

Interest of radiology in the diagnosis and treatment of vascular access complication

*D. HENROTEAUX MD
Médical Imaging Dpt
CHU Sart-Tilman - 4000 Liège*

- **Wat's is a vascular access ?**
- **Which complication ?**
 - **early**
 - **late**

WICH VASCULAR ACCESS ?

- Use
- Duration of use
- Type/amount of substance to be delivered
- Vascular status of patient
- Need for blood samples

***Choice/indication
varies widely from hospital to hospital***

WICH VASCULAR ACCESS ?

SHORT TERM < 2 weeks

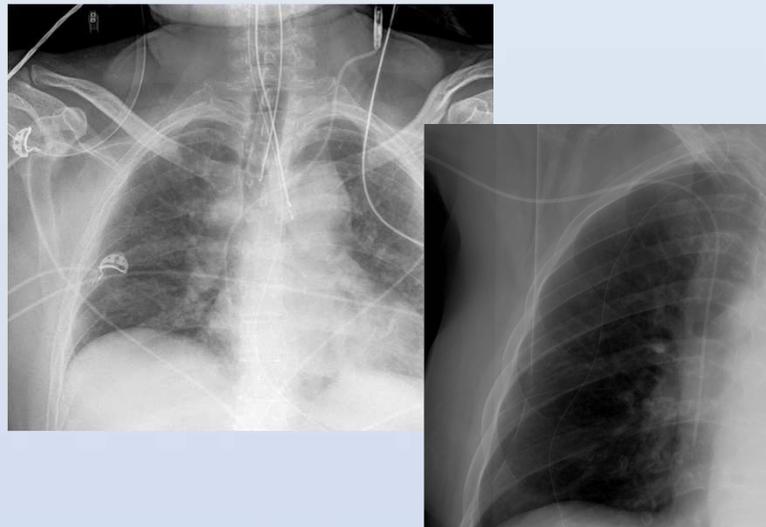
- **Peripheral venous cathéter**
- **Central monitoring cathéter**
- **Dialysis temporary cathéter**
- **Central temporary cathéter PVC**



WICH VASCULAR ACCESS ?

MID TERM < 2 weeks to 2 months

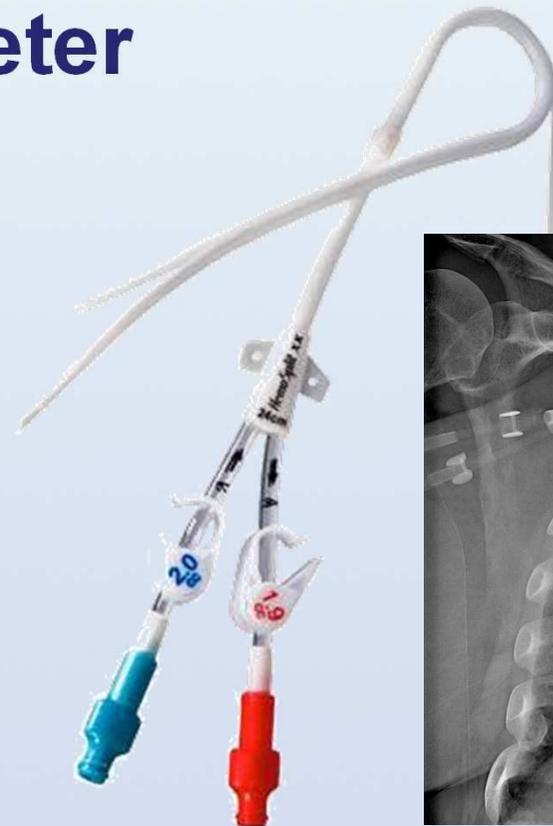
- **Central silicone catheter**
- **Périphéral inserted central catheter :
PICC**



WICH VASCULAR ACCESS ?

LONG TERM > 2 mois

- **Tunneled catheter**
- **Port-a-cath**



WHAT COMPLICATIONS ?

- **Early**

- Puncture complication
- Plicature
- Wrong position
- Aberrant course
- Dislogment

- **Late**

- Device thrombosis
- Fibrin sheath
- Central venous thrombose
- Vascular perforation
- Cardiac dysarythmias
- Pinch-off syndrome
- Infection

*First treatment of early vascular acces dysfunction
= PREVENTION*

- **Good initial positioning**
- **Pressure-flow testing**
- **Lock LP/heparine/citrate**
- **Antiplatelet/anticoagulant ?**



CATHETER TIP POSITION

- **USA recommendations (ASA & FDA)**
lower 1/3 of superior vena cava
- **EU recommendations (RCN)**
upper part of the atrium

CATHETER TIP POSITION

Complication Rates Related to Catheter Tip Location

TABLE 4. Multiple Regression Analysis of Complication Rates Between Central and Noncentral Groups Adjusted for Age, Gender, Catheter Size, and Duration

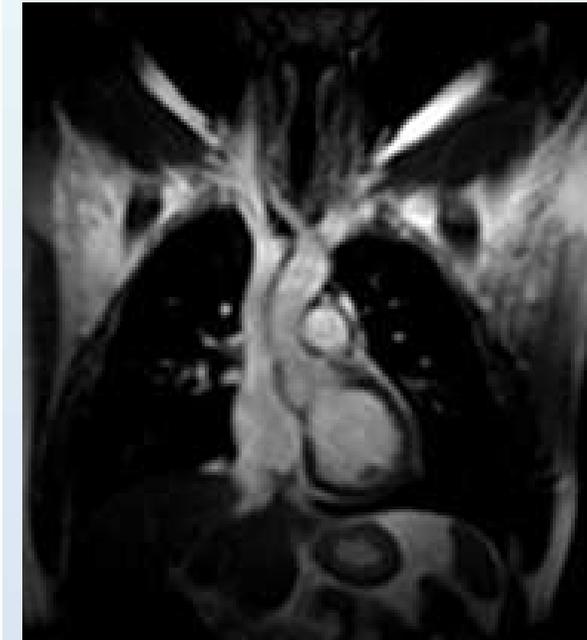
Variable	Adjusted OR	95% Confidence Interval
Noncentral tip location	8.28	5.11–13.43
Age	.97	.93–1.02
Gender	1.49	.94–2.37
Catheter size (2F)	1.16	.24–5.51
Catheter size (3F)	1.56	.36–7.01
Catheter duration	.97	.937–.99

Non central group is 8 times more likely to have a complication

Table 3—Dimensions of SVC and Relationship of Central Venous Structures With Radiographic Landmarks*

	All Patients	Men	Women
SVC length, cm			
Median	6.8	6.4	6.8
Range	4.4 to 10.0	4.4 to 8.6	4.4 to 10.0
25th to 75th percentile	5.4 to 7.3	5.4 to 7.4	5.3 to 7.0
SVC origin to cephalad aspect of the azygous arch			
Median	0.4	0.6	0.1
Range	-1.1 to 2.9	-1.1 to 2.9	-1.0 to 2.8
25th to 75th percentile	0.0 to 1.3	0.0 to 1.3	0.0 to 0.8
SVC origin to right tracheobronchial angle			
Median	1.5	1.5	1.1
Range	0.1 to 3.8	0.1 to 3.8	0.3 to 3.5
25th to 75th percentile	0.9 to 2.5	0.9 to 2.6	0.7 to 2.0
SVC origin to right heart border			
Median	5.8	6.0	5.8
Range	2.5 to 10.0	3.3 to 7.9	2.5 to 10.0
25th to 75th percentile	5.3 to 6.8	5.3 to 7.0	5.2 to 6.8
Right mainstem to right heart border			
Median	4.3	4.2	4.3
Range	2.0 to 6.5	2.4 to 6.1	2.0 to 6.5
25th to 75th percentile	3.5 to 5.0	3.3 to 5.1	3.8 to 5.1
Right tracheobronchial angle to right atrial origin			
Median	4.9	4.9	4.9
Range	2.9 to 6.8	2.9 to 6.2	3.6 to 6.8
25th to 75th percentile	4.1 to 5.9	3.5 to 5.6	4.3 to 6.2

*No significant differences existed in measured variables between genders.



SVC varies in size considerably from 4,4 to 10,0 cm with no correlation with the dimension of the others vascular structures

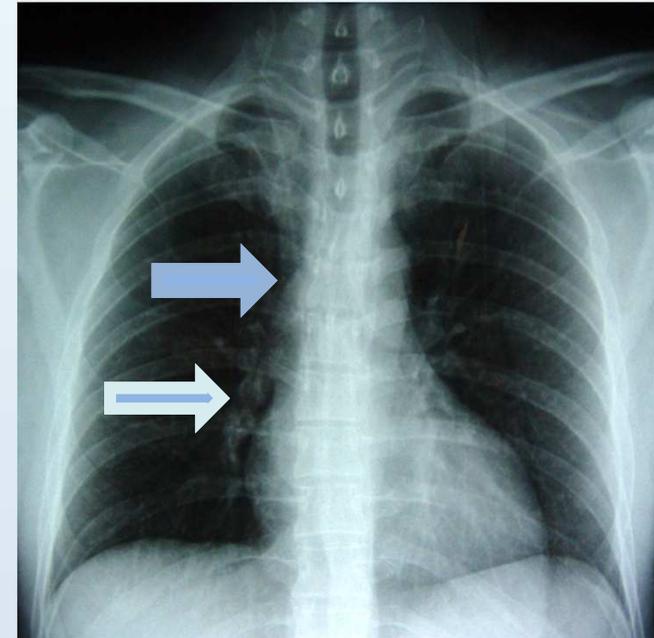
- **Caudal margin of clavicles**
- **Intervertebral disk T5-T6**
- **Right third intercostal space**
- **Sixth thoracic vertebral body**

*More reliable landmarks of cephalic origin of
SVC = right tracheo-bronchial angle*

Table 3—Dimensions of SVC and Relationship of Central Venous Structures With Radiographic Landmarks*

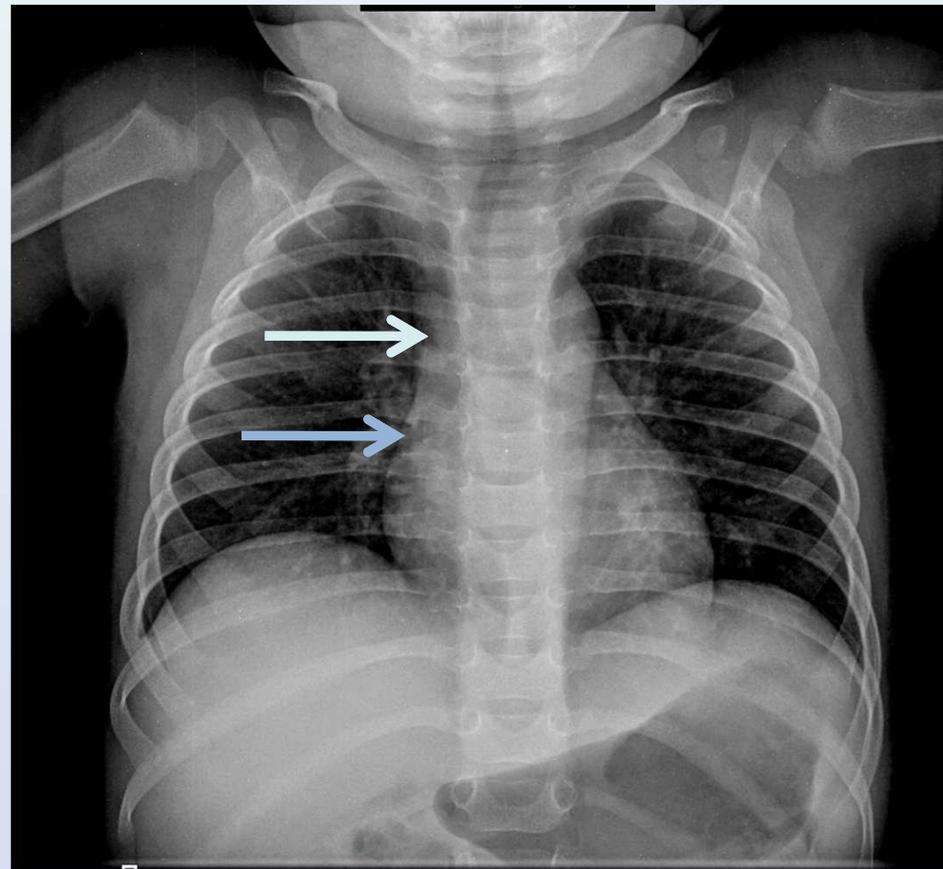
	All Patients	Men	Women
SVC length, cm			
Median	6.8	6.4	6.8
Range	4.4 to 10.0	4.4 to 8.6	4.4 to 10.0
25th to 75th percentile	5.4 to 7.3	5.4 to 7.4	5.3 to 7.0
SVC origin to cephalad aspect of the azygous arch			
Median	0.4	0.6	0.1
Range	-1.1 to 2.9	-1.1 to 2.9	-1.0 to 2.8
25th to 75th percentile	0.0 to 1.3	0.0 to 1.3	0.0 to 0.8
SVC origin to right tracheobronchial angle			
Median	1.5	1.5	1.1
Range	0.1 to 3.8	0.1 to 3.8	0.3 to 3.5
25th to 75th percentile	0.9 to 2.5	0.9 to 2.6	0.7 to 2.0
SVC origin to right heart border			
Median	5.8	6.0	5.8
Range	2.5 to 10.0	3.3 to 7.9	2.5 to 10.0
25th to 75th percentile	5.3 to 6.8	5.3 to 7.0	5.2 to 6.8
Right mainstem to right heart border			
Median	4.3	4.2	4.3
Range	2.0 to 6.5	2.4 to 6.1	2.0 to 6.5
25th to 75th percentile	3.5 to 5.0	3.3 to 5.1	3.8 to 5.1
Right tracheobronchial angle to right atrial origin			
Median	4.9	4.9	4.9
Range	2.9 to 6.8	2.9 to 6.2	3.6 to 6.8
25th to 75th percentile	4.1 to 5.9	3.5 to 5.6	4.3 to 6.2

*No significant differences existed in measured variables between genders.

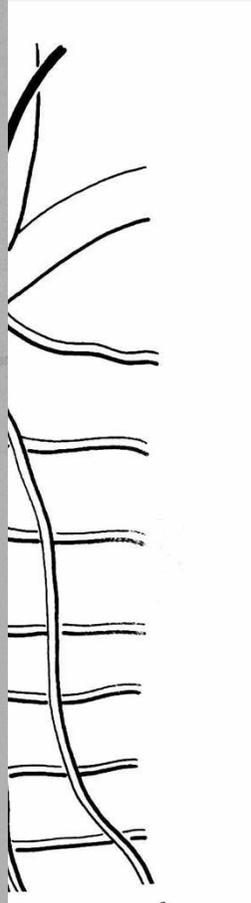


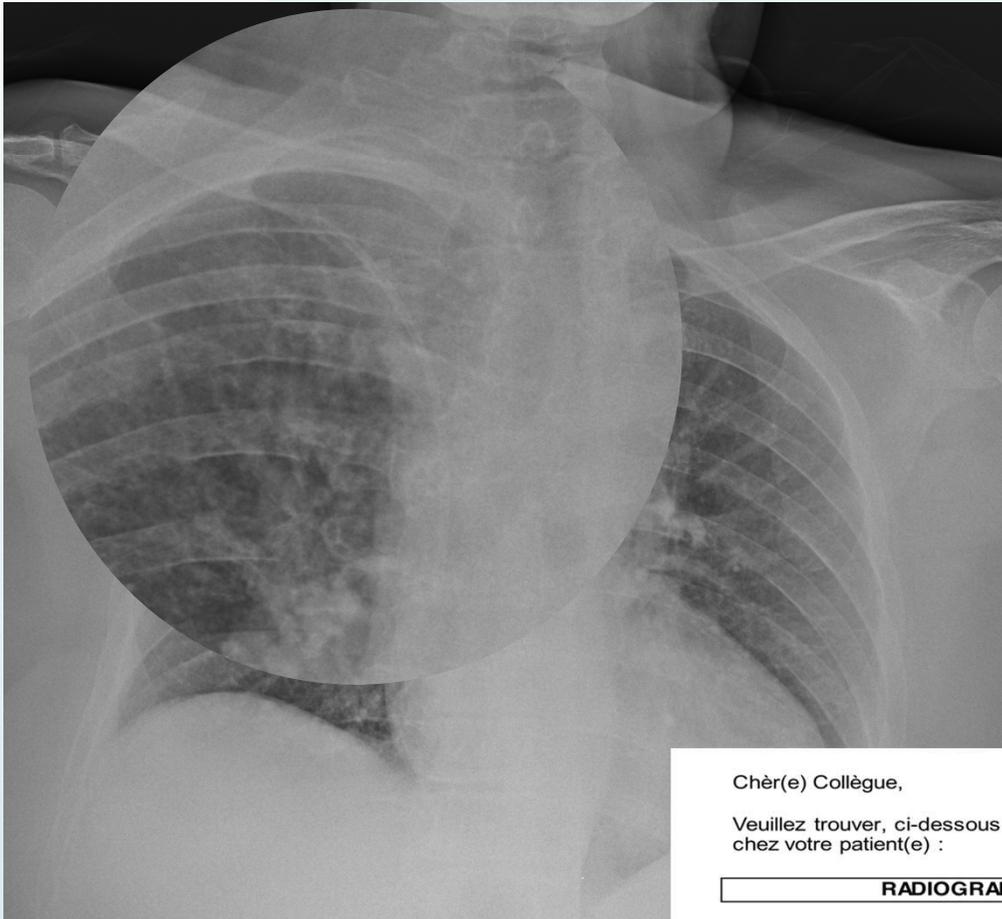
The right tracheo-bronchial angles within 0,1 to 3,8 cm of the upper margin of SVC and always below the junction of the brachio-cephalic veins

- **Right tracheo-bronchial angle**
- **Right superior border of the heart**



CATHETER MALPOSITION?





C.H.R. DE LA CITADELLE

DEMANDE D'EXAMEN

Adressée au service de : *Neuro*

Médecin demandeur : (cachet-signature)

Examen demandé : *Pne thorax*

Pour scanner et IRM : justification médicale si l'examen précédent date de moins de 30 jours.

ventricle postérieur

Date de la demande : *pendant Brocep*

Diagnostic présumé : *accident vasculaire cérébral*

Rendez-vous : date Heure *14h00*

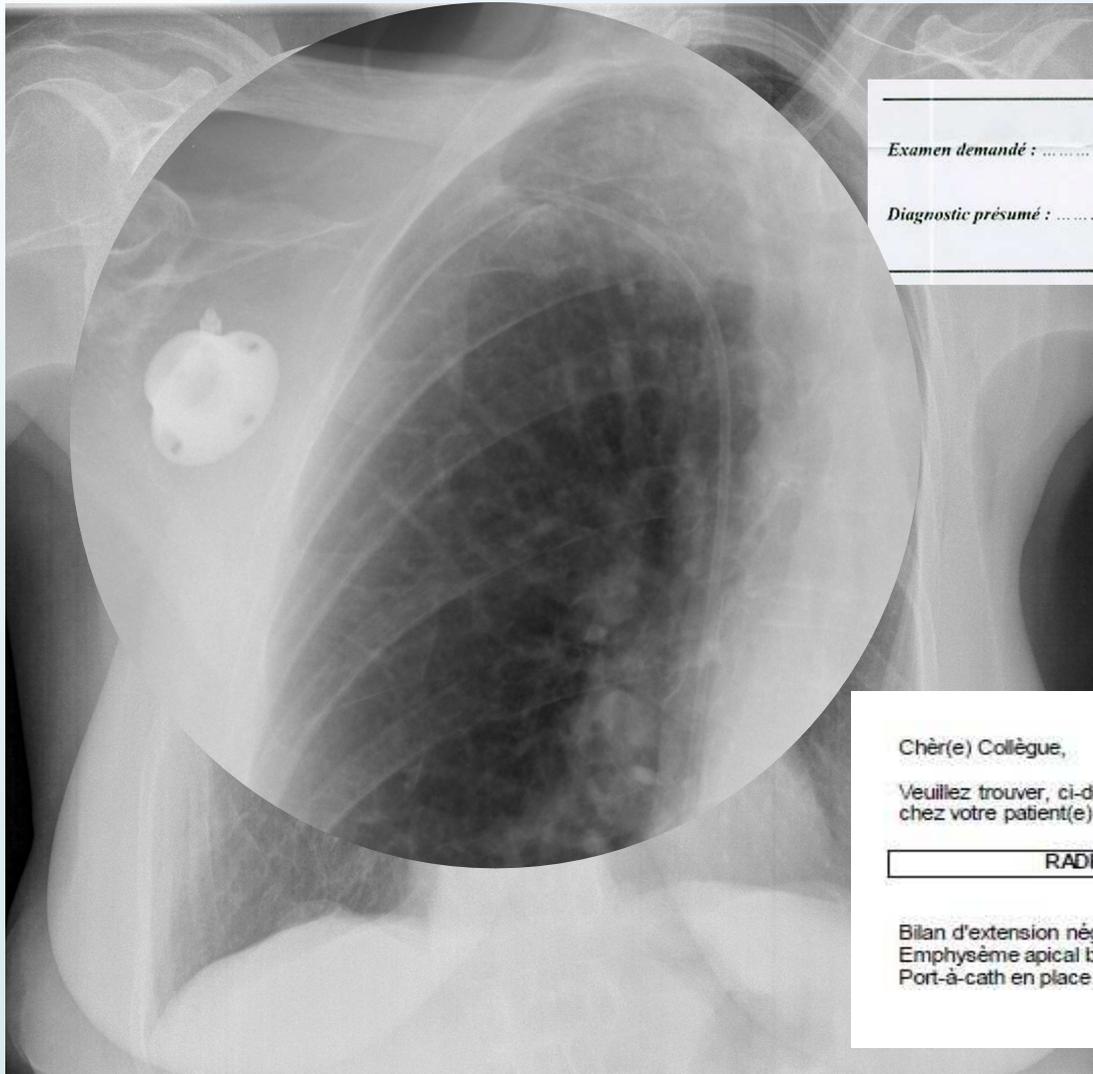
DR DELHOUCHE R. MD
CHR CITADELLE
1-6-590-63-650
PROTOCOLE *2/10/12*

Chèr(e) Collègue,

Veuillez trouver, ci-dessous, le résultat de l'examen radiologique réalisé, ce jour, chez votre patient(e) :

RADIOGRAPHIE DU THORAX (1cl) DU 08.10.2012:

Cathéter central en place.
Coeur de volume normal.
Aorte déroulée et calcifiée.
Discrète surcharge bronchovascularielle centrale.
Pas de foyer pleuro-parenchymateux évolutif formellement objectivé.



Examen demandé :

Rx Thorax ^{Ch} F + P

Diagnostic présumé :

Aut. nég. de l'extension

Chère(e) Collègue,

Veillez trouver, ci-dessous, le résultat de l'examen radiologique réalisé, ce jour, chez votre patient(e)

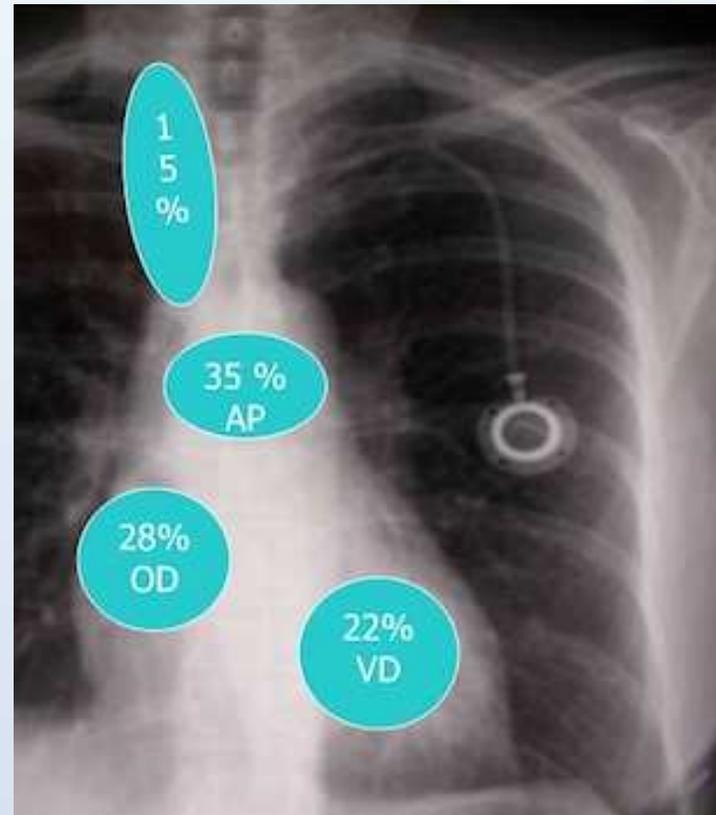
RADIOGRAPHIE DU THORAX (2cl) DU 28.02.2013:

Bilan d'extension négatif.
Emphysème apical bilatéral.
Port-à-cath en place

BROKEN CATHETER

- Dysfunction KT 56%
- Arythmia 13%
- Thoracic signs 5%
- Septic syndroma 2%
- Asymptomatic 25%

MORTALITY 1,8 %

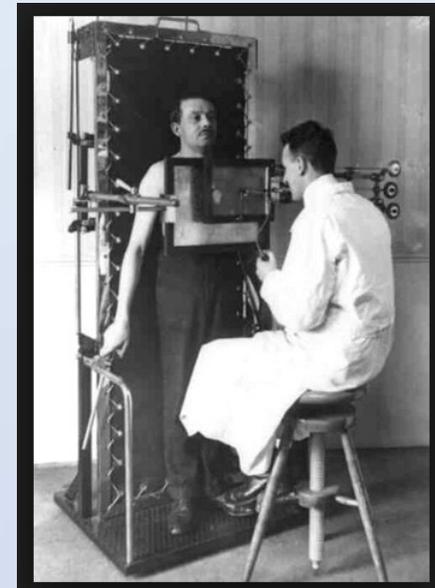


TRY TO EXTRACT IT

**If there is vascular access problem first
line examination**

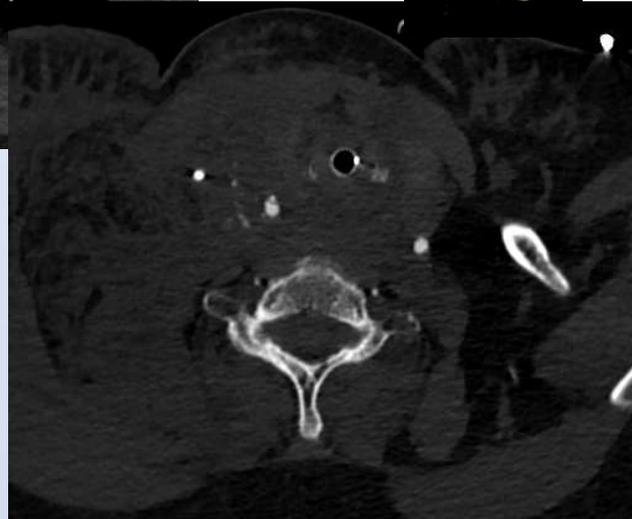
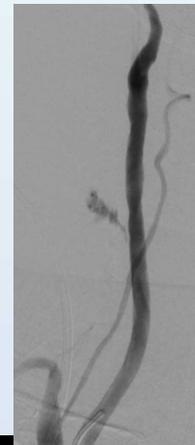
Old plain thorax radiography

But be careful !



WHY A GUIDANCE ?

To avoid complication



ANATOMICAL GUIDANCE

Investigator	Access site	Overall success (success at first attempt)	Time (mean seconds)	Complications
Agee (21)	IJV	90%–95% (?)	?	2%
Ledgerwood (19)	SCV	90%–95% (?)	?	2%–5%
Denys (20)	IJV	88.1% (38%)	44.5	8.3%
Teichgraber (16)	IJV	52% (52%)	51.4	12%
Sznajder (22)	IJV, EJV, SCV	85.4% (?)	?	5.8%–11%
Farrell (18)	IJV	82% (35.9%)	?	7.7%

IJV, internal jugular vein; SCV, subclavian vein; EJV, external jugular vein.

Adapted from Namyslowski J. Temporary acute care central venous access devices. *Semin Intervent Radiol* 1998;15:253–258; with permission.

ECHOGRAPHIC GUIDANCE

Investigator	Access site	Overall success (success at first attempt)	Time (mean seconds)	Complications
Denys (20)	IJV	100% (78%)	9.8	1.7%
Teichgraber (16)	IJV	96% (96%)	15.2	0%
Farrell (18)	IJV	96.7% (83.3%)	?	0%

IJV, internal jugular vein.

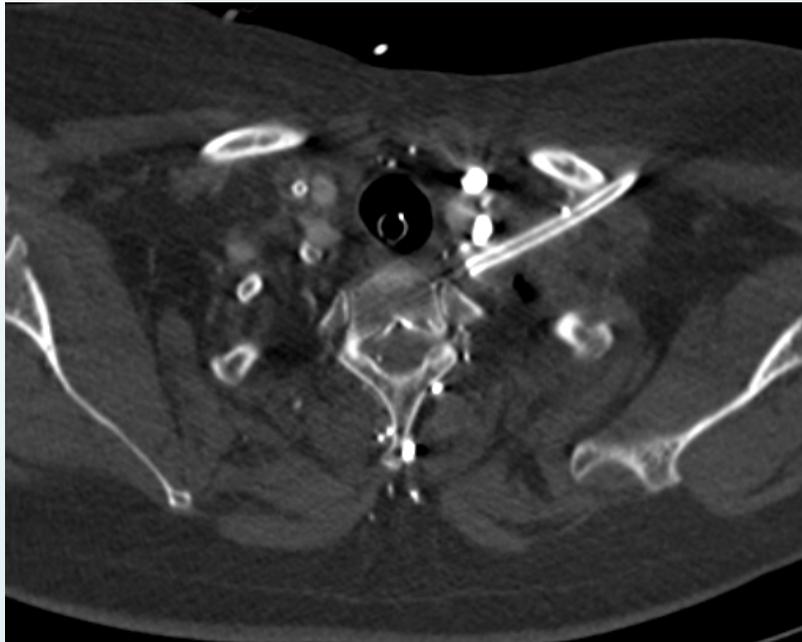
Adapted from Namyslowski J. Temporary acute care central venous access devices. *Semin Intervent Radiol* 1998;15:253–258; with permission.

POLYTRAUMATIZED PATIENT

- subarachnoid haemorrhage
- # spleen (splenectomy)
- # liver
- # multiple pelvis
- # lower limb
- flail chest

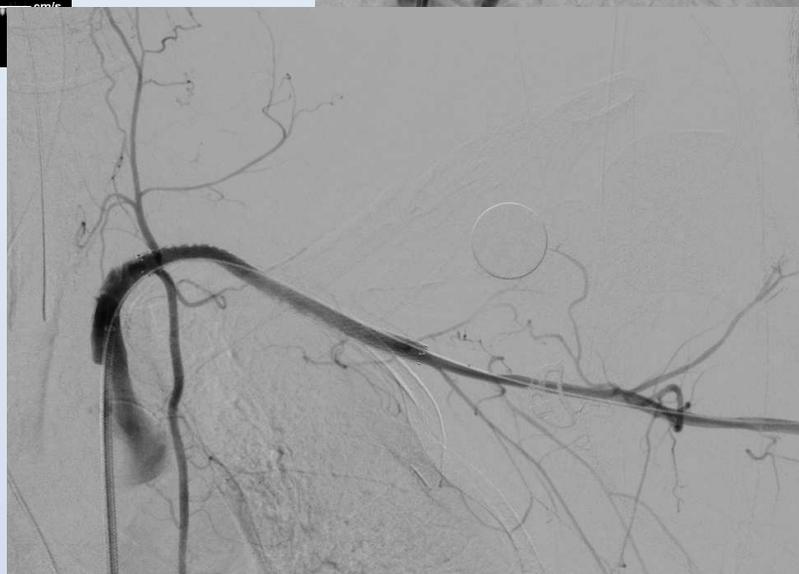
Examens demandés/proposés : (obligatoire)			
Pct US a. MS G.			
Informations cliniques pertinentes et explication de la demande de diagnostic : (obligatoire)			
<input type="checkbox"/> Contrôle postopératoire			
Pct a. n. clou G. - # bipolice humérus G. - Intériorité MS G. → p. c. s. m. s.			
Examen(s) pertinent(s) précédent(s) relatif(s) à la demande de diagnostic : (obligatoire)			
<input type="checkbox"/> CT	<input type="checkbox"/> RMN	<input type="checkbox"/> RX	<input type="checkbox"/> Échographie
<input type="checkbox"/> Autres :			<input type="checkbox"/> Inconnu <i>leson</i>
Date de réalisation :			

WHAT TO DO ?

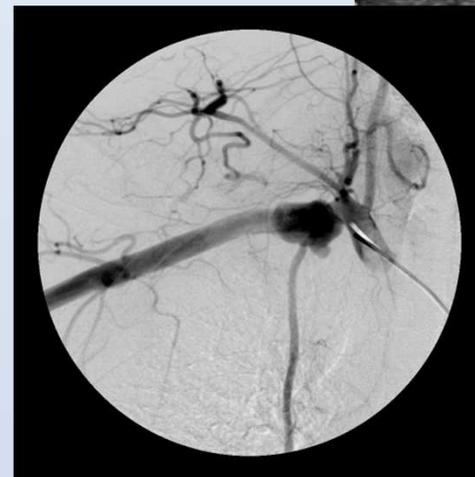
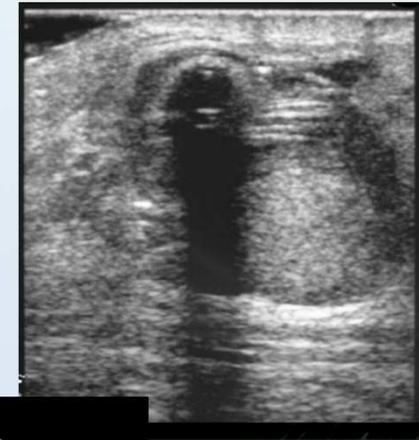


**do not remove the catheter in the
absence of a doctor able to handle
major bleeding**

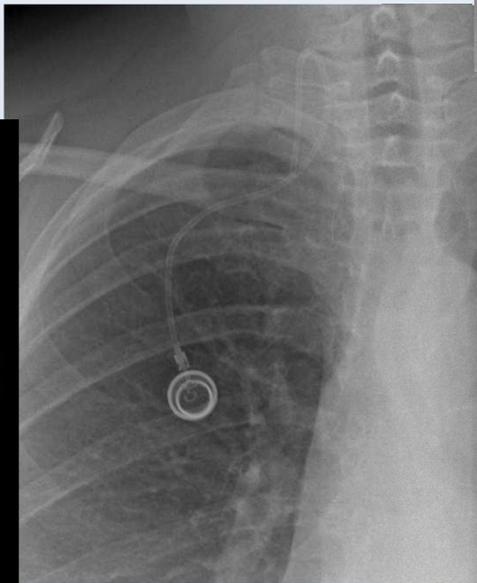




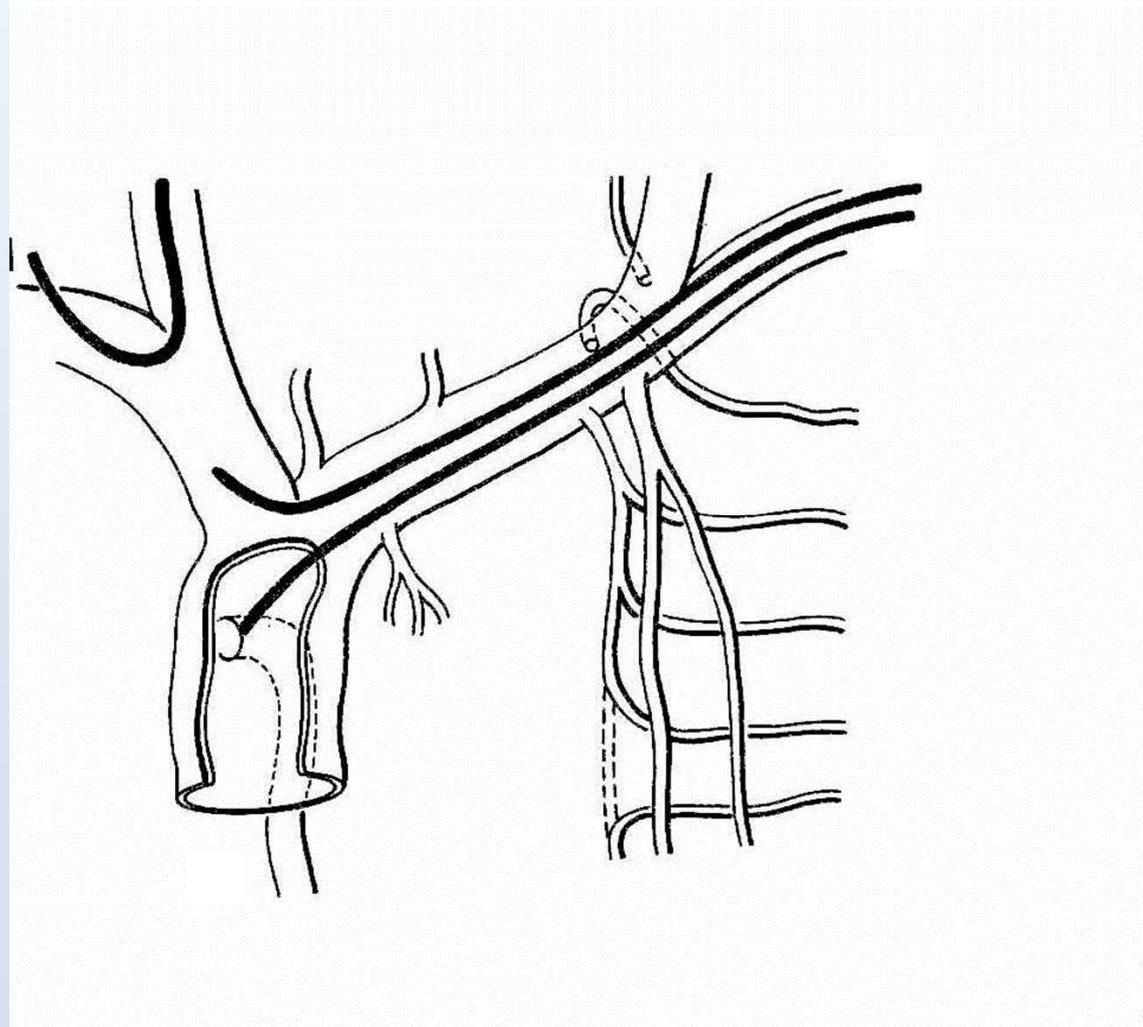
- **Hématome**
- **Pseudo-aneurysm**
- **Occlusion**
- **Fistule artério-veineuse**



CATHETER MALPOSITION



CATHETER MALPOSITION

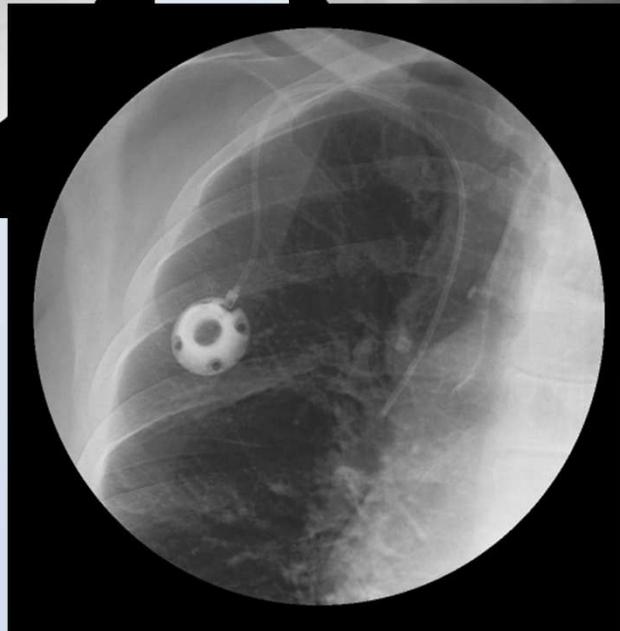
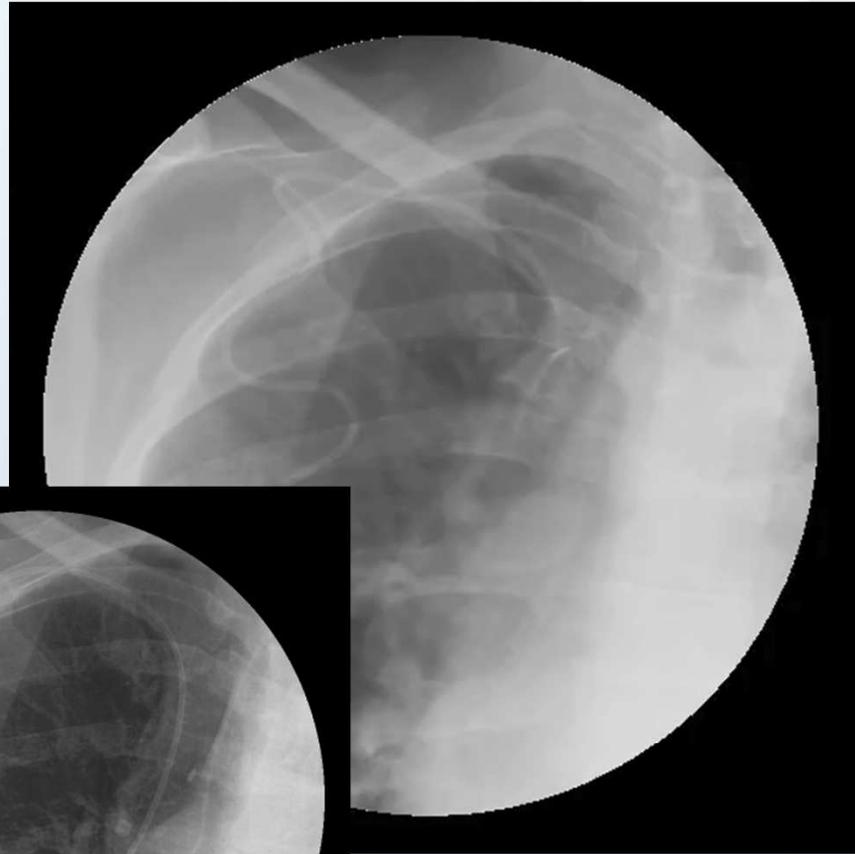
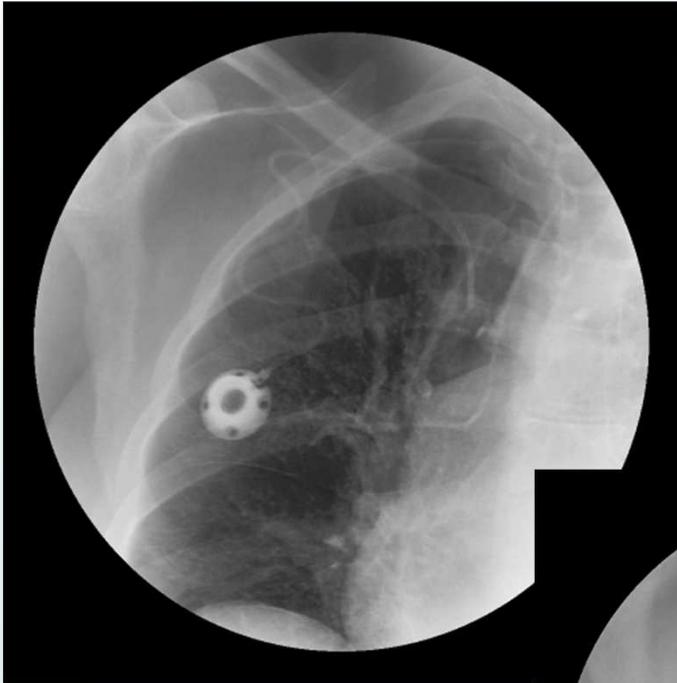


What to do?

If it's possible try repositioning the catheter

- **Femoral/jugular vein access**
- **Loop technic**
- **Lasso technic**

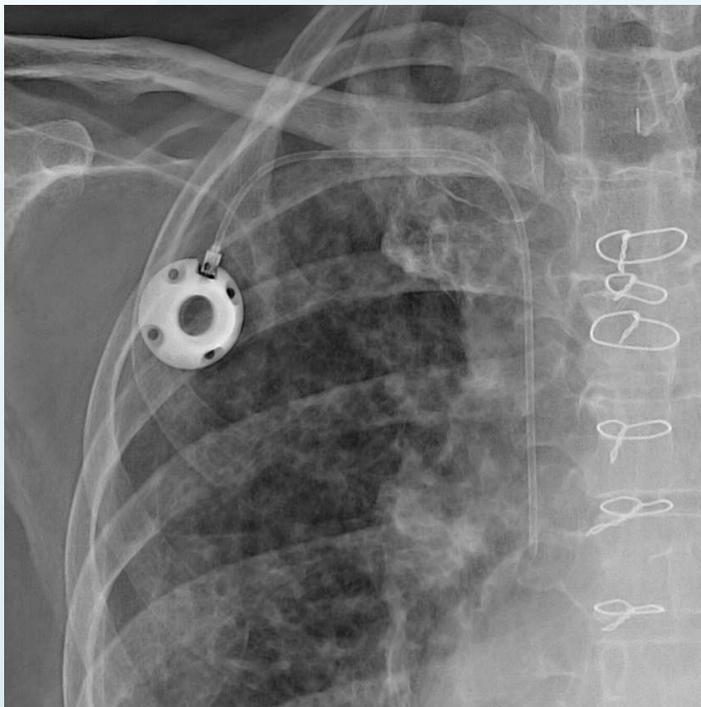
LASSO TECHNIC



LOOP TECHNIC



PORT PUNCTURE IMPOSSIBLE



Perform a lateral view !



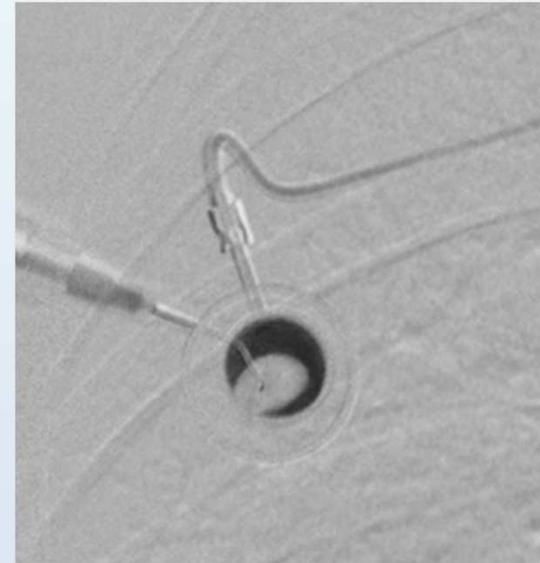
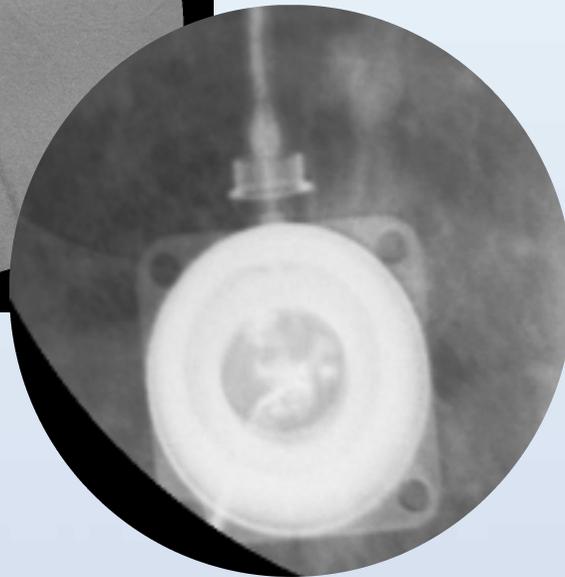
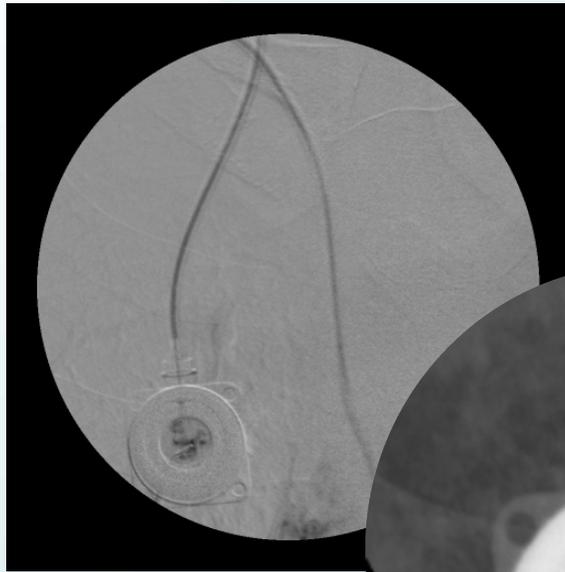
Think of the X-ray basic principle

No explication with thorax Xray



Contrast media injection

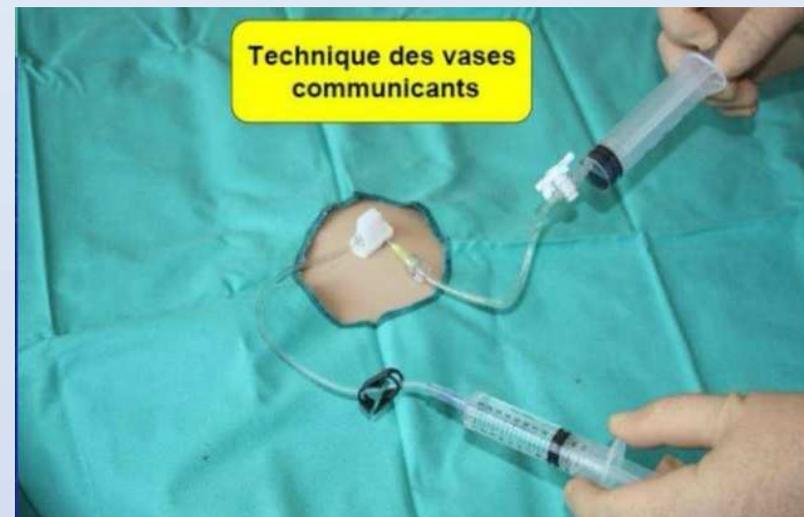
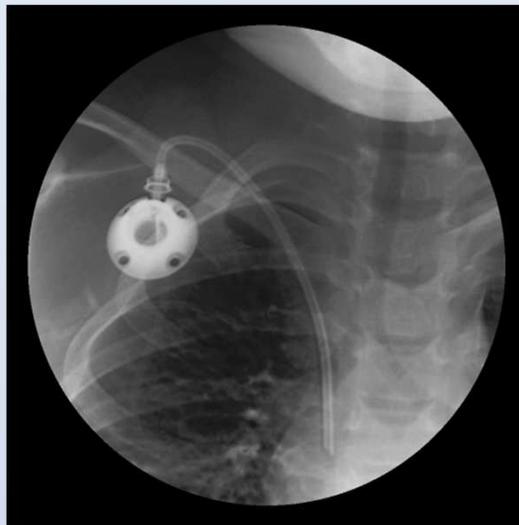
THROMBOSIS



**If thrombosis is incomplete:
local injection of thrombolytic drug**

IMPOSSIBLE TO SUCK OR INJECT

- **Open clamps !!!!**
- **Ensure the absence of extravasation**
- **Use the double needle technic**



Courtesy Dr PY Marcis

FIBRIN SHEATH

- **Difficulty to suck**
- **Injection possible but often difficult**

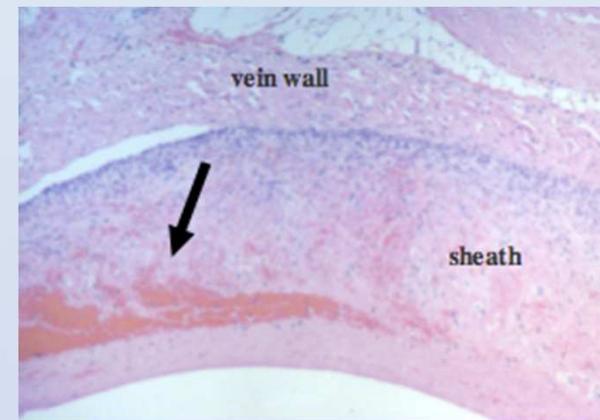


Catheter pseudo-enlargement
Catheter end-hole obstruction

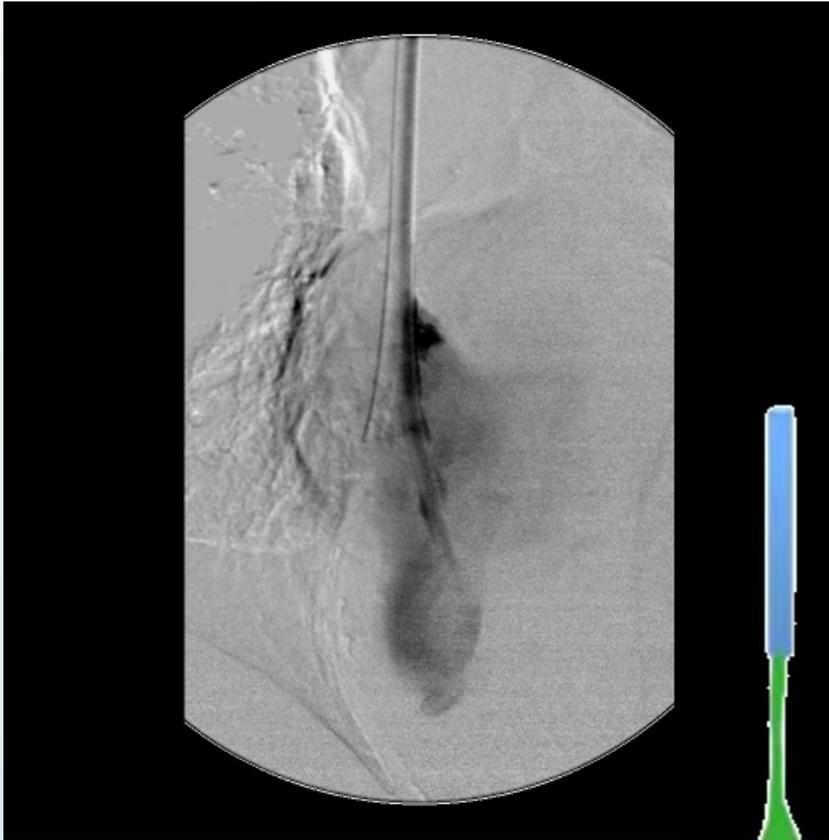
FIBRIN SHEATH

DEPOSIT FORMATION ON CATHETER SURFACE COMPOSED BY

- **Fibrinogen, albumin, lipoprotein, coagulation factor**
- **Collagen, smooth muscle cells**
- **Platelets, leukocyte**



FIBRIN SHEATH

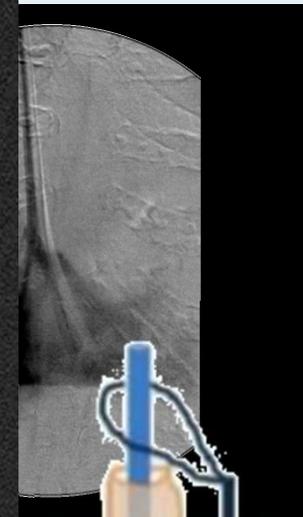
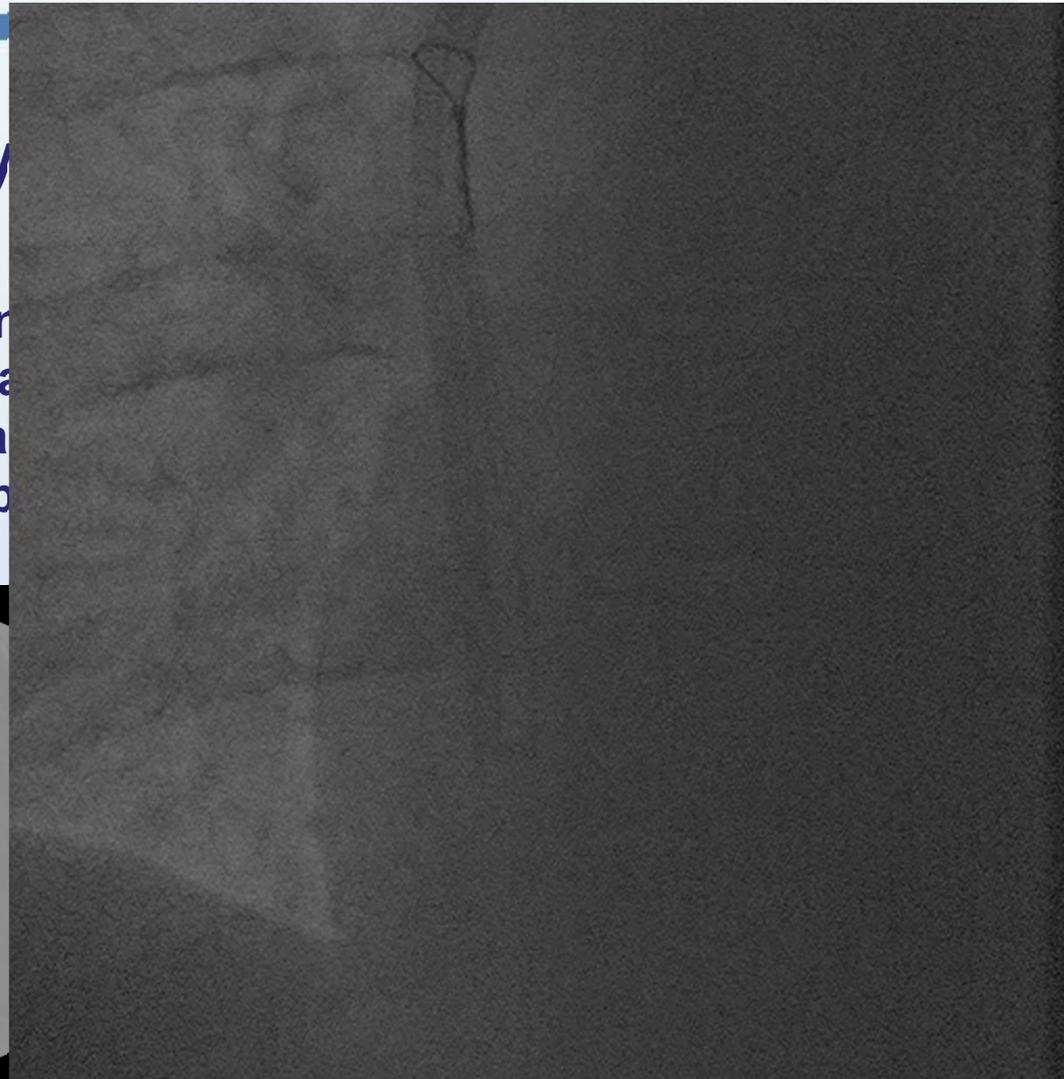
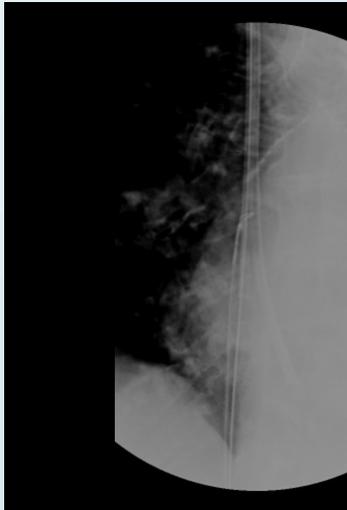


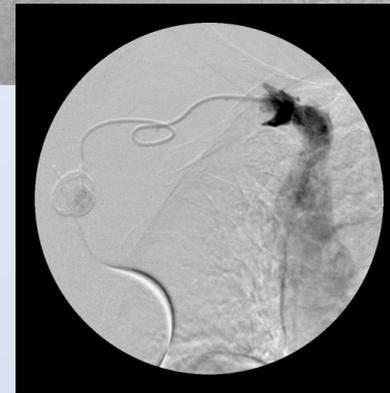
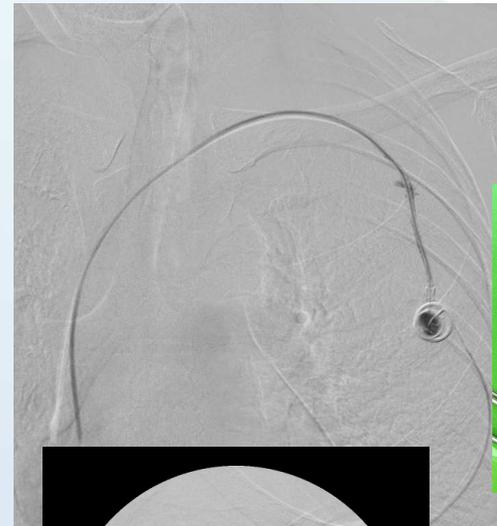
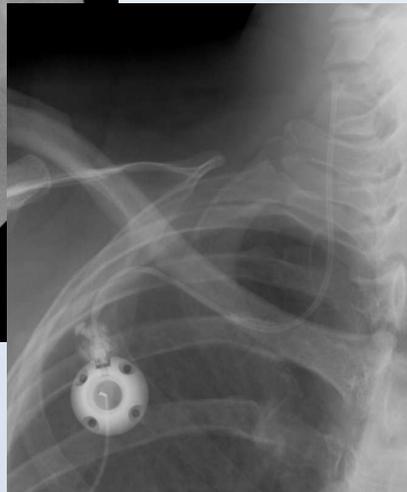
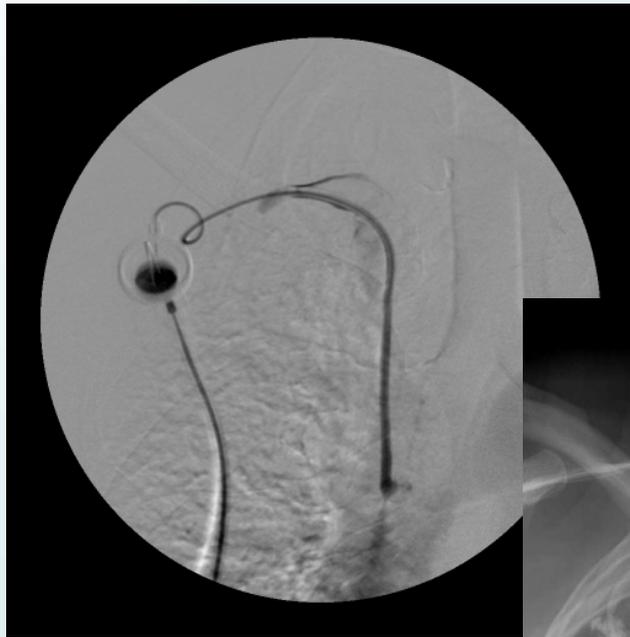
FIBRIN SHEATH

- **Thrombolysis**

- **Stripping**

- Reverse lumen
- Catheter exchange
- Guide wire manipulation
- Balloon disruption





The only solution is removal the port



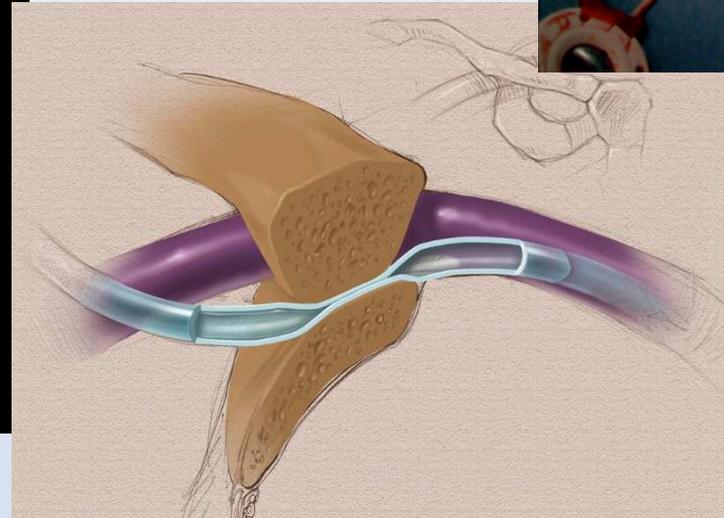
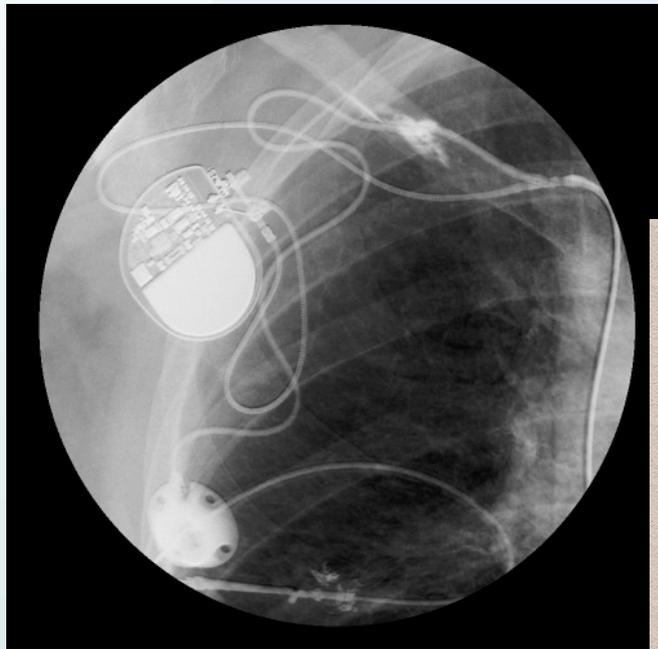
Courtesy Dr PY Marcis



**The only solution
is removal the port**

PINCH OFF SYNDROME

CAN LEAD TO BROKEN CATHETER

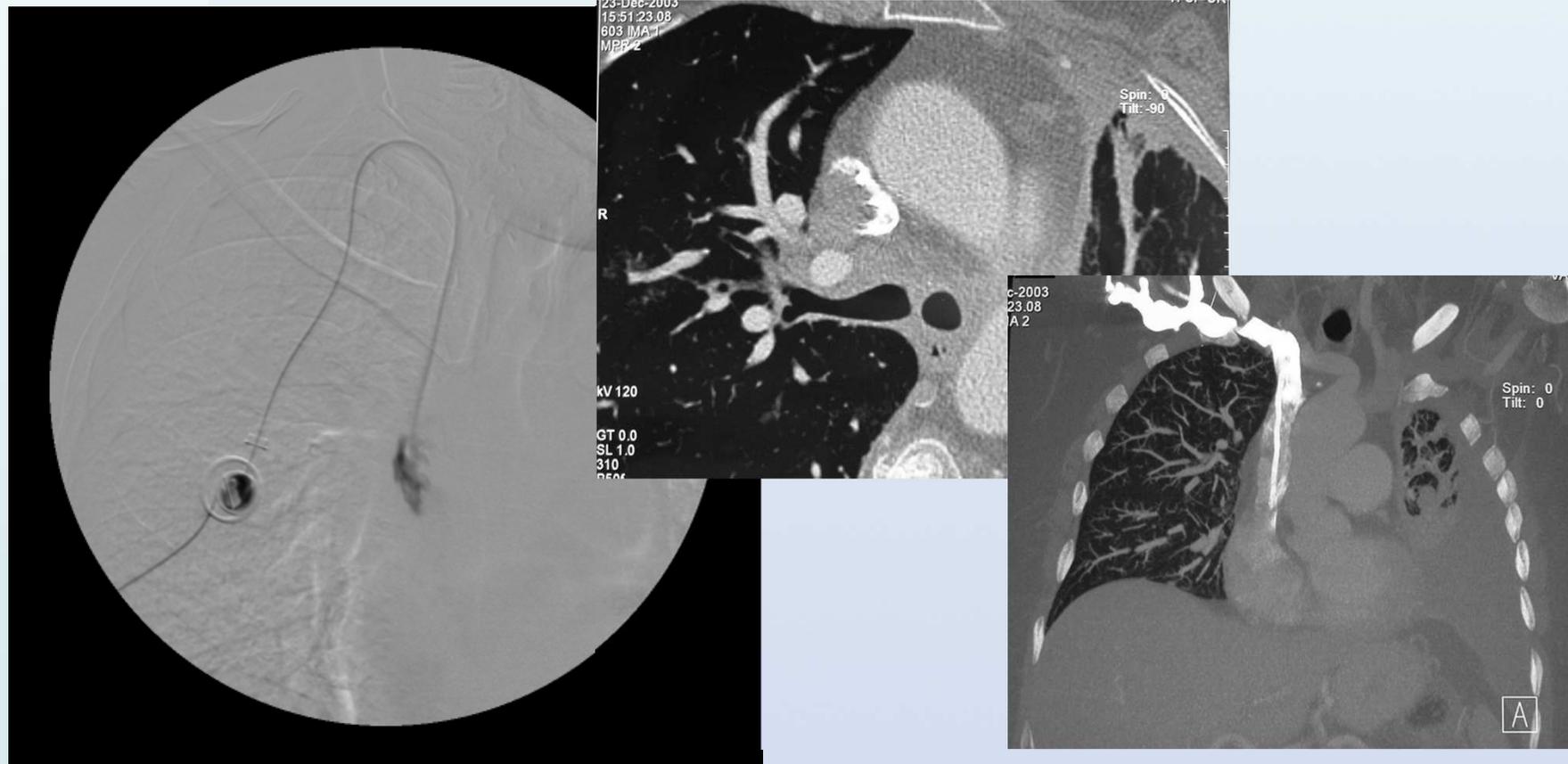


**Subclavian vein puncture at the union to
external and middle third of clavicle**

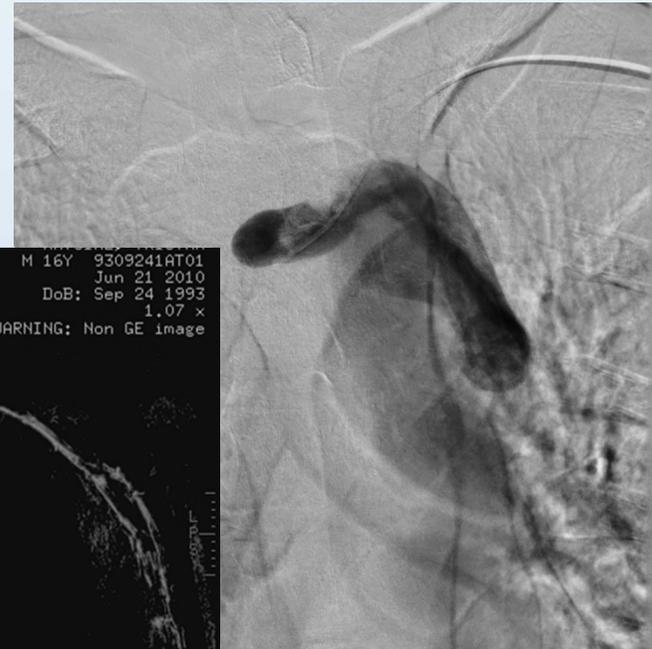
CATHETER FRAGMENT REMOVAL



Do we need another imaging modality?



Young with cystic fibrosis and multiple previous vascular access



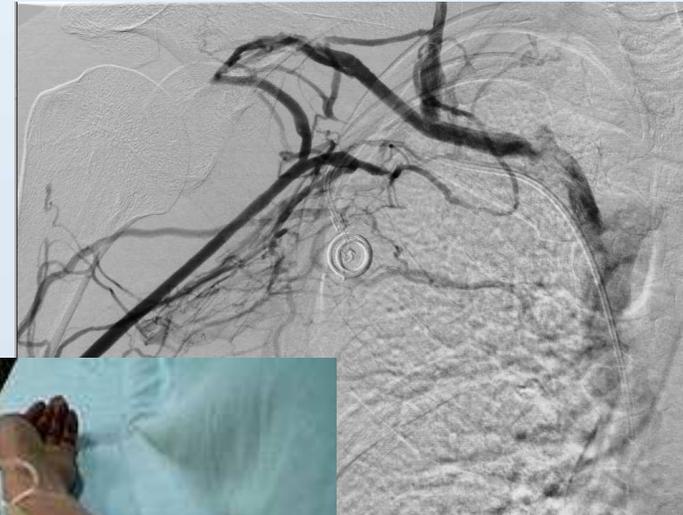
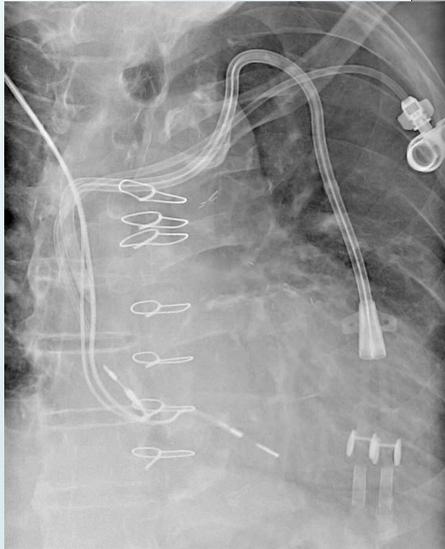
Do we need another imaging modality?

Sometimes

- If no diagnosis with thorax Xray and contrast media injection
- If difficulties to put a vascular access in a patient with previous vascular access

VENOUS PRESERVATION

- Un réseau veineux périphérique sur-exploité
- Une veine cave supérieur sur-occupée



- **Examens radiologiques**
- **Bilans biologiques**
- **Examens de médecine nucléaire**
- **Traitements IV**
- **Interventions chirurgicales**
- **...**

***UNE GRAND NOMBRE DE GESTES MÉDICAUX
NÉCESSITE UN ABORD VASCULAIRE VEINEUX***

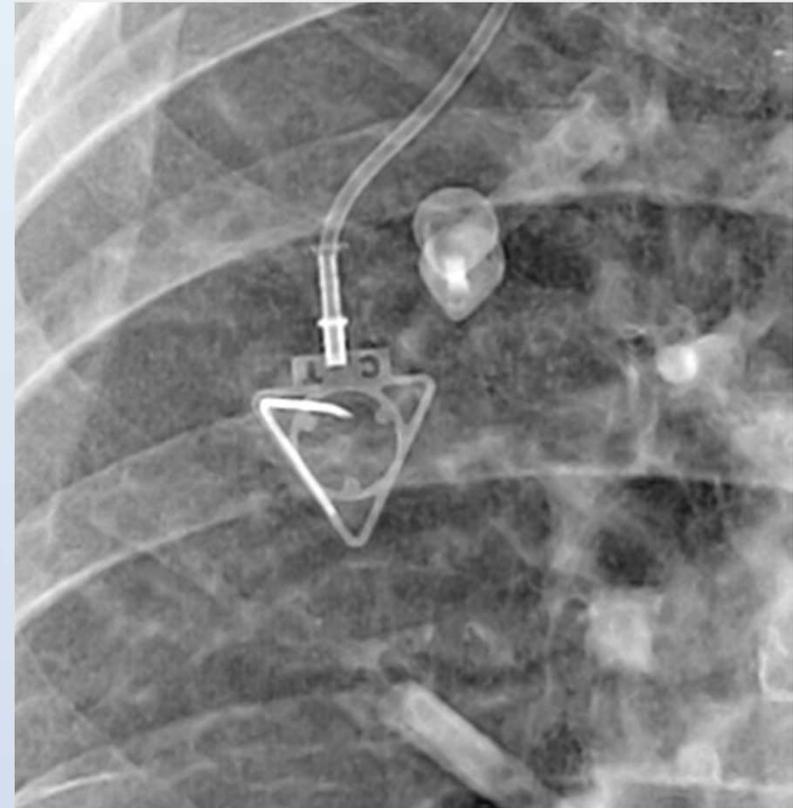
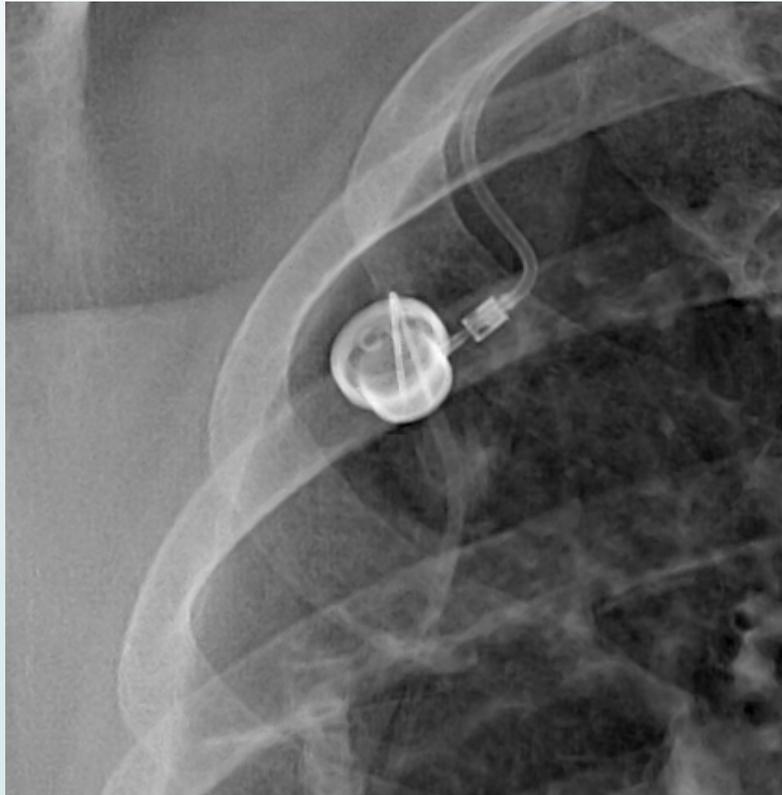
-
- **Cardiologue**
- **Néphrologue**
- **Diabétologue**
- **Anesthésiste**
- **Médecin biologiste**
- **Oncologue**
- **...**

**LA MISE EN PLACE DE L'ACCÈS
VASCULAIRE EST LE PLUS
SOUVENT DÉLÉGUÉ AUX
INFIRMIÈRES, TECHNOLOGUES, ...**

- **Bon position du patient et de l'intervenant**
- **Température adéquate dans le local**
- **Garrot serré assez longtemps**
- **Choix optimal du site de ponction**
- **Utilisation des aiguilles du plus petit calibre possibles**



HIGH PRESSURE PAC





Thank you for you attention

