

# Artères sub clavières et vertébrales

Gabrielle SARLON BARTOLI

PU PH Médecine vasculaire – CHU Timone

# Questions

**Question 1 : Le matériel à utiliser et description du déroulement d'un examen normal**

**Question 2 : Variantes anatomiques et pièges lors de l'examen échodoppler de l'axe vertébro sous clavier**

**Question 3 : Critères de sténose de l'artère vertébrale**

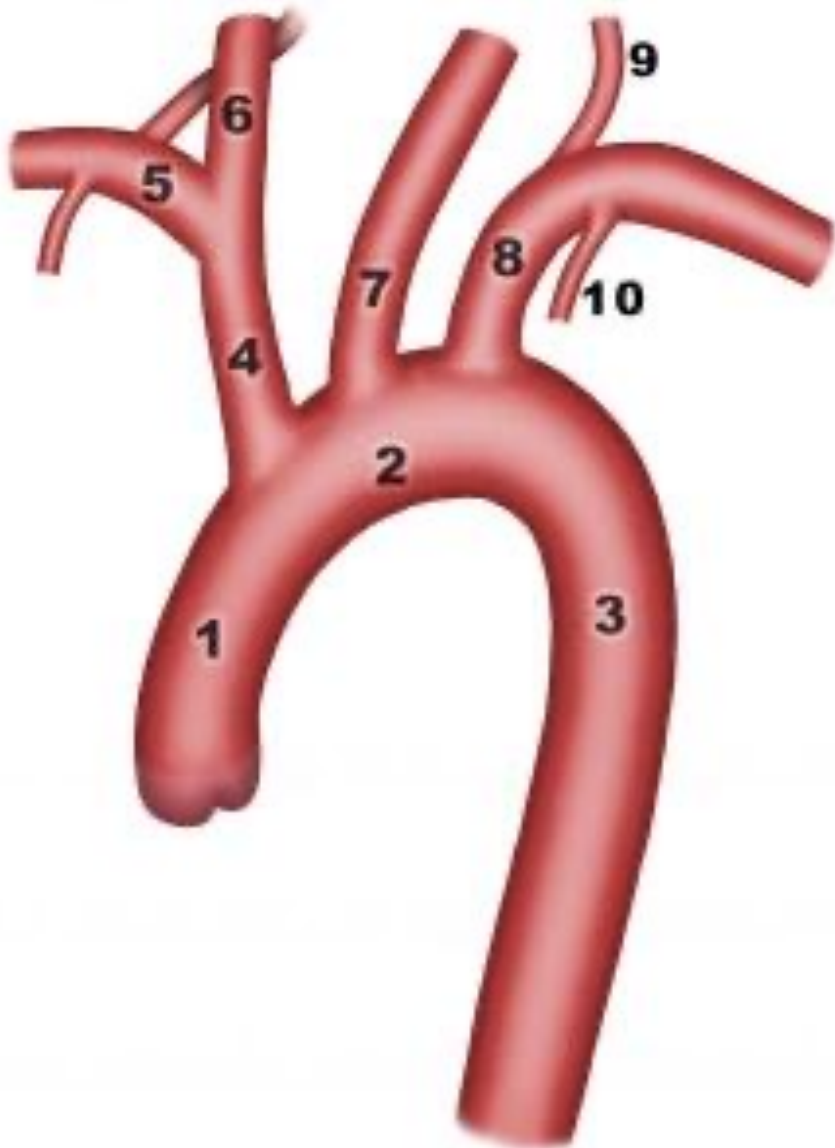
**Question 4 : Critères de sténose de l'artère sous clavière**

**Question 5 : Vol vertébro sous clavier : explication physiopathologique et description de l'aspect doppler**

# Introduction

- ❑ Indissociable de l'étude des artères carotides
- ❑ Signes cliniques divers et non spécifiques
- ❑ Variantes anatomiques
- ❑ Accès parfois difficile

# Anatomie des art sub clavières

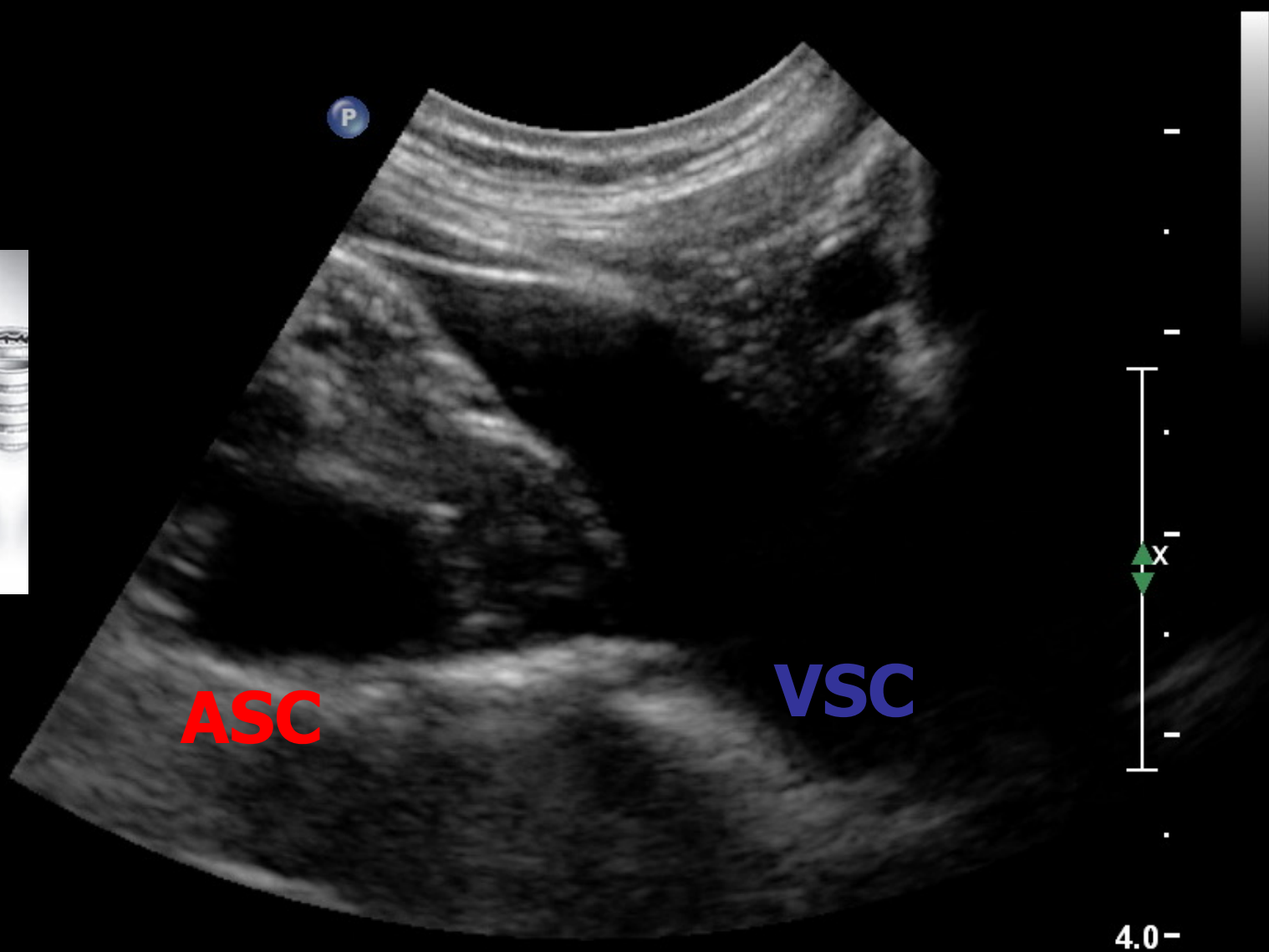
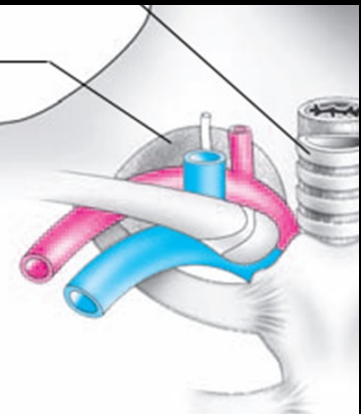


- ❑ Diamètre 10mm
- ❑ A subclavière droite :
  - Naissance du TABC
  - Trajet cervical
- ❑ A subclavière gauche :
  - Naissance de la crosse
  - Trajet thoraco-cervical
- ❑ Terminaison :
  - ❑ Artère axillaire
- ❑ Veines :
  - En avant
  - Confluence

CI 66Hz  
RV

C3

2D  
62%  
C 55  
P Arrêt  
Gén

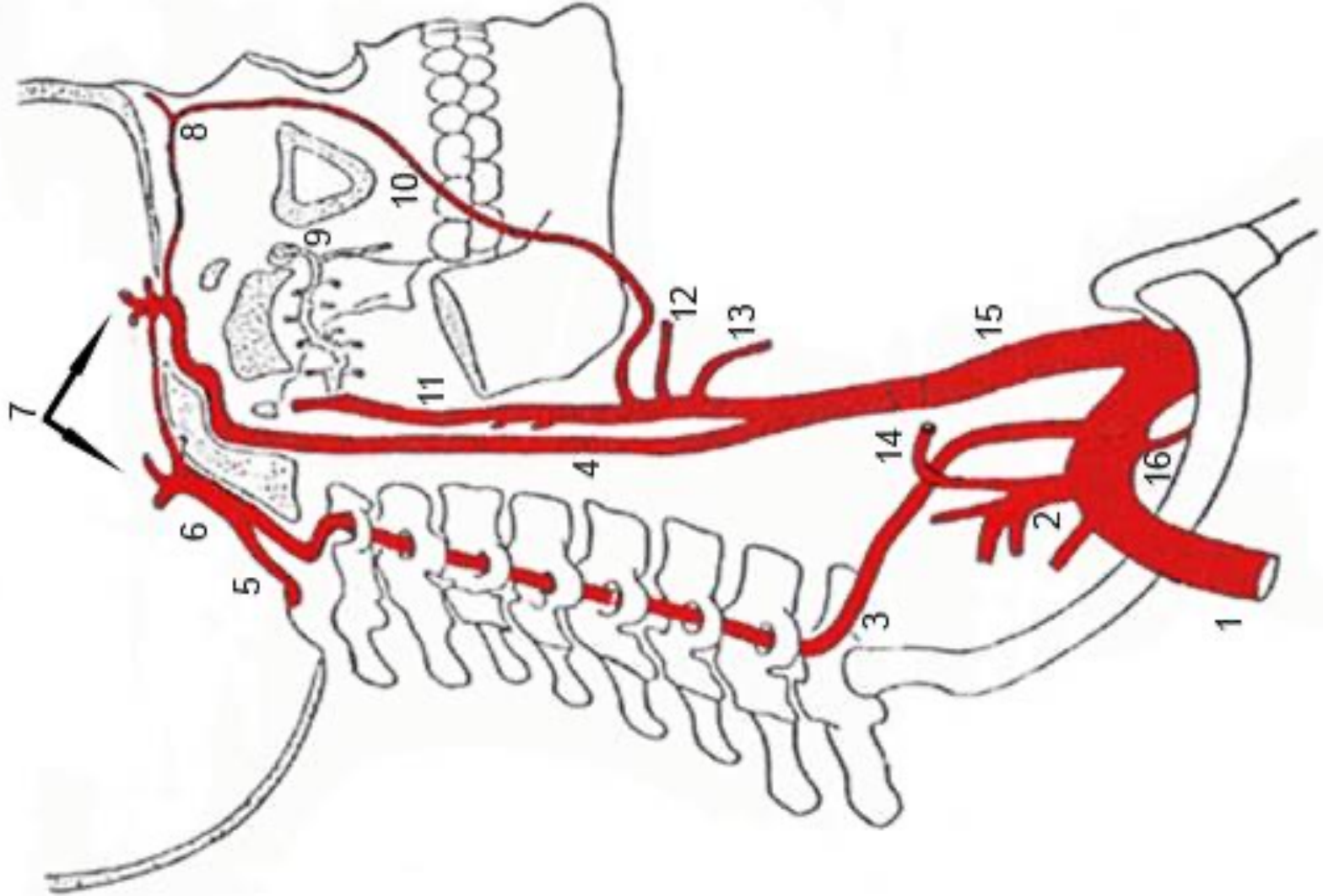


ASC

VSC

4.0-

# Anatomie des art vertébrales



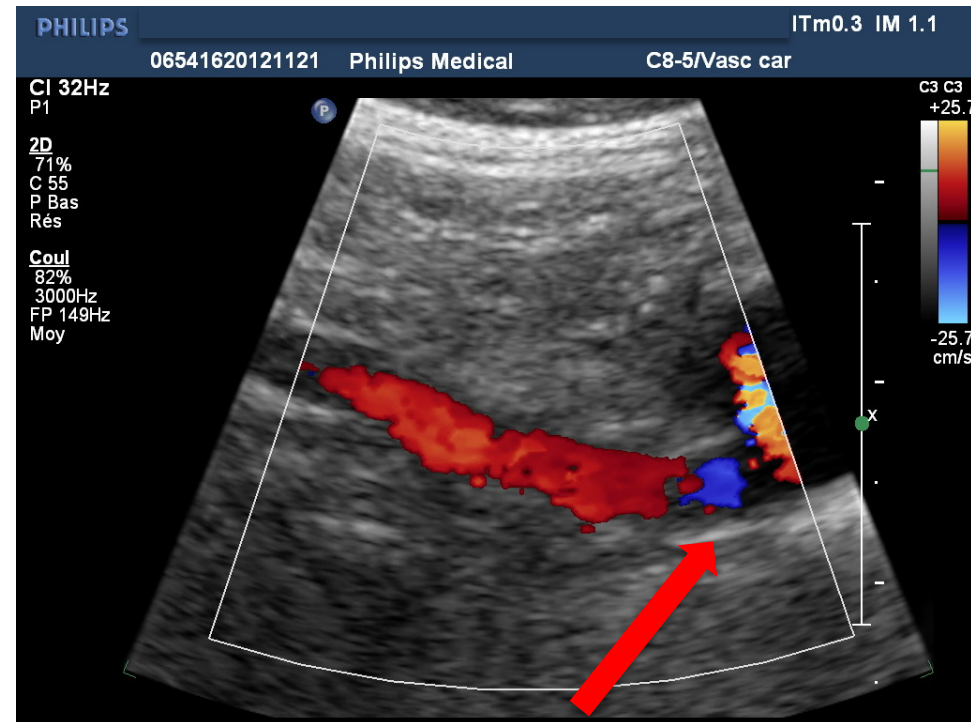
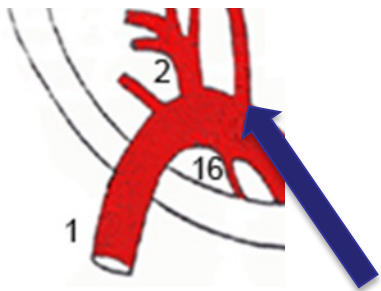
# Anatomie des art vertébrales

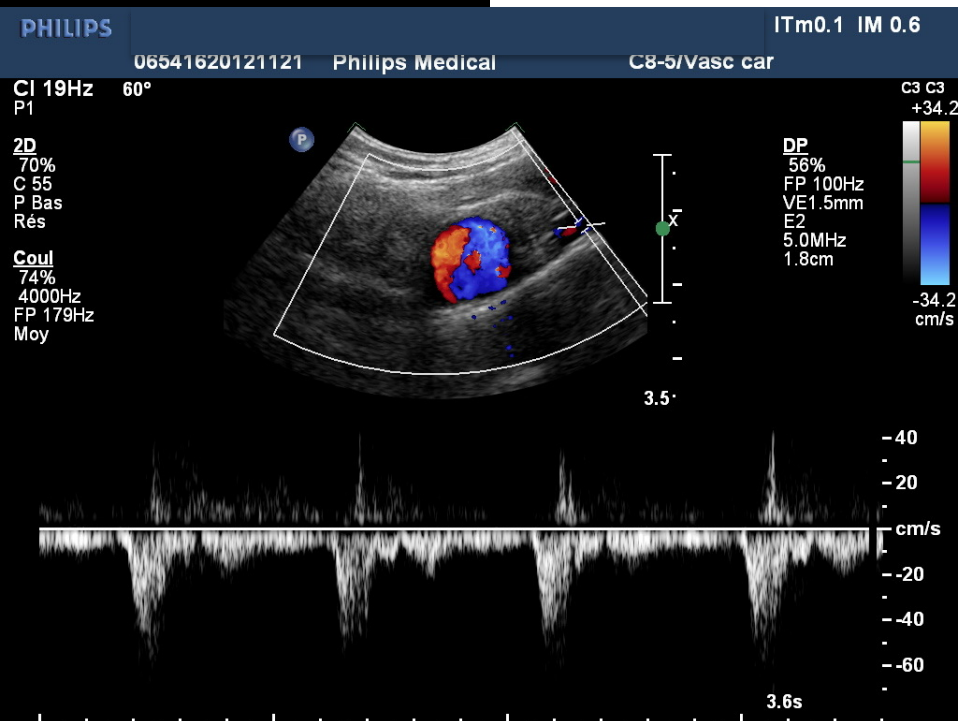
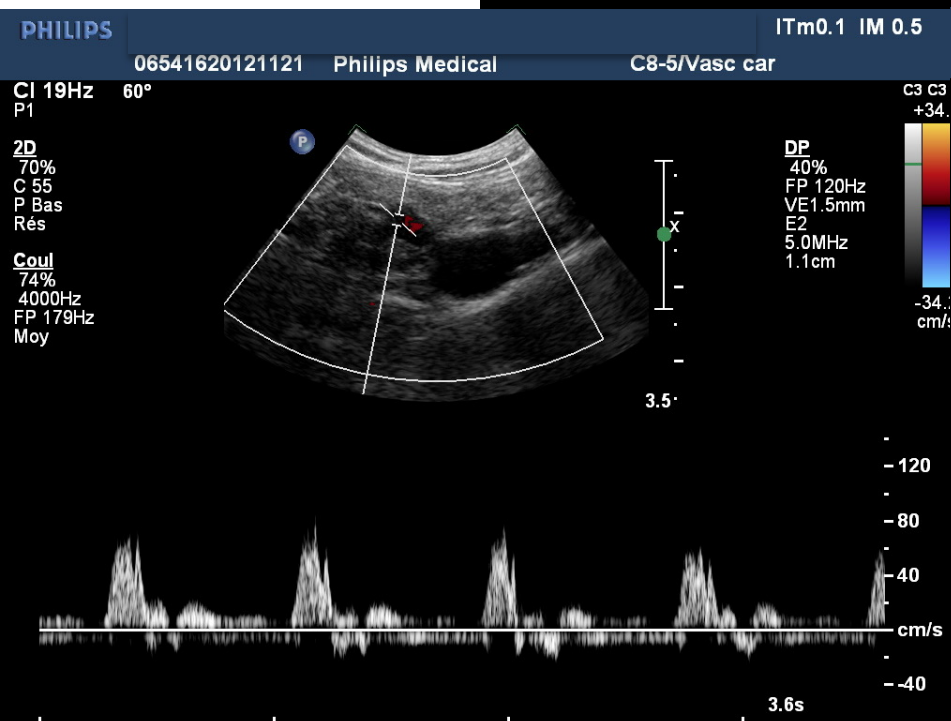
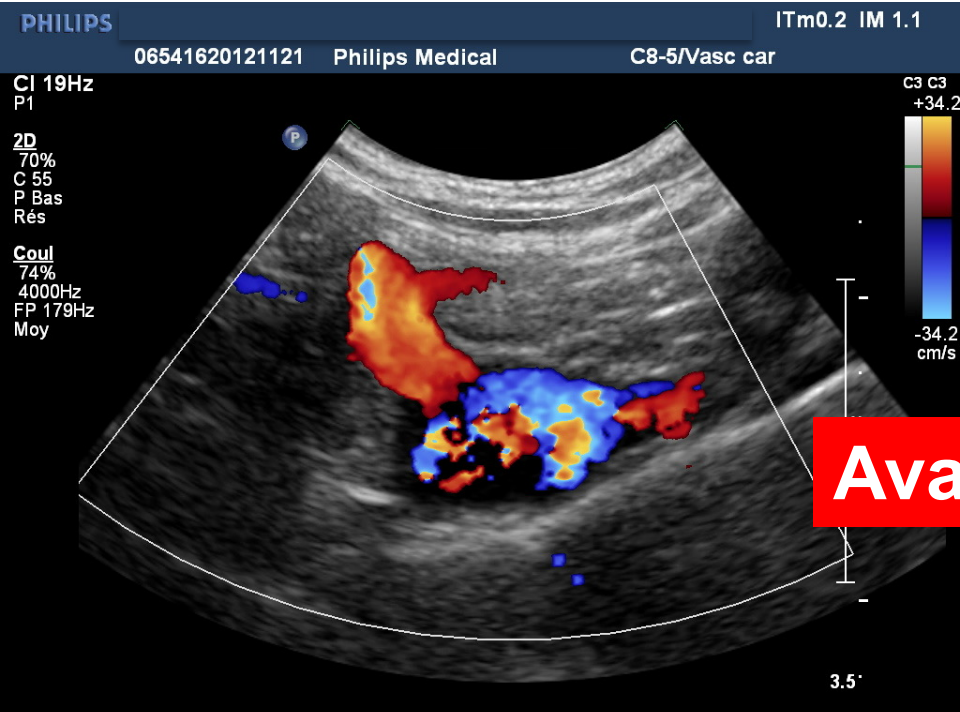
Origine : ostium V0

Face postéro-inférieure

5% naissance de la crosse (VG)

Accessible D > G







# Anatomie des art vertébrales

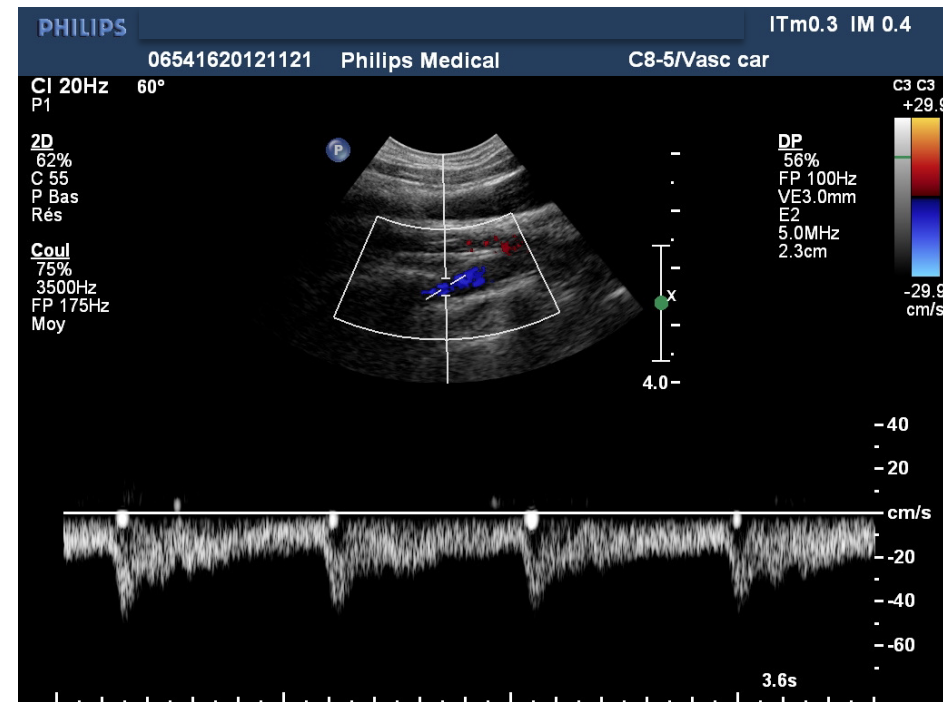
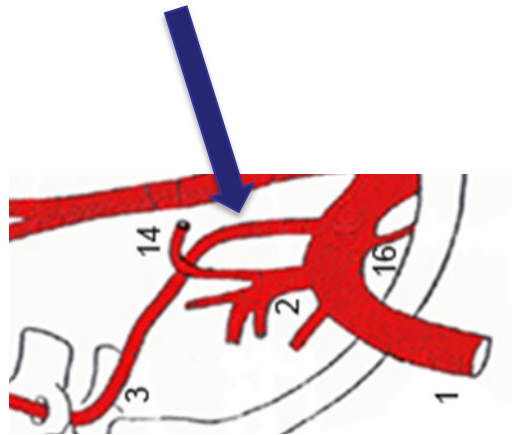
Segment pré-transversaire V1

Profond et rectiligne

Diamètre 4mm

Longueur 3-5cm

Terminaison : canal transverse de C6



# Anatomie des art vertébrales

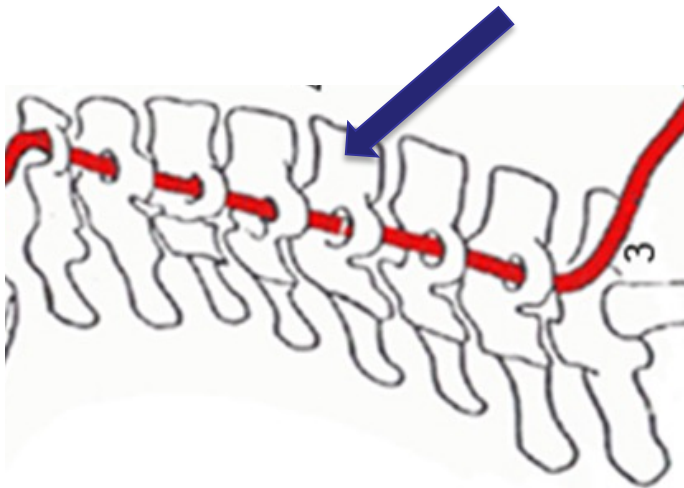
Segment transversaire V2

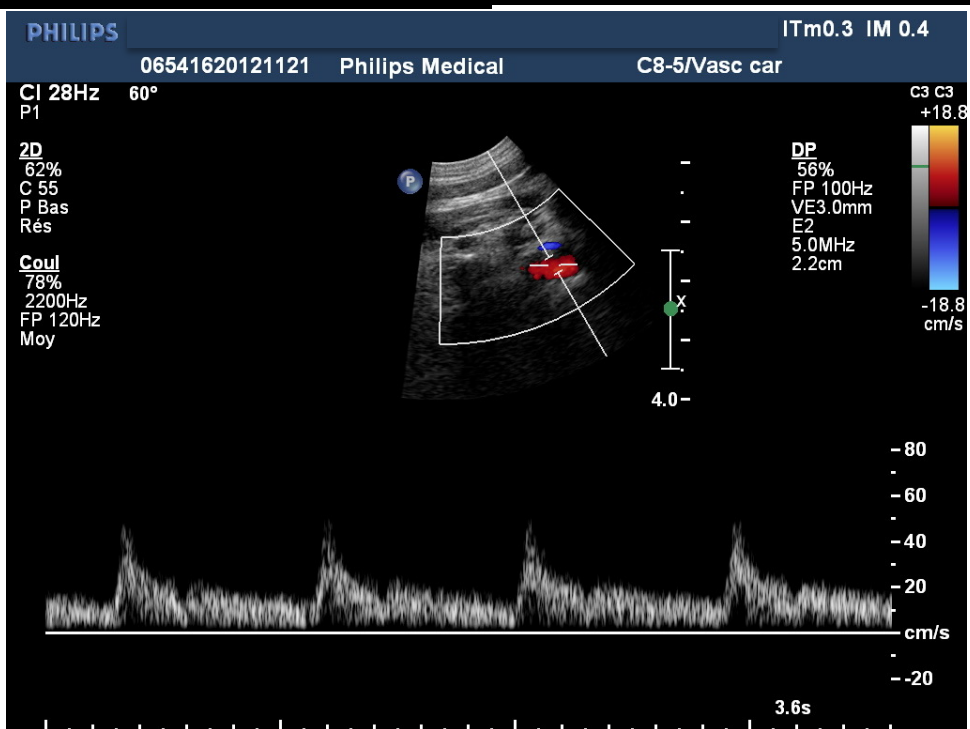
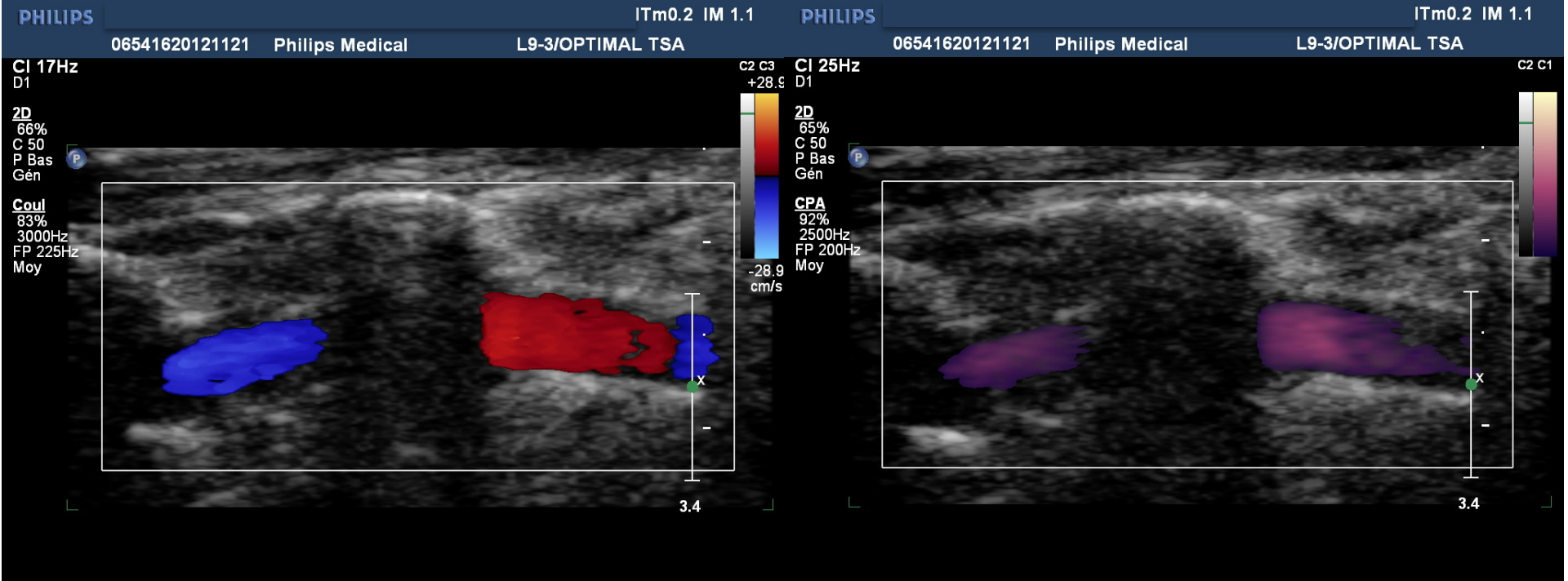
Rectiligne et vertical

Dans le canal transversaire des vertèbres cervicales

Veine en avant

Terminaison : C2



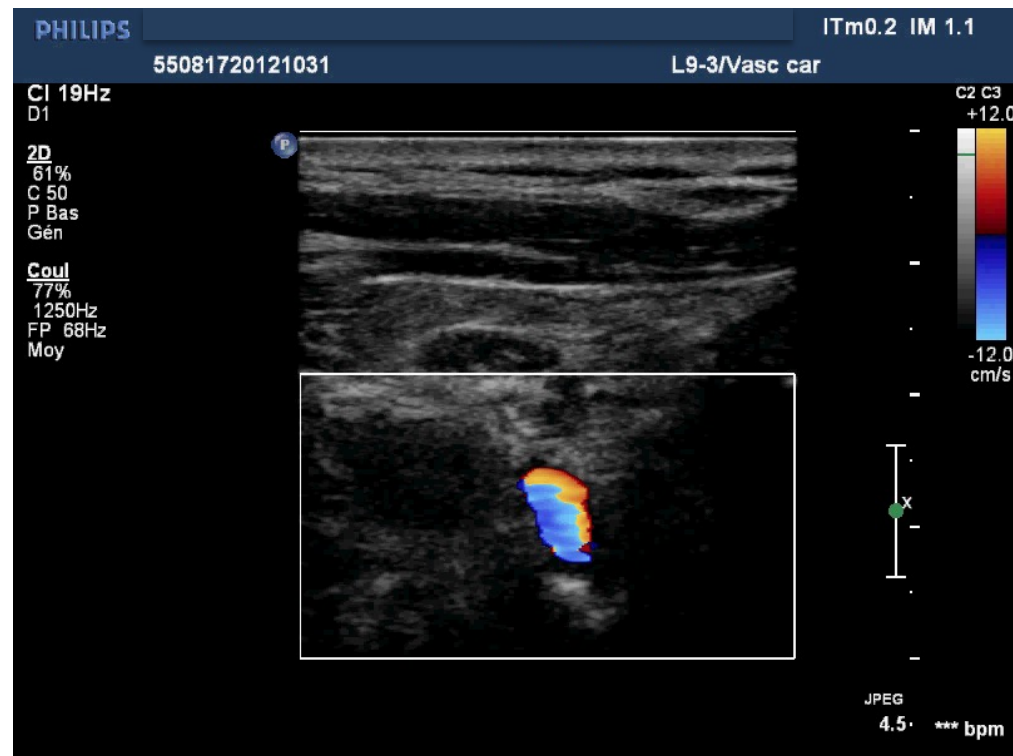
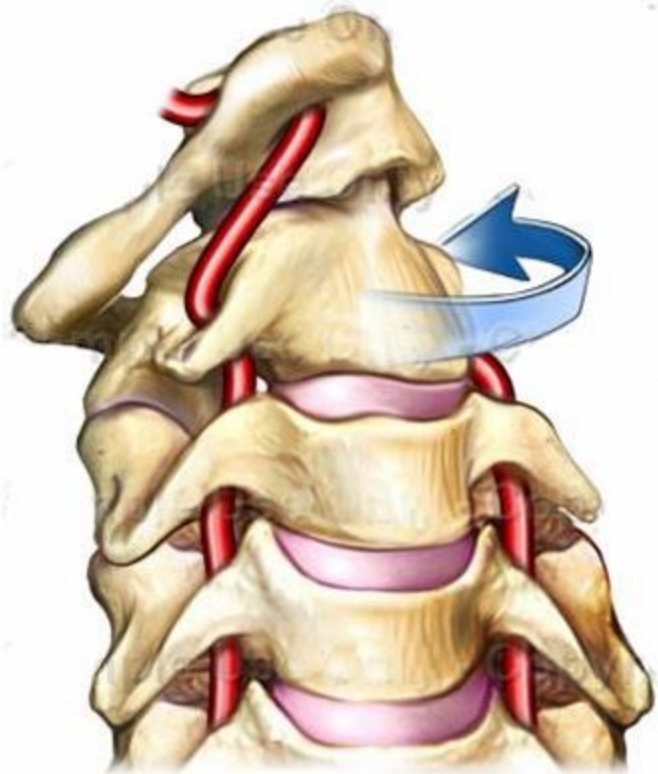


# Anatomie des art vertébrales

Segment atlanto-axoïdien V3

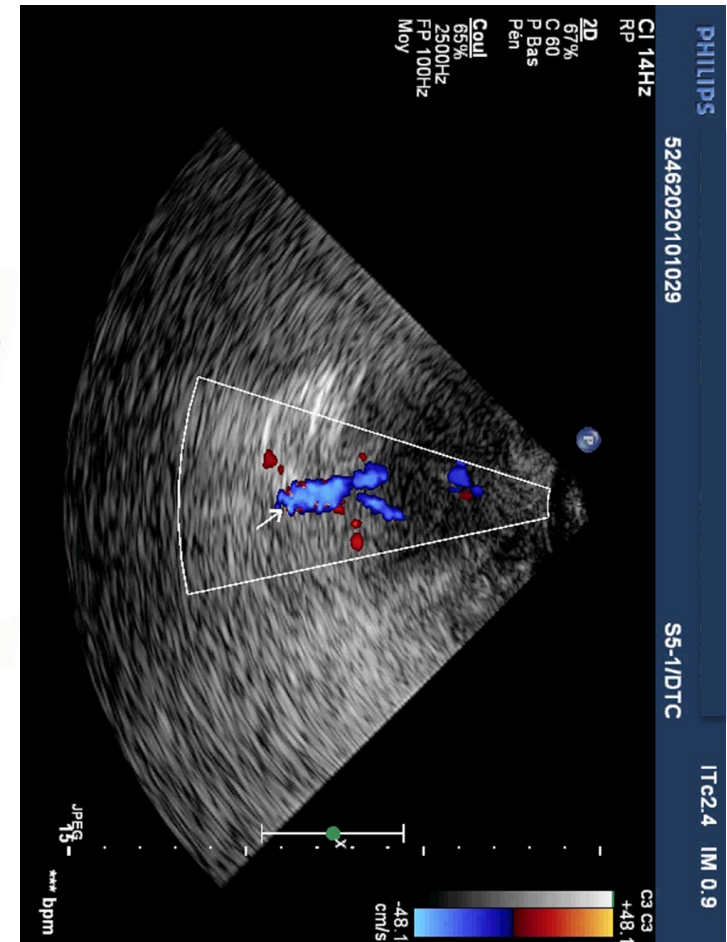
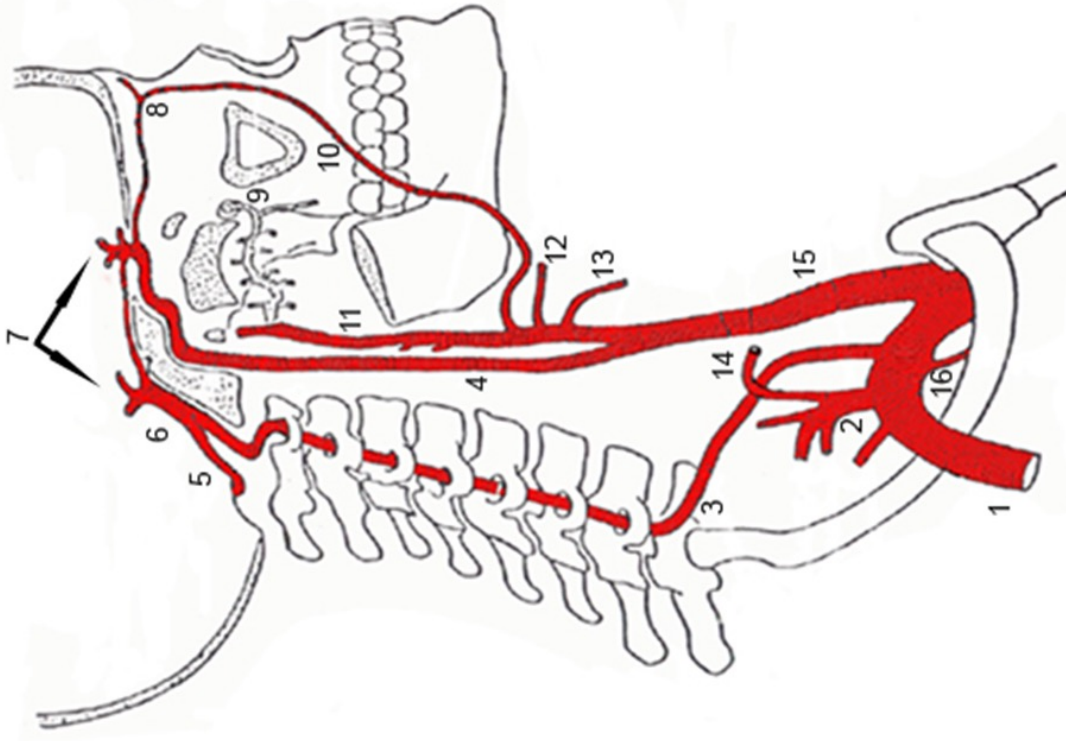
Boucle de sécurité au niveau de la masse latérale de l'atlas

Terminaison : trou occipital



# Anatomie des art vertébrales

Segment intra-crânien V4  
Terminaison en PICA dans 25%

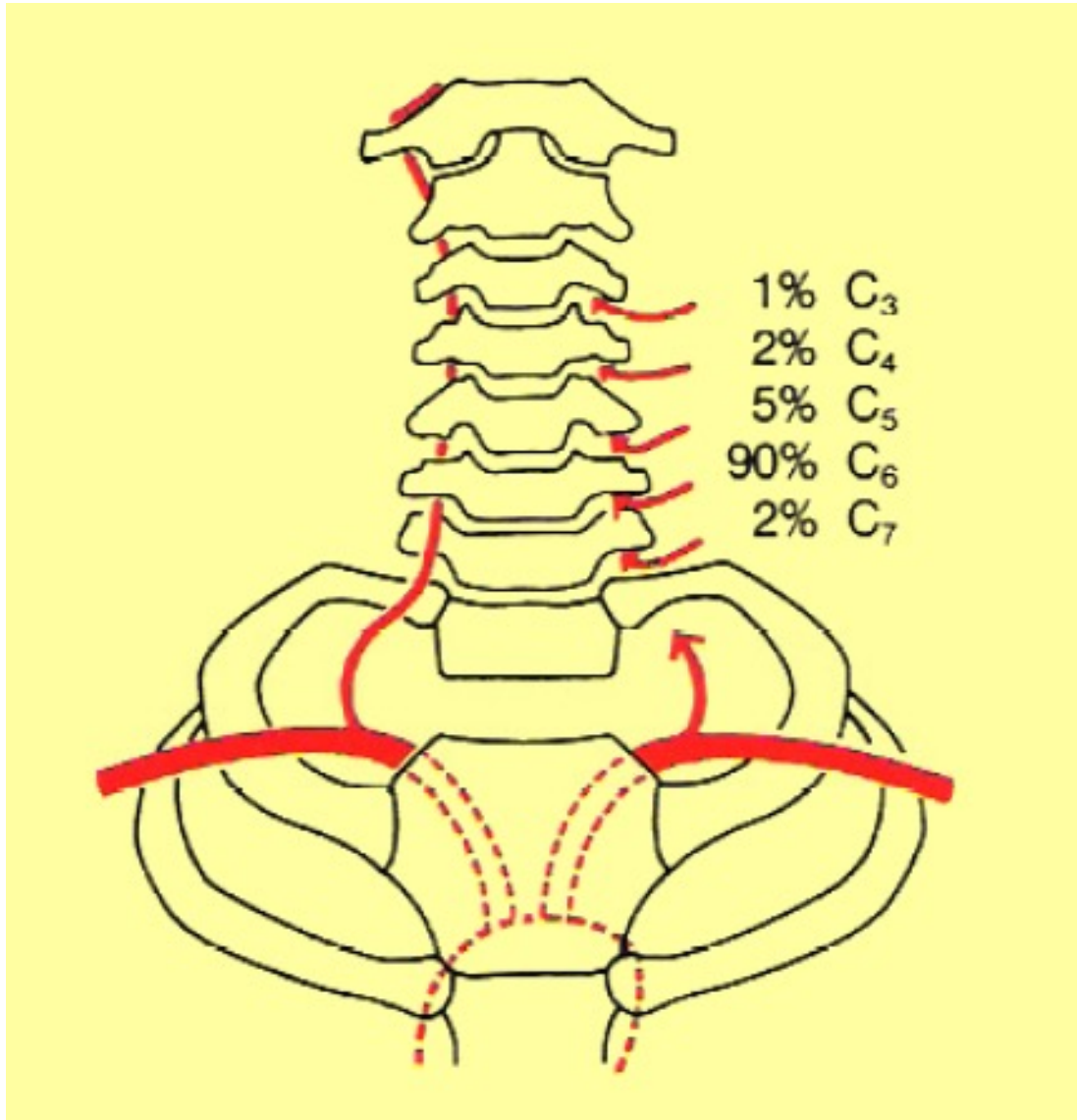


# Variantes anatomiques

## □ Calibre :

- Asymétrie fréquente 70%
  - Dominance 50% VG et 25% VD
- Hypoplasie 10% (diamètre <2mm)
  - IR augmenté
- Agénésie 5% (VD)

# Variantes anatomiques



**V2**

# Techniques

- ❑ Mesure de la PA aux deux bras
- ❑ Sondes linéaire ou convexes
- ❑ Haute ou basse fréquence



**ASC**  
**V0**  
**V1**  
**V3**



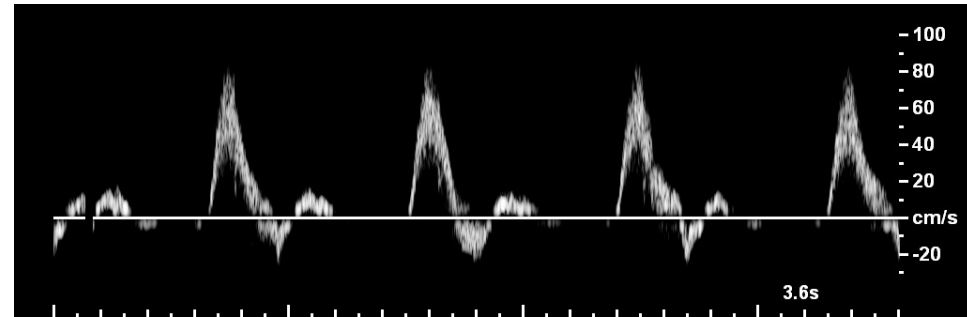
**V2**



# Spectres normaux

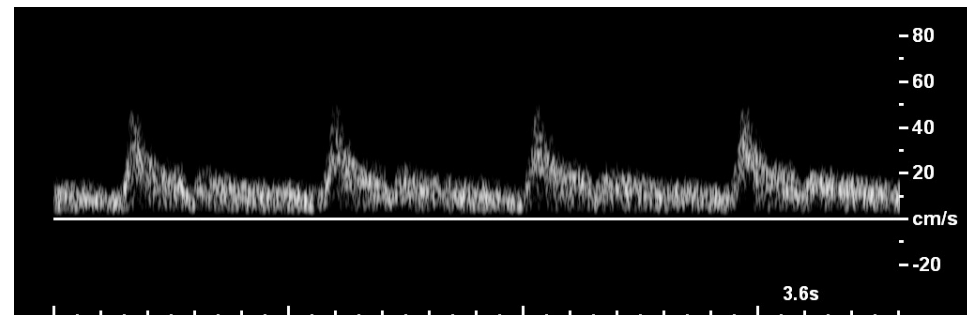
## ASC

VSM 80-150cm/sec  
Flux tri-phasique



## AV

VSM 20-60cm/sec  
Flux basse résistance



# Pièges

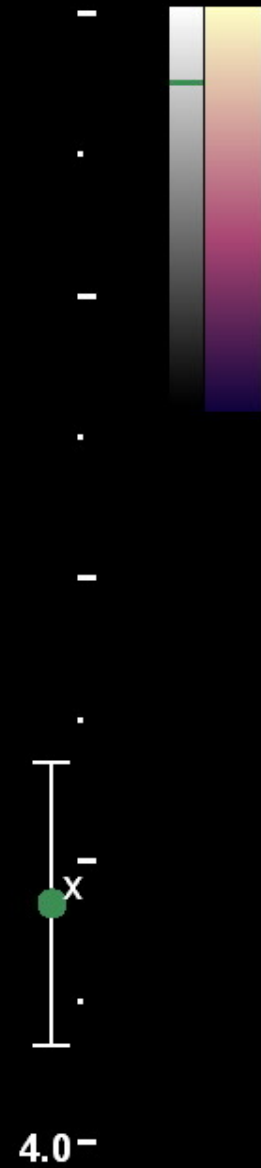
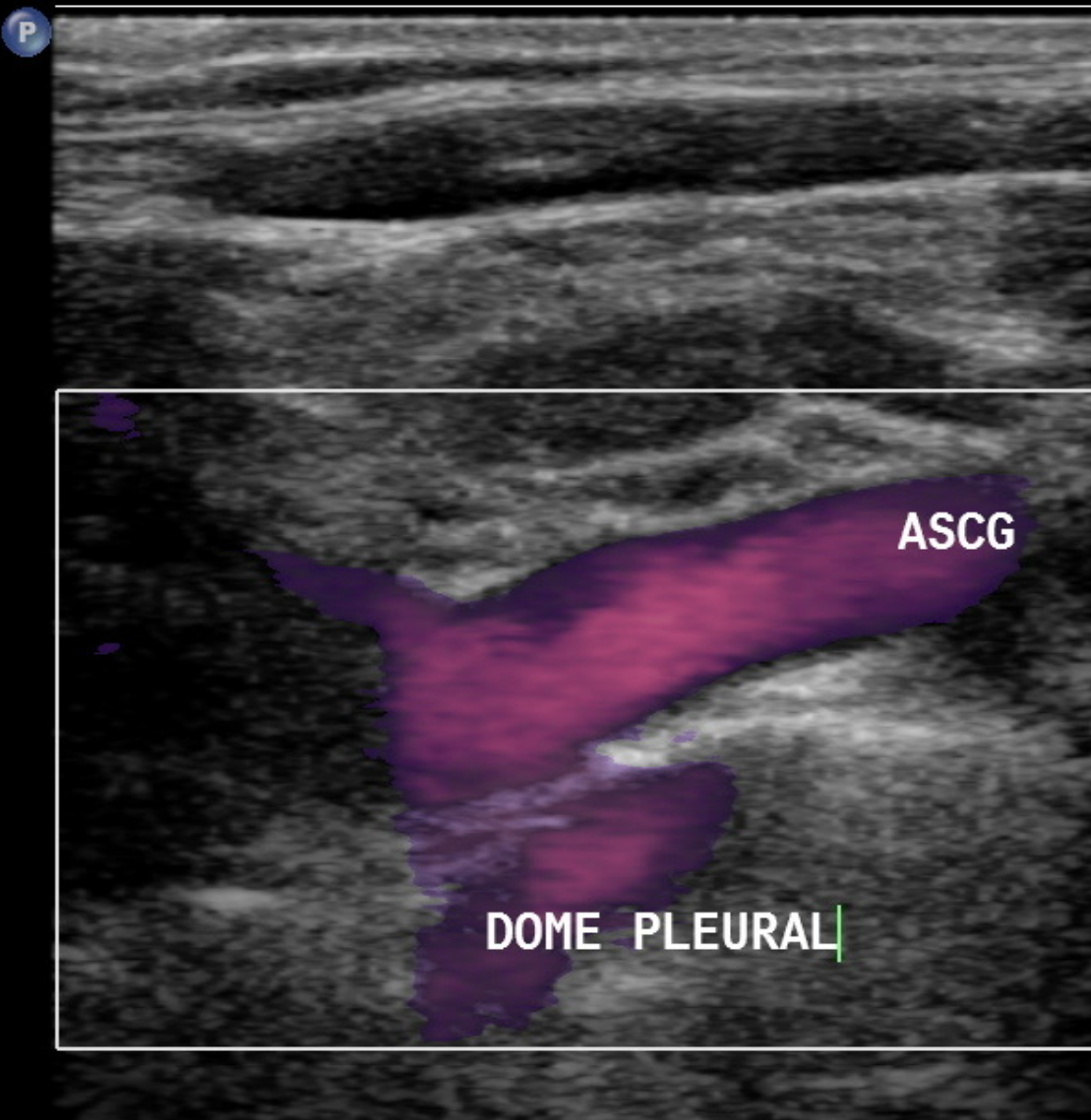
- ❑ Confondre l'artère sub-clavière et l'image en miroir : dôme pleural
- ❑ Confondre V1 et tronc thyro-cervical : goitre
- ❑ Confondre V3 et ACI : sonde trop antérieure

CI 20Hz  
D1

2D  
65%  
C 50  
P Bas  
Gén

CPA  
85%  
2500Hz  
FP 200Hz  
Moy

C2 C1



# Pathologies

- ❑ Athérome : sténose et occlusion
- ❑ Vol vertébro-subclavier
- ❑ Dysplasie fibromusculaire
- ❑ Dissection
- ❑ Artérite inflammatoire
- ❑ Maladie du tissu élastique

# Athérome

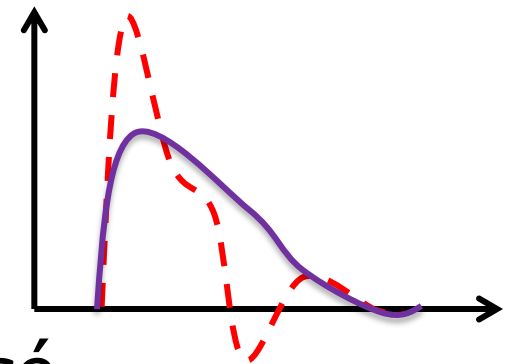
Fréquence	Ostium AV	Bulbe carotidien	Athérome intra-crânien
Autopsie (1)	14-39%	32-72%	31-45%
Angiographie (2)	18-41%	34-68%	28-45%

1 : Schwartz, Br Med J 1961

2 : Hass, JAMA 1968

# Sténose sub clavière

- $\geq 50\%$  : VSM  $> 200\text{cm/sec}$
- $\geq 70\%$  :
  - VMS  $> 200\text{cm/sec}$
  - Turbulences
  - Flux d'aval démodulé et amorti
  - Flux vertébral alternant ou inversé
  - Epreuve d'hyperhémie
  - Asymétrie de PA humérale :
    - ✓ Différence  $> 15\text{ mmHg}$



# Hyperhémie post ischémique

- ❑ Sonde en V2 homolatéral
- ❑ Brassard huméral gonflé à pression supra systolique
- ❑ Démasque un vol vertébral

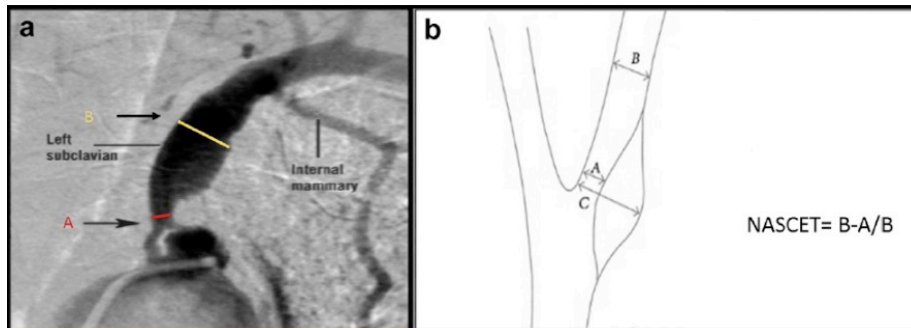
# Validation of subclavian duplex velocity criteria to grade severity of subclavian artery stenosis

Albeir Y. Mousa, MD,<sup>a</sup> Ramez Morkous, MD,<sup>b</sup> Mike Broce, BA,<sup>b</sup> Michael Yacoub, MD,<sup>a</sup> Andrew Sticco, MD,<sup>a</sup> Ravi Viradia, MD,<sup>a</sup> Mark C. Bates, MD,<sup>a</sup> and Ali F. AbuRahma, MD,<sup>a</sup> Charleston, WVa

- ❑ 177 patients
- ❑ 268 artères
- ❑ Comparaison US vs angiographie

## ARTICLE HIGHLIGHTS

- **Significance:** This article reports ultrasound criteria to detect subclavian artery obstruction.
- **Type of Research:** Retrospective cohort study
- **Take Home Message:** Peak systolic velocity of  $>240$  cm/s in the subclavian artery had a good sensitivity to detect  $>70\%$  stenosis
- **Recommendation:** It is suggested that ultrasound has high sensitivity for detecting subclavian artery stenosis compared with angiography.
- **Strength of Recommendation:** 2. Weak
- **Level of Evidence:** C. Low or very low



**Conclusions:** In patients with known or suspected disease involving the great vessels, a subclavian artery flow velocity exceeding 240 cm/s seems to be predictive of significant subclavian stenosis. Thus, we propose new SDUS VC, for predicting subclavian artery stenosis. However, because of the use of a convenience sample, it is possible that the current proposed cutoff point might need to be adjusted for other populations. (J Vasc Surg 2017;■:1-7.)

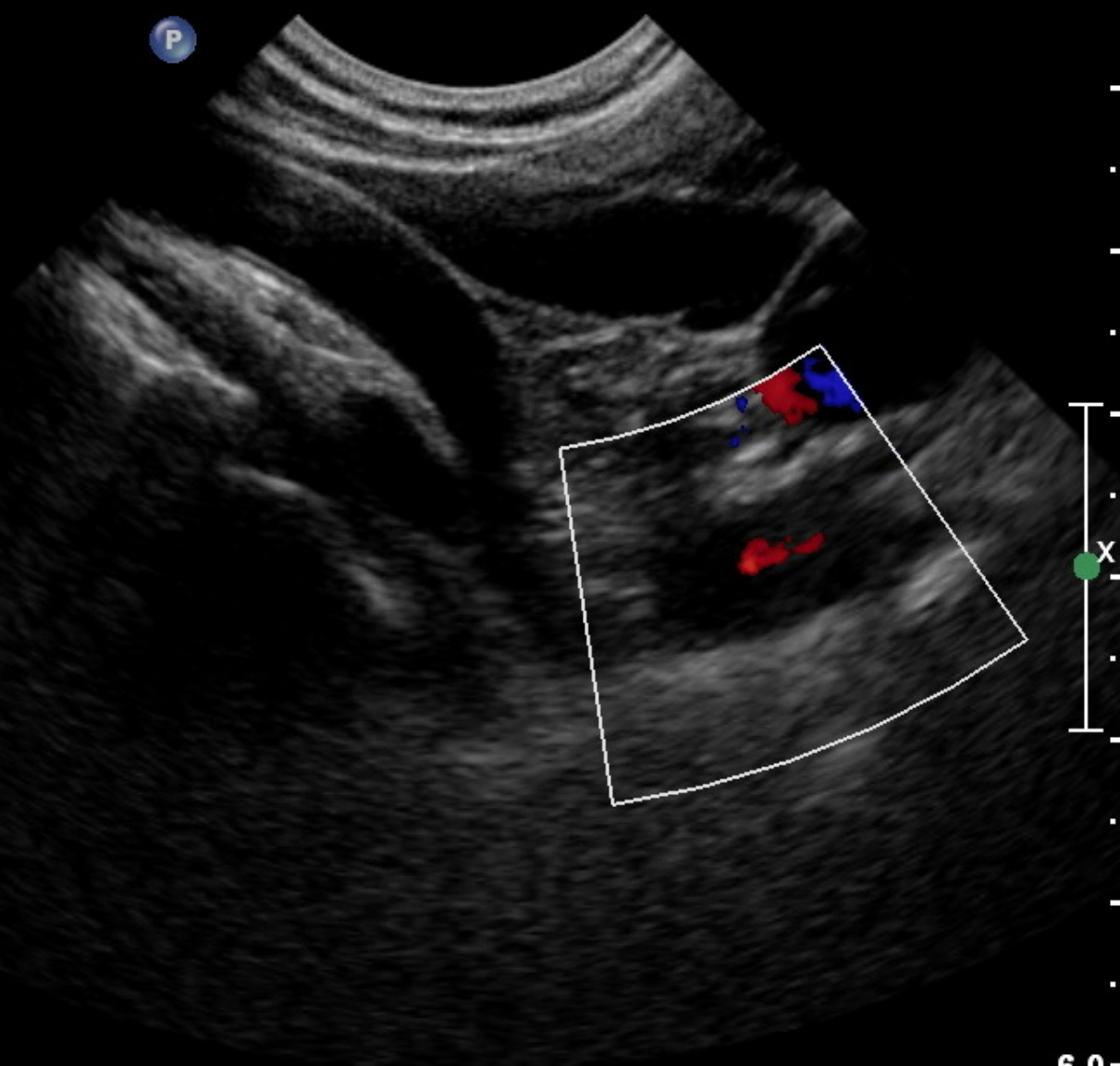
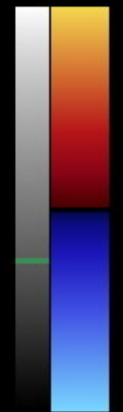


CI 22Hz  
P1

2D  
69%  
C 55  
P Bas  
Rés

Coul  
77%  
4000Hz  
FP 139Hz  
Moy

C3 C3  
+34.2



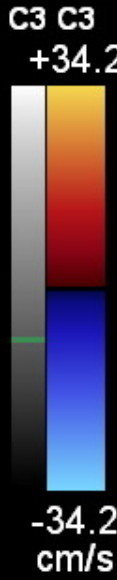
6.0-

CI 23Hz  
P1

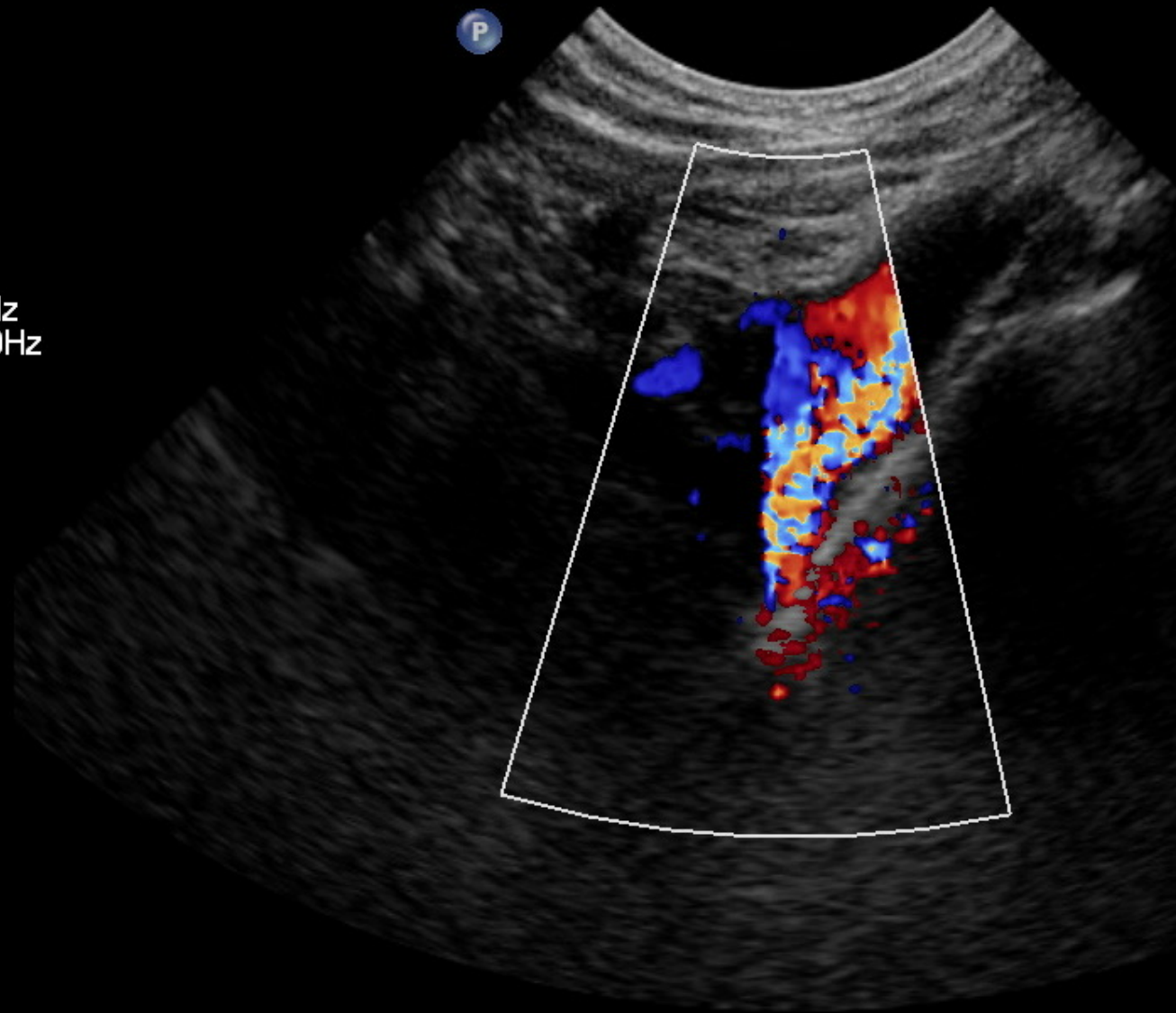
2D  
66%  
C 55  
P Bas  
Rés

Coul  
77%  
4000Hz  
FP 139Hz  
Moy

P



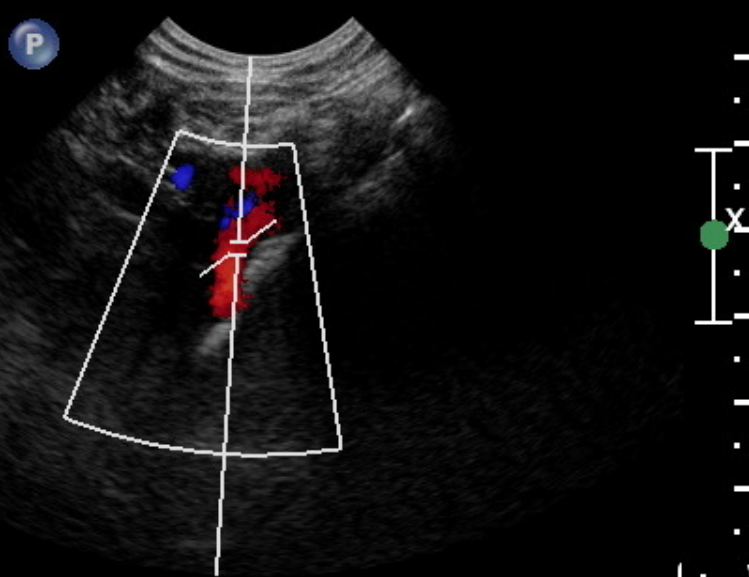
5.0-



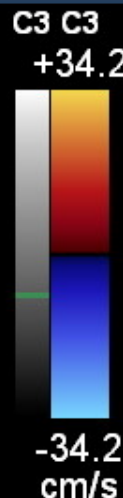
CI 21Hz 50°  
P1

2D  
69%  
C 55  
P Bas  
Rés

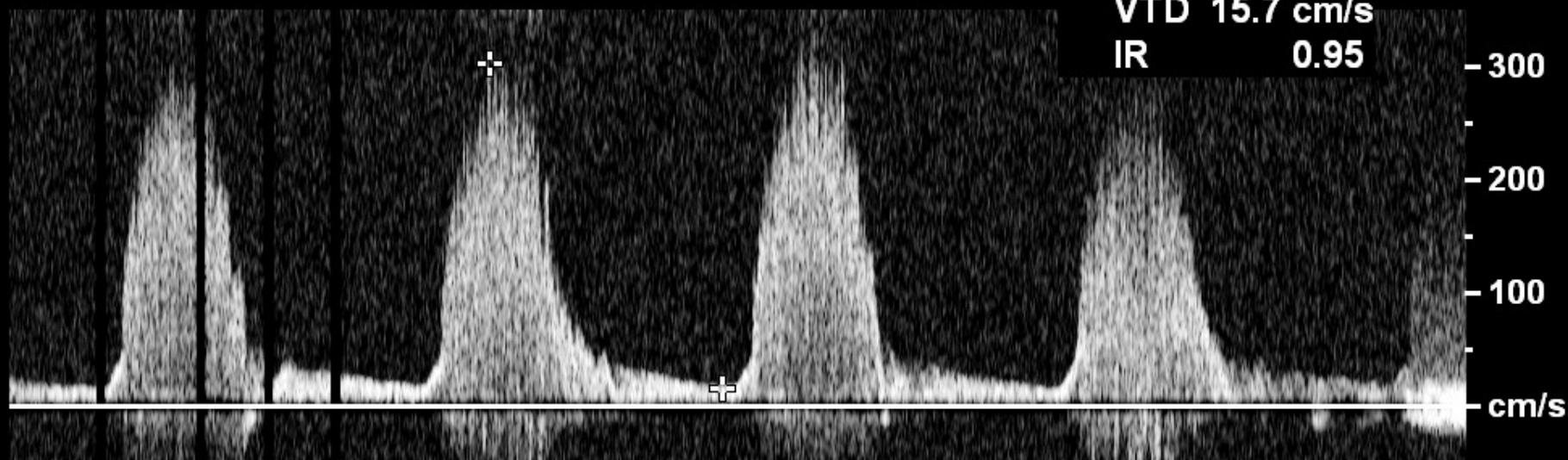
Coul  
77%  
4000Hz  
FP 139Hz  
Moy



DP  
84%  
FP 200Hz  
VE1.5mm  
E2  
5.0MHz  
2.2cm



VSM 302 cm/s  
VTD 15.7 cm/s  
IR 0.95



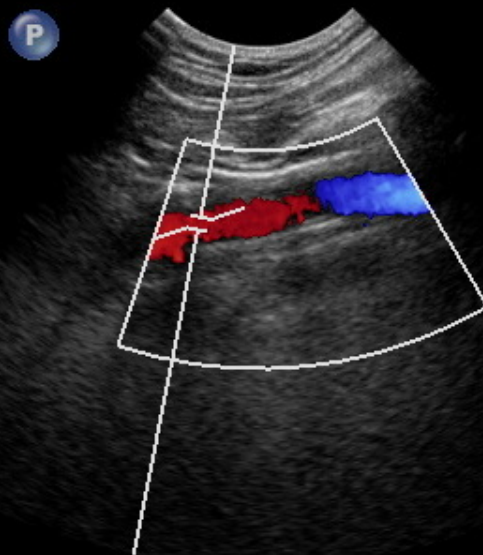
3.6s

CI 17Hz 60°  
P1

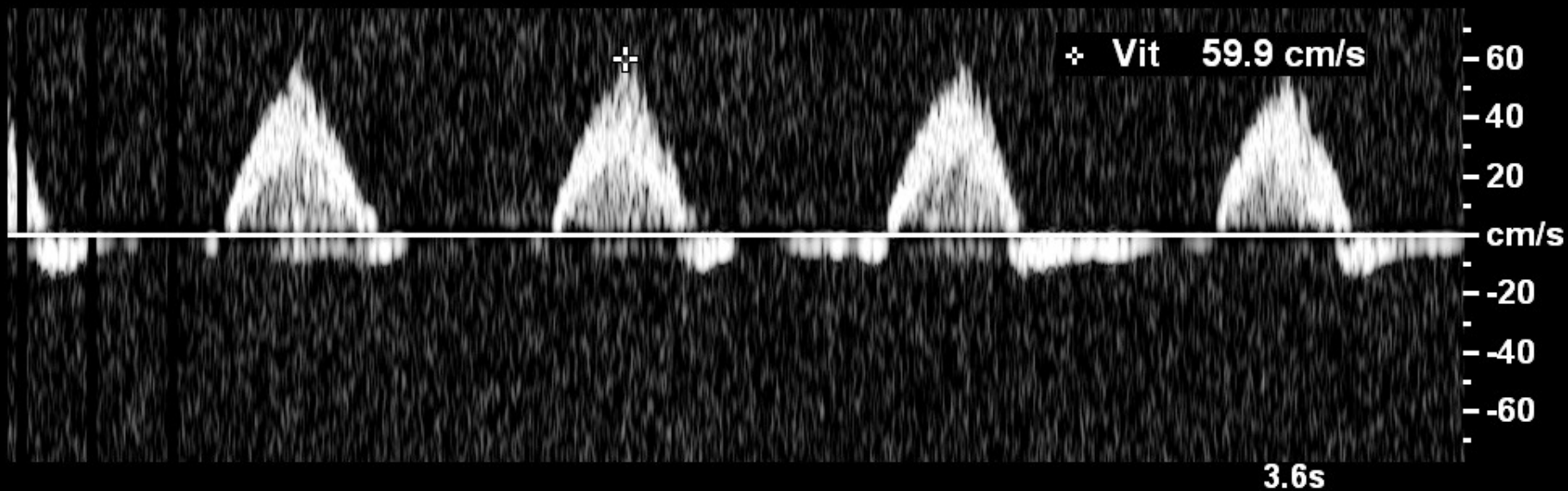
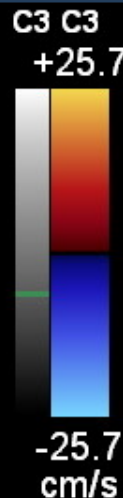
2D  
73%  
C 55  
P Bas  
Rés

Coul  
77%  
3000Hz  
FP 119Hz  
Moy

AX G



DP  
84%  
FP 110Hz  
VE1.5mm  
E2  
5.0MHz  
2.1cm



CI 27Hz 60°  
P1

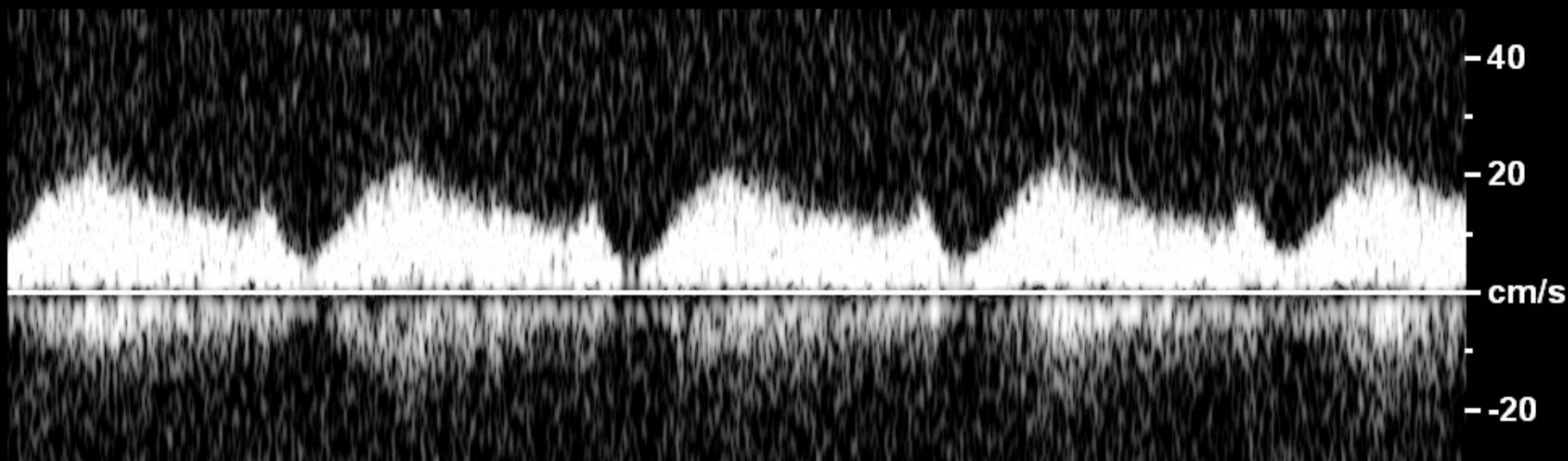
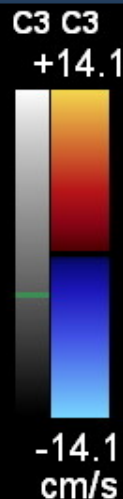
2D  
61%  
C 55  
P Bas  
Rés

Coul  
77%  
1650Hz  
FP 82Hz  
Moy

V2 G



DP  
84%  
FP 70Hz  
VE1.5mm  
E2  
5.0MHz  
1.6cm



3.6s

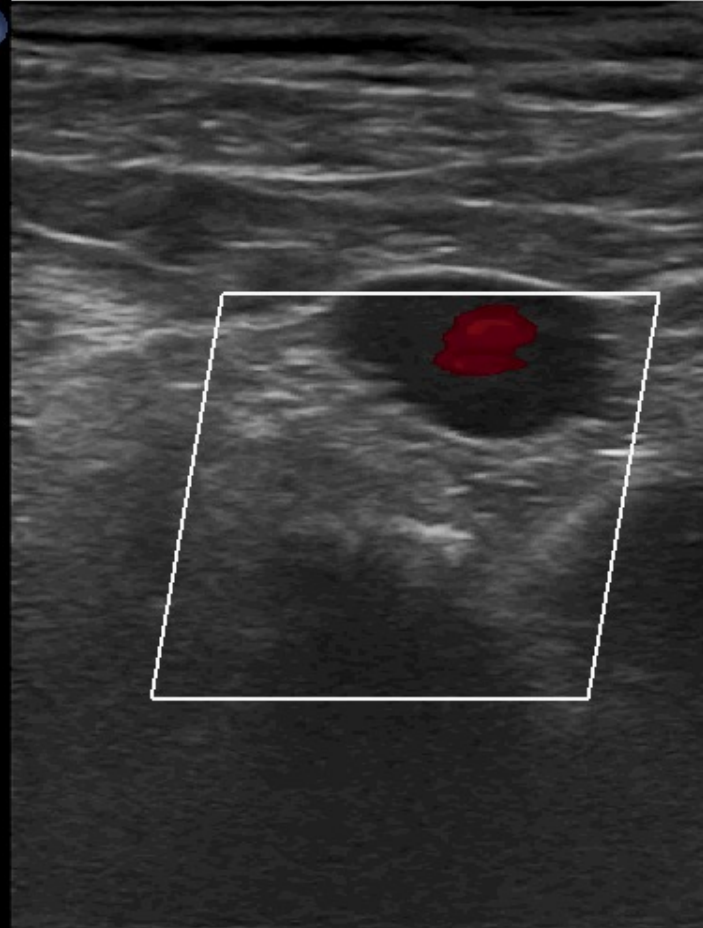
TSA  
L12-3  
18Hz

2D  
67%  
R Dyn 56  
P Bas  
HRés

Coul  
56%  
3000Hz  
FP 225Hz  
4.0MHz

SS CLAV D

P



X2

5.0cm

\*\*\* bpm

00151320201116

HOPITAL DE LA TIMONE

Affiniti 70G

ITm0.3

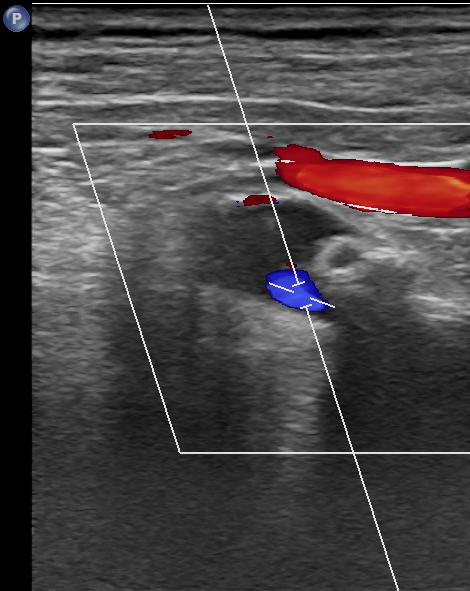
IM 0.3

TSA

L12-3

15Hz

52°



✦ Vit 281 cm/s

M5 M3  
+28.9



5.0cm-

2D

67%

R Dyn 56

P Bas

HRés

Coul

56%

3000Hz

FP 225Hz

4.0MHz

DP

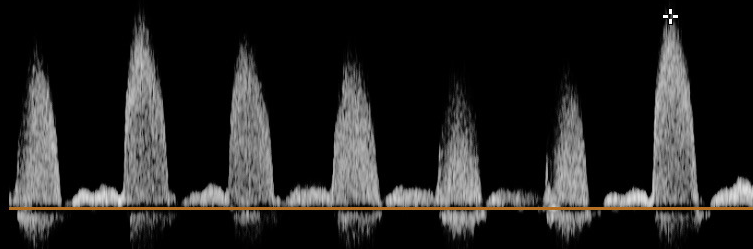
50%

FP 120Hz

VE2.0mm

3.6MHz

2.6cm



-300

-200

-100

-cm/s

--100

F# 39

36mm/s

# Sténose subclavière : localisation

- ❑ Avant la naissance de la vertébrale :
  - Pré-vertébrale
  - Signes neurologiques à l'effort du MS (vol)
  - Athérome
  
- ❑ Post-vertébrale :
  - Claudication du membre supérieur
  - Inflammation



# Sténose vertébrale

- ❑ 247 patients, étude rétrospective
  
- ❑ Comparaison écho vs angio
  
- ❑ Nombre de patients
  - 30 avec AV normale ou sténose < 50%
  - 76 avec sténose 50-69%
  - 116 avec sténose 70-99%

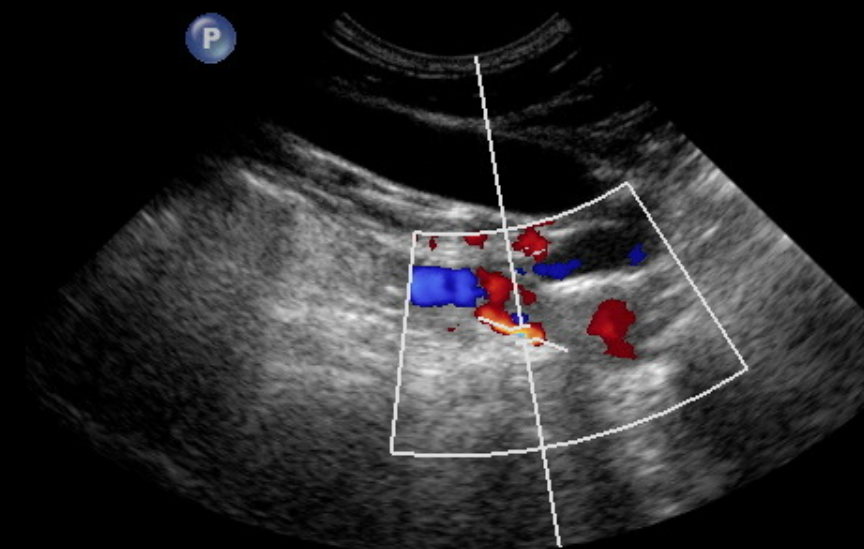
# Sténose vertébrale

Sténose	VSM	VTD	Rapport systolique
<b>50-69%</b>	> 140 cm/sec	> 35 cm/sec	> 2,1
<b>70-99%</b>	<b>&gt; 210 cm/sec</b>	<b>&gt; 50 cm/sec</b>	<b>&gt; 4</b>

CI 14Hz 60°  
P1

2D  
67%  
C 55  
P Bas  
Rés

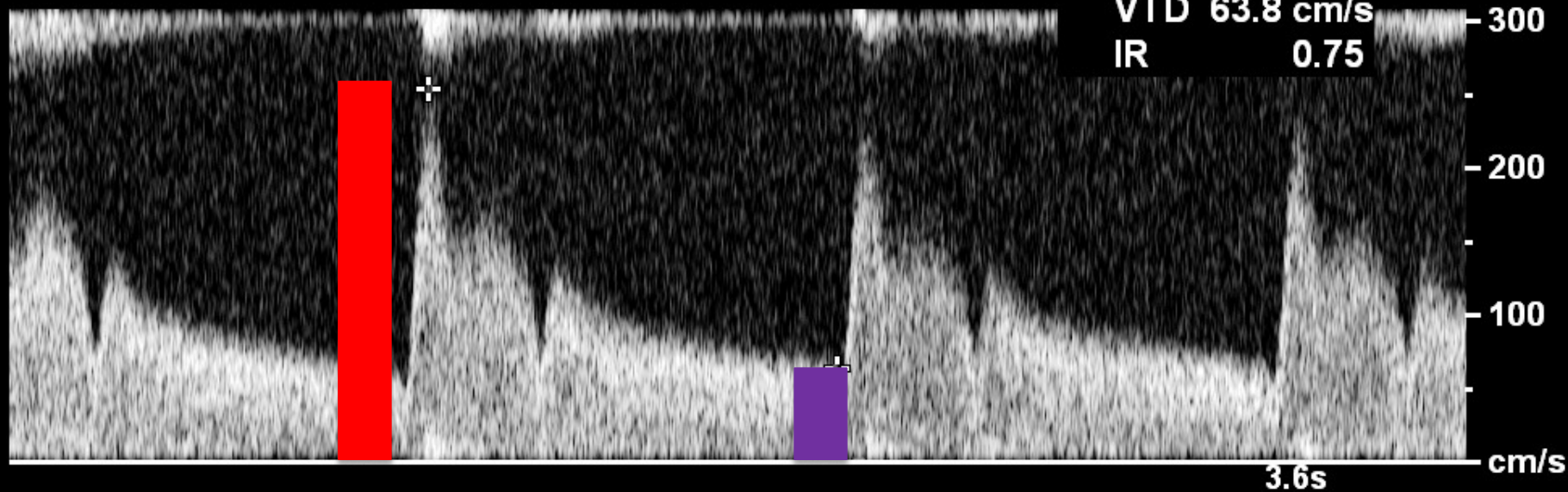
Coul  
78%  
3000Hz  
FP 149Hz  
Moy



DP  
84%  
FP 150Hz  
VE1.5mm  
E2  
5.0MHz  
2.8cm



VSM 254 cm/s  
VTD 63.8 cm/s  
IR 0.75

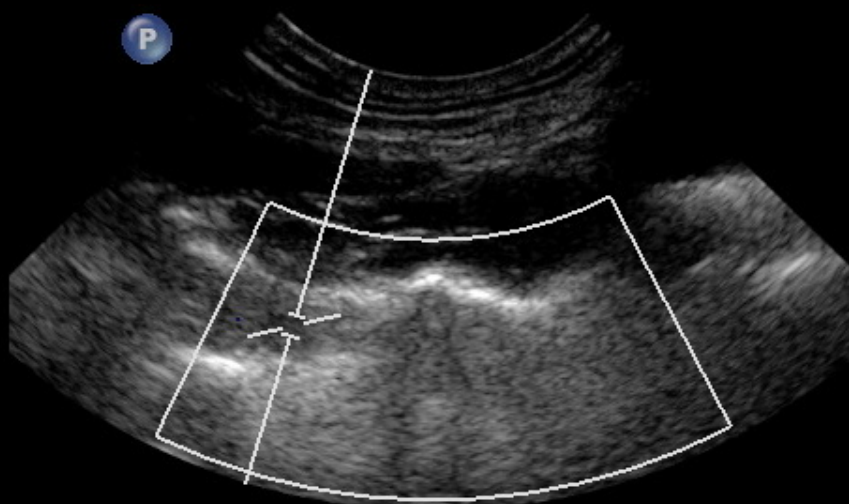


CI 15Hz 60°  
P1

2D  
62%  
C 55  
P Bas  
Rés

Coul  
78%  
3000Hz  
FP 149Hz  
Moy

V2

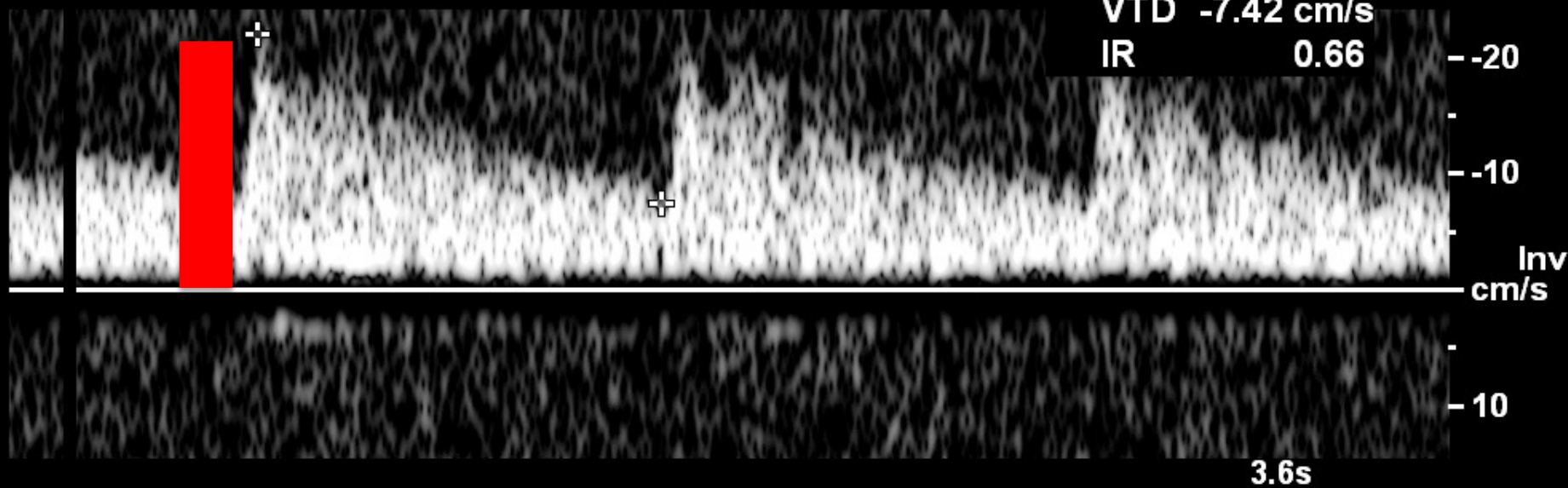


DP  
84%  
FP 70Hz  
VE 1.5mm  
E2  
5.0MHz  
1.9cm

C3 C3  
+25.7



3.0-  
+ VSM -22.0 cm/s  
VTD -7.42 cm/s  
IR 0.66



# Occlusion vertébrale

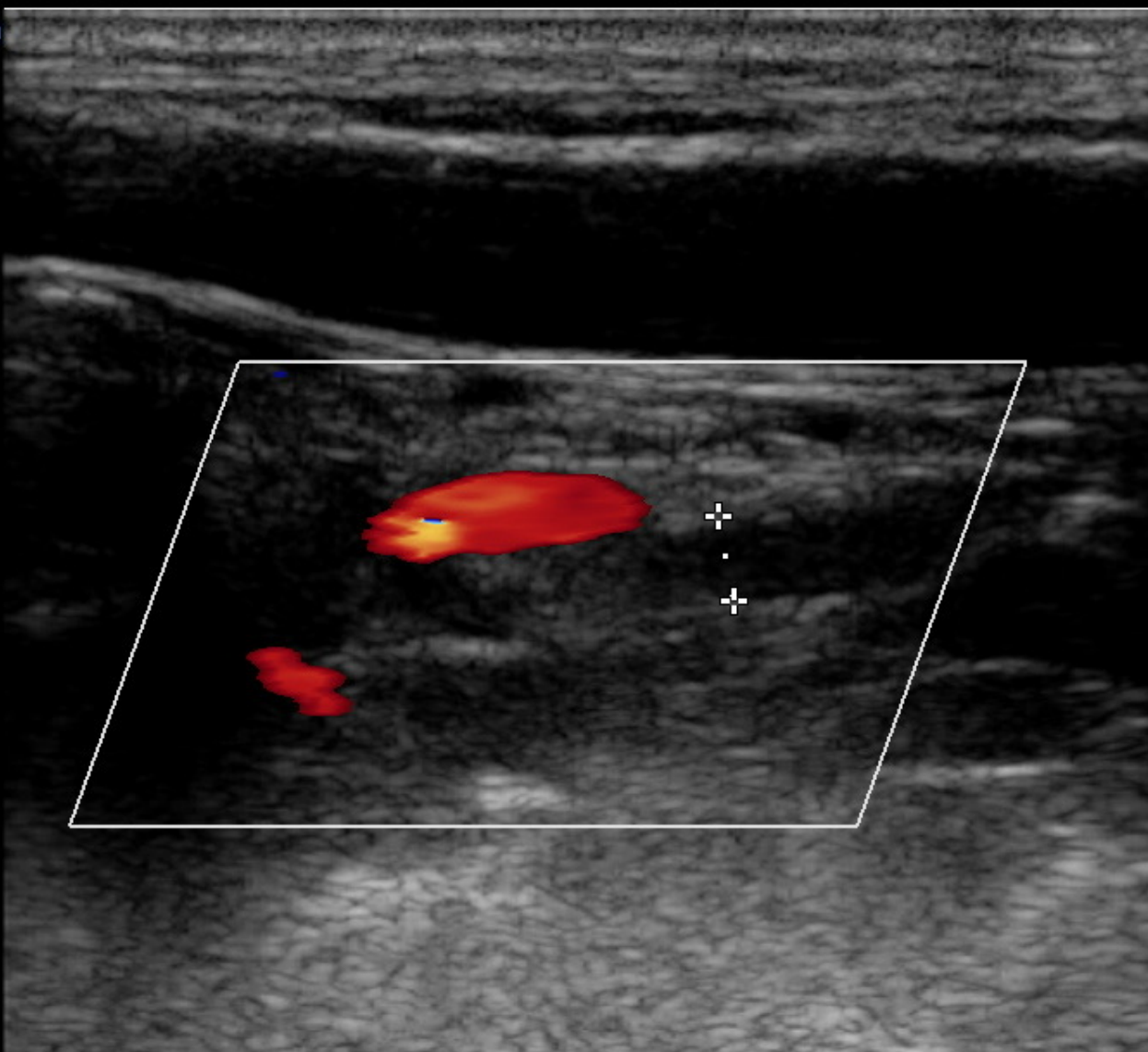
- ❑ Absence de signal doppler
- ❑ Calibre normal en 2D
- ❑ Collatérales cervicales
- ❑ Flux d'aval amorti
- ❑ Diagnostic différentiel :
  - Hypoplasie ou agénésie
  - Calibre diminué
  - Pas de collatérales
  - Artère controlatérale de large calibre

CI 18Hz  
3.5cm

2D  
60%  
C 62  
P Bas  
Pén

Coul  
76%  
5.0MHz  
FP Moy.  
Moy

P



C1 C3  
+32.1

- 0

- 1

- 2

- 3

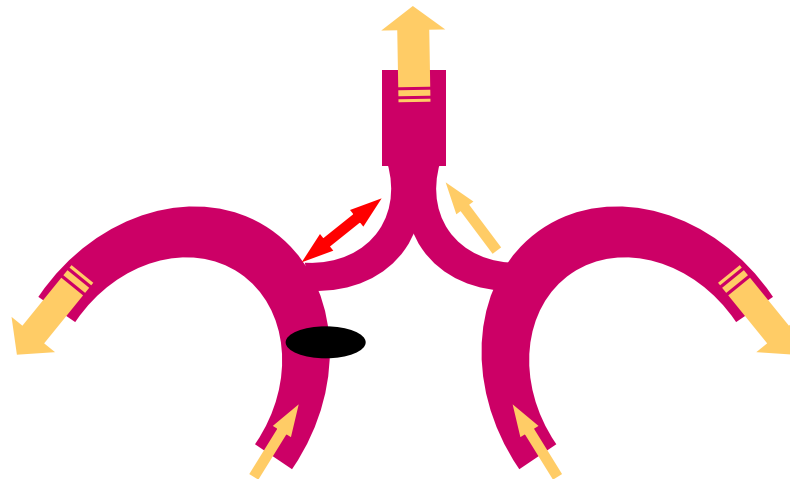
-32.1  
cm/s



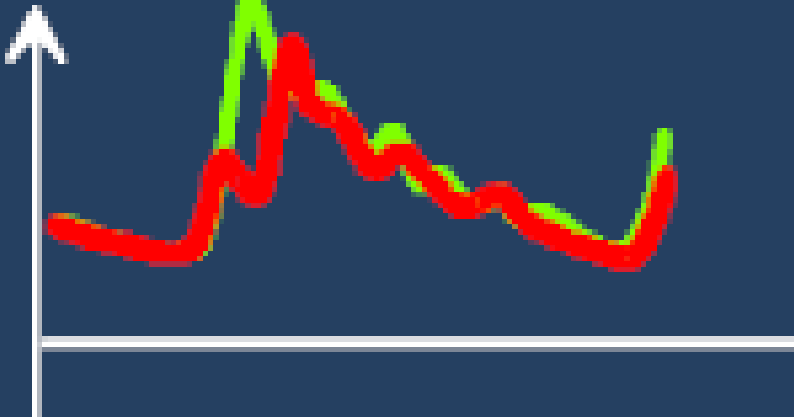
+ Dist 0.289 cm

# Vol vertébro-subclavier

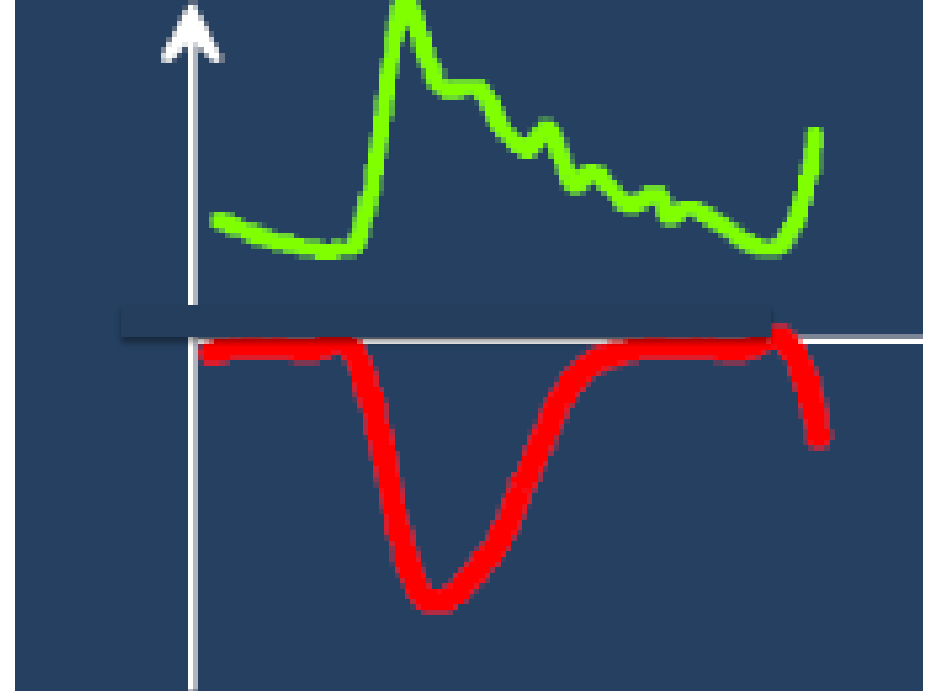
- ❑ Sténose de l'ASC en amont de l'AV
- ❑ Pression art encéphaliques > pression MS
- ❑ Symptomatologie neurologique positionnelle



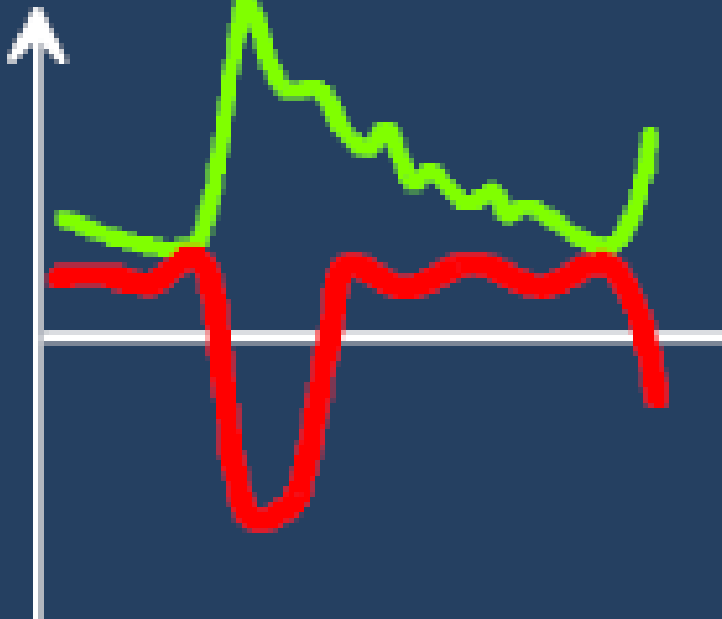
**Pré vol**



**Vol permanent**



**Vol intermittent**





CI 27Hz 60°  
P1

2D  
61%  
C 55  
P Bas  
Rés

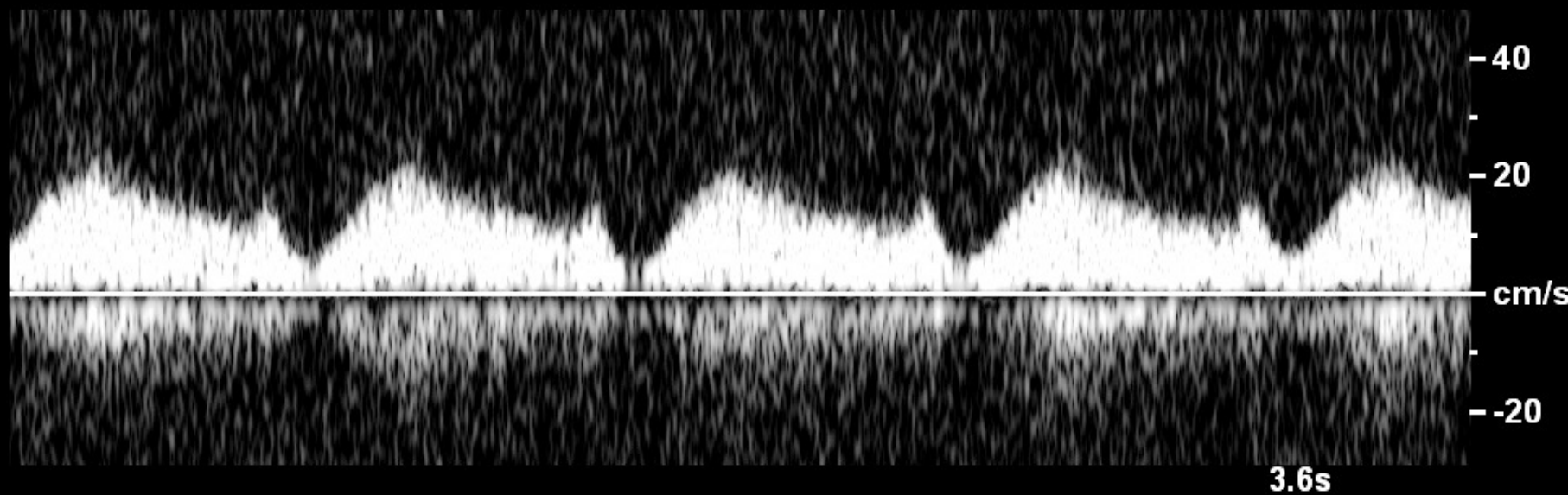
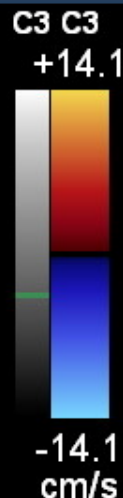
Coul  
77%  
1650Hz  
FP 82Hz  
Moy

V2 G

P



DP  
84%  
FP 70Hz  
VE1.5mm  
E2  
5.0MHz  
1.6cm



03220920121127

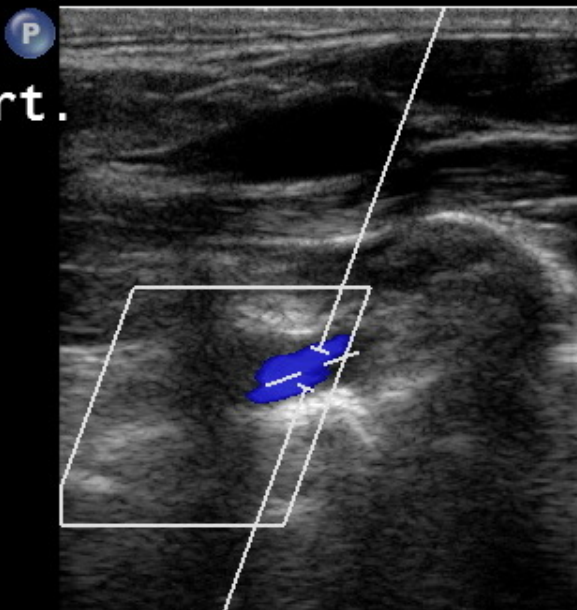
HOPITAL LA TIMONE

L11-3/OPTIMAL TSA

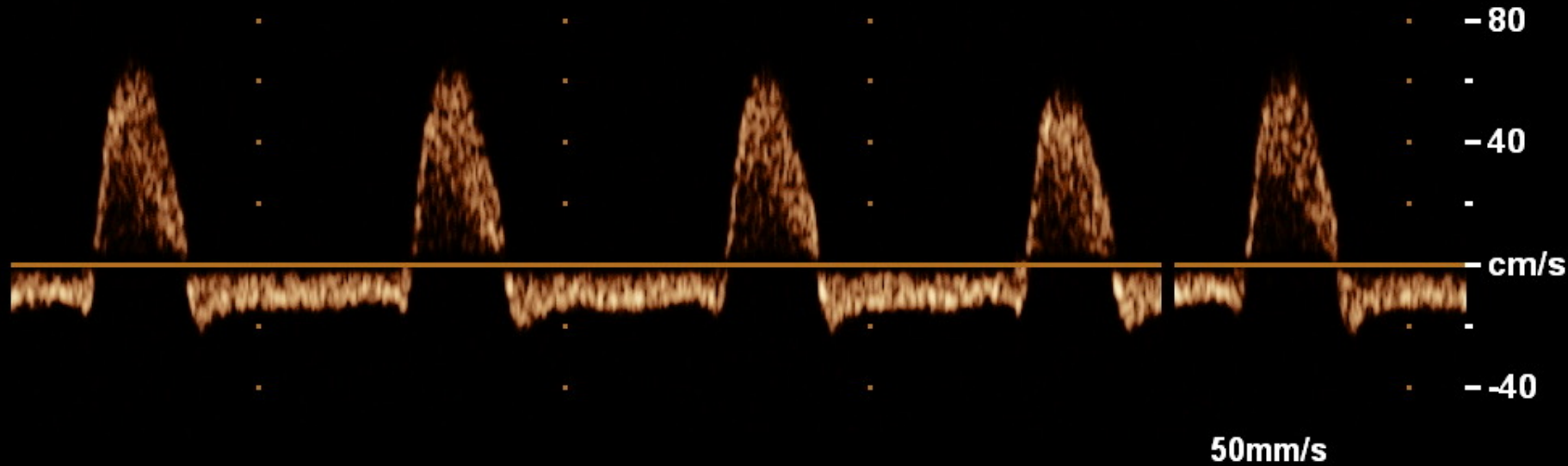
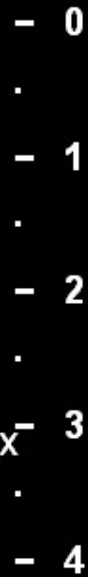
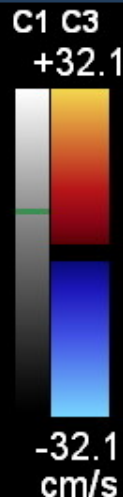
CI 18Hz 50°  
4.5cm

2D  
64%  
C 62  
P Bas  
Pén

Gauche Vert.  
V2



DP  
55%  
3.6MHz  
FP 60Hz  
VE3.0mm  
2.9cm



03220920121127

L11-3/OPTIMAL TSA

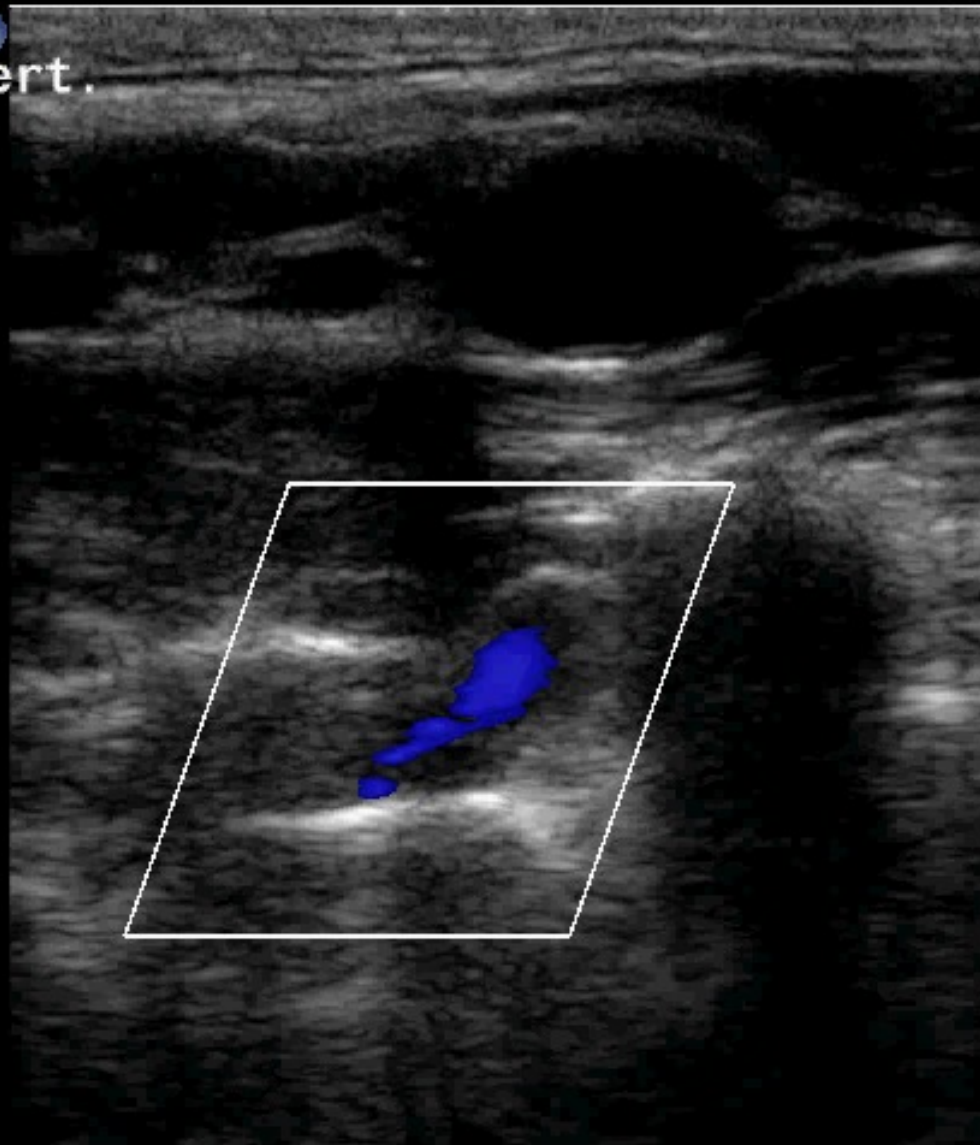
CI 18Hz  
4.5cm

**2D**  
65%  
C 62  
P Bas  
Pén

**Coul**  
76%  
4.0MHz  
FP Moy.  
Moy

Gauche  
V2

P  
Vert.



C1 C3  
+42.8

- 0

- 1

- 2

- 3

- 4

-42.8  
cm/s

X.

JPEG

\*\*\* bpm

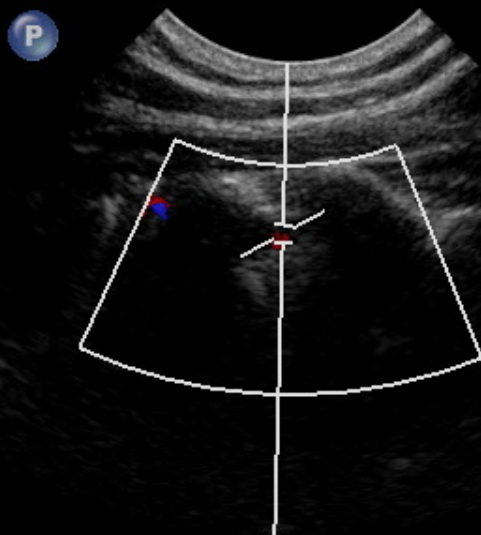


CI 23Hz 60°  
P1

2D  
61%  
C 55  
P Bas  
Rés

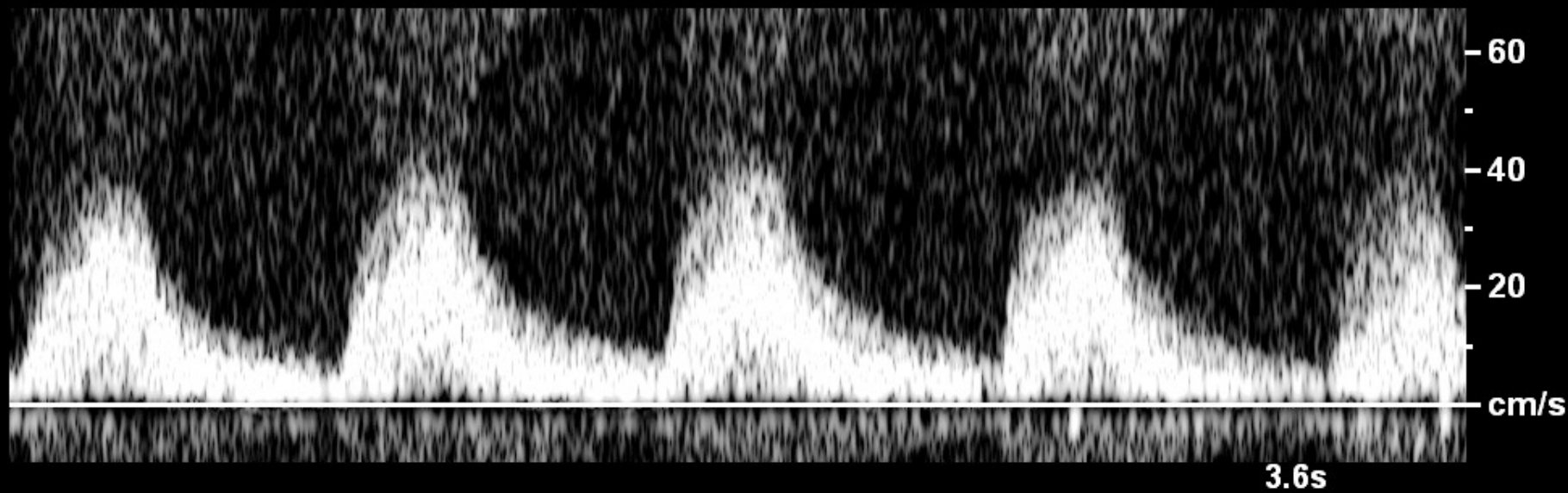
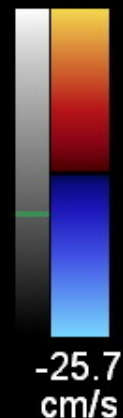
Coul  
77%  
3000Hz  
FP 119Hz  
Moy

V1 D



DP  
84%  
FP 70Hz  
VE1.5mm  
E2  
5.0MHz  
1.4cm

C3 C3  
+25.7

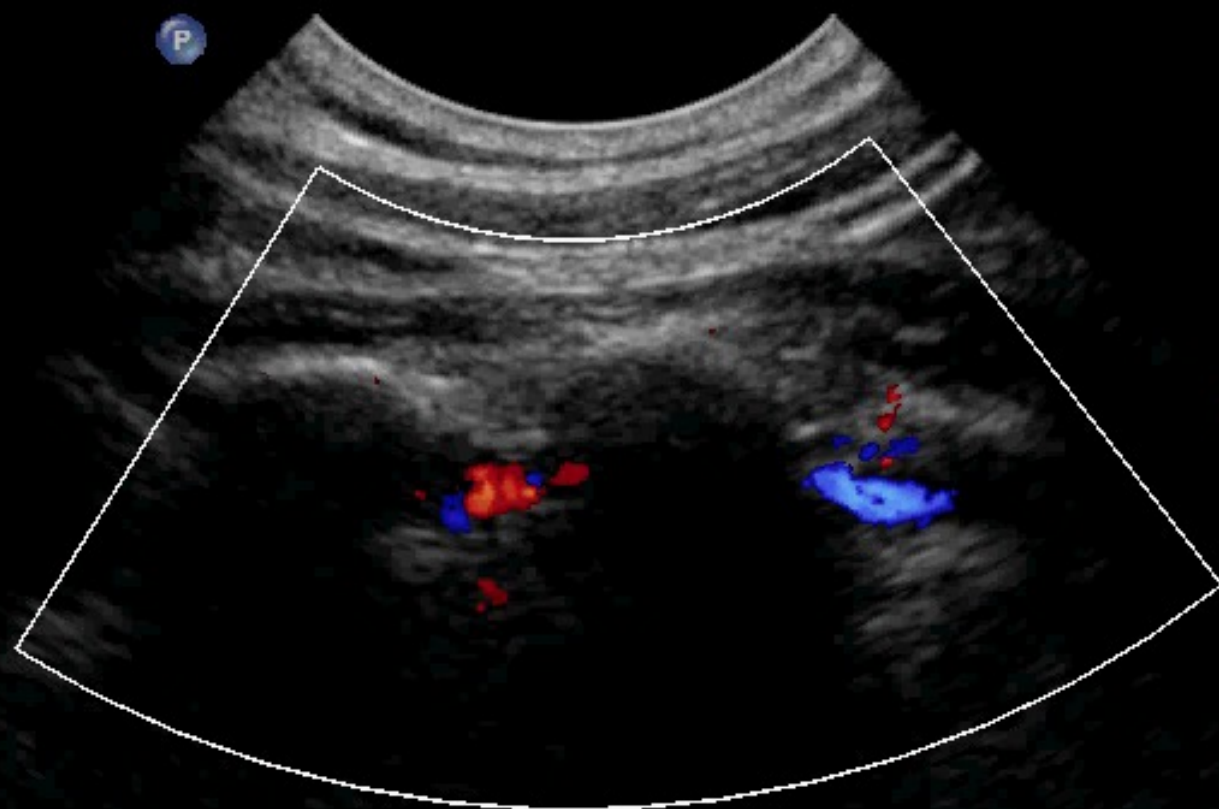


CI 18Hz  
P1

2D  
67%  
C 55  
P Bas  
Rès

Coul  
77%  
1200Hz  
FP 71Hz  
Moy

V1 D



C3 C3  
+10.3



JPEG  
4.0

\*\*\* bpm

# Dysplasie fibromusculaire

- ❑ Succession de sténoses et de dilatations
- ❑ Tortuosités artérielles
- ❑ Segments moyens et distaux des ACI et AV extra-crâniennes

**The United States Registry for Fibromuscular Dysplasia : Results in the First 447 Patients**  
Jeffrey W. Olin, James Froehlich, Xiaokui Gu, J. Michael Bacharach, Kim Eagle, Bruce H. Gray, Michael R. Jaff, Esther S.H. Kim, Pam Mace, Alan H. Matsumoto, Robert D. McBane, Eva Kline-Rogers, Christopher J. White and Heather L. Gornik

*Circulation.* 2012;125:3182-3190; originally published online May 21, 2012;

**66% de localisation rénale**

**56% de localisation carotidienne**

**18% de localisation vertébrale**

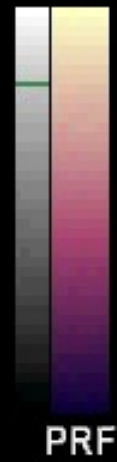
14450920080304

C8-5/TSFS2

CI 17Hz  
5.0cm

2D  
73%  
C 55  
P Bas  
Rès  
CPA  
89%  
4.5MHz  
FP Max  
Bas

C3 C1  
0.7



Vert. Gauche ATCD DISSEC 1993



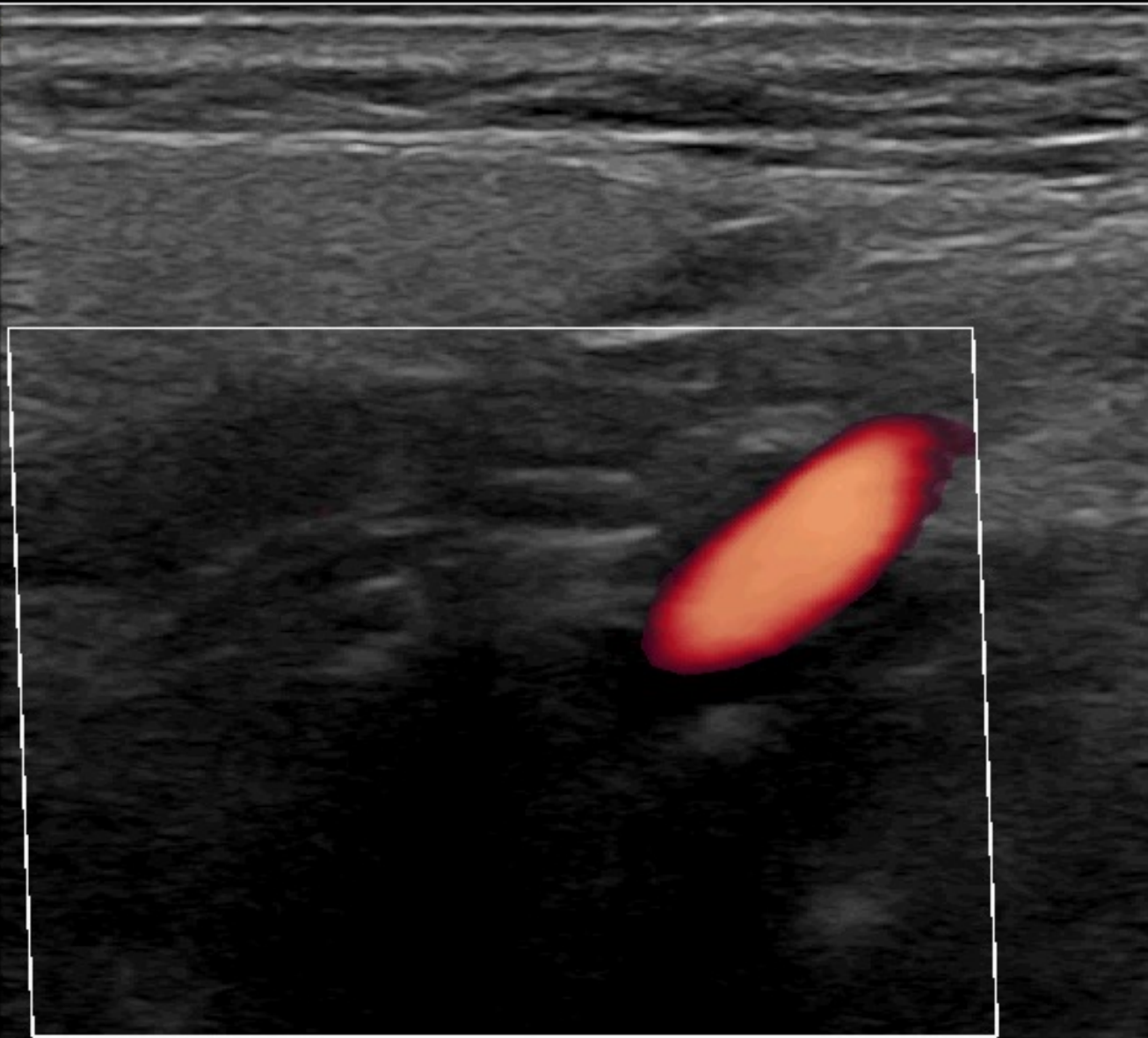
JPEG - 5\*\*\* bpm

TSA  
L12-3  
19Hz

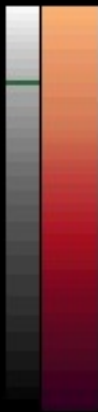
P

2D  
65%  
R Dyn 50  
P Bas  
HGén

CPA  
52%  
2000Hz  
FP 110Hz  
4.0MHz



M3 M3



3.5cm \*\*\* bpm



# Dissection

## **TABC – ASC**

- Flap
- Vrai et faux chenal
- Thrombose
- Anévrisme
- Flux démodulé

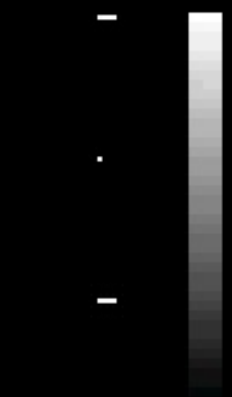
## **A VERTEBRALE**

- Hématome pariétal
- Lumière diminuée
- Sténose longue

CI 33Hz  
RV

2D  
42%  
C 50  
P Bas  
Rès

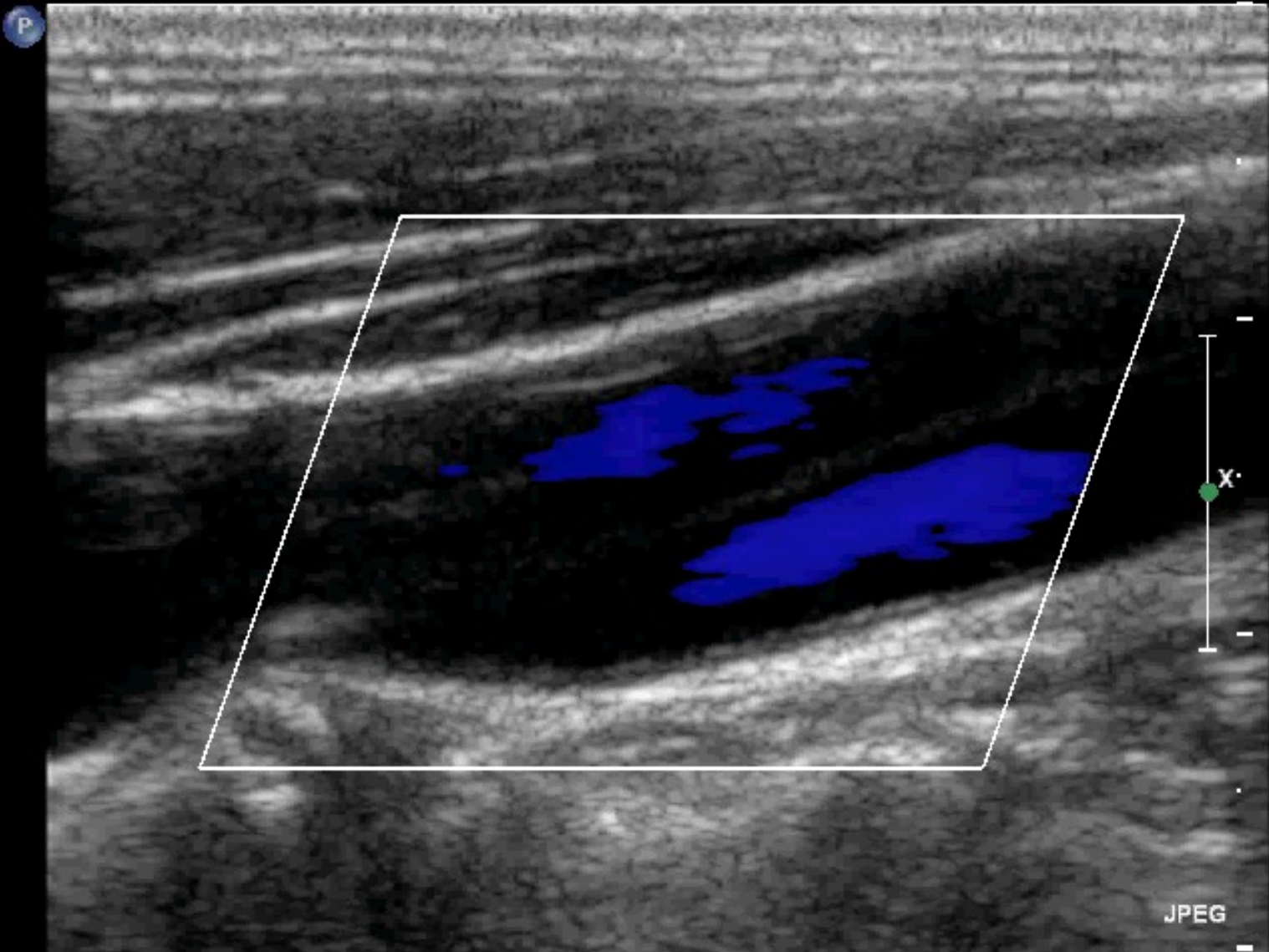
C2



JPEG  
4.0 \*\*\* bpm

CI 12Hz  
3.0cm

**2D**  
64%  
C 66  
P Bas  
Pén  
**Coul**  
76%  
5.0MHz  
FP Moy.  
Moy



JPEG

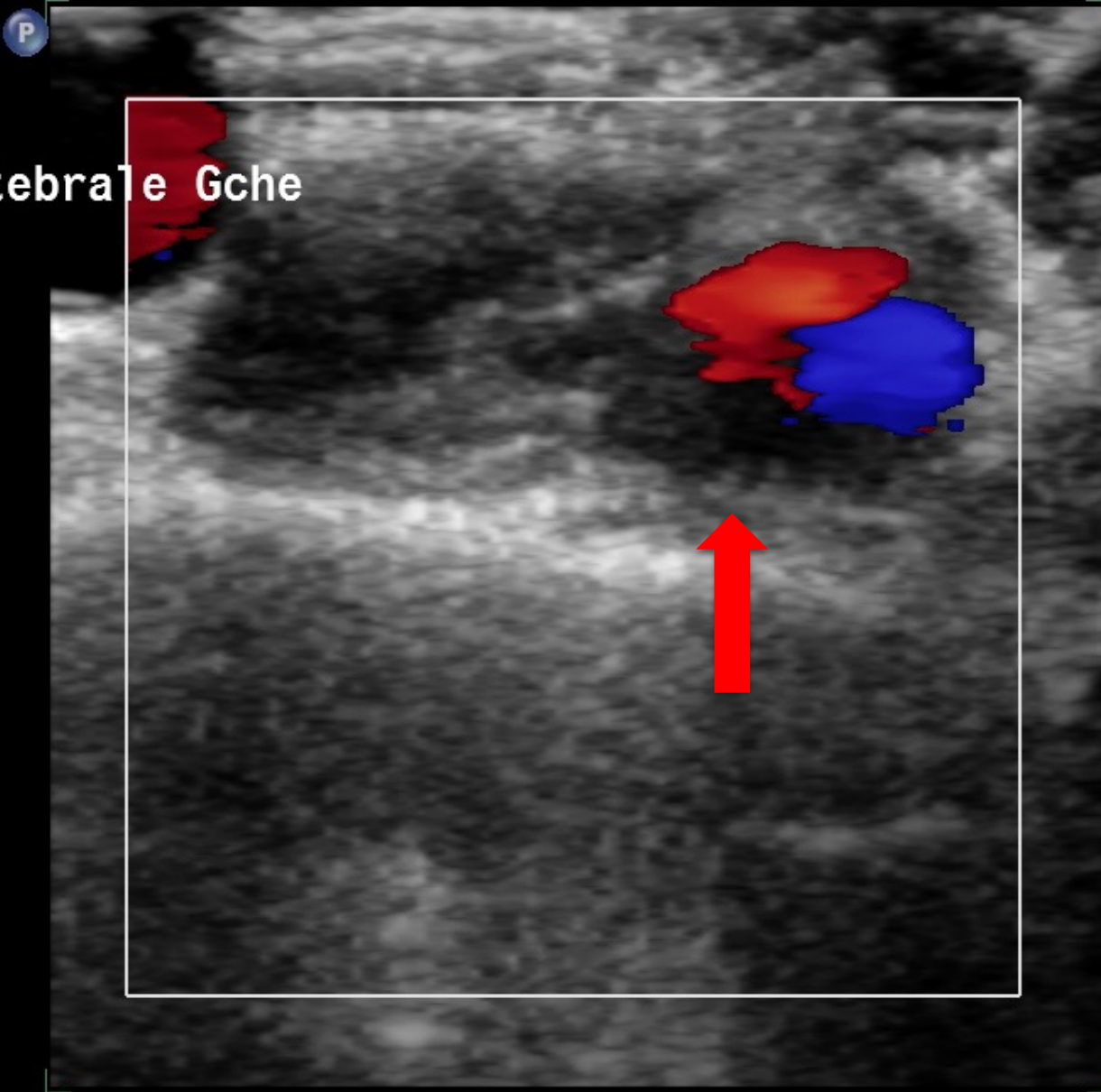
3 bpm

**CI 28Hz**  
R1

**2D**  
72%  
C 50  
P Bas  
Gén

**Coul**  
85%  
3500Hz  
FP 227Hz  
Moy

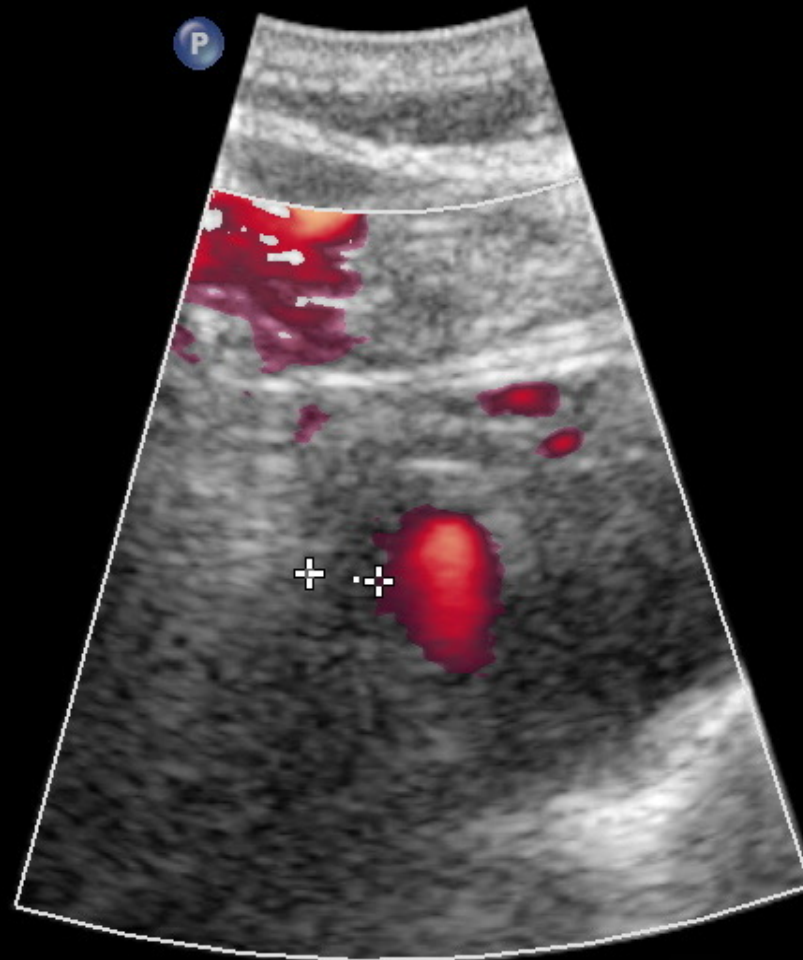
Vertebrale Gche



**CI 24Hz**  
P1

**2D**  
72%  
C 54  
P Bas  
Rés

**CPA**  
91%  
2000Hz  
FP 120Hz  
Moy



✦ Dist 0.237 cm

CI 24Hz  
P1

2D  
72%  
C 54  
P Bas  
Res

CPA  
91%  
2000Hz  
FP 120Hz  
Moy

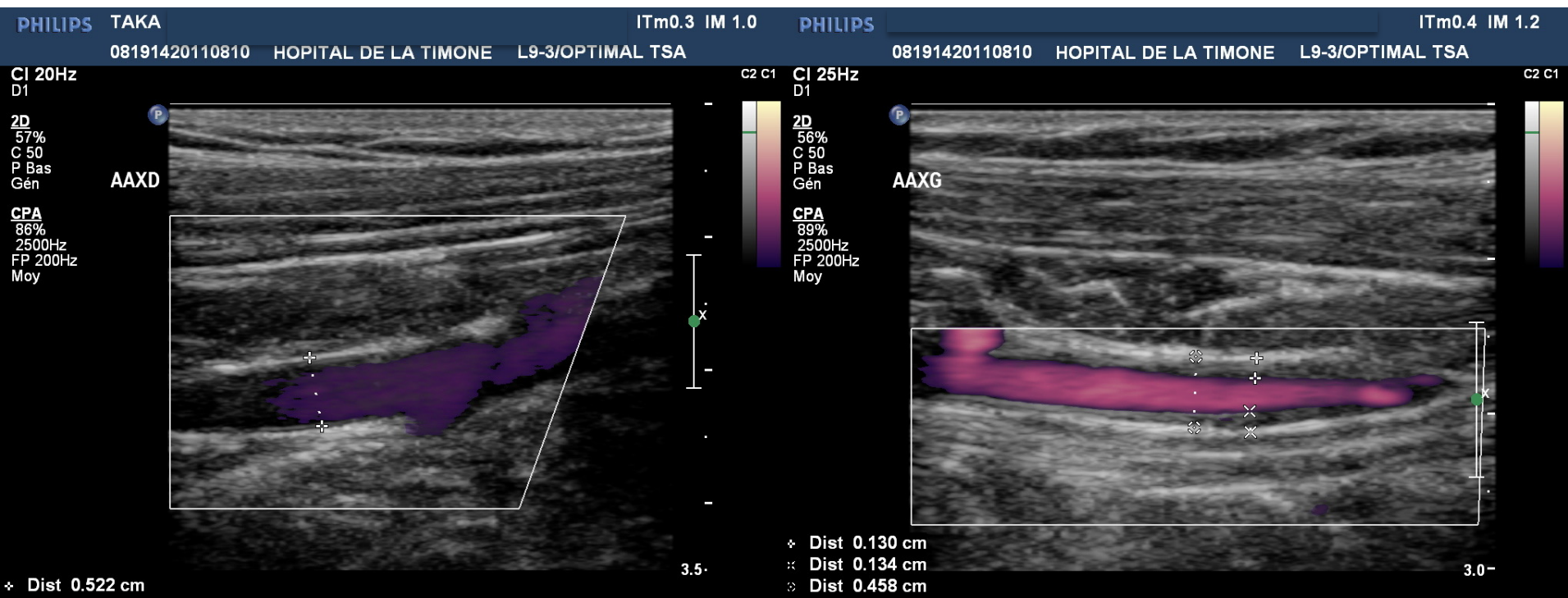


3.0  
JPEG

\*\*\* bpm

# Artérite inflammatoire

- Epaissement homogène, échogène et circonférentiel de l'intima et de la média
- Artère sous-clavière post-vertébrale ou artère axillaire → claudication du membre supérieur



CI 28Hz  
D1

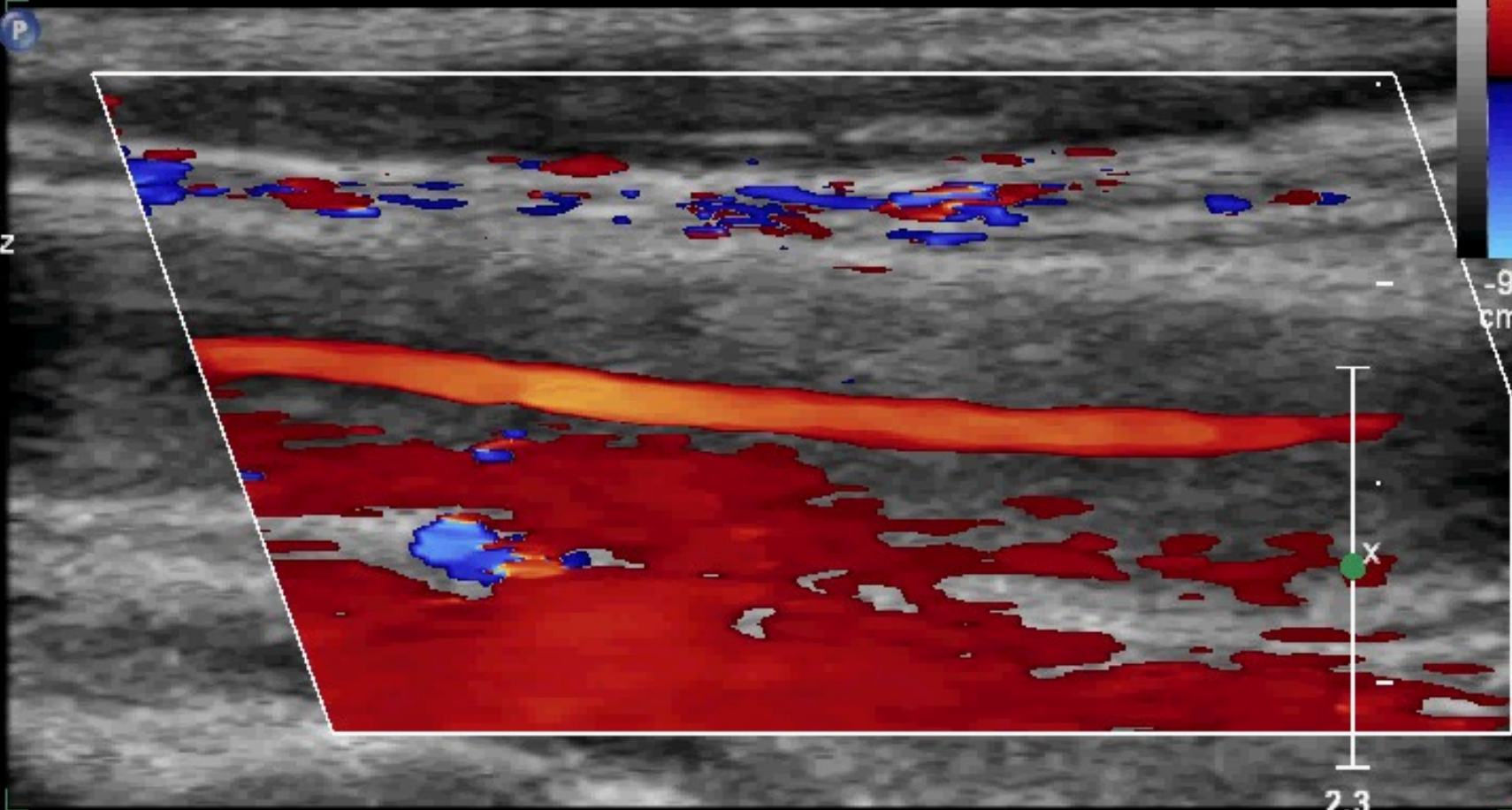
AGC

C2 C3  
+9.6

2D  
57%  
C 50  
P Moy  
HGén

Coul  
78%  
1000Hz  
FP 95Hz  
Moy

P



2.3

JPEG

\*\*\* bpm



Vasc carotide

L12-3

50Hz

RV

2D

46%

R Dyn 56

P Bas

HGen

ITm0.3

IM 1.3

M3



5.0cm

Dist 1.48 cm

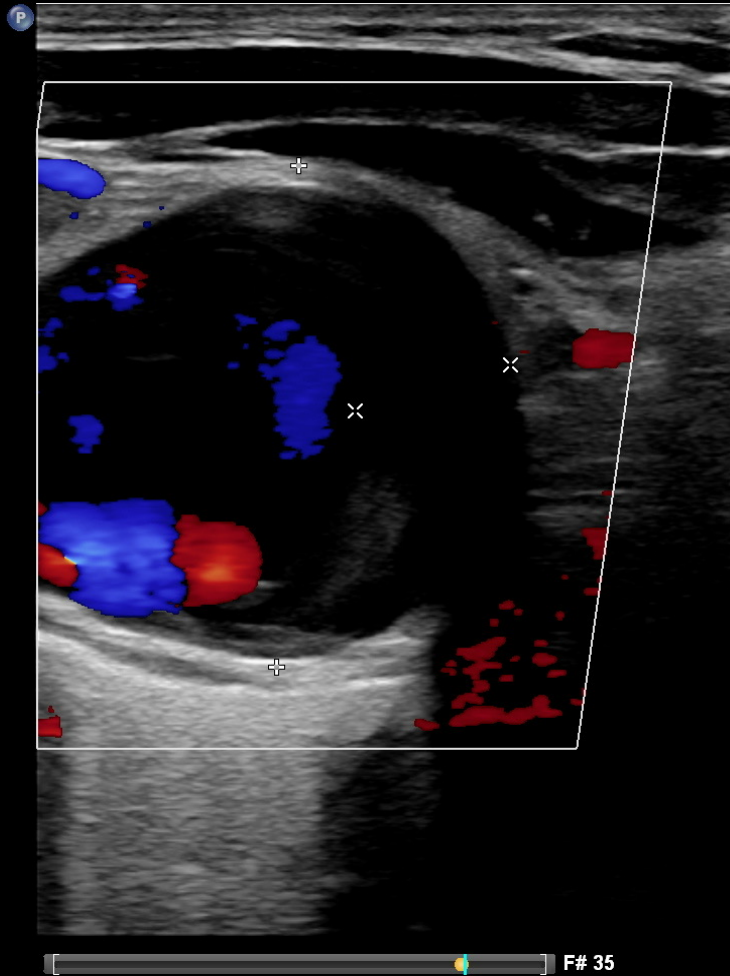
F#249

L12-3  
16Hz

2D  
46%  
R Dyn 56  
P Bas  
HGén

Coul  
51%  
2909Hz  
FP 130Hz  
4.0MHz

Dist 2.70 cm  
Dist 0.866 cm



M3 M3  
+28.0  
-28.0  
cm/s

x3

5.0cm

A vertical velocity scale on the right side of the image. It ranges from -28.0 cm/s (blue) to +28.0 cm/s (red). A green dot is positioned at the -28.0 mark, with a vertical line extending upwards and the label 'x3' next to it. Below the scale, there is a horizontal line with a green dot and the label '5.0cm'.

Vasc carotide

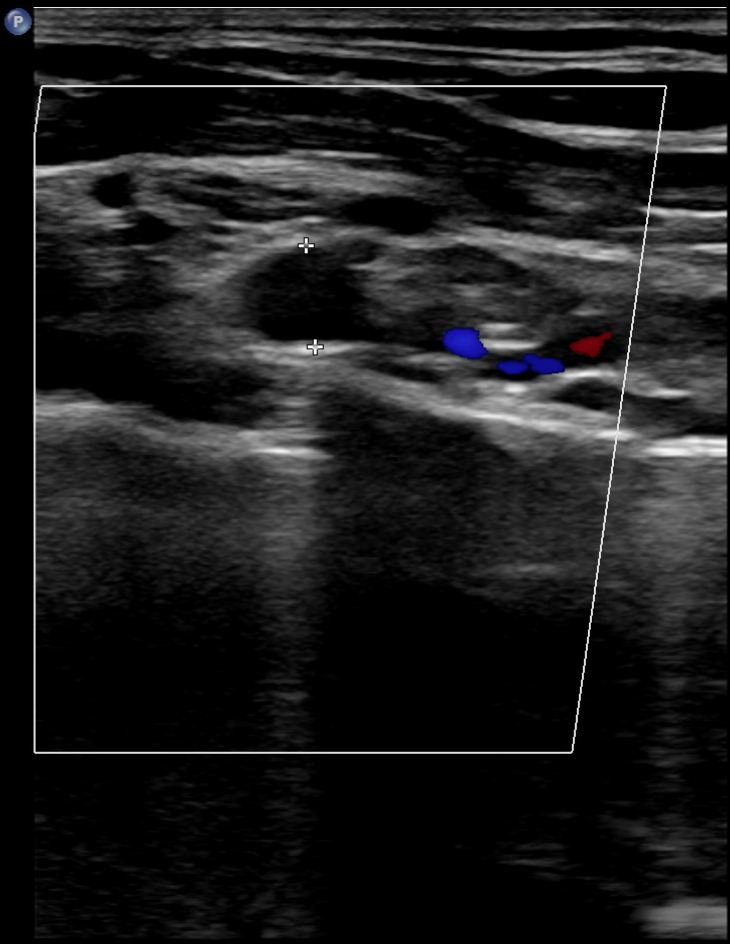
L12-3  
16Hz

2D  
46%  
R Dyn 56  
P Bas  
HGén

Coul  
51%  
2909Hz  
FP 130Hz  
4.0MHz

Droite

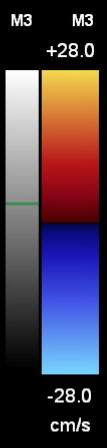
Dist 0.546 cm



F# 46

IM 0.2

IM 1.3



5.0cm

# Conclusion

- ❑ Signes aspécifiques
- ❑ Accès parfois difficile
- ❑ Savoir varier les sondes
- ❑ Etiologie athéromateuse : ostium de l'artère vertébrale et l'artère sub clavière pré vertébrale
- ❑ Mesure de la PA aux deux bras