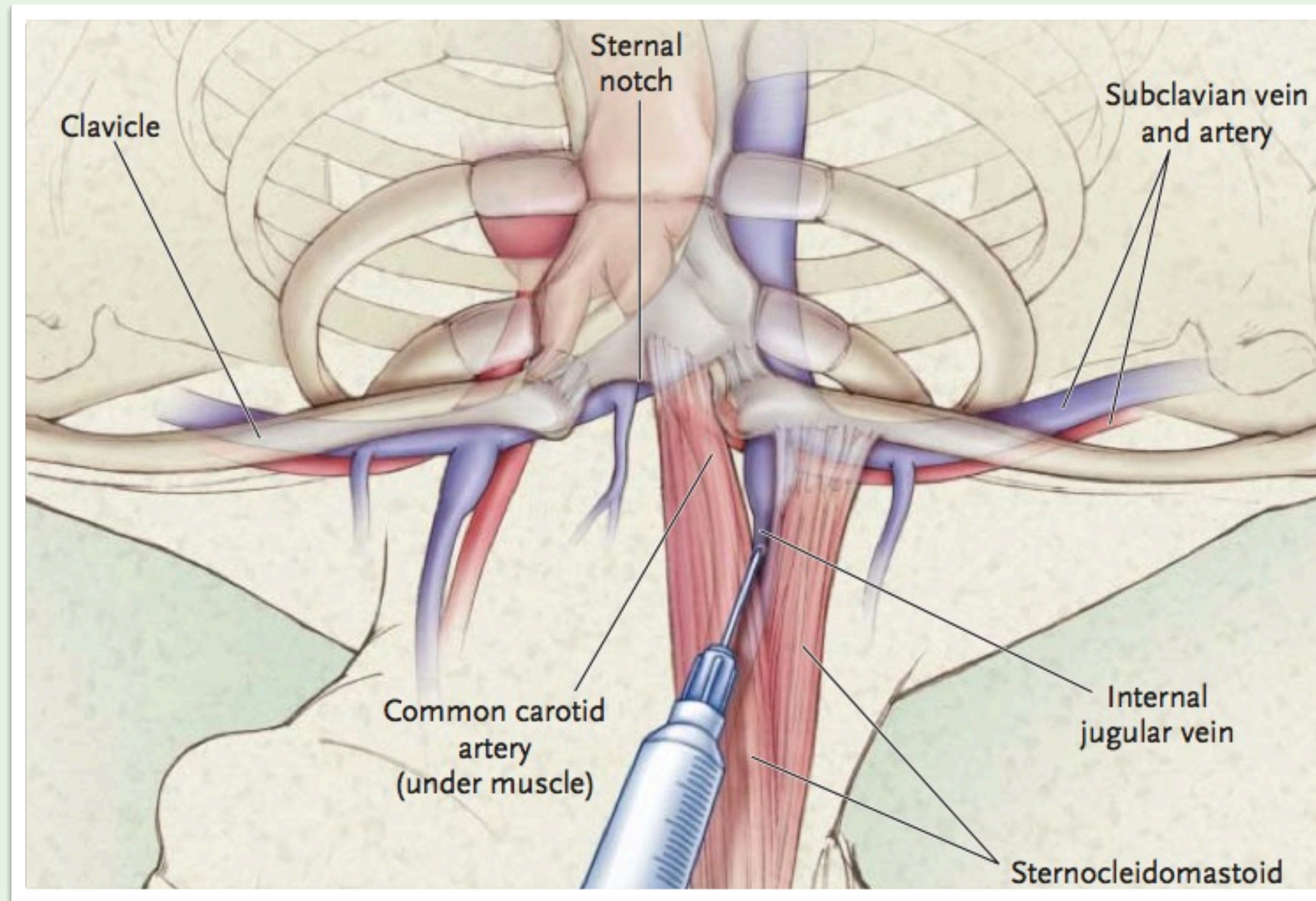
Source: Levraut et coll. Crit Care Med 1997

“Bicarbonate fluids led to a more rapid fall in lactate and greater improvement in base excess during CRRT, but not overall control of acidosis.”

Source: Agarwal et coll. Nephron Clin Pract 2011

Accès

Mise en place cathéter

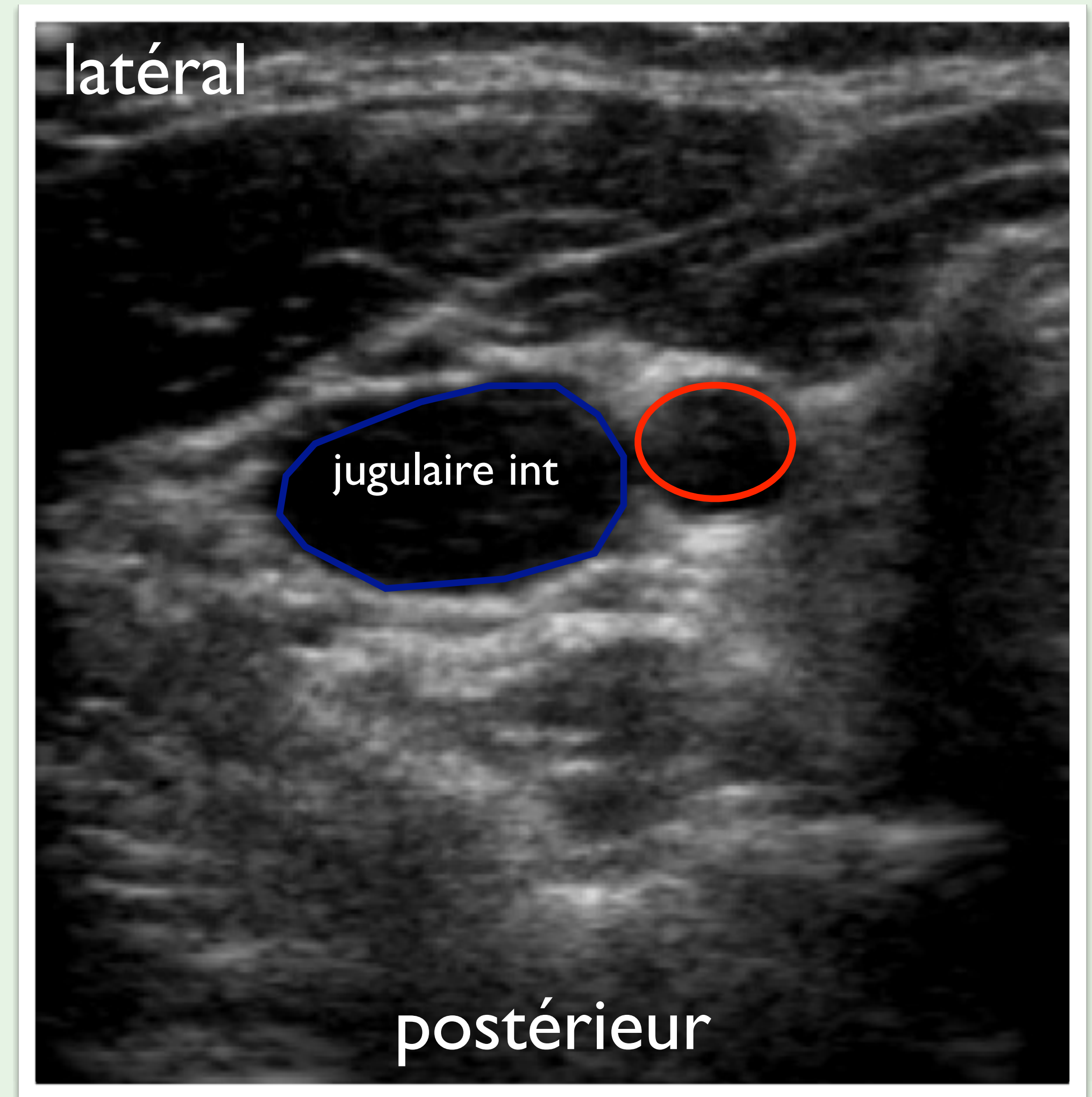
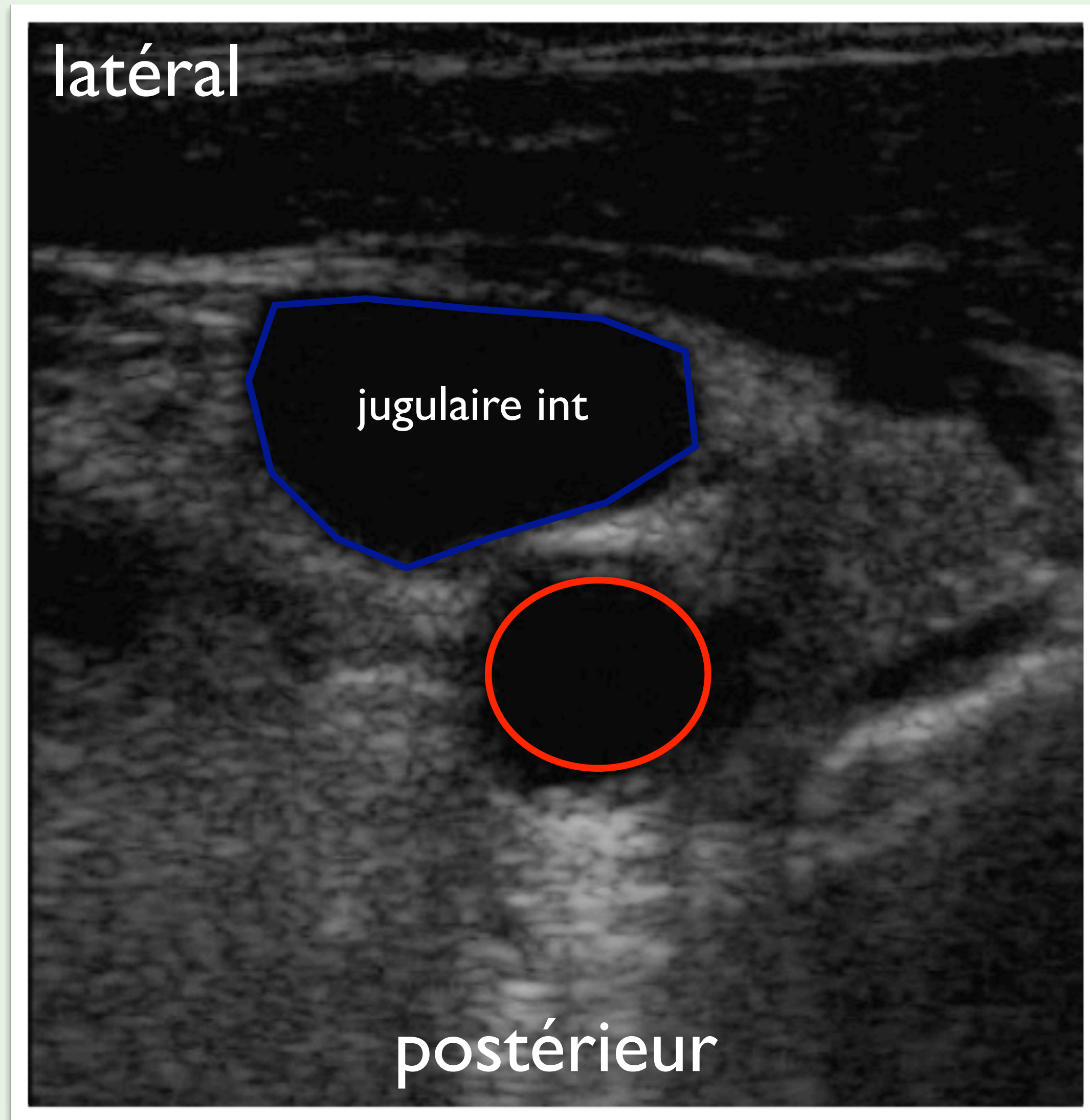


Complications ponctions à “l’aveugle”



	Jugulaire interne	Sous-Clavière	Fémoral
Ponction artérielle	6.3-9.4	3.1-4.9	9-15
Pneumo-thorax	< 0.1-0.2	1.5-3.1	NA
Hématome	< 0.1-2.2	1.5-3.1	NA
Total	6.3-11.8	6.2-10.7	12.8-19.4

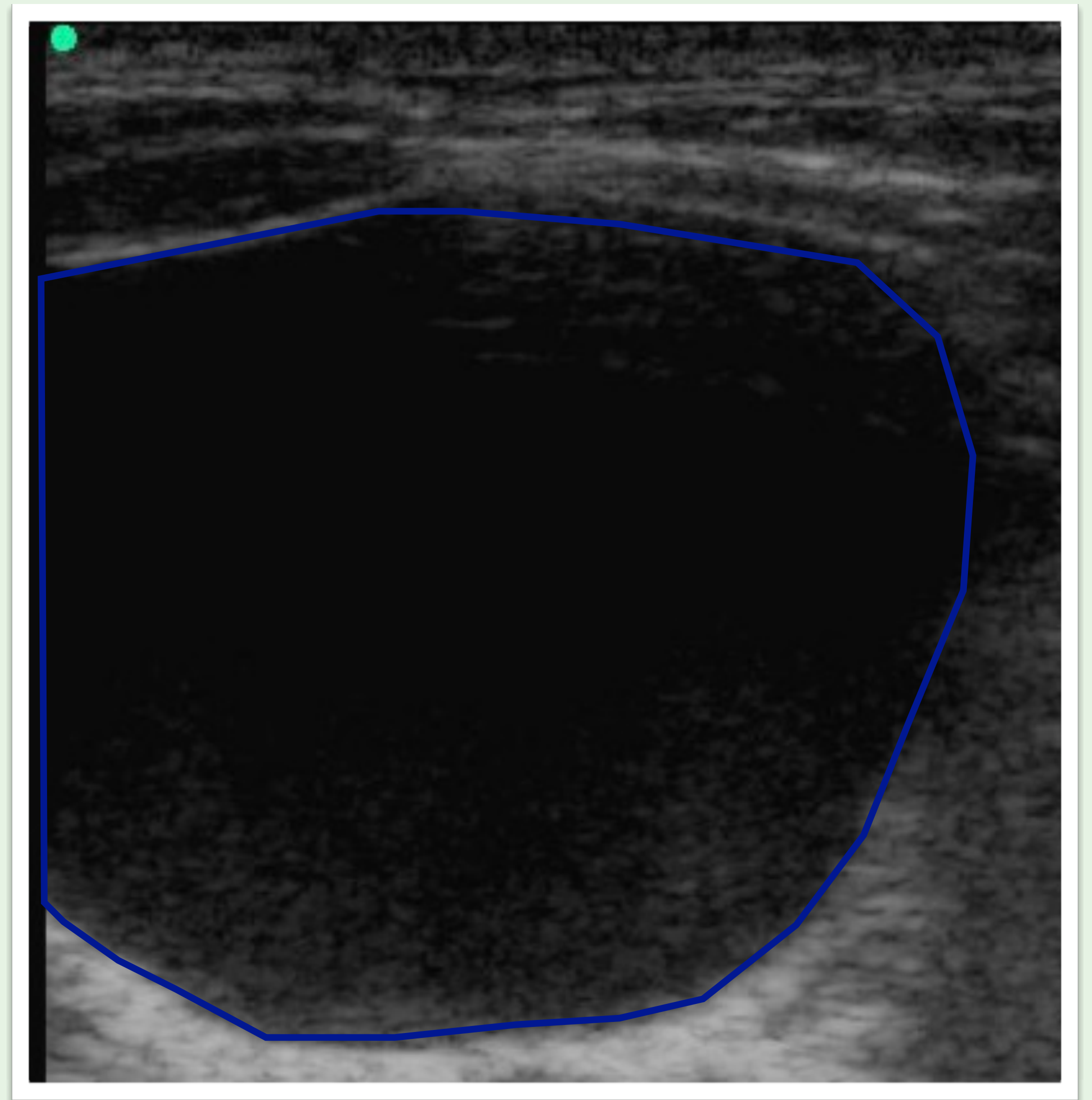
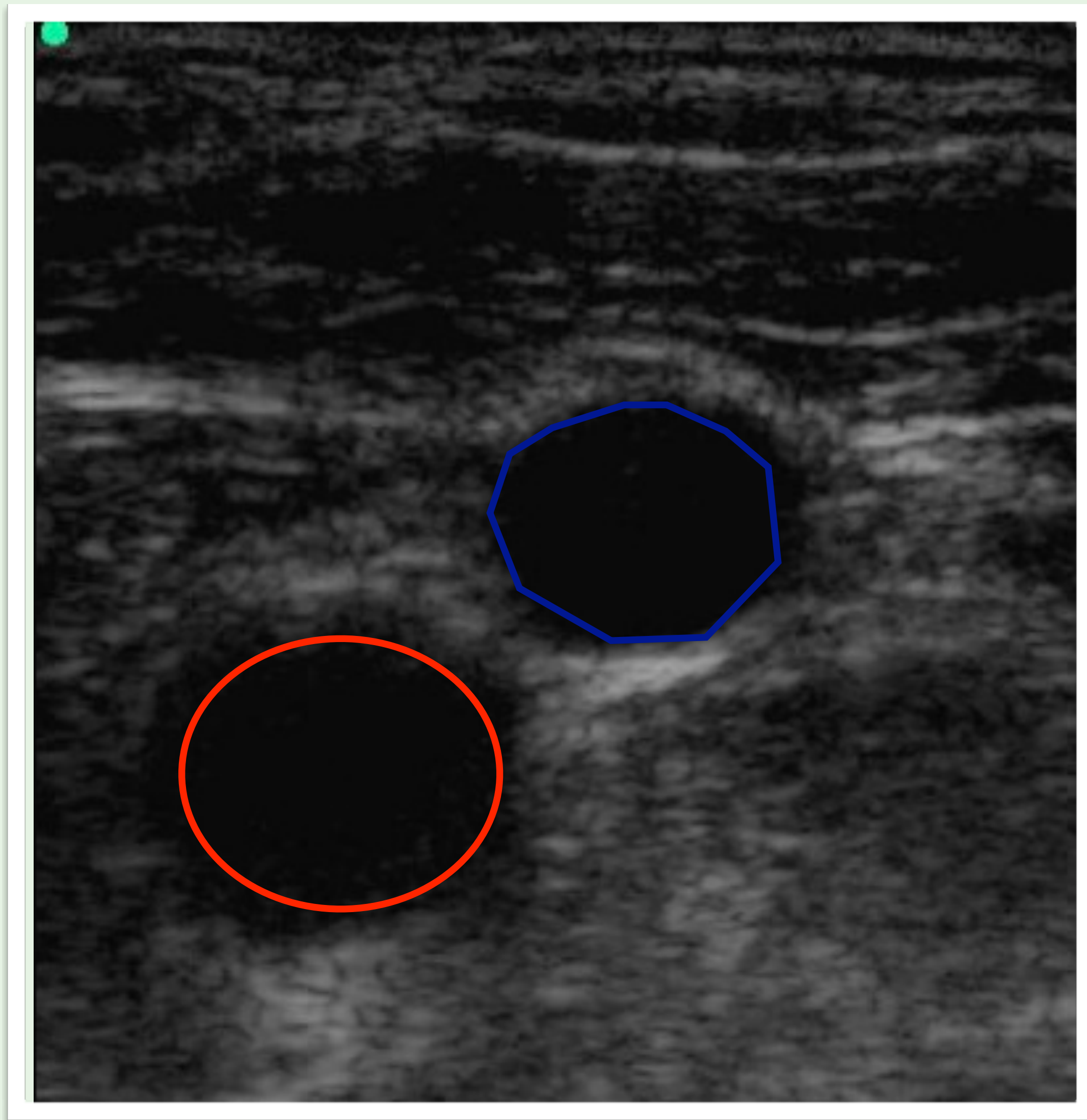
Variante au niveau jugulaire interne



Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

En utilisant une échographie avec onde veculaire (E-10 MHz) on peut faire la différence entre l'artère (pulatile et incompressible) et la veine (compressible, pulatile et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.

Calibre de la veine



Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

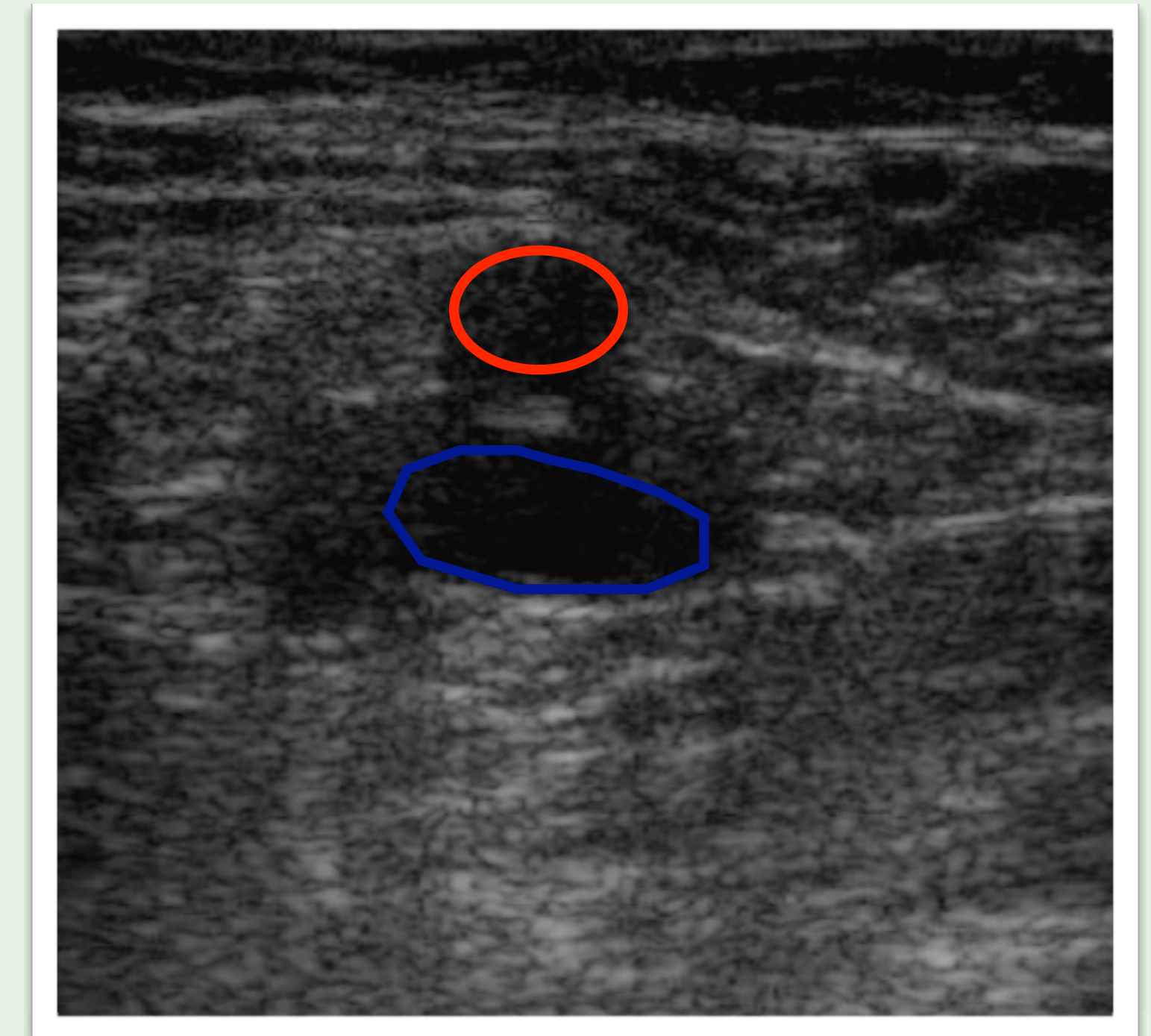
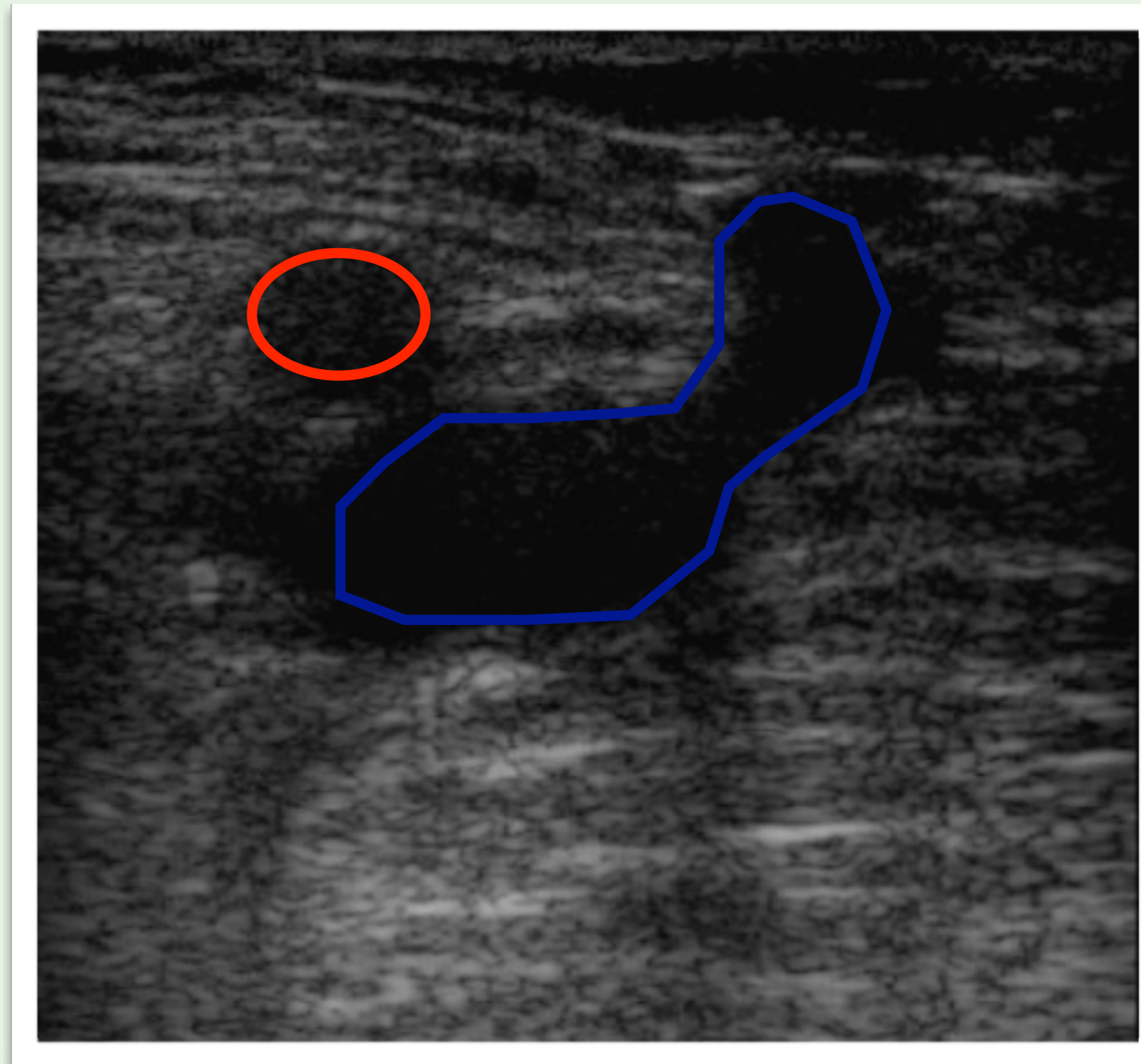
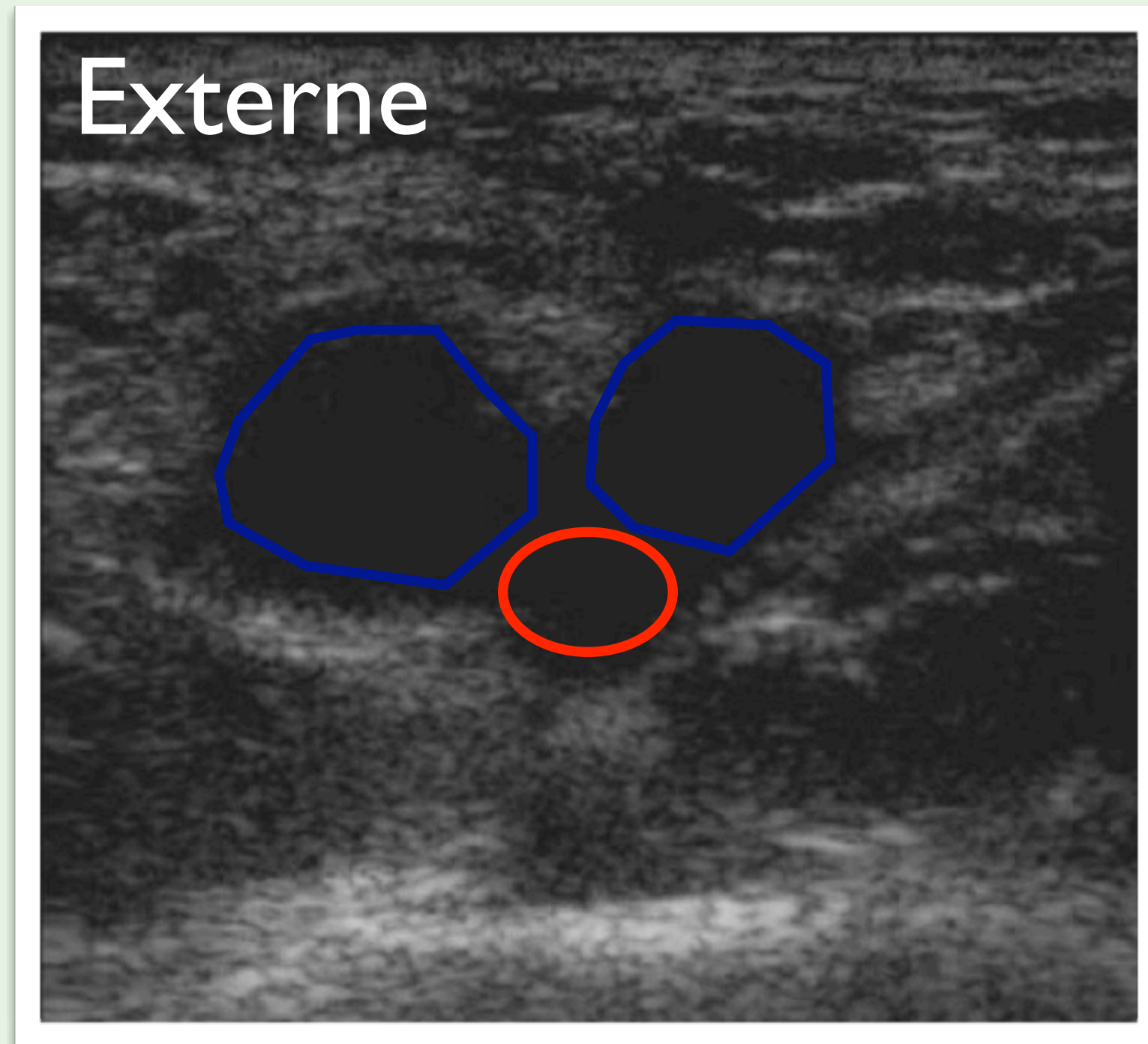
En utilisant une échographie avec onde veculaire (E-10 MHz) on peut faire la différence entre l'artère (élastile et incompressible) et la veine (compressible, élastile et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variations anatomiques.

veine fémorale

IVAN ✓

2-3 cm plus bas

~~IVAN~~ ✓



haut - - - - - ➔ bas de la cuisse

Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

En utilisant une échographie avec onde vasculaire (E-10 MHz) on peut faire la différence entre l'artère (élastique et incompressible) et la veine (compressible, élastile et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.

Ponction écho-guidée

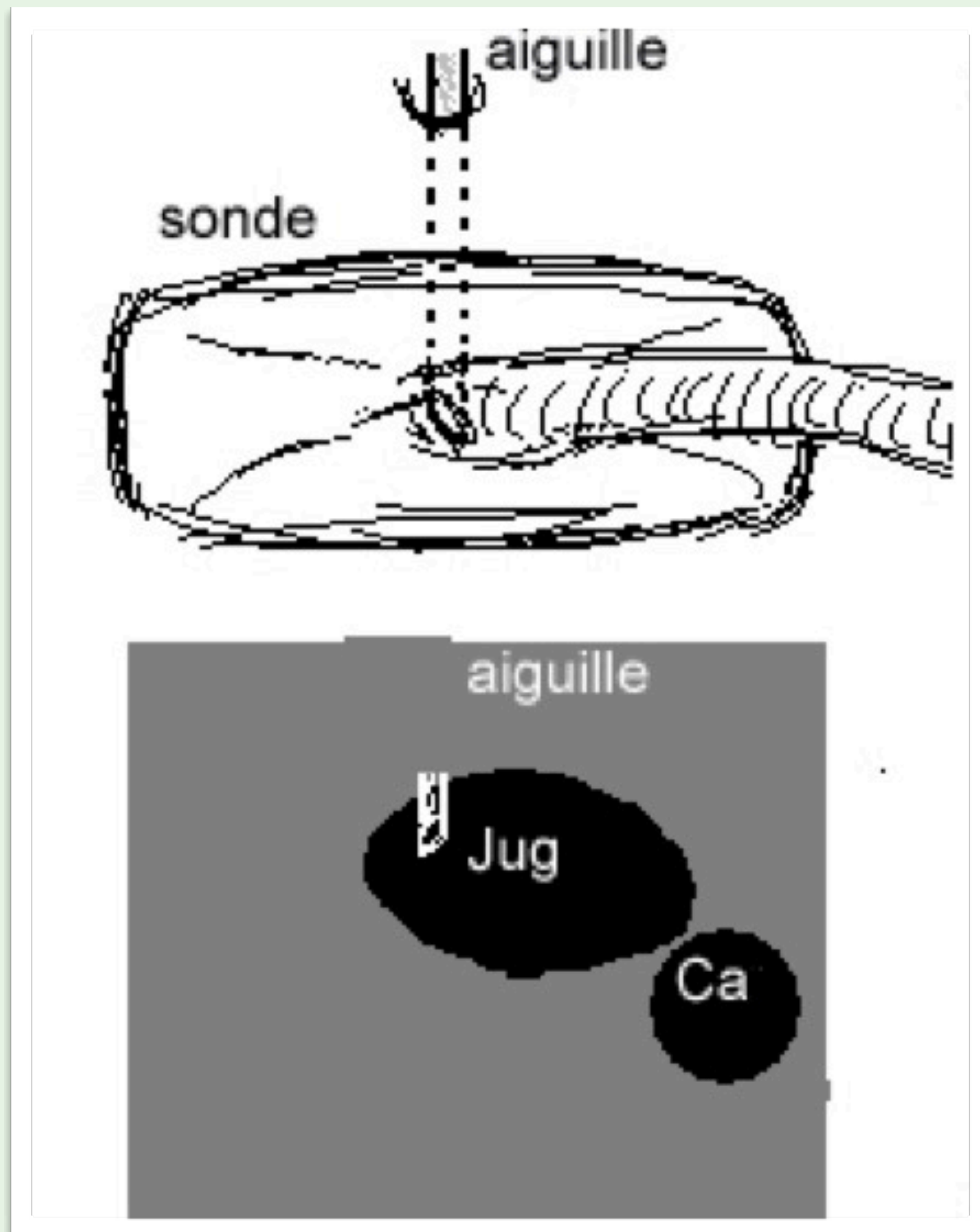
En utilisant une **échographie avec sonde vasculaire** (5-10 MHz) on peut faire la **différence** entre **l'artère** (pulsatile et incompressible) et **la veine** (compressible, pulsatile et sensible aux mouvements respiratoires).

Ce qui est surtout intéressant c'est de **pouvoir visualiser les variantes anatomiques**.

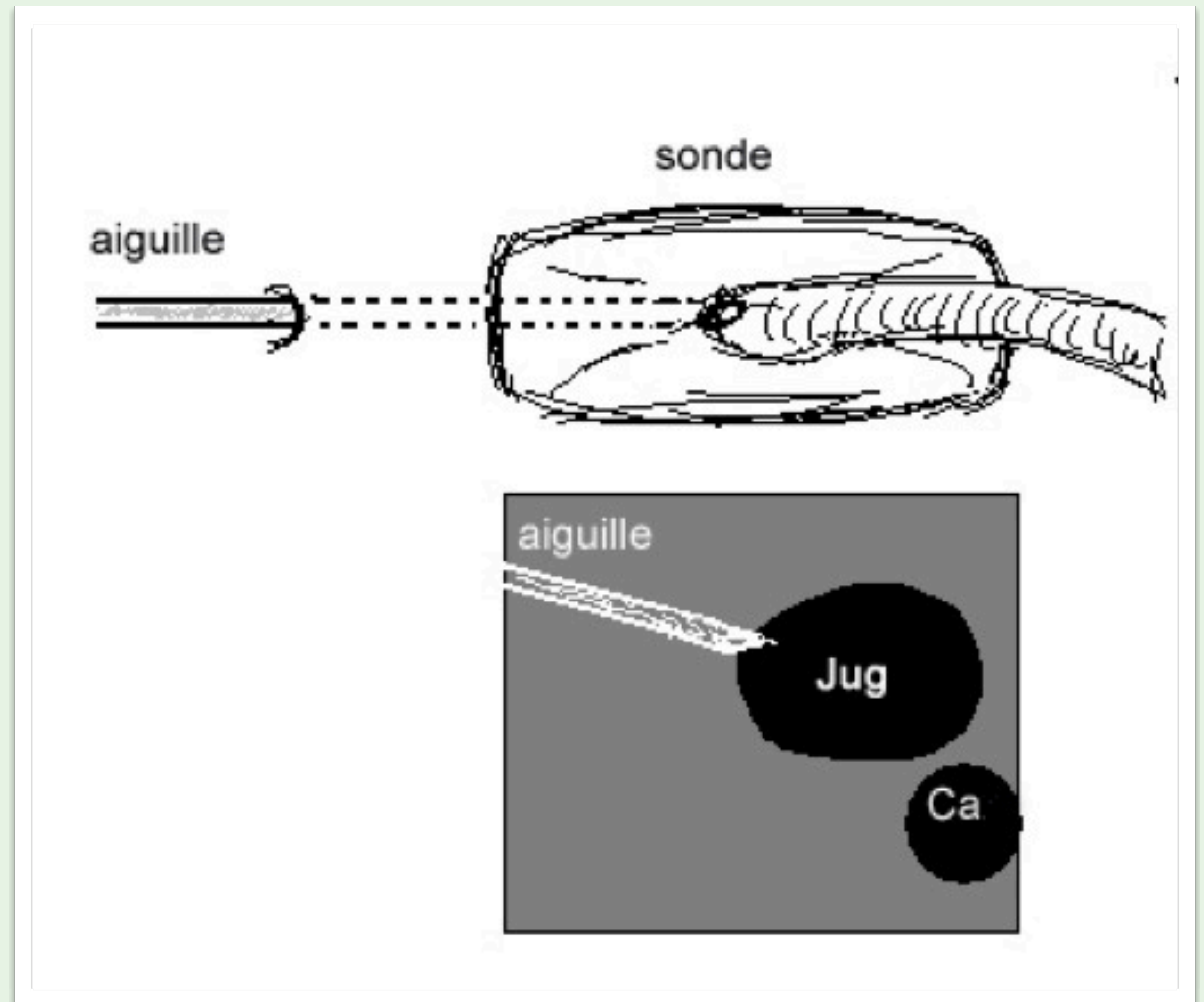
Source: <http://nephrohug.com/2010/04/26/apologie-de-la-ponction-veineuse-echoguidee/>

Ponction écho-guidée

perpendiculaire



parallèle

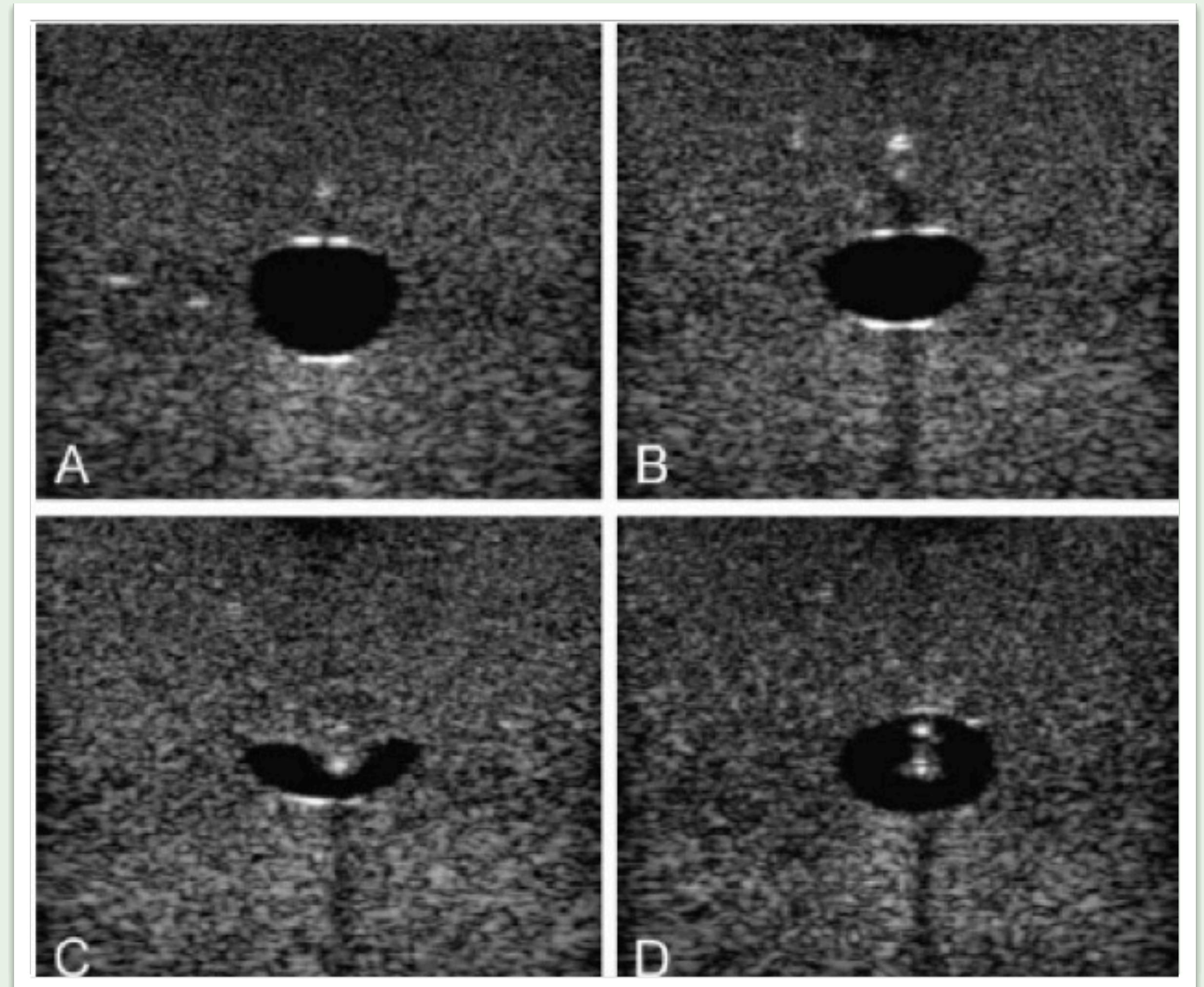
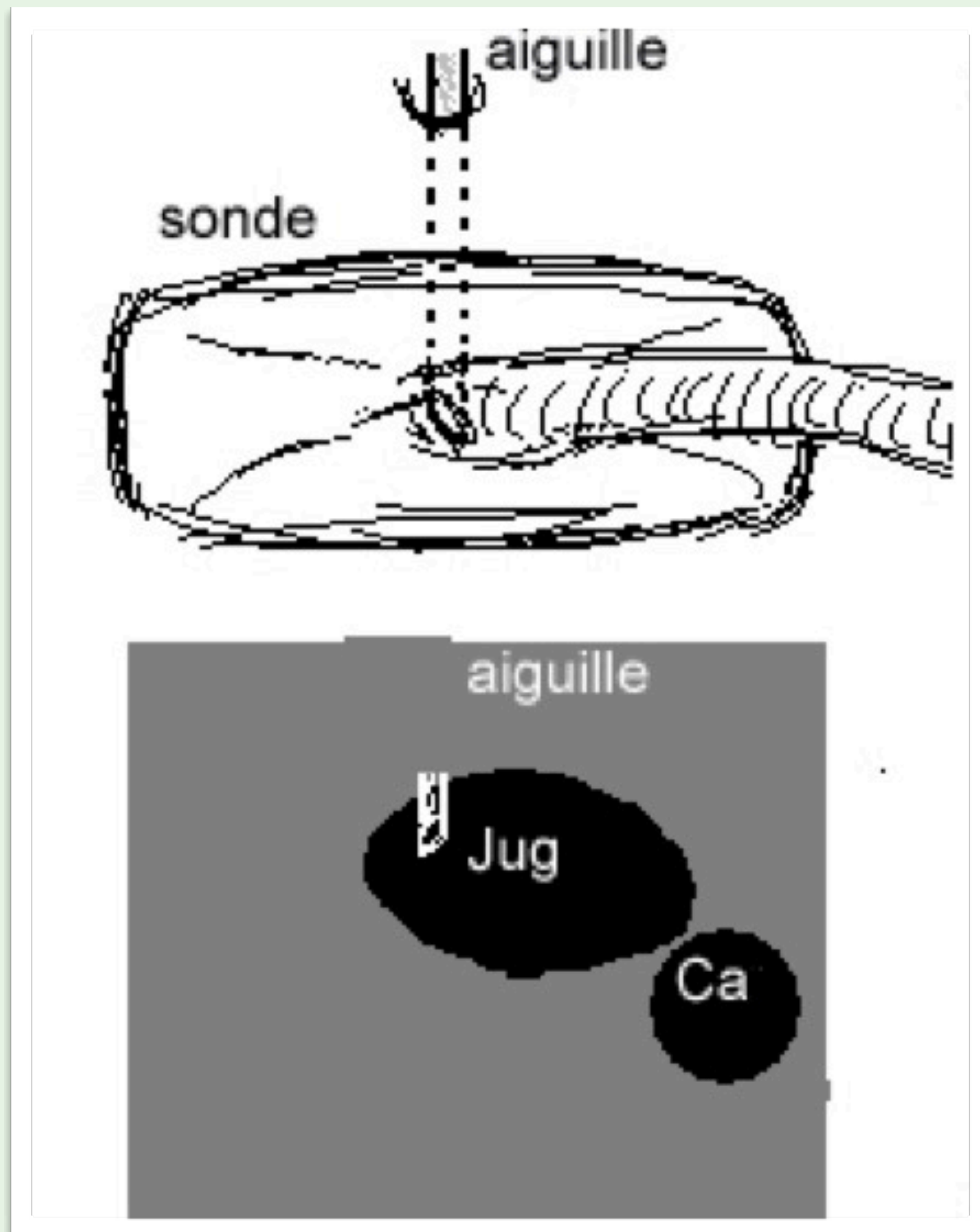


Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

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Ponction écho-guidée

perpendiculaire

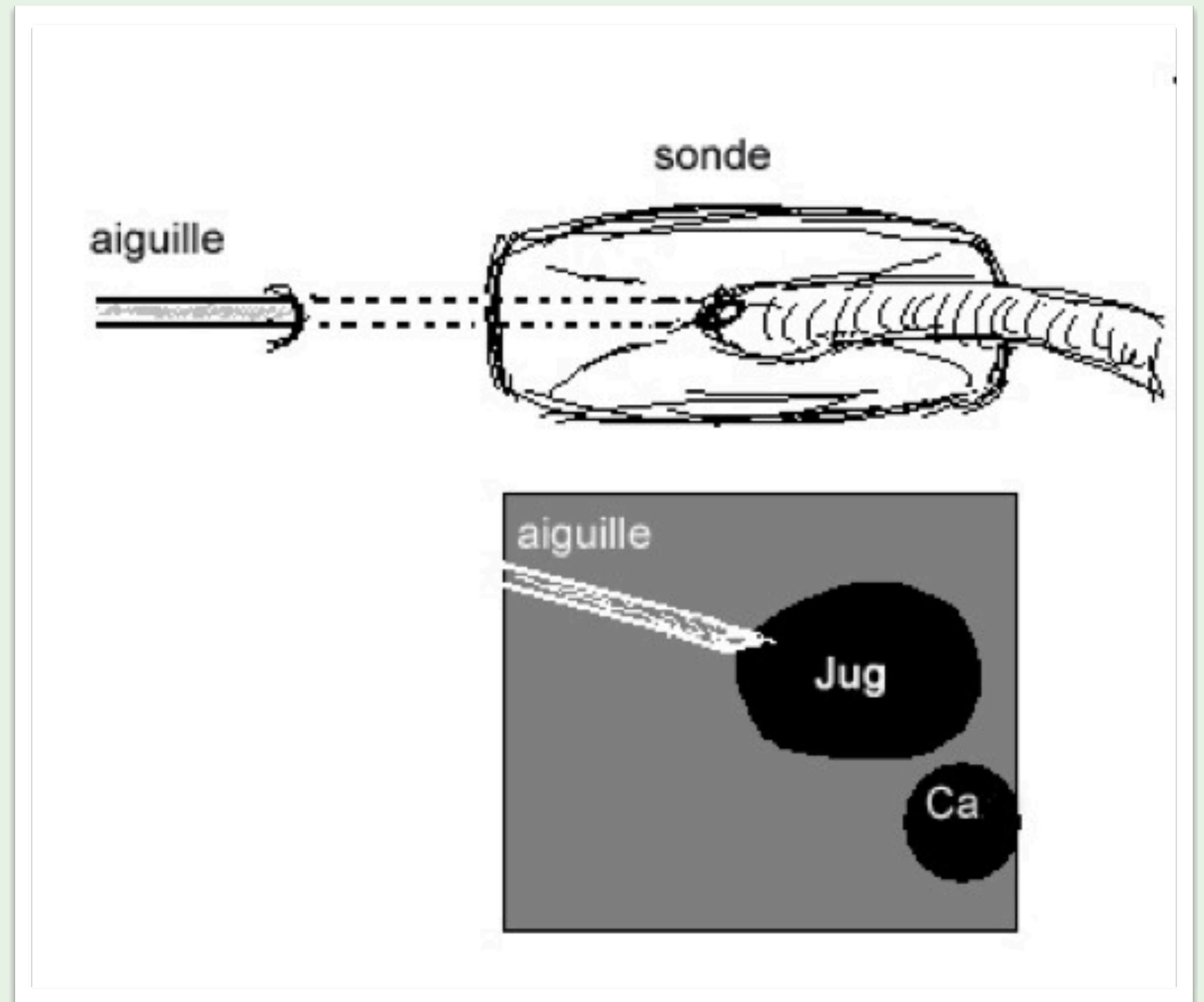
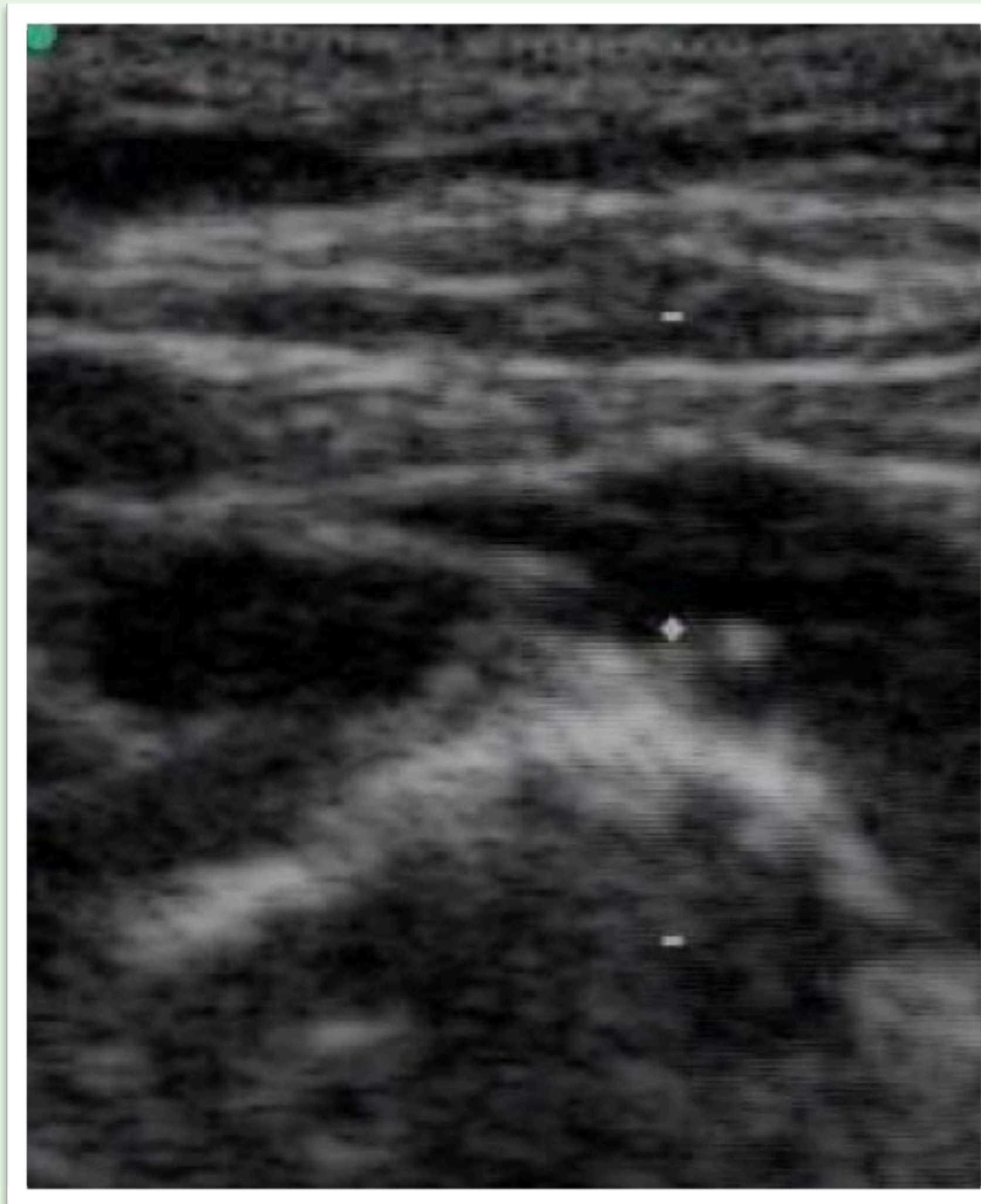


Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

En utilisant une échographie avec onde sismique (E-10 MHz) on peut faire la différence entre l'artère (élastique et incompressible) et la veine (compressible, élastique et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.

Ponction écho-guidée

parallèle

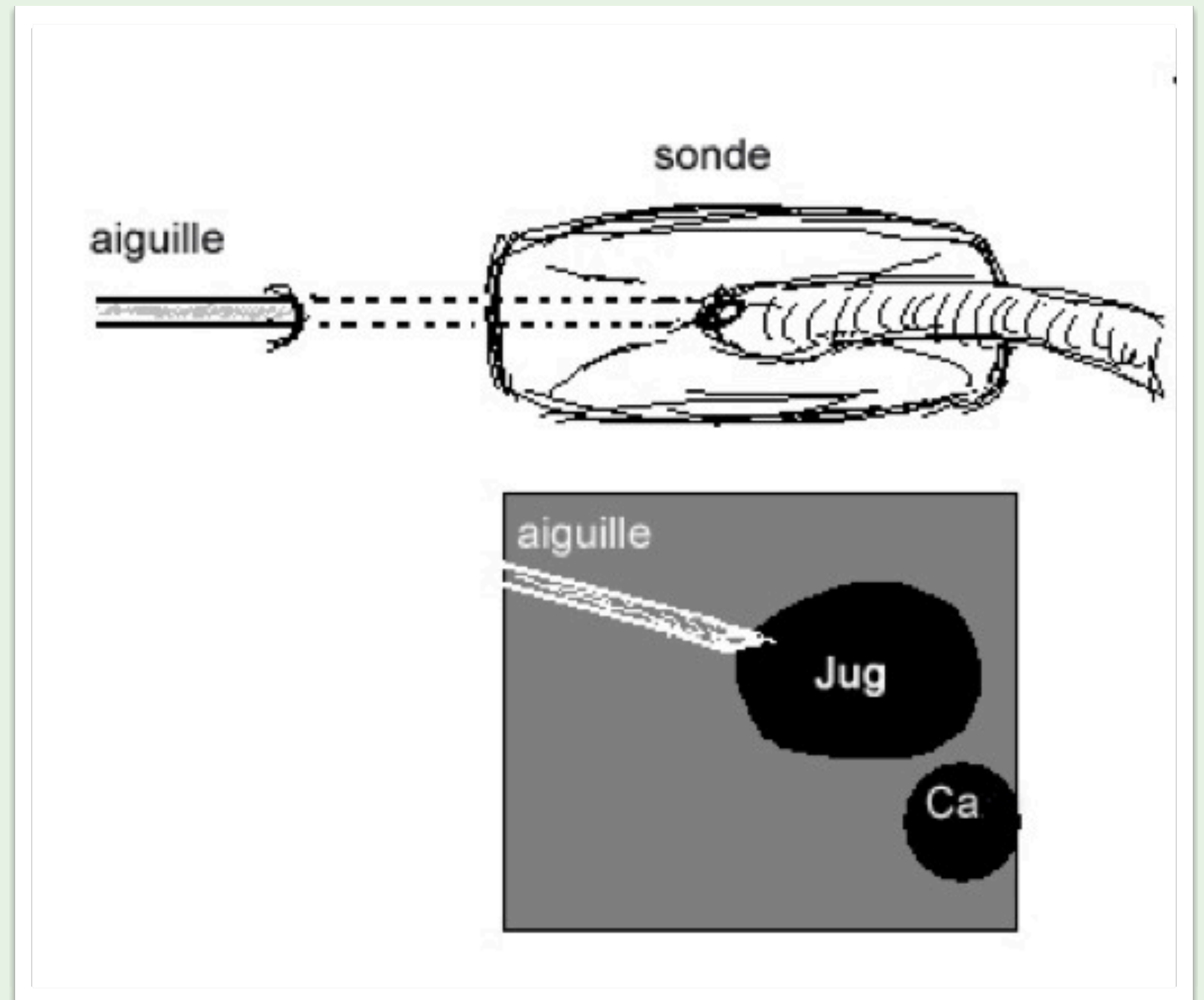
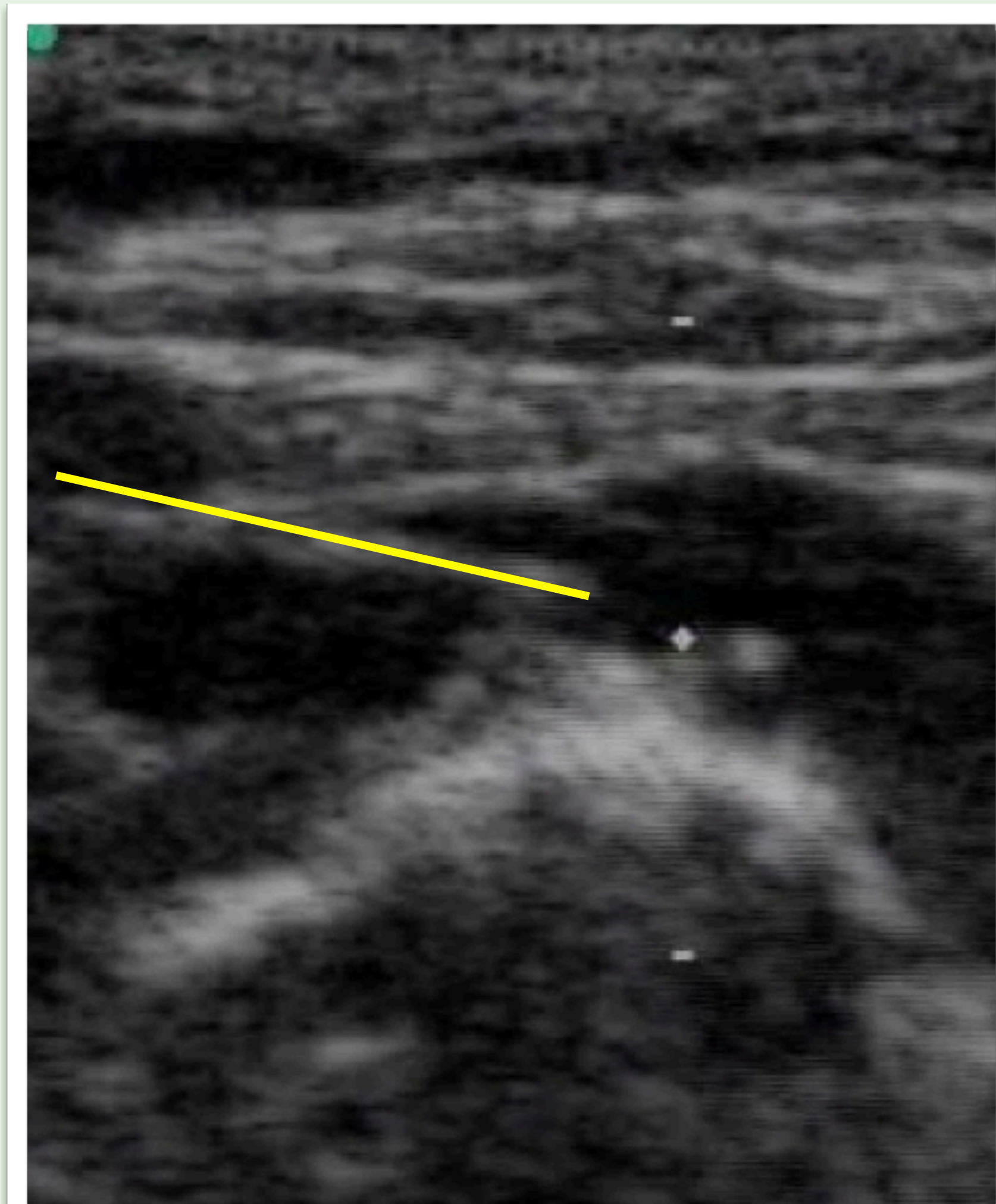


Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

En utilisant une échographie avec sonde vasculaire (5-10 MHz) on peut faire la différence entre l'artère (pulsatile et incompressible) et la veine (compressible, pulsatile et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.

Ponction écho-guidée

parallèle



Source: <http://www.alrf.asso.fr/aea/site/2008/desruennes.pdf>

En utilisant une échographie avec sonde vasculaire (5-10 MHz) on peut faire la différence entre l'artère (inextensible, incompressible, inélastique et sensible aux mouvements respiratoires) et la veine (compressible, inélastique et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.

First-ever **clinical practice guidelines on acute kidney injury** by **Kidney Disease Improving Global Outcome** (KDIGO) published this summer 2011

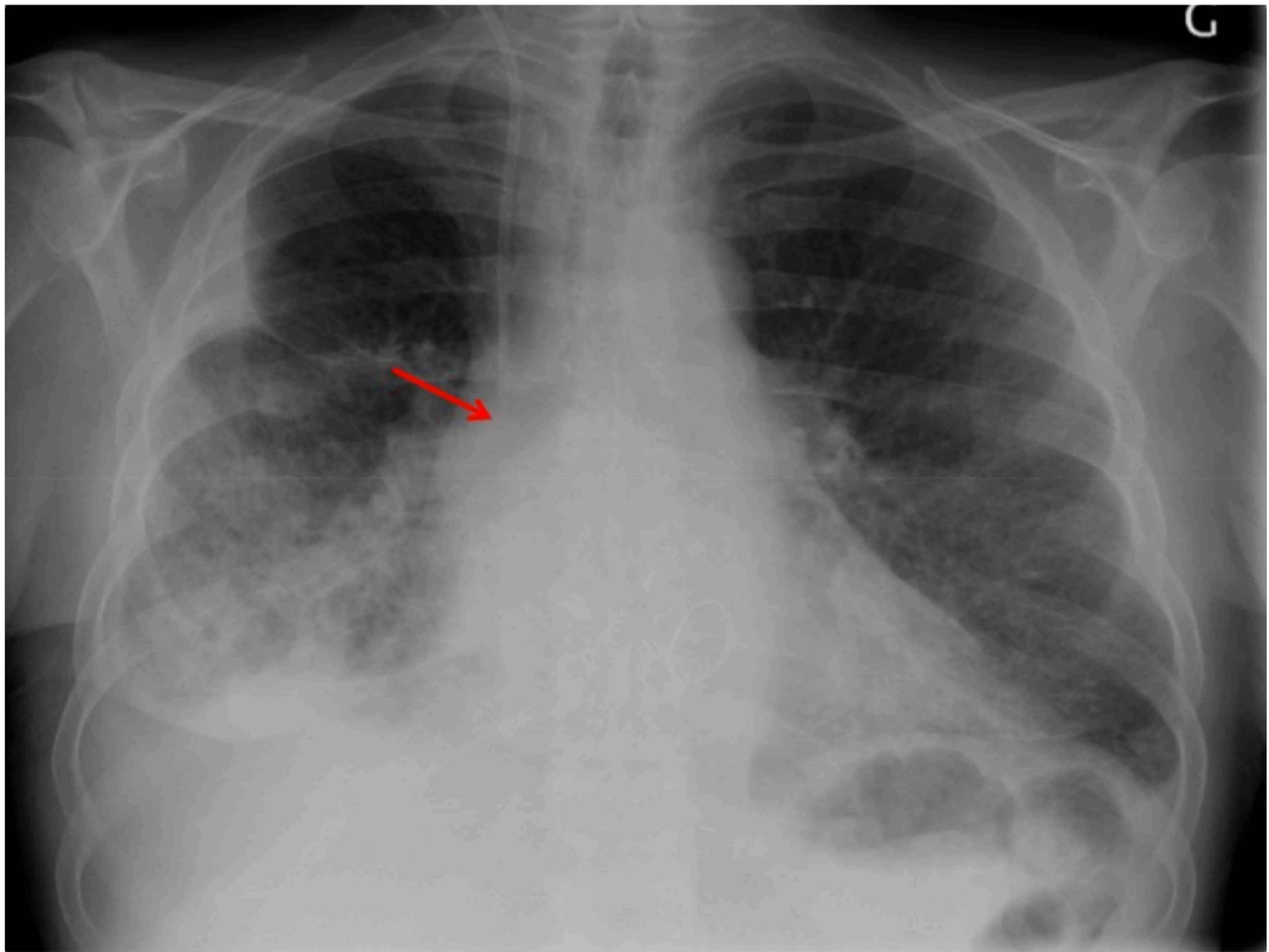
Ultrasonography-guided catheter insertion
(grade A evidence)

"This is going to be a change for many institutions but the evidence is so compelling that we felt we had to recommend the use of ultrasound."

- Dr John Kellum -

Source: The National Kidney Foundation 2011 Spring Clinical Meetings: Session #227. Presented **April 29, 2011**.

En utilisant une échographie avec onde vasculaire (5-10 MHz) on peut faire la différence entre l'artère (pulsatile et incompressible) et la veine (compressible, pulsatile et sensible aux mouvements respiratoires). Ce qui est surtout intéressant c'est de pouvoir visualiser les variantes anatomiques.



Anticoagulation

B.E.S.T. kidney investigators

“Approximately one-third received CRRT without anticoagulation (33.1%). Among patients who received anticoagulation, unfractionated heparin (UFH) was the most common choice (42.9%), followed by sodium citrate (9.9%)...”

54 ICUs in 23 countries, a cohort of 1'006 patients

Source: Uchino et coll. Intensive Care Med 2007

Anticoagulation au citrate

“En chélatant le calcium nécessaire à de nombreuses étapes de la coagulation le citrate est un anticoagulant de référence.”

neutralisation par administration de calcium en aval du circuit

Source: <http://nephrohug.com>

Citrate-based Regional Anticoagulation Versus Heparin for CRRT

“Open-label randomized control trial assessing the **effectiveness of citrate-based regional anticoagulation in critically ill patients with AKI** and with a special emphasis on the safety profile of this treatment in patients with severe liver failure..”

190 patients en 2 ans

Source: <http://clinicaltrials.gov>

Complications

Metabolic	Cardiovascular	Gastrointestinal	Neurologic	Hematologic	Infectious
Hyperkalemia	Pulmonary edema	Nausea	Neuromuscular	Anemia	Pneumonia
Metabolic acidosis	Arrhythmias	Vomiting	Irritability	Bleeding	Wound infections
Hyponatremia	Pericarditis	Malnutrition	Asterixis		Intravenous line infections
Hypocalcemia	Pericardial effusion	Gastritis	Seizures		Septicemia
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Hypermagnesemia	Myocardial infarction	Gastrointestinal bleeding	Somnolence		
Hyperuricemia	Pulmonary embolism	Stomatitis or gingivitis	Coma		
	Pneumonitis	Parotitis or pancreatitis			

Complications of ARF

Source: Uchino et coll. JAMA 2005

Metabolic	Cardiovascular	Gastrointestinal	Neurologic	Hematologic	Infectious
Hypokaliema	Pulmonary edema	Nausea	Neuromuscular	Anemia	Pneumonia
Metabolic alkalosis	Arrythmias	Vomiting	Irritability	Bleeding	Wound infections
Dysnatremia	Pericarditis	Malnutrition	Asterixis	Thrombocytopenia	Intravenous line infections
Hypocalcemia	Pericardial effusion	Gastritis	Seizures		Septicemia
Hypophosphatemia	Hypertension	Gastrointestinal ulcers	Mental status changes		Urinary tract infection
Hypomagnesemia	Myocardial infarction	Gastrointestinal bleeding	Somnolence		
Hyperuricemia	Pulmonary embolism	Stomatitis or gingivitis	Coma		
	Pneumonitis	Parotitis or pancreatitis			

Complications of CRRT

“The risk of **hypomagnesemia** and **hypokalemia** can be attenuated by adjusting magnesium and potassium concentrations in the dialysis solution to levels near to the plasma water values. Since critically ill patients are prone to developing dialysis-induced **hypophosphatemia**, phosphorous must be monitored and supplemented if necessary.”

Source: Locatelli et coll. Kidney Int Suppl 1998

“Perte d’acides aminés durant l’EERC (10-15 g par jour), de protéines (5 g par jour), de glucose ($> 25-50$ g/j) et de vitamines hydrosolubles (vitamine C).”

Source: Cano et coll. Clin Nutr 2006

“The clinical diagnosis of HIT in ICU patients initiating CRRT is challenging given the decrease in platelet counts seen following CRRT initiation in the majority of patients.”

Source: Holmes et coll. J Thromb Thromboysis 2009

“Drug dosing in the intensive care unit can be challenging. There are no available recommendations to adapt drug dosing in a given critically ill patient with a given modality of CRRT.”

Source: Bourquin et coll. Nephrol Ther 2009

Drug Prescribing in Renal Failure

Dosing Guidelines for Adults and Children

FIFTH EDITION



George R. Aronoff, MD
William M. Bennett, MD
Jeffrey S. Berns, MD
Michael E. Brier, PhD
Mishamini Kastekar, PharmD
Bruce A. Mueller, PharmD
Deborah A. Paska, PharmD
William E. Schroyer, MD



SANFORDGUIDE
Antimicrobial Therapy, Inc.



A black and white photograph of a large crowd of people, mostly young adults, dressed in formal evening wear like tuxedos and gowns. They are all looking towards the camera with expressions of surprise or excitement, with many having their mouths open. The text 'merci de votre attention' is overlaid in the center in a bold, red, sans-serif font.

merci de votre attention

Dr Vincent Bourquin – service de néphrologie – <http://nephrohug.com>