

Artères sub clavières et vertébrales

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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

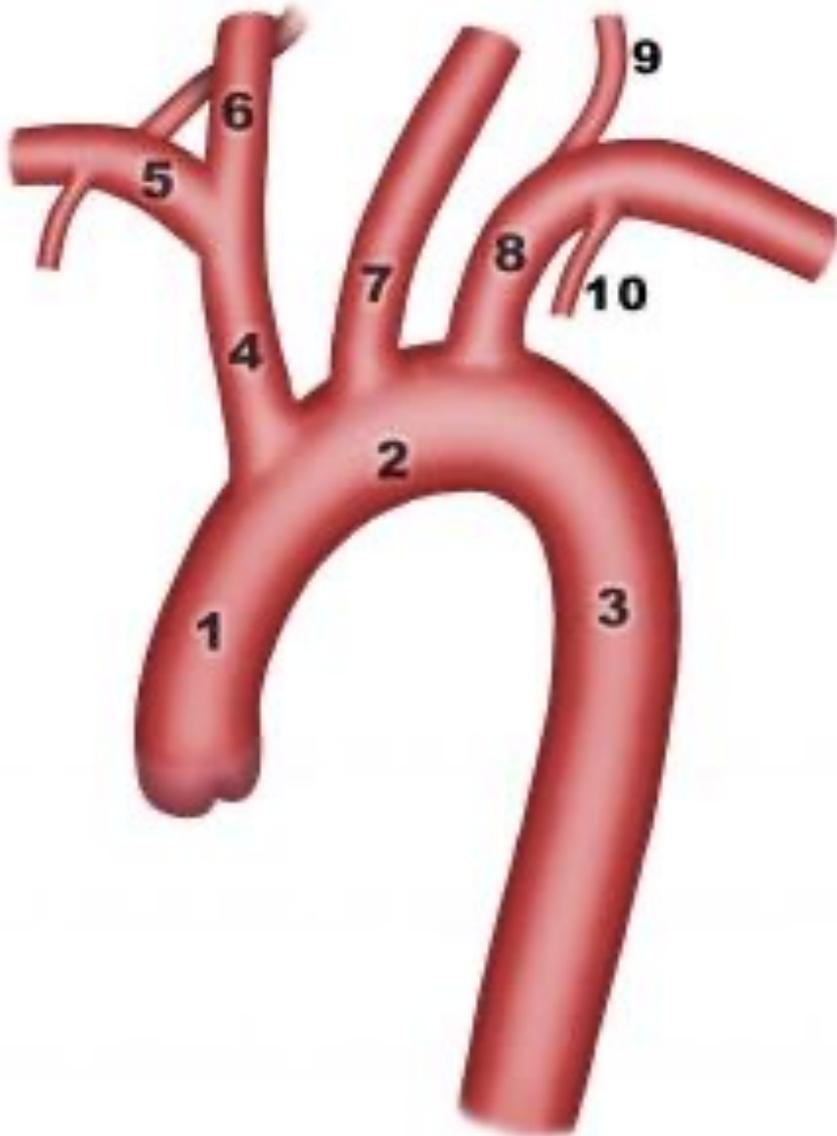
Question 4 : Critères de sténose de l'artère sous clavière

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

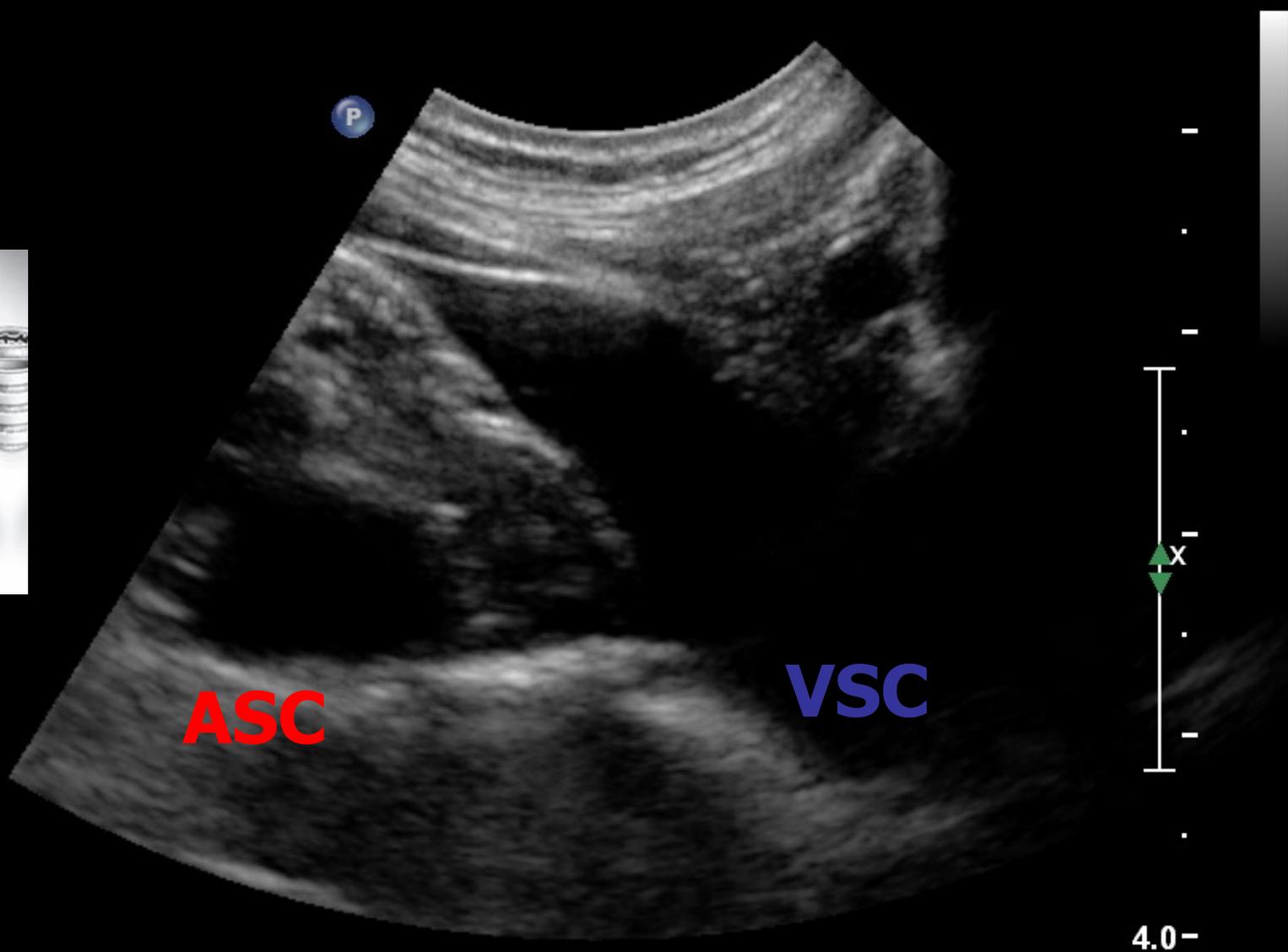
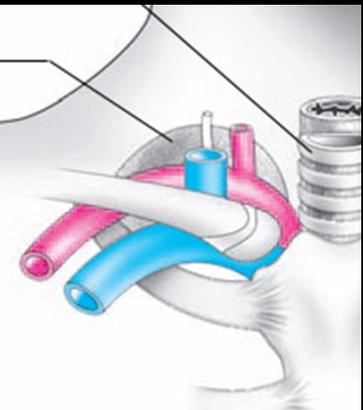


- ❑ Diamètre 10mm
- ❑ A subclavière droite :
 - Naissance du TABC
 - Trajet cervical
- ❑ A subclavière gauche :
 - Naissance de la crosse
 - Trajet thoraco-cervical
- ❑ Terminaison :
 - ❑ Artère axillaire
- ❑ Veines :
 - En avant
 - Confluence

CI 66Hz
RV

C3

2D
62%
C 55
P Arrêt
Gén

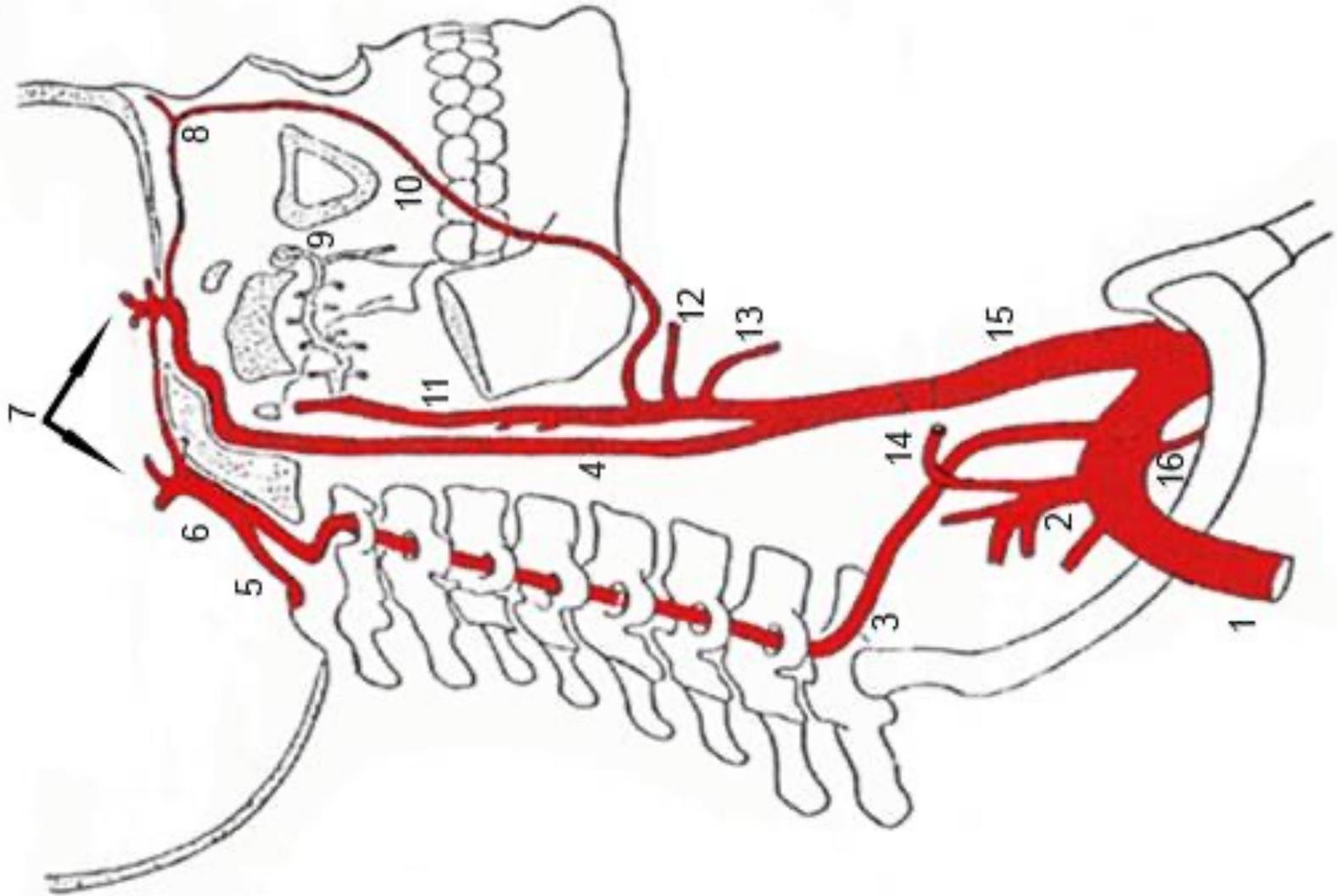


ASC

VSC

4.0

Anatomie des art vertébrales



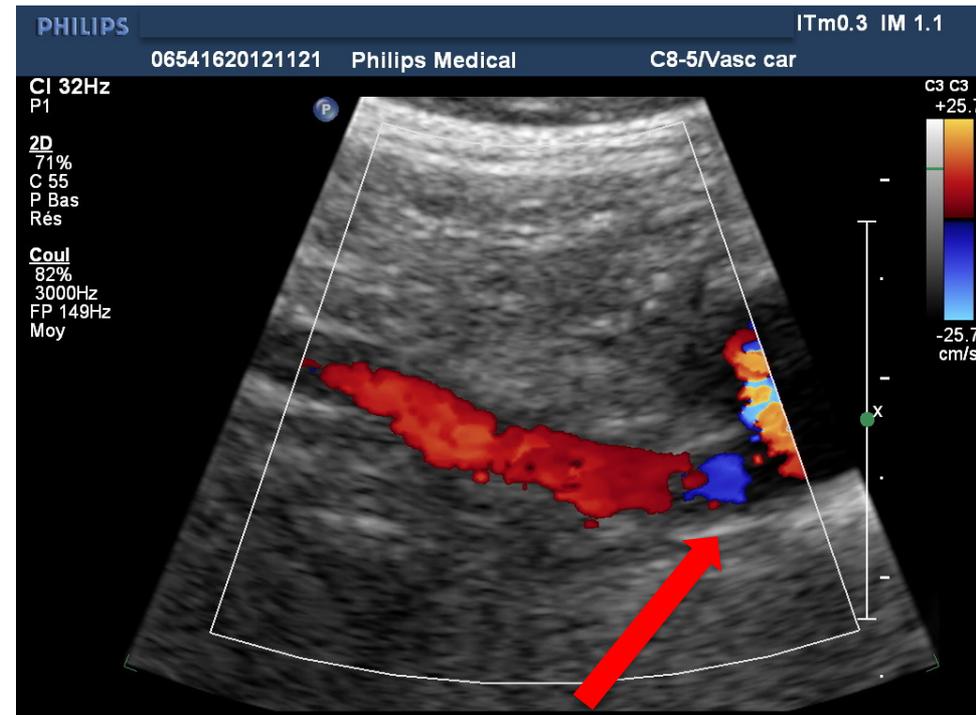
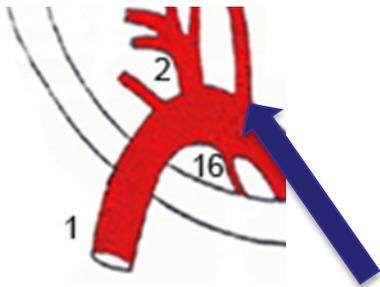
Anatomie des art vertébrales

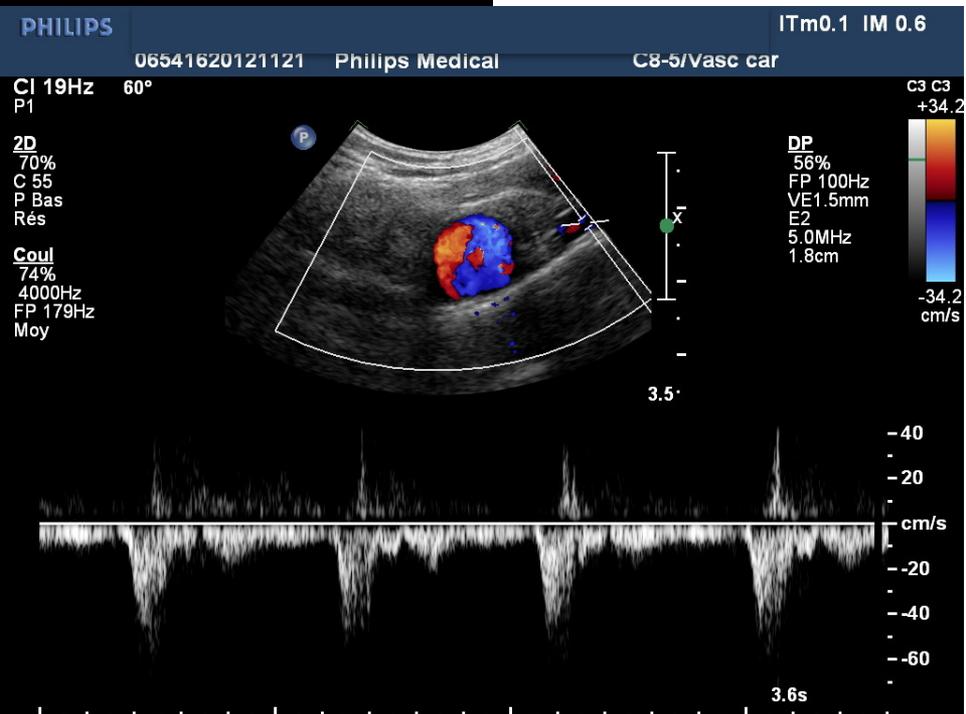
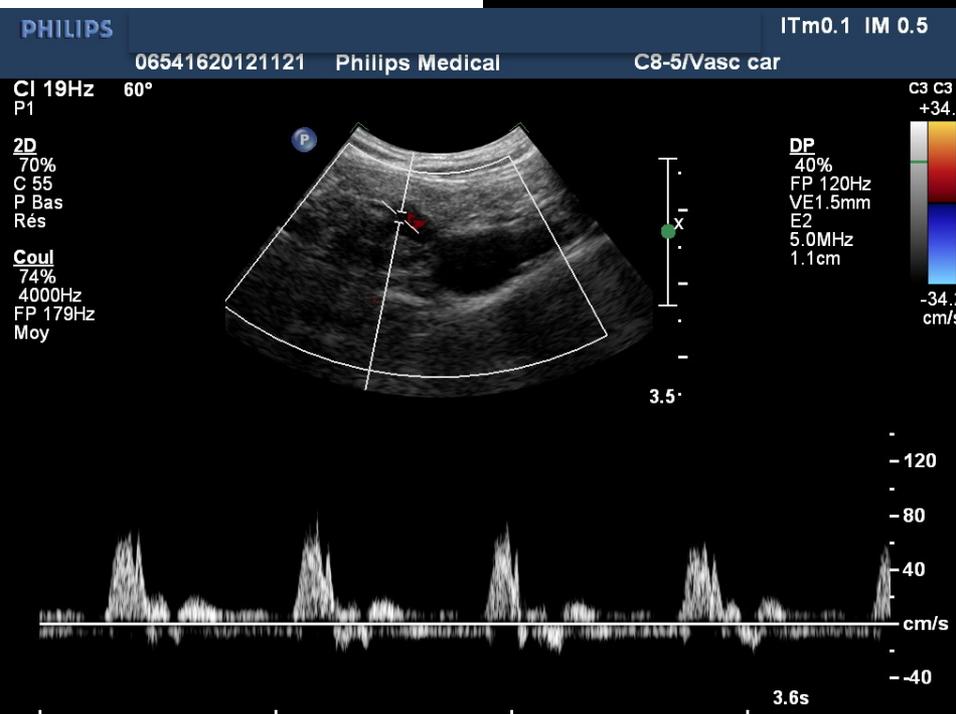
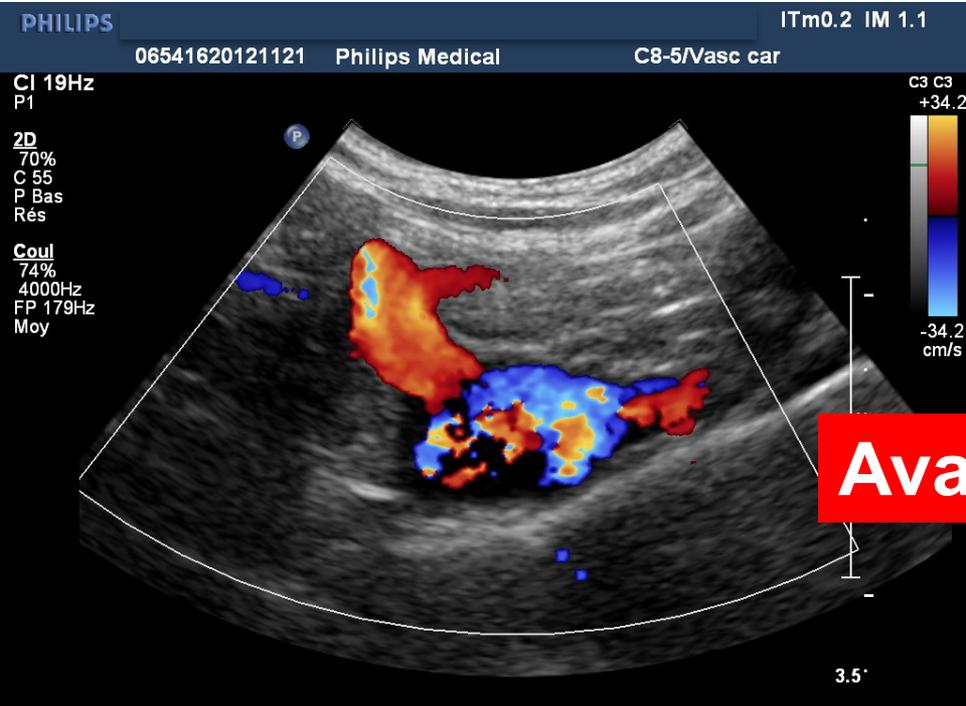
Origine : ostium V0

Face postéro-inférieure

5% naissance de la crosse (VG)

Accessible D > G





Anatomie des art vertébrales

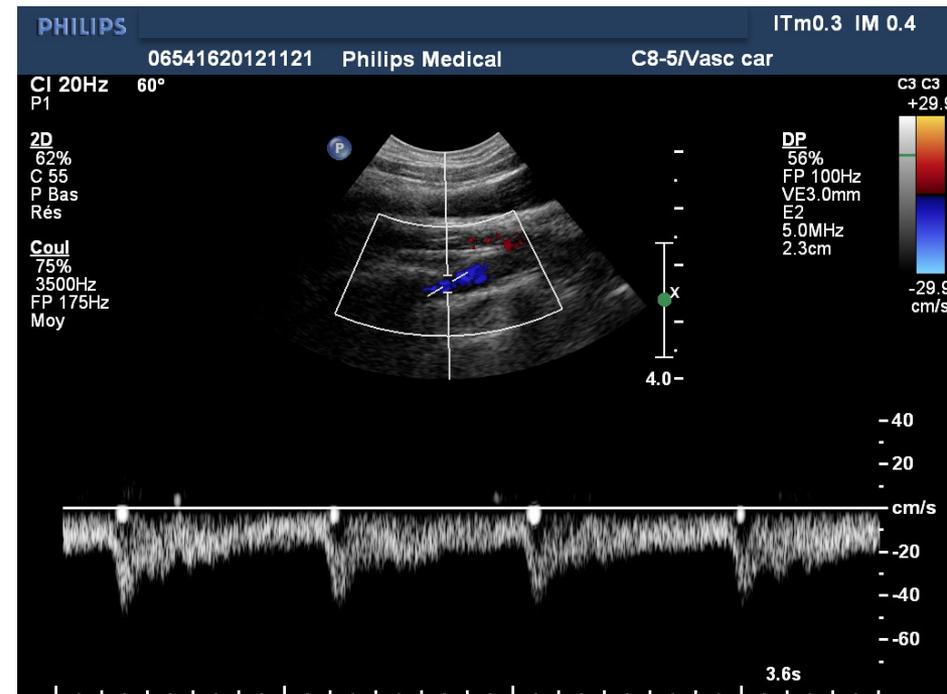
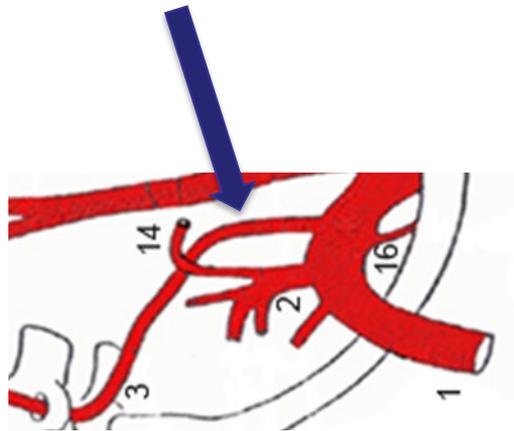
Segment pré-transversaire V1

Profond et rectiligne

Diamètre 4mm

Longueur 3-5cm

Terminaison : canal transverse de C6



Anatomie des art vertébrales

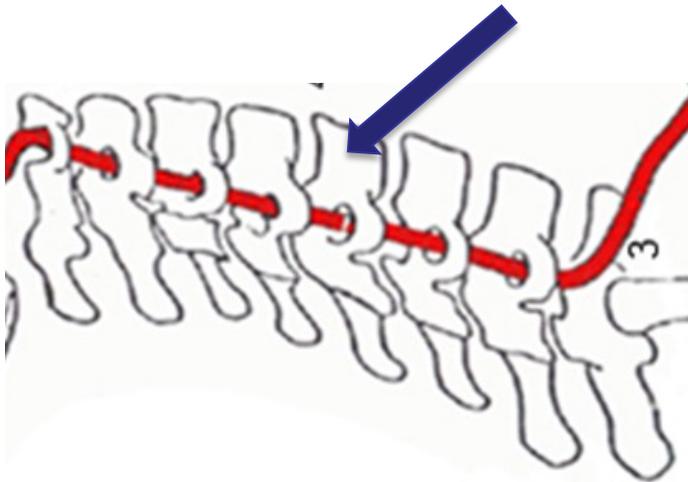
Segment transversaire V2

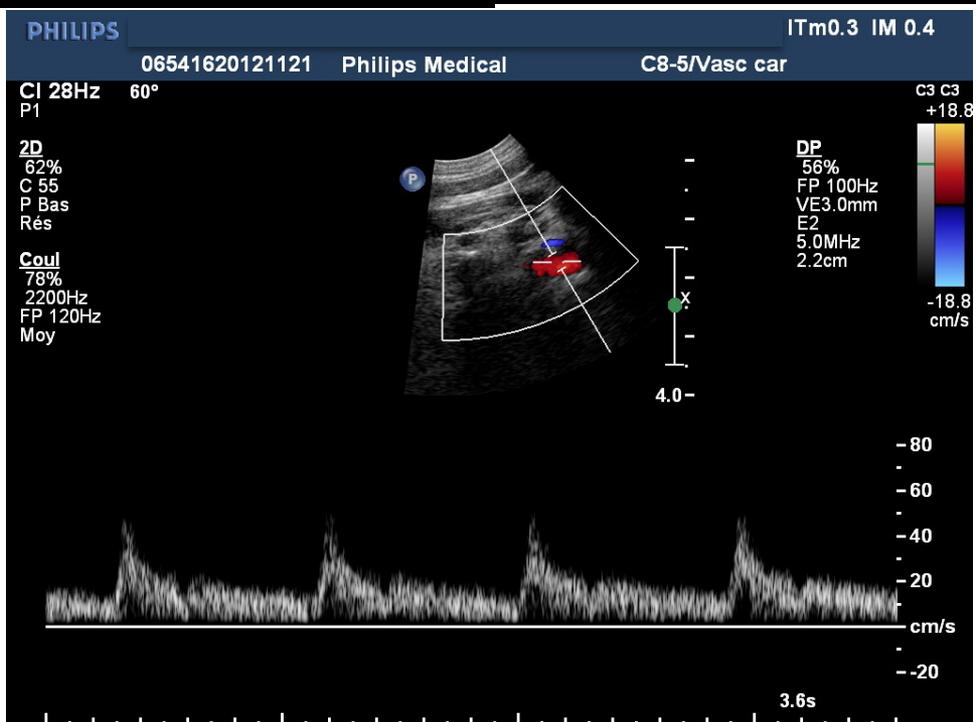
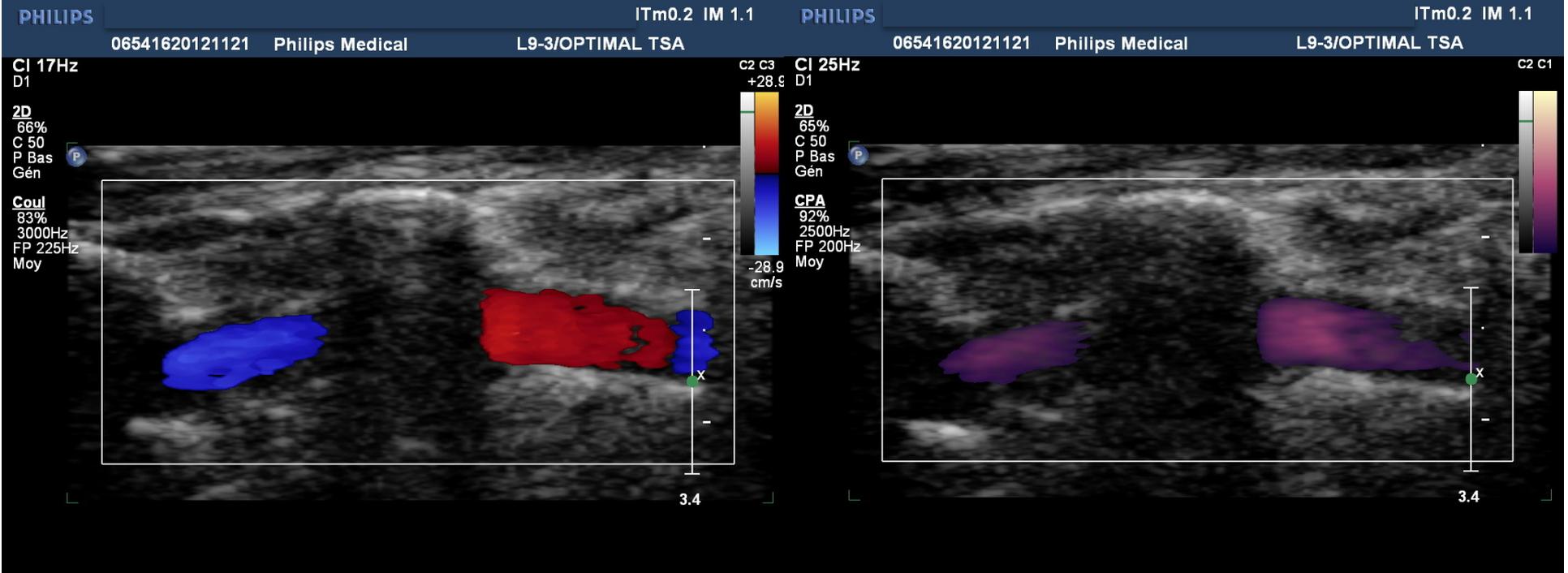
Rectiligne et vertical

Dans le canal transversaire des vertèbres cervicales

Veine en avant

Terminaison : C2



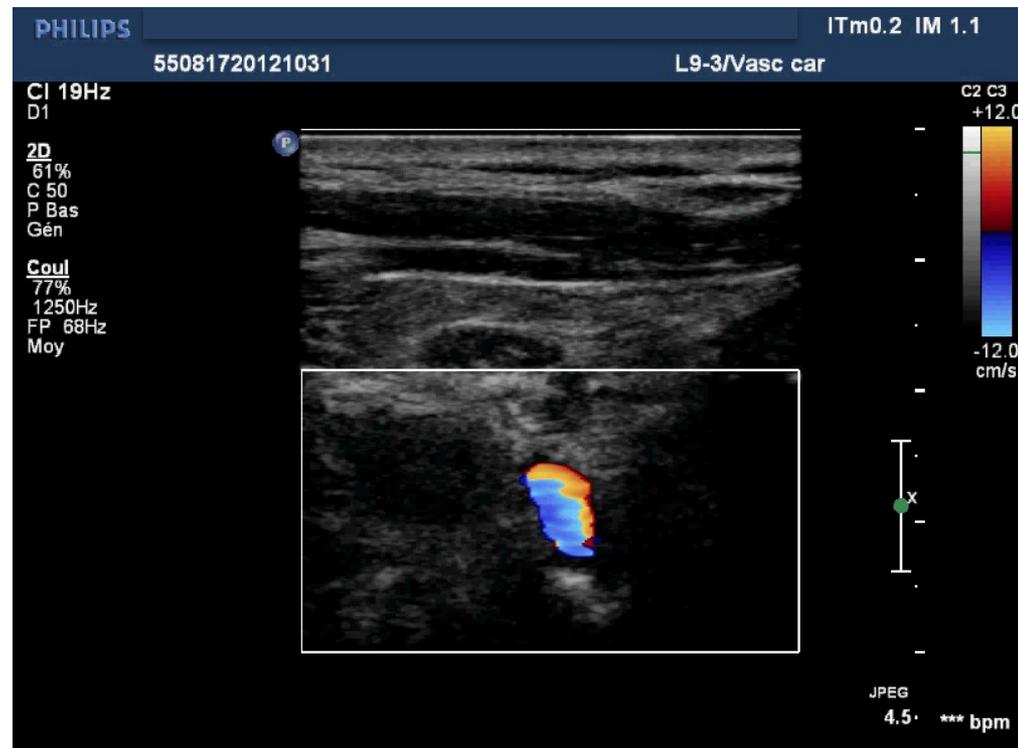
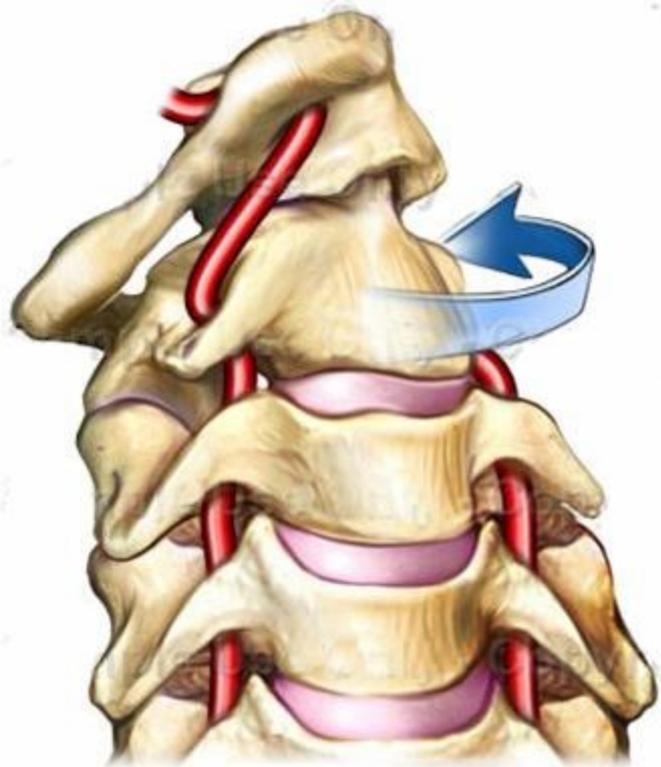


Anatomie des art vertébrales

Segment atlanto-axoïdien V3

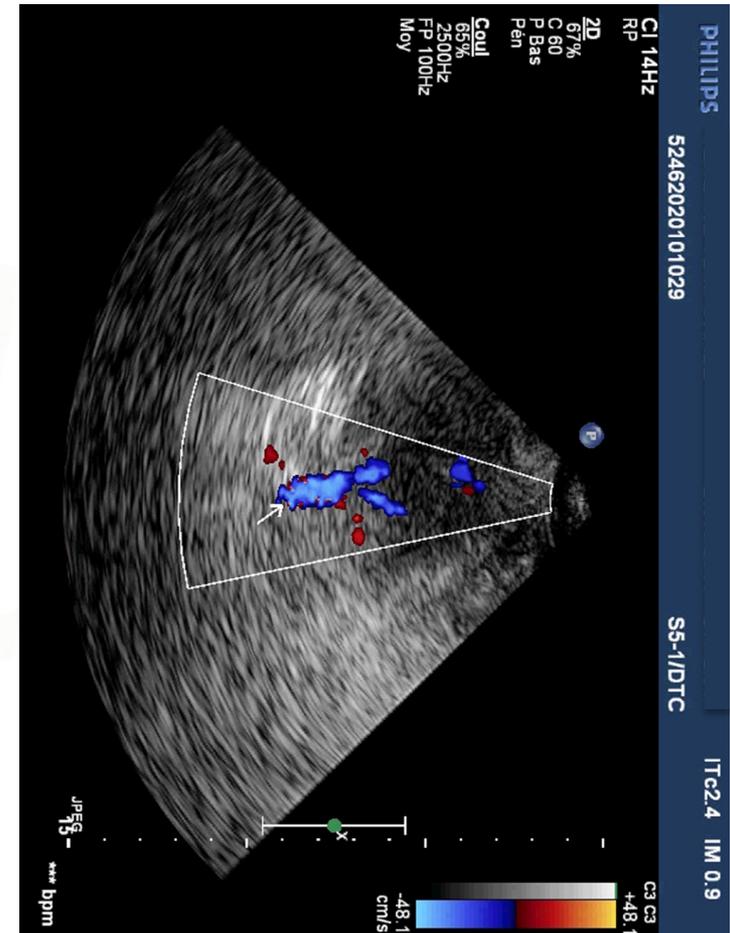
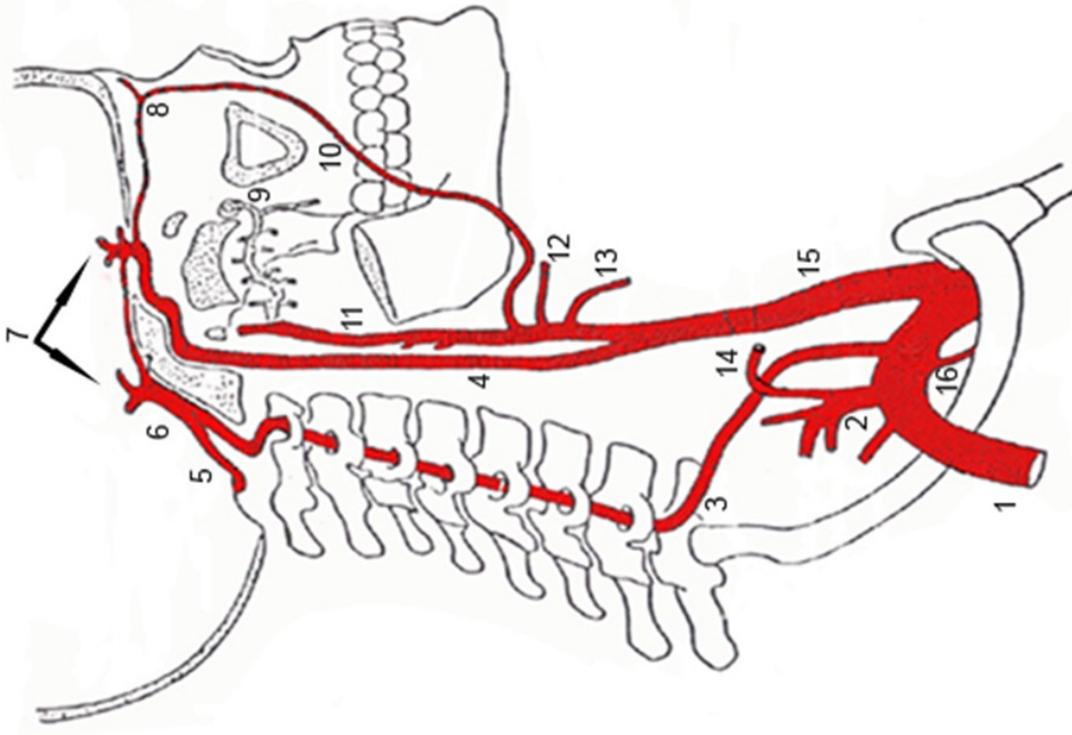
Boucle de sécurité au niveau de la masse latérale de l'atlas

Terminaison : trou occipital



Anatomie des art vertébrales

Segment intra-crânien V4
Terminaison en PICA dans 25%

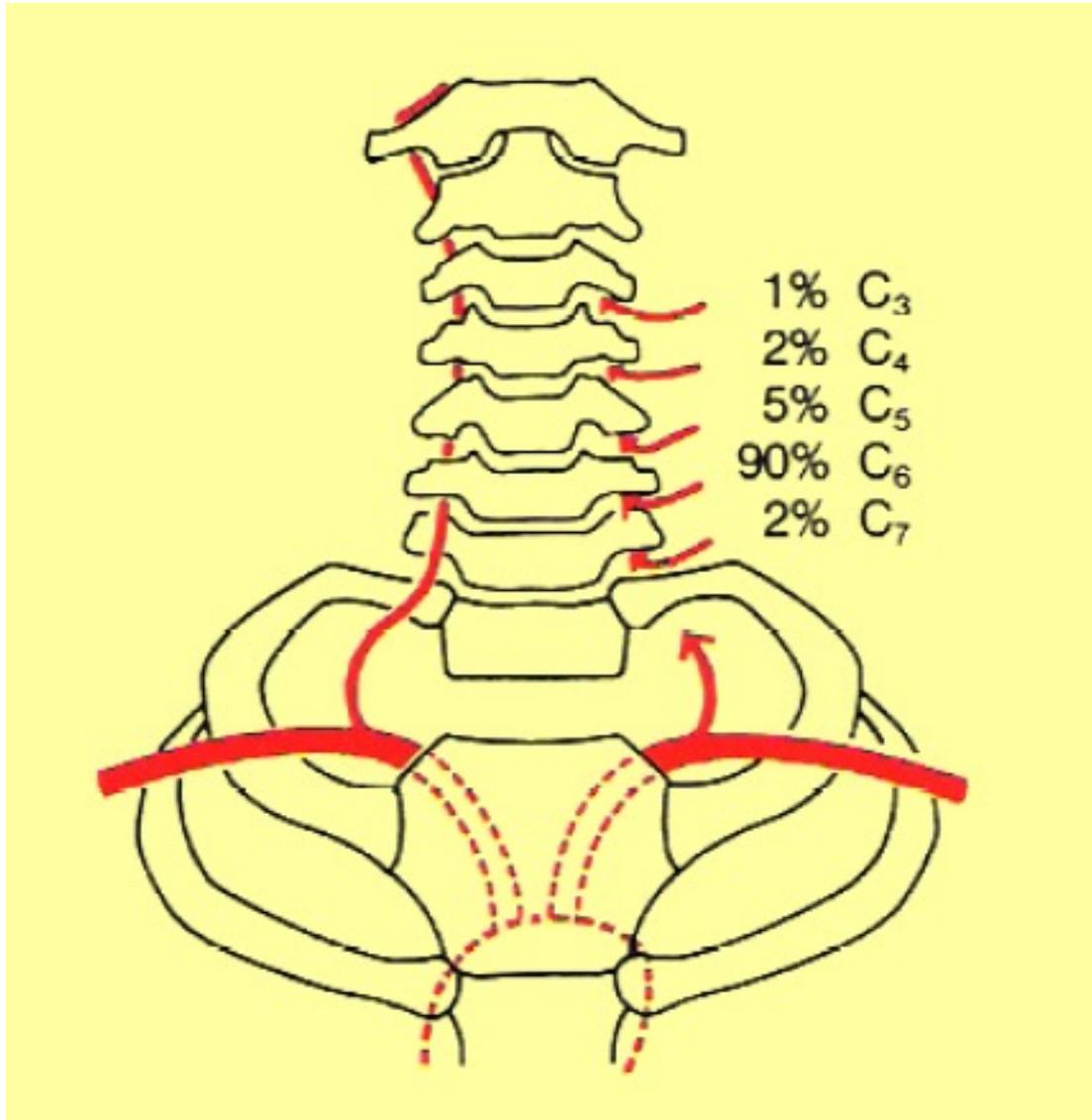


Variantes anatomiques

□ 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

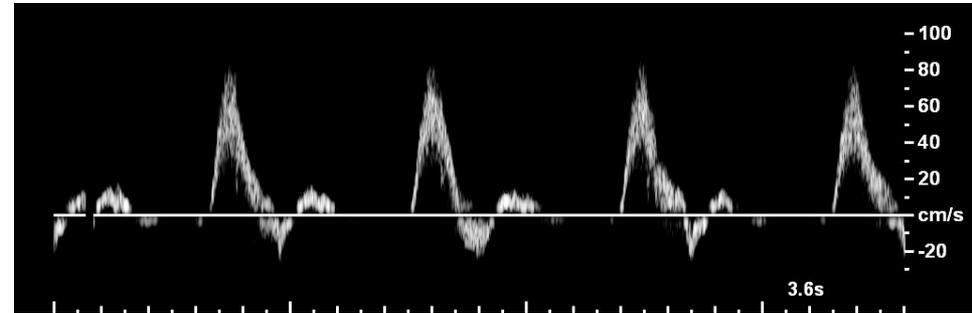


V2

Spectres normaux

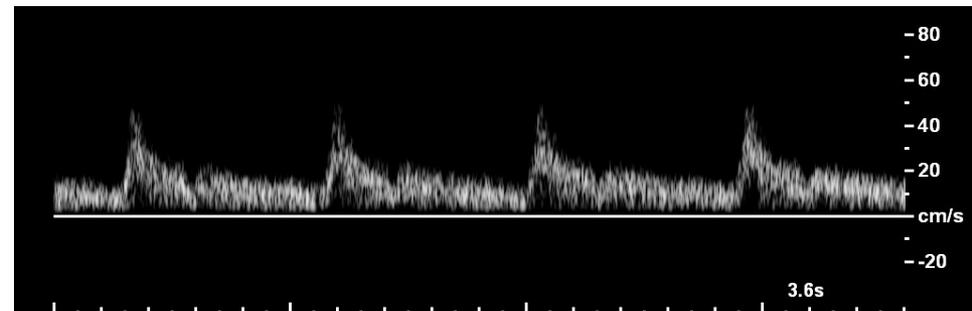
ASC

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

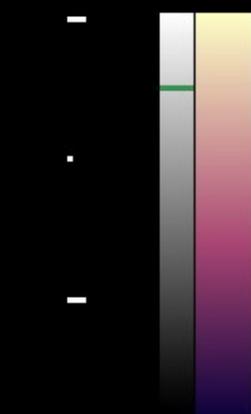
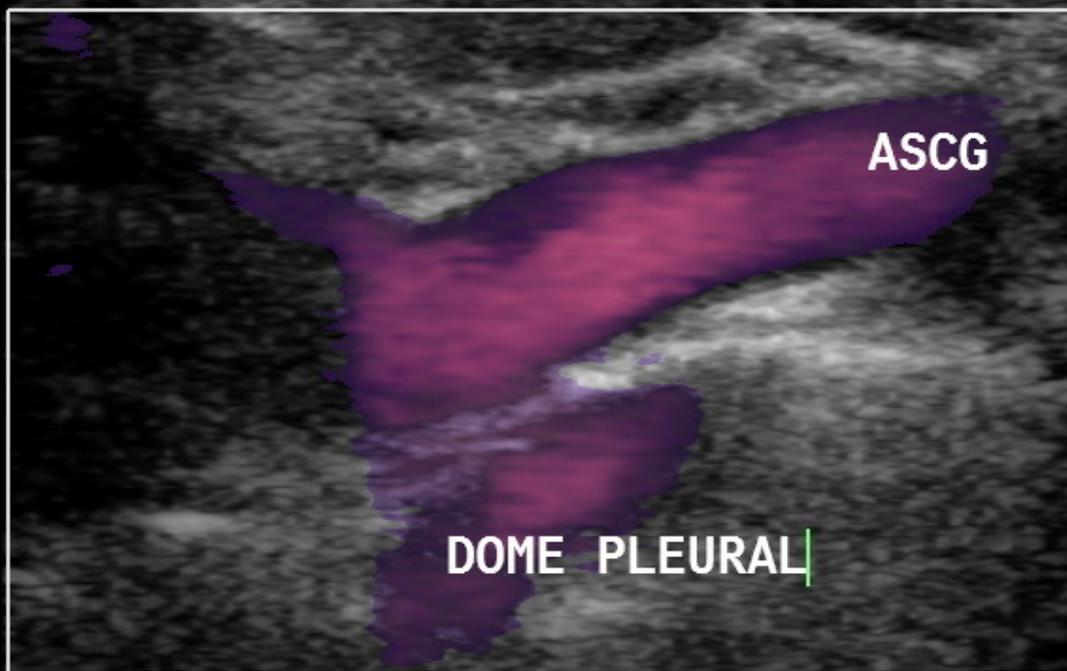
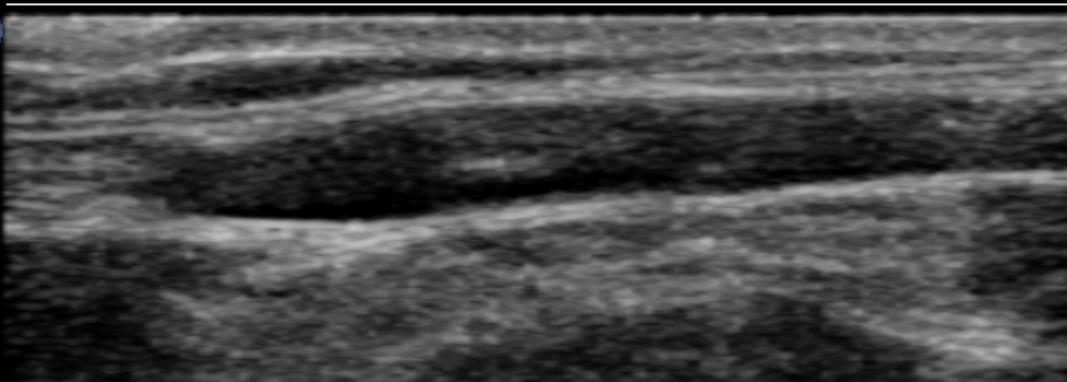
CI 20Hz
D1

2D
65%
C 50
P Bas
Gén

CPA
85%
2500Hz
FP 200Hz
Moy

C2 C1

P



4.0

Pathologies

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

Athérome

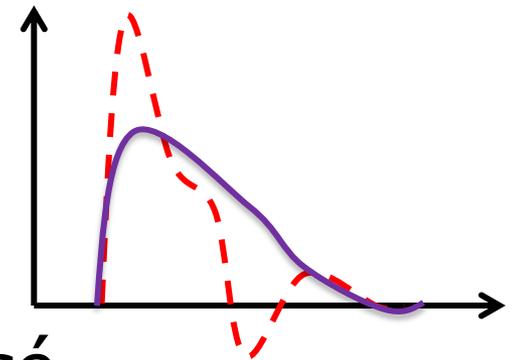
| Fréquence | Ostium AV | Bulbe carotidien | Athérome intra-crânien |
|------------------|-----------|------------------|------------------------|
| Autopsie (1) | 14-39% | 32-72% | 31-45% |
| Angiographie (2) | 18-41% | 34-68% | 28-45% |

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 $> 15\text{ mmHg}$



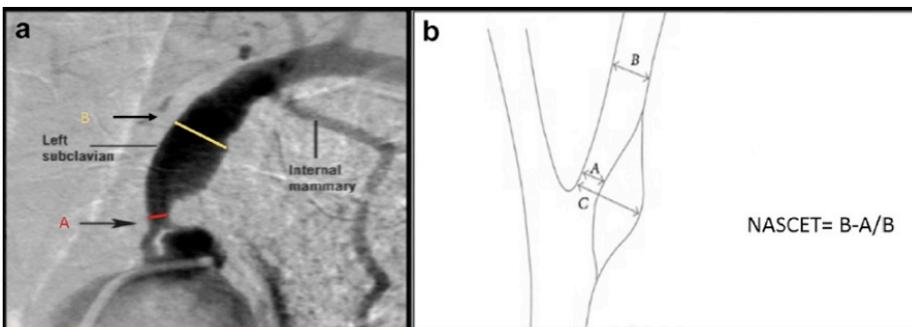
Hyperhémie post ischémique

- ❑ 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,^a Ramez Morkous, MD,^b Mike Broce, BA,^b Michael Yacoub, MD,^a Andrew Sticco, MD,^a Ravi Viradia, MD,^a Mark C. Bates, MD,^a and Ali F. AbuRahma, MD,^a 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

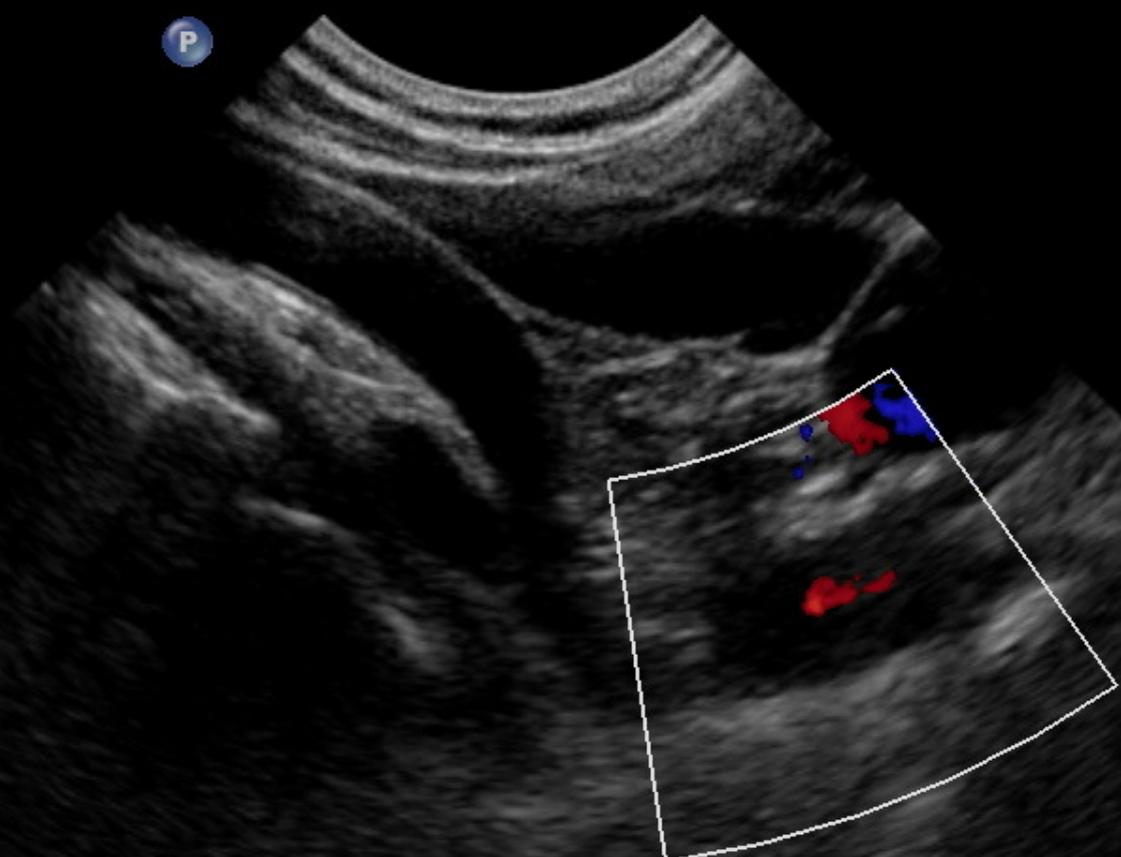


-34.2
cm/s

P



6.0-



CI 23Hz
P1

2D
66%
C 55
P Bas
Rés

Coul
77%
4000Hz
FP 139Hz
Moy

P

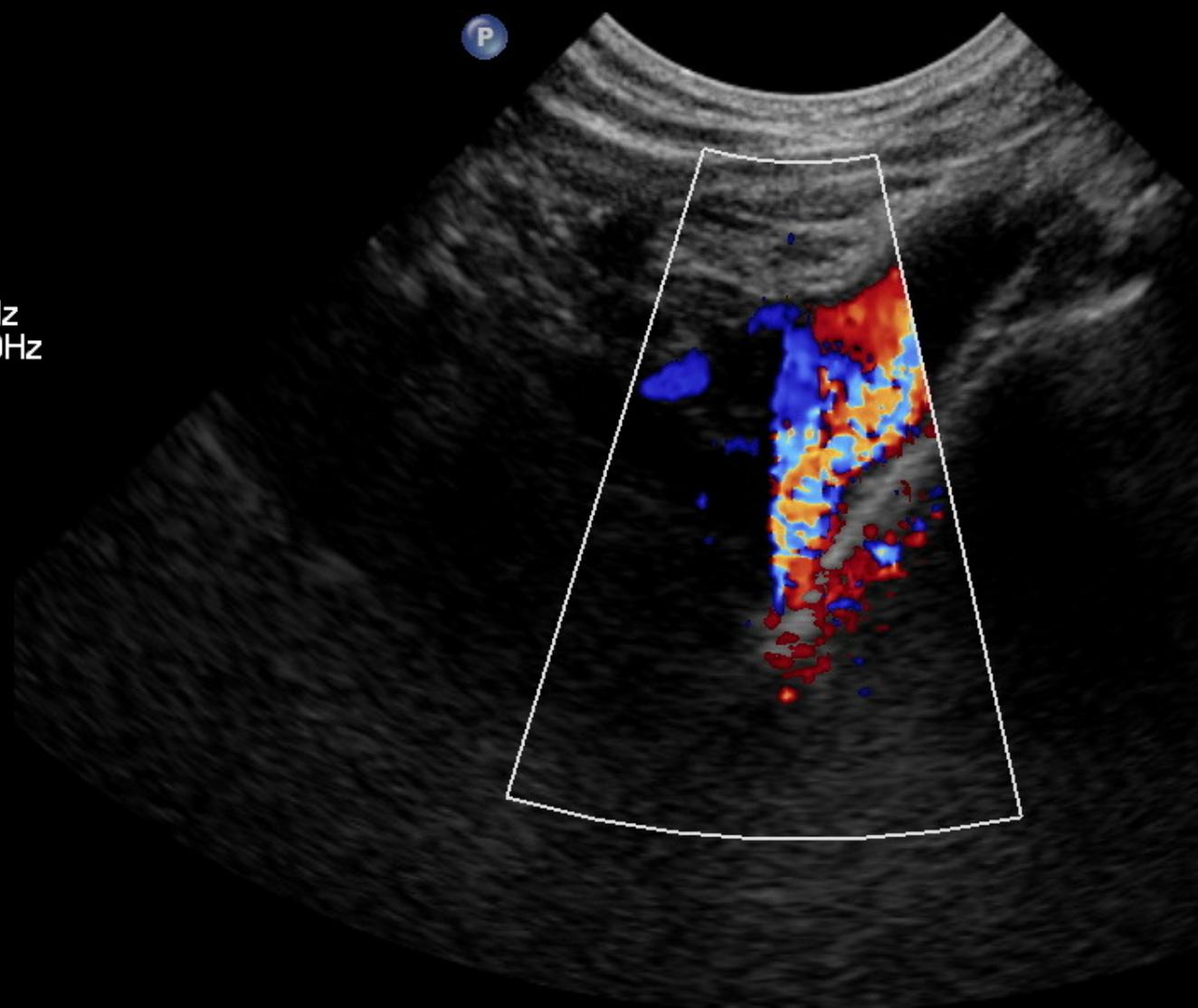
C3 C3
+34.2



-34.2
cm/s



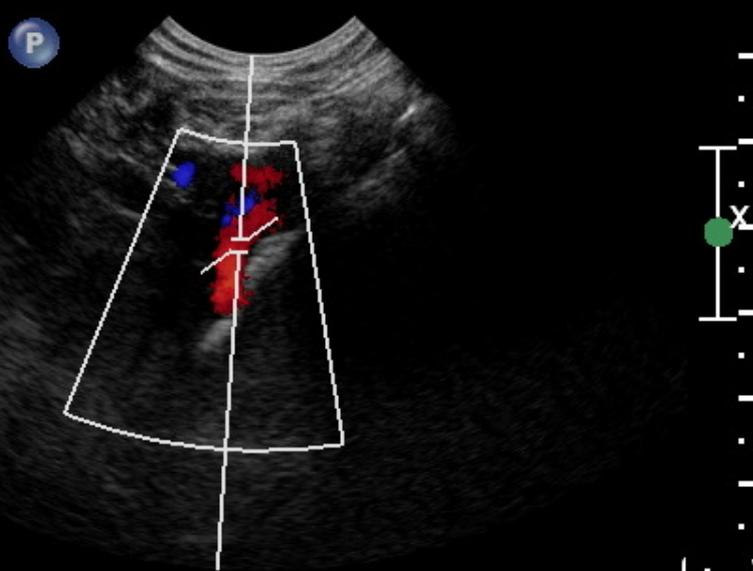
5.0-



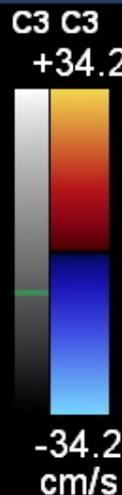
CI 21Hz 50°
P1

2D
69%
C 55
P Bas
Rés

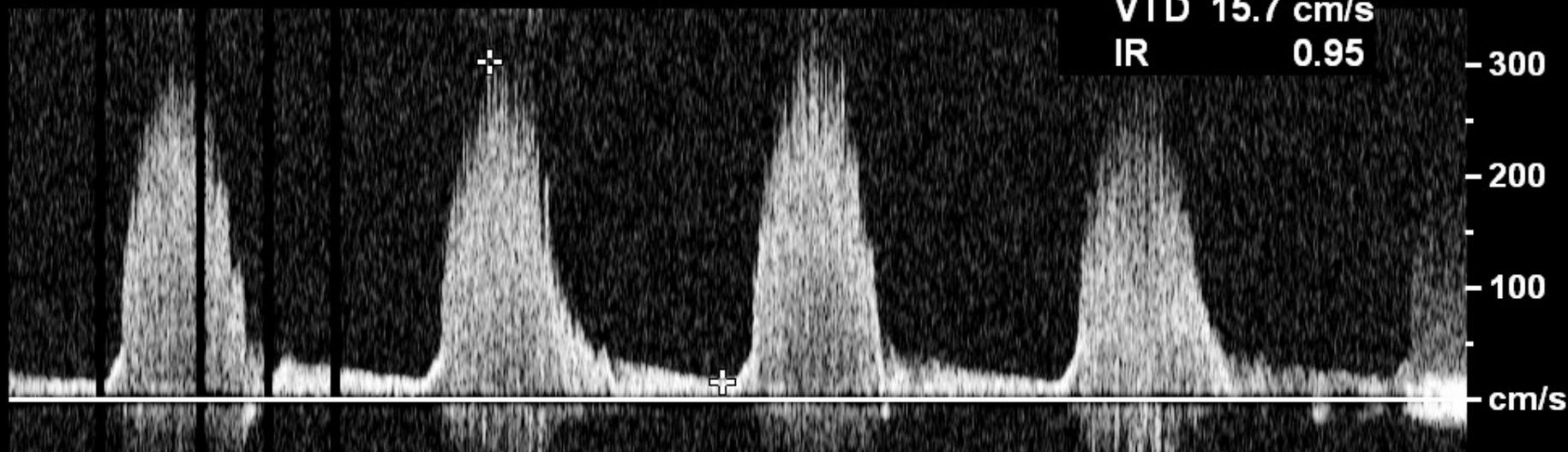
Coul
77%
4000Hz
FP 139Hz
Moy



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



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



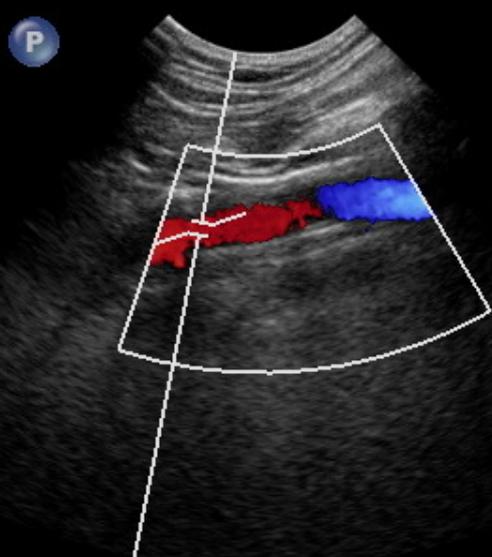
3.6s

CI 17Hz 60°
P1

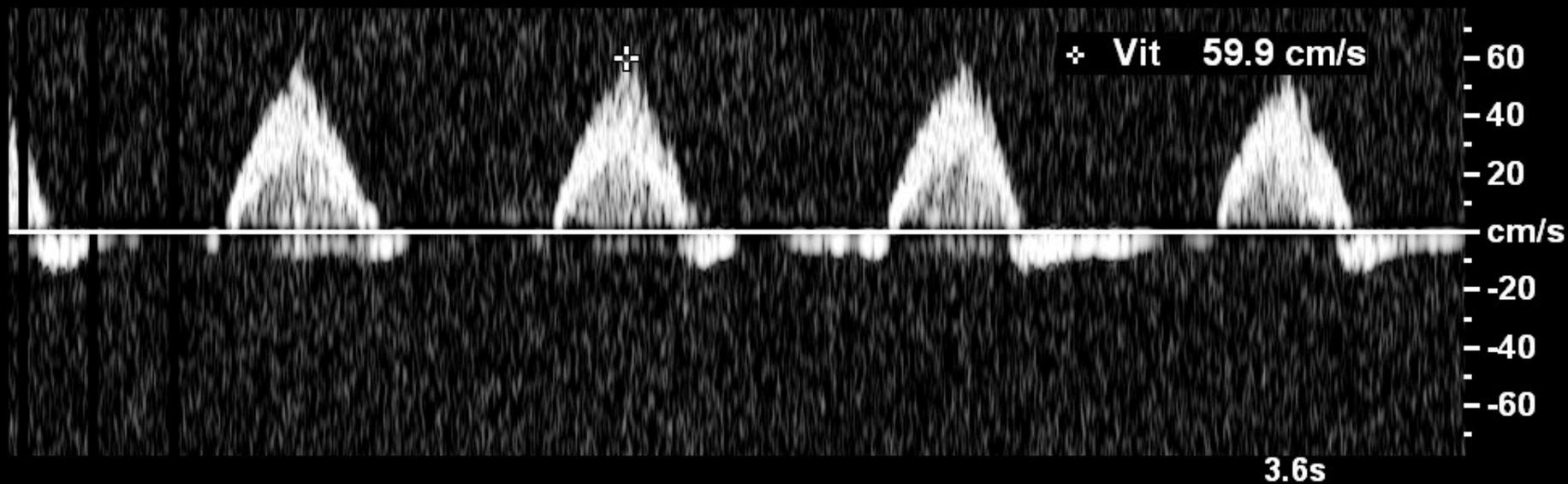
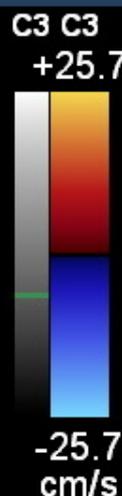
2D
73%
C 55
P Bas
Rés

Coul
77%
3000Hz
FP 119Hz
Moy

AX G



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



CI 27Hz 60°
P1

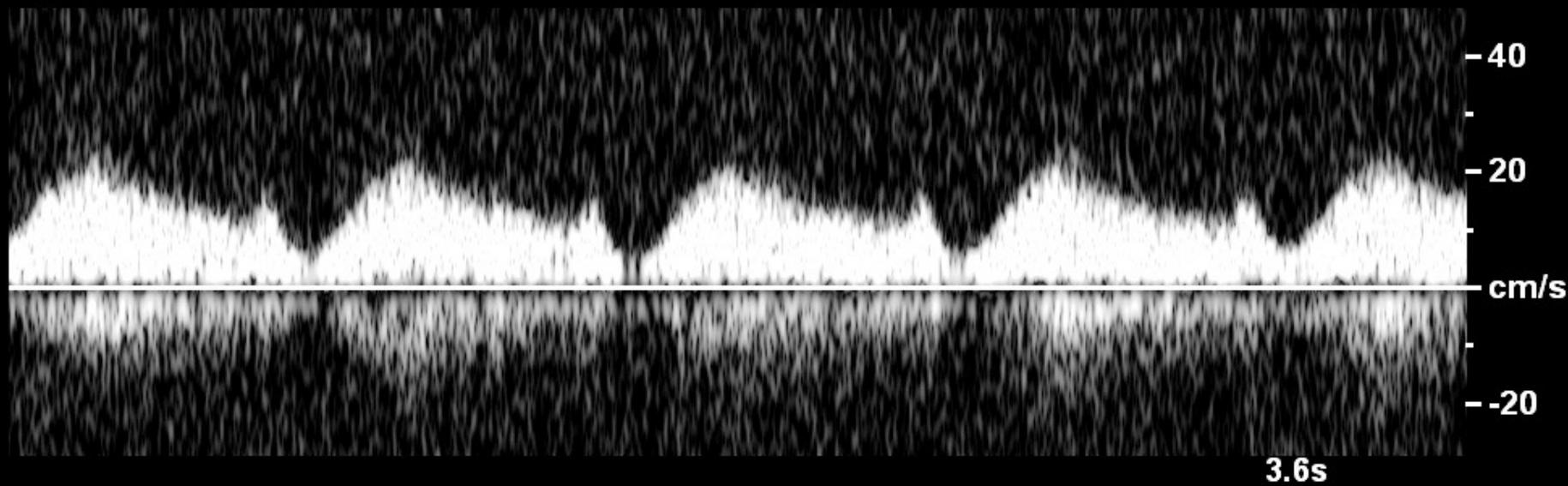
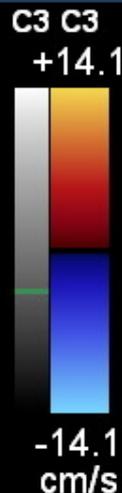
2D
61%
C 55
P Bas
Rés

Coul
77%
1650Hz
FP 82Hz
Moy

V2 G



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



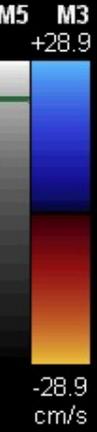
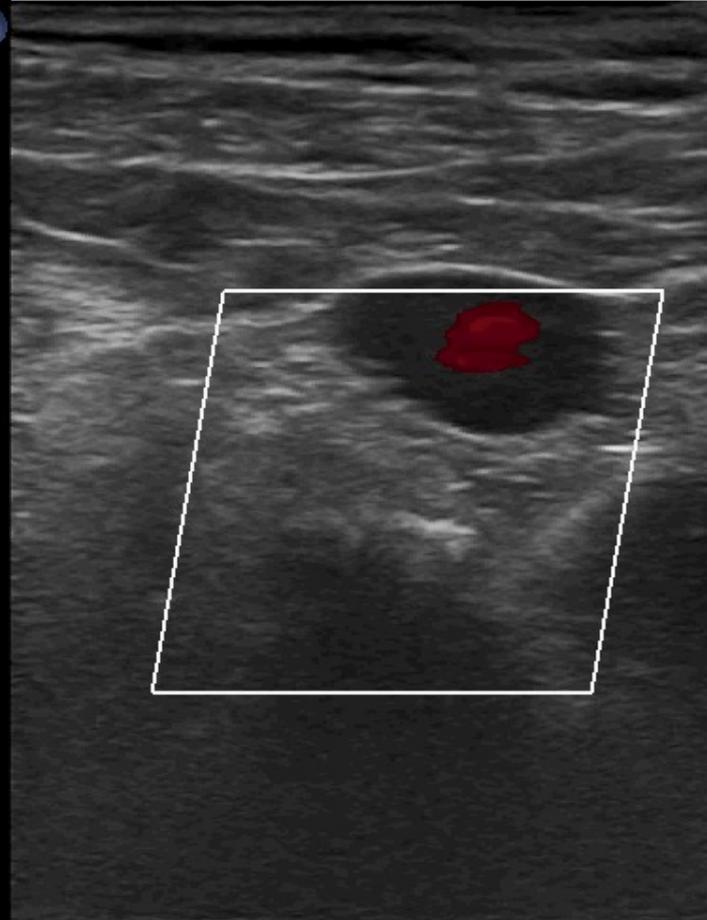
TSA
L12-3
18Hz

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

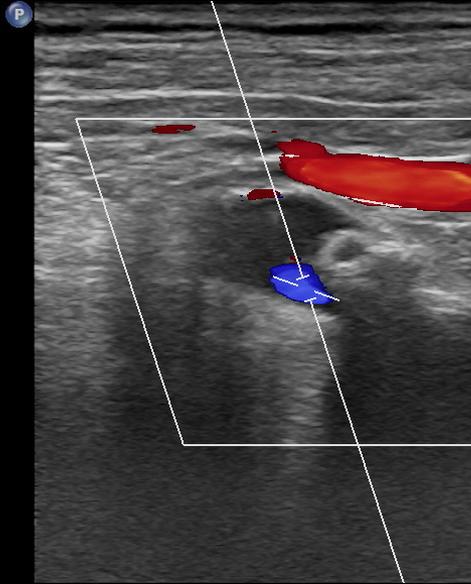
IM 0.3

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

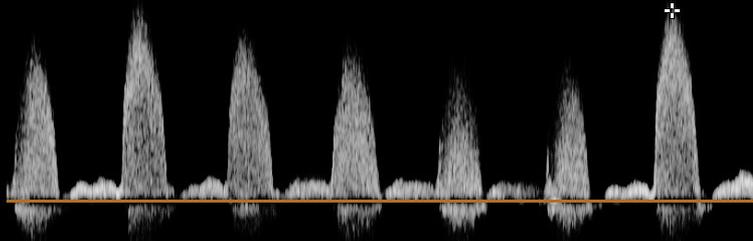
50%

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%

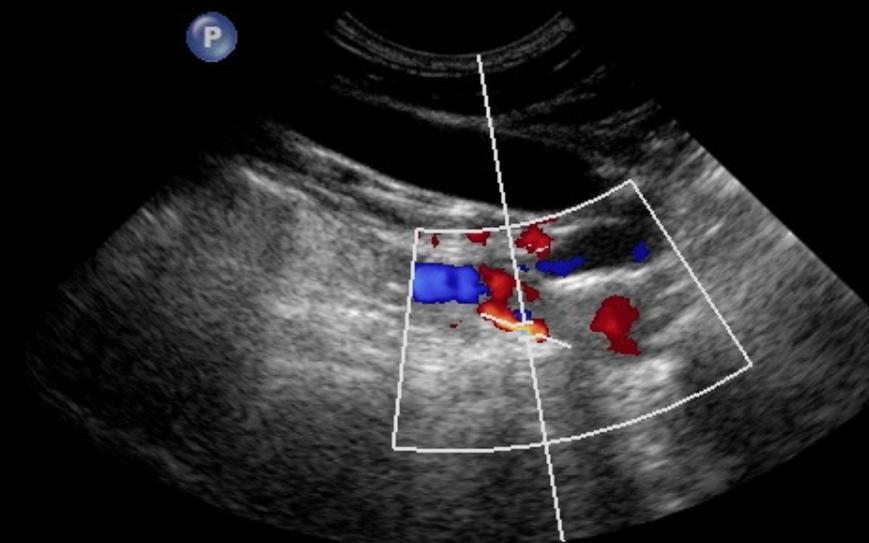
Sténose vertébrale

| Sténose | VSM | VTD | Rapport systolique |
|---------------|------------------------|-----------------------|--------------------|
| 50-69% | > 140 cm/sec | > 35 cm/sec | > 2,1 |
| 70-99% | > 210 cm/sec | > 50 cm/sec | > 4 |

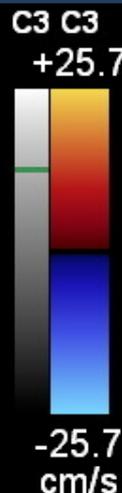
CI 14Hz 60°
P1

2D
67%
C 55
P Bas
Rés

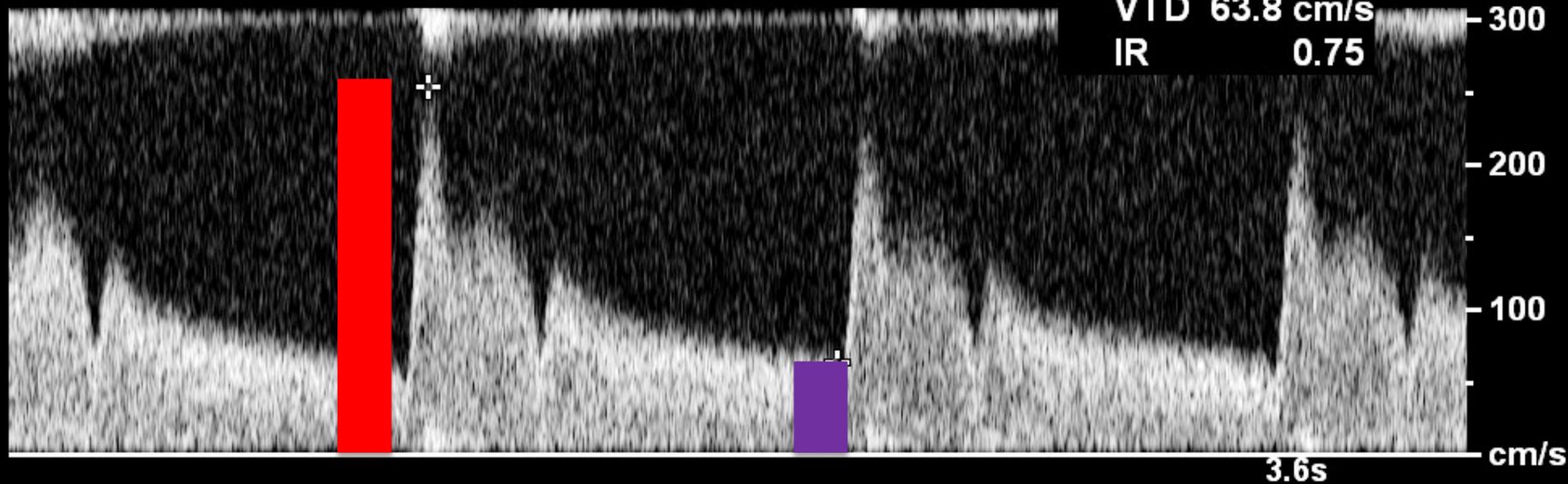
Coul
78%
3000Hz
FP 149Hz
Moy



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



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

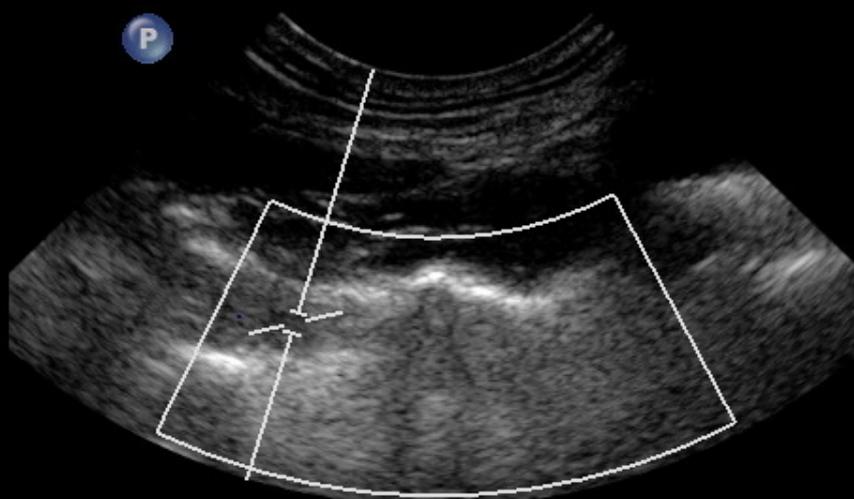


CI 15Hz 60°
P1

2D
62%
C 55
P Bas
Rés

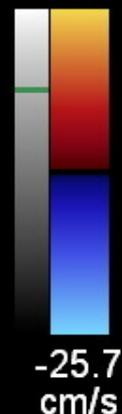
Coul
78%
3000Hz
FP 149Hz
Moy

V2

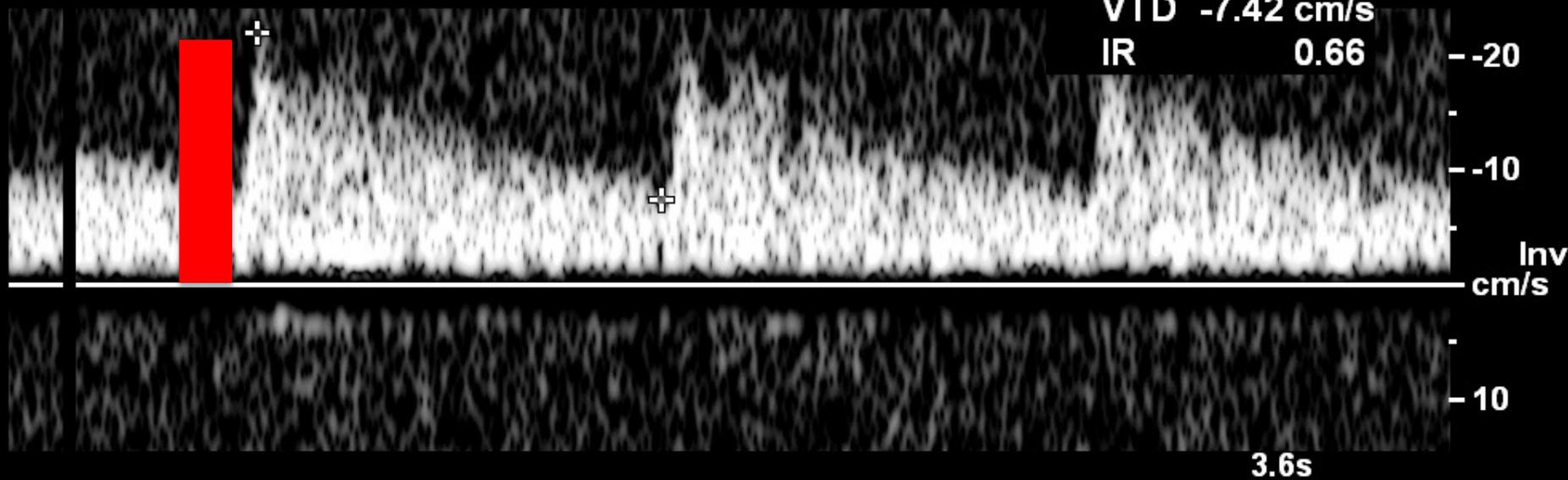


DP
84%
FP 70Hz
VE 1.5mm
E2
5.0MHz
1.9cm

C3 C3
+25.7



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



Occlusion vertébrale

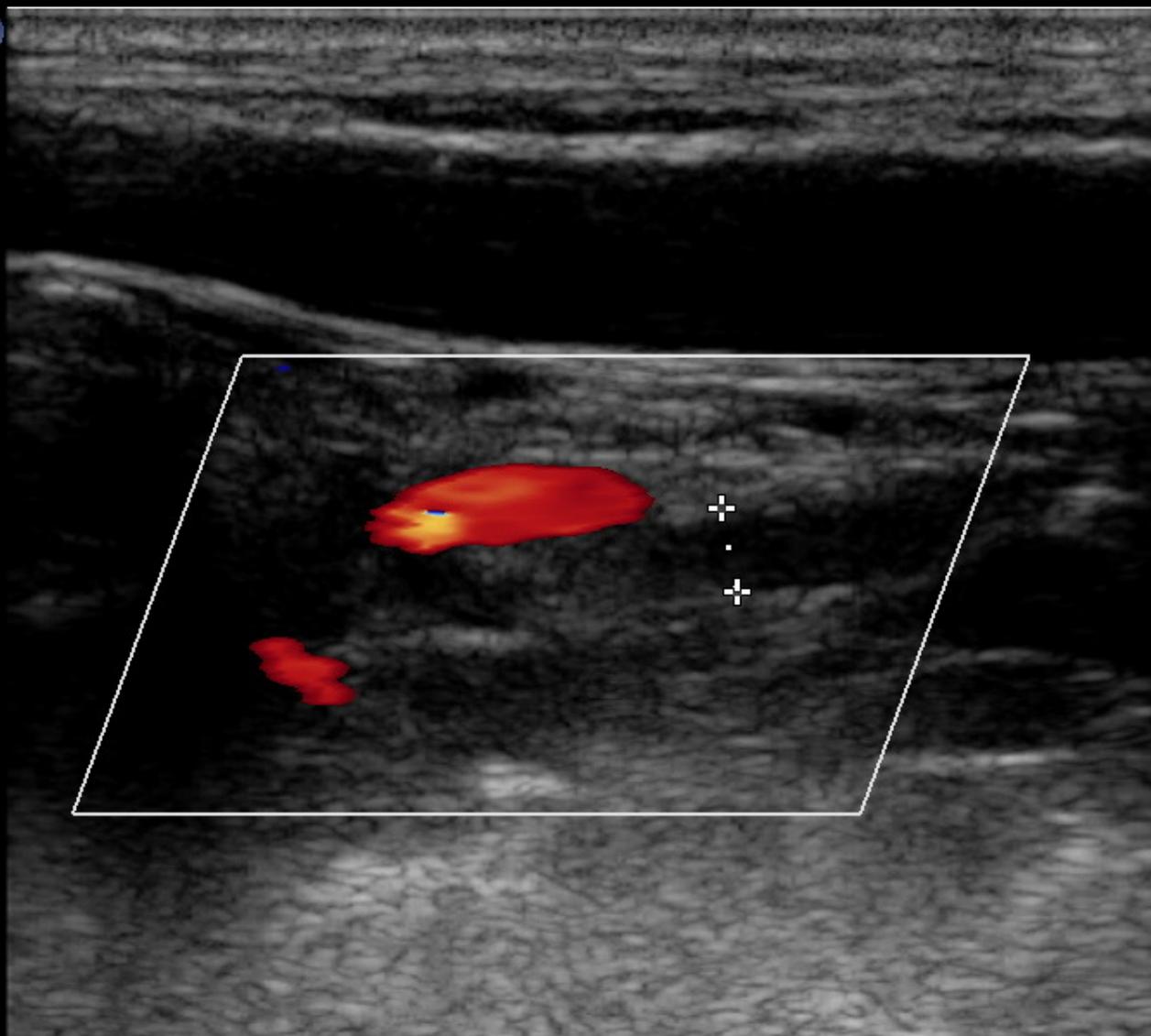
- ❑ Absence de signal doppler
- ❑ Calibre normal en 2D
- ❑ Collatérales cervicales
- ❑ Flux d'aval amorti
- ❑ Diagnostic différentiel :
 - Hypoplasie ou agénésie
 - Calibre diminué
 - Pas de collatérales
 - Artère controlatérale de large calibre

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

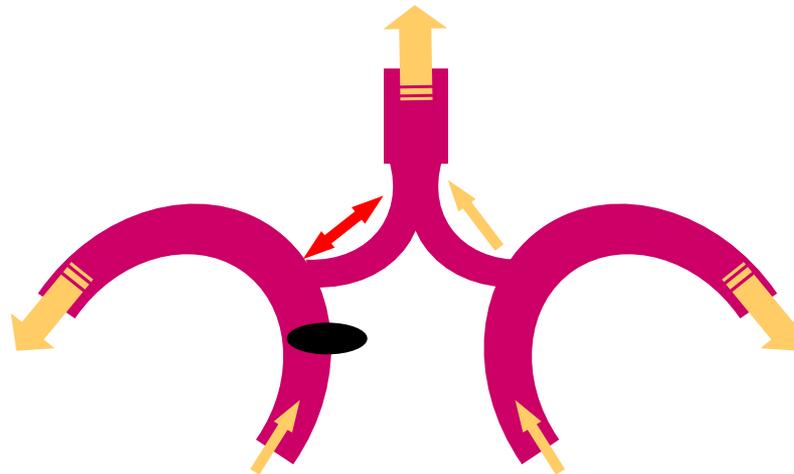
-32.1
cm/s



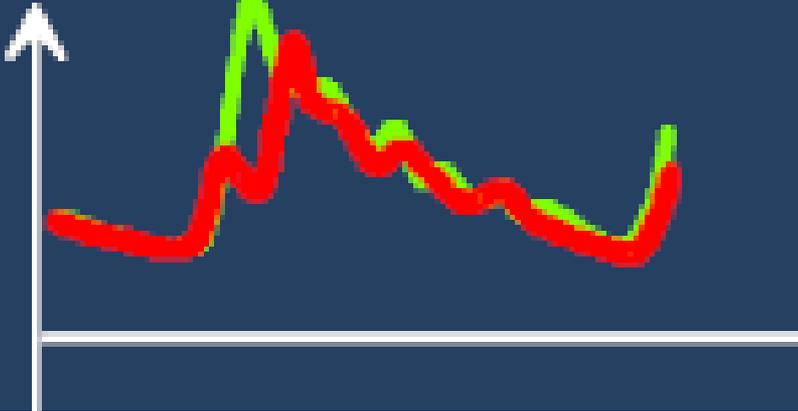
+ Dist 0.289 cm

Vol vertébro-subclavier

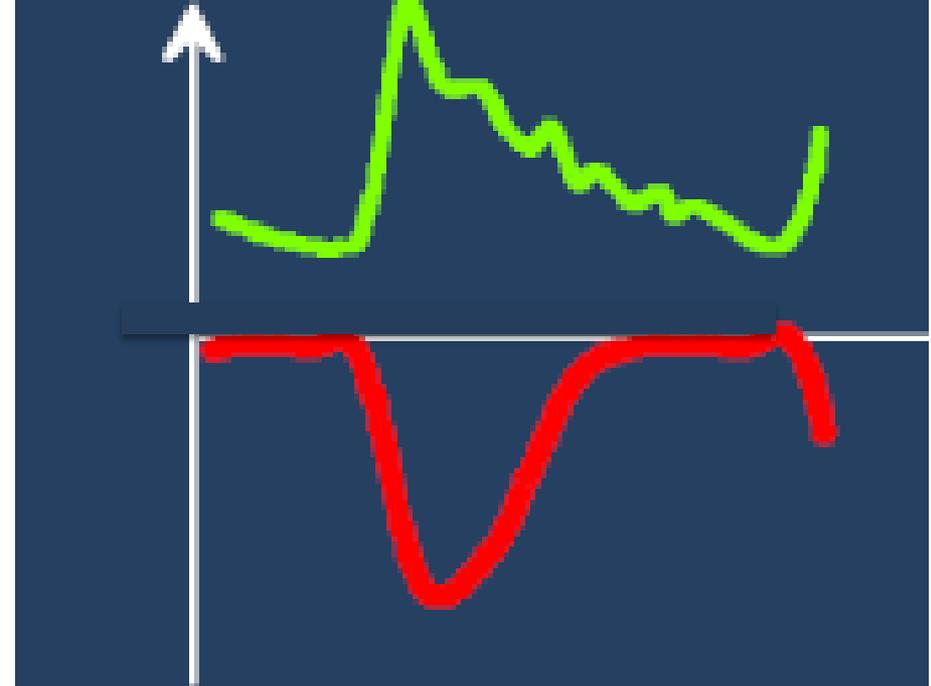
- ❑ Sténose de l'ASC en amont de l'AV
- ❑ Pression art encéphaliques > pression MS
- ❑ Symptomatologie neurologique positionnelle



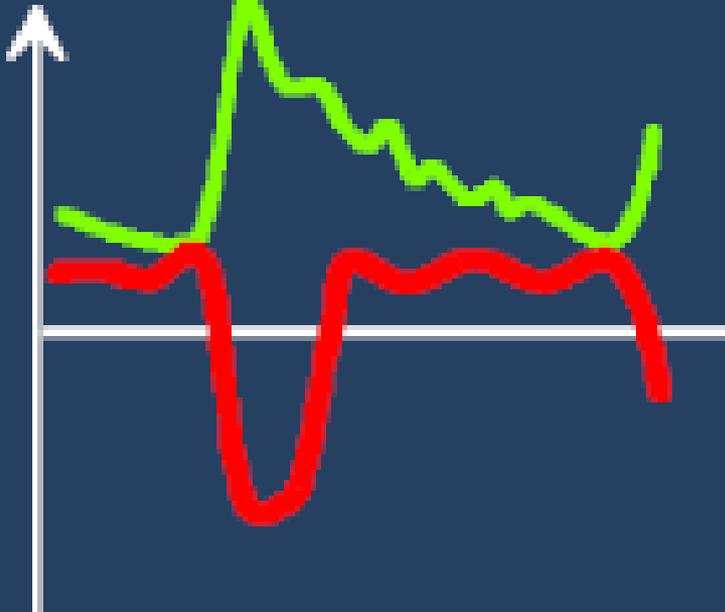
Pré vol



Vol permanent



Vol intermittent



CI 27Hz 60°
P1

2D
61%
C 55
P Bas
Rés

Coul
77%
1650Hz
FP 82Hz
Moy

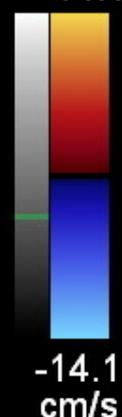
V2 G

P

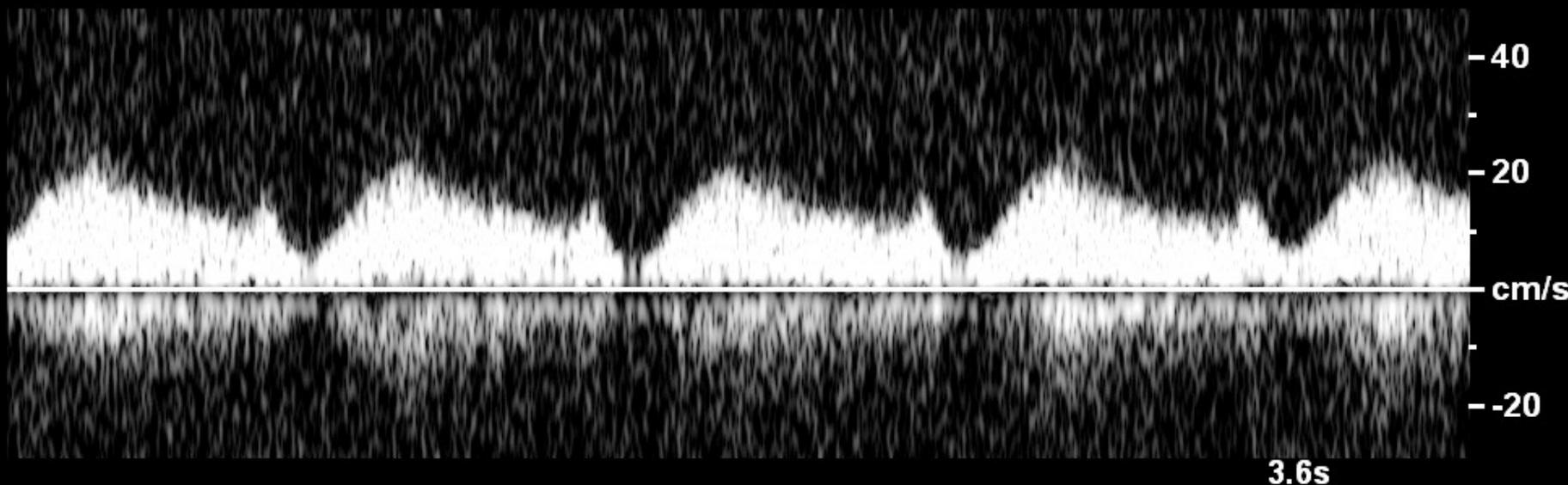


DP
84%
FP 70Hz
VE1.5mm
E2
5.0MHz
1.6cm

C3 C3
+14.1



4.0-



03220920121127

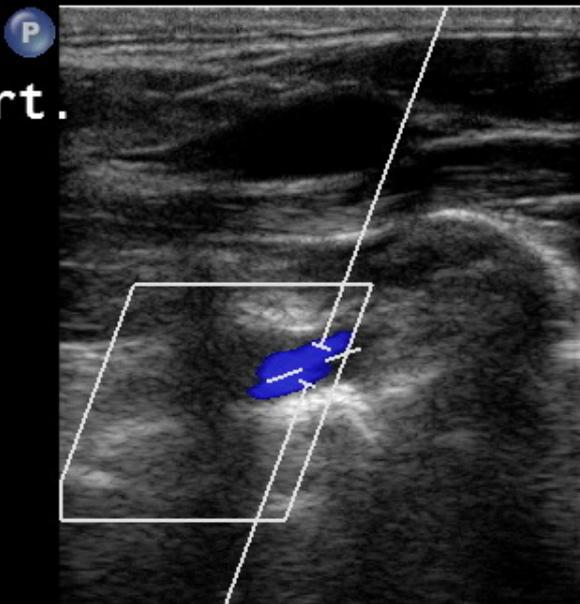
HOPITAL LA TIMONE

L11-3/OPTIMAL TSA

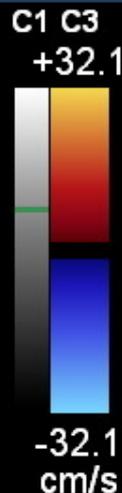
CI 18Hz 50°
4.5cm

2D
64%
C 62
P Bas
Pén

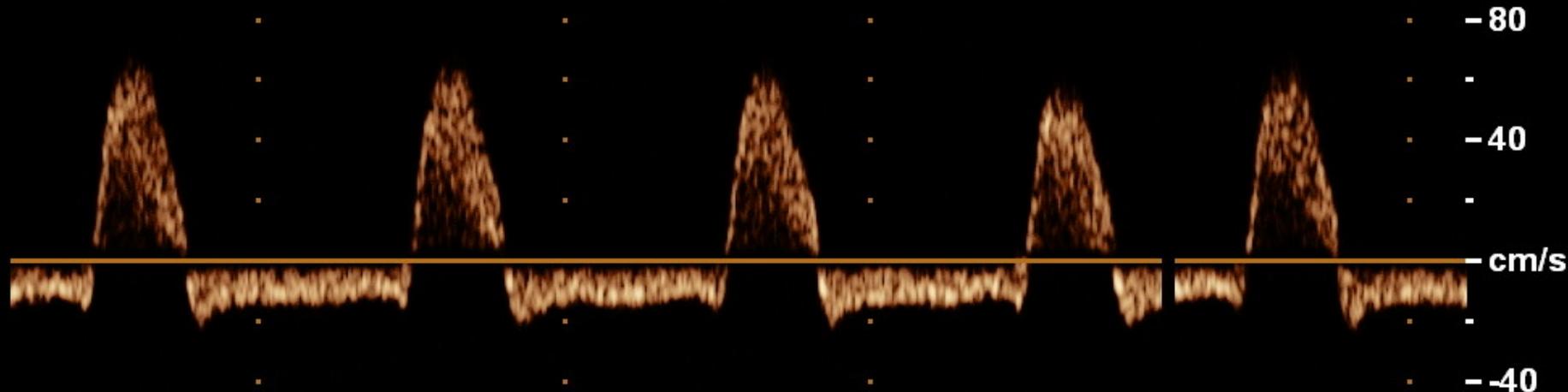
Gauche Vert.
V2



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



- 0
.
- 1
.
- 2
.
- 3
X
- 4
.



50mm/s

03220920121127

L11-3/OPTIMAL TSA

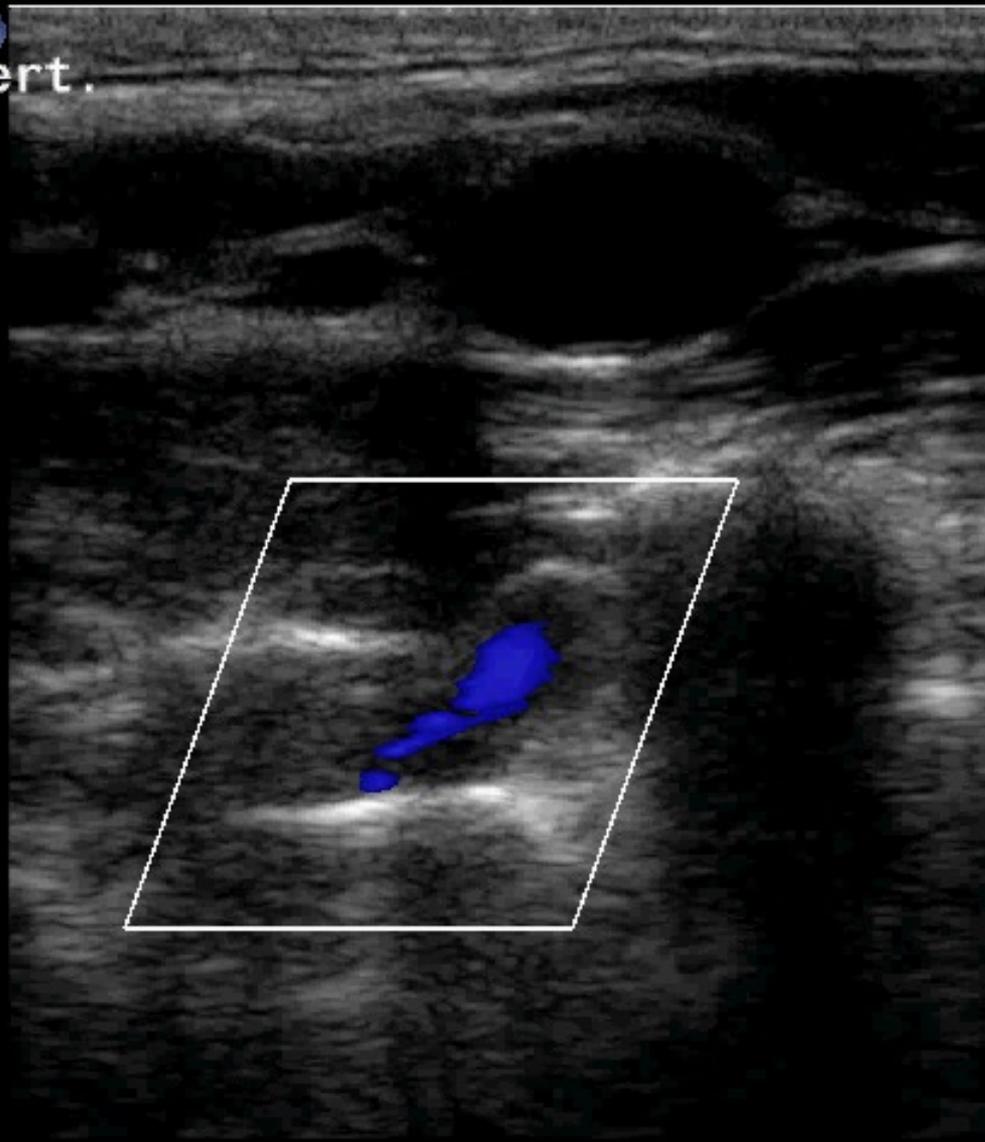
CI 18Hz
4.5cm

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



X.

JPEG

*** bpm

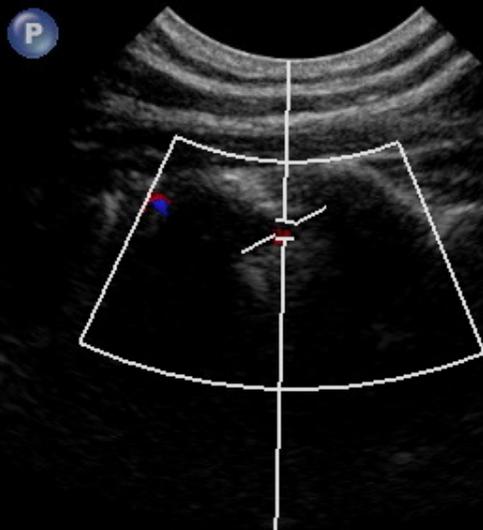


CI 23Hz 60°
P1

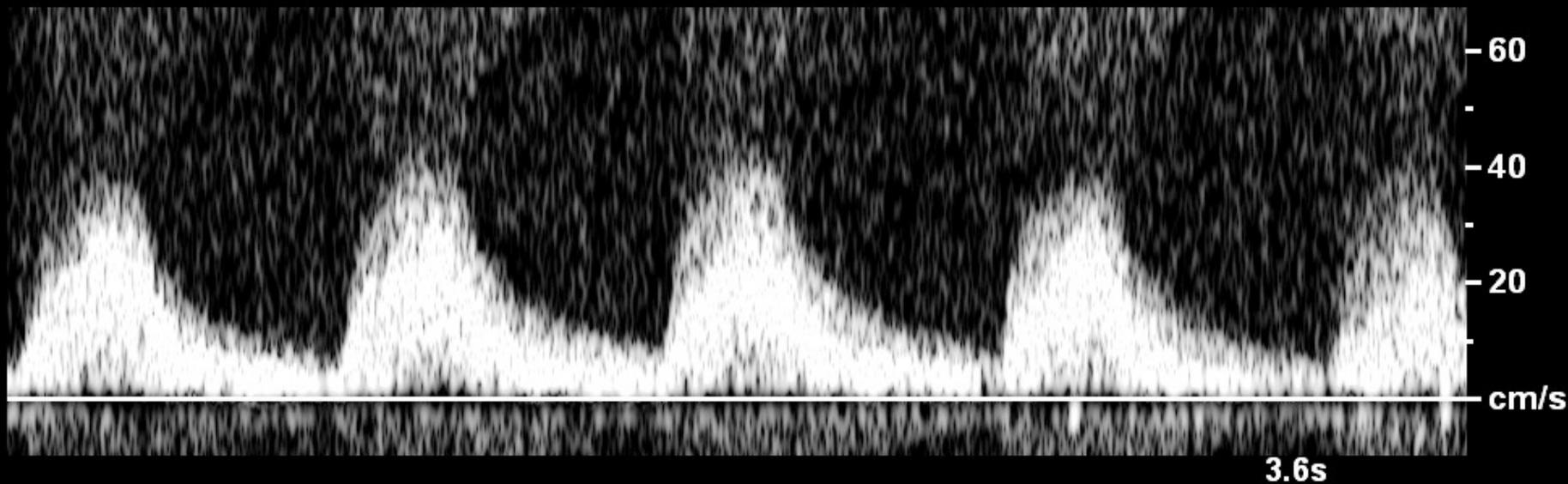
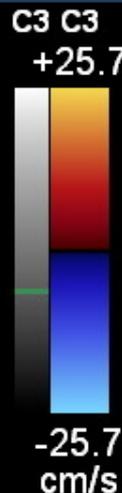
2D
61%
C 55
P Bas
Rés

Coul
77%
3000Hz
FP 119Hz
Moy

V1 D



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

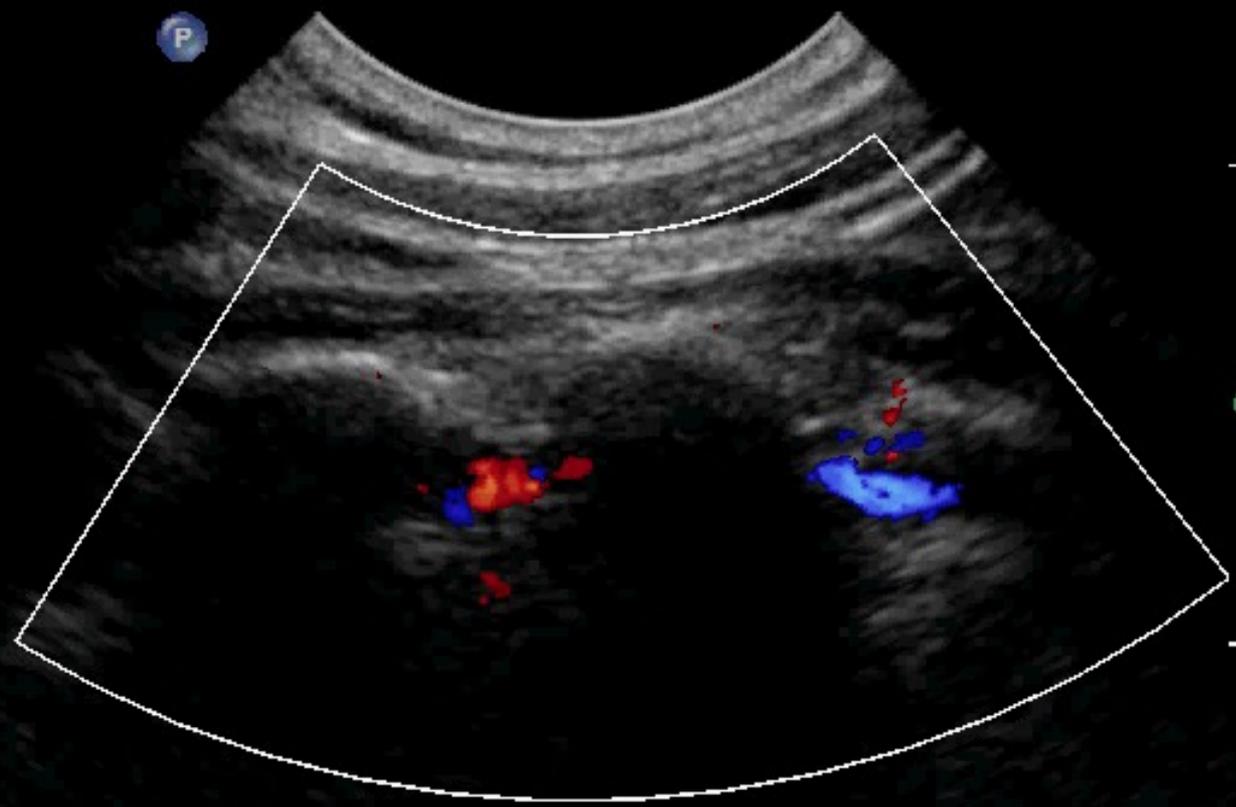


CI 18Hz
P1

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

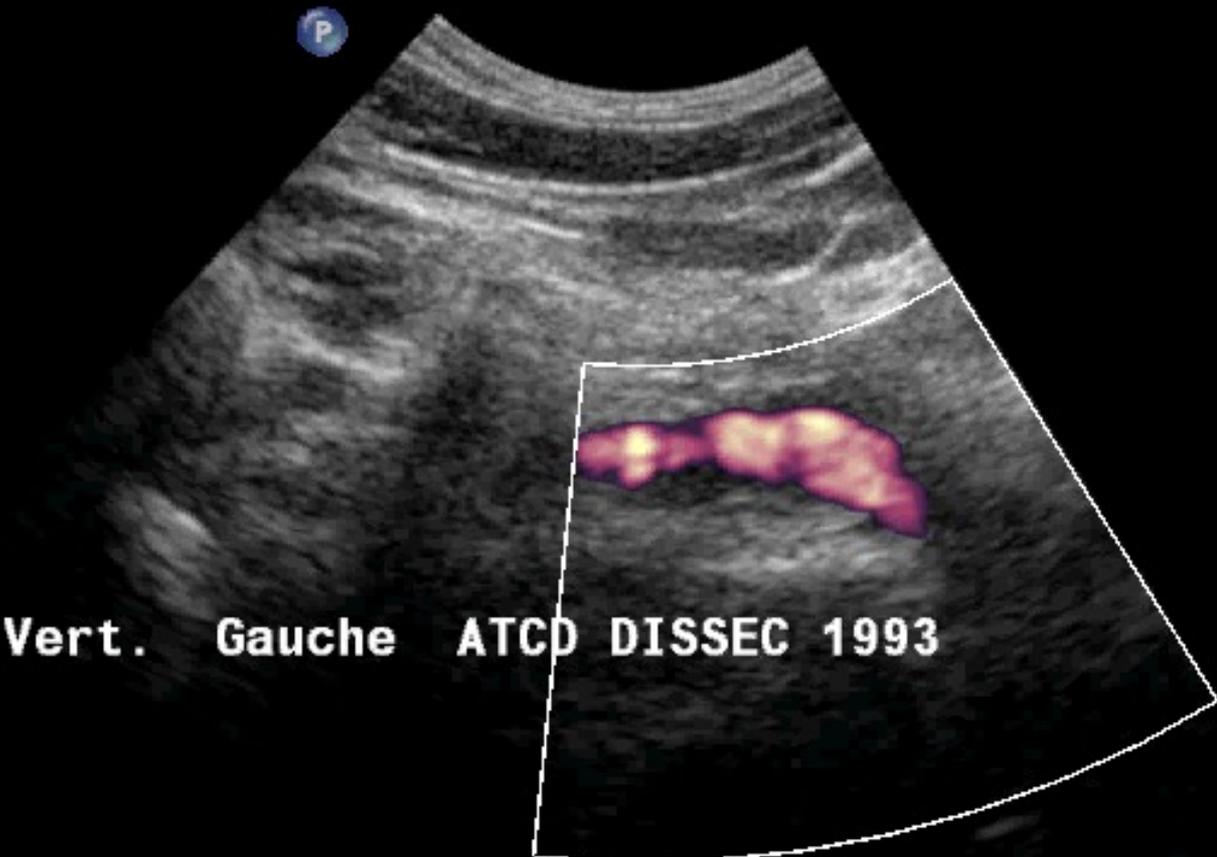
14450920080304

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



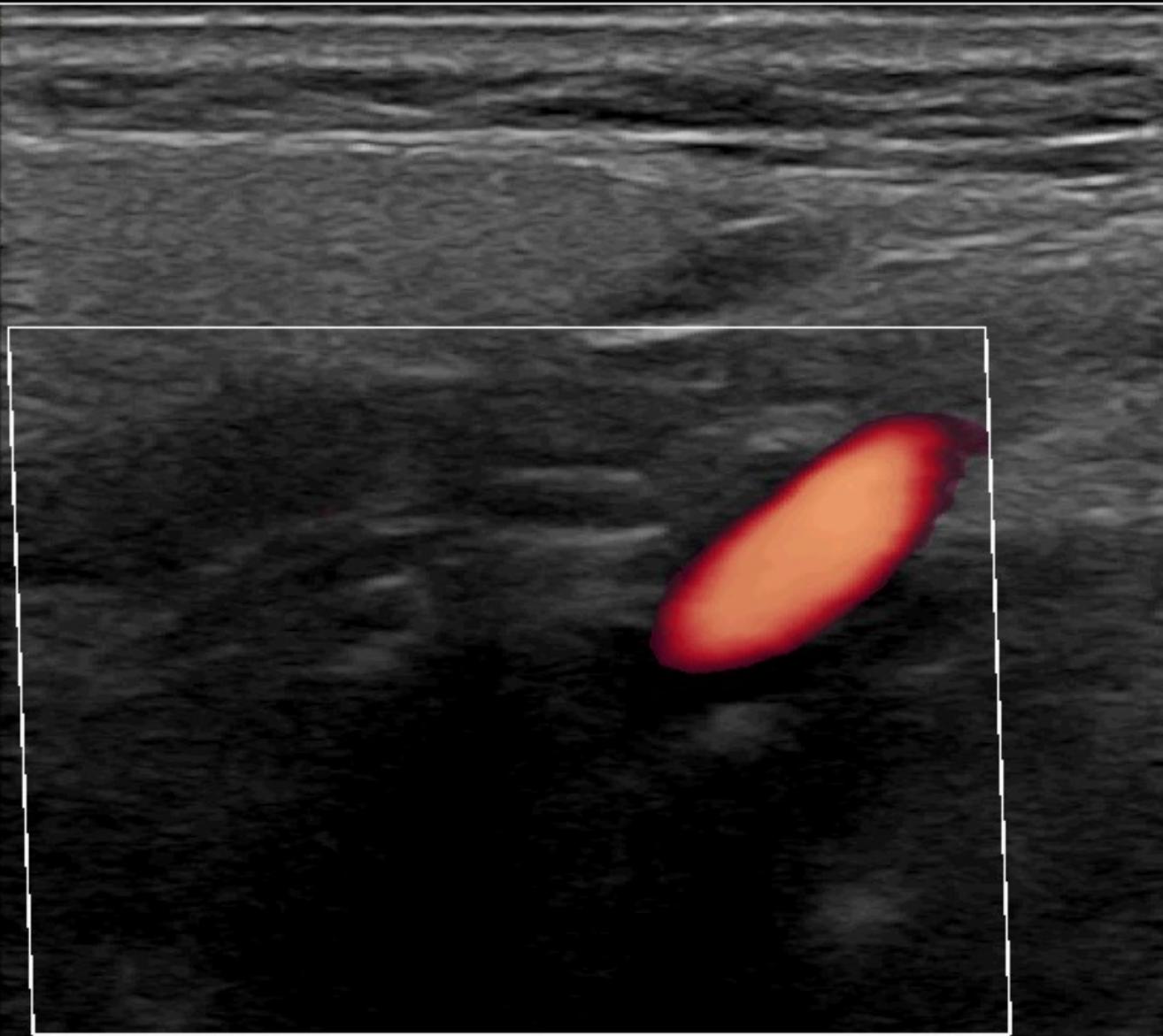
JPEG - 5*** bpm

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

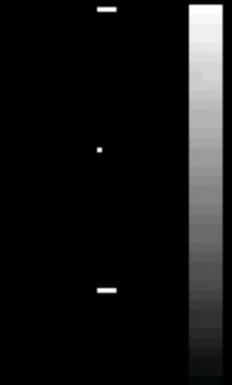
A VERTEBRALE

- Hématome pariétal
- Lumière diminuée
- Sténose longue

CI 33Hz
RV

2D
42%
C 50
P Bas
Rès

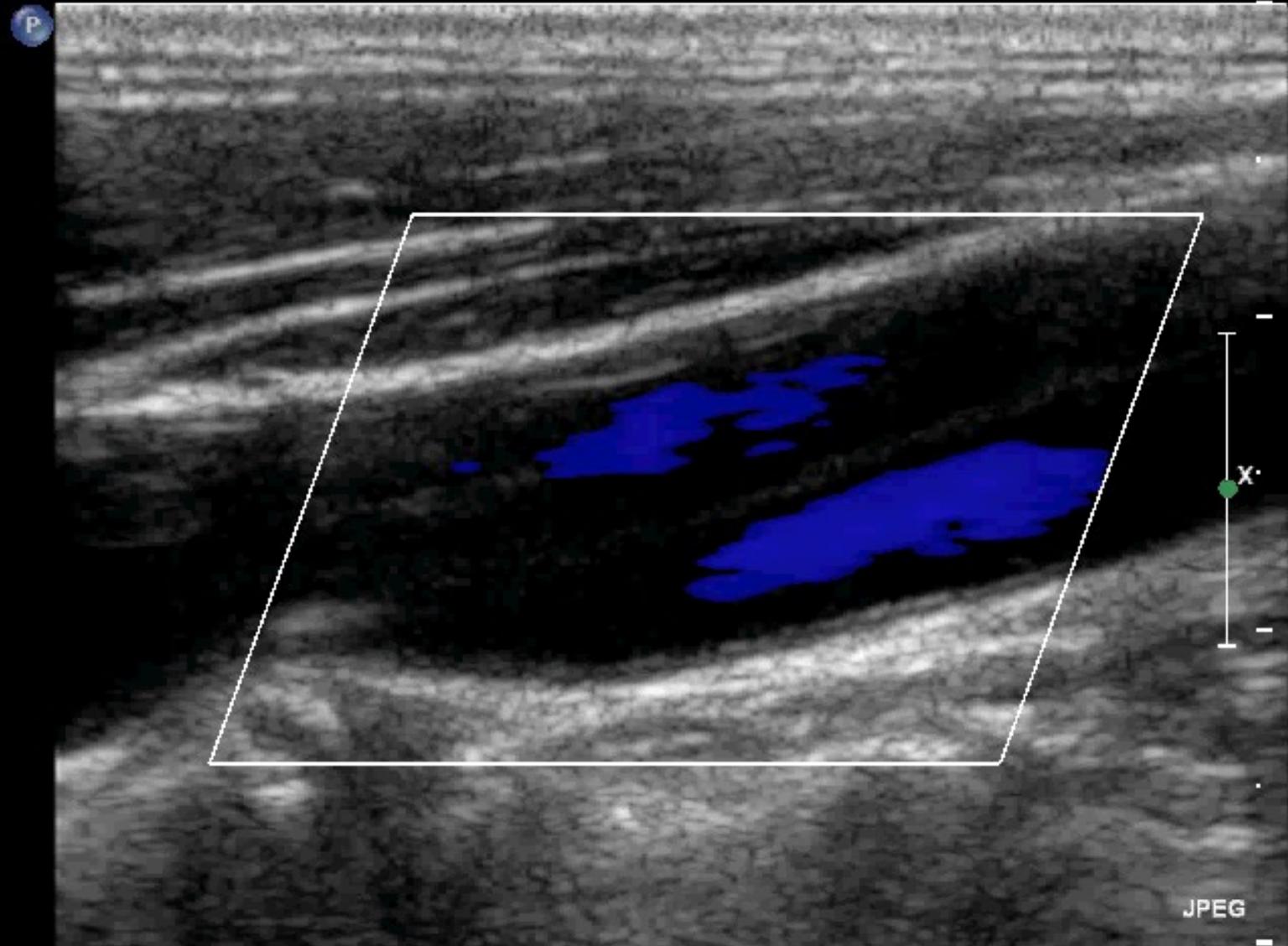
C2



JPEG
4.0 *** bpm

CI 12Hz
3.0cm

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



JPEG

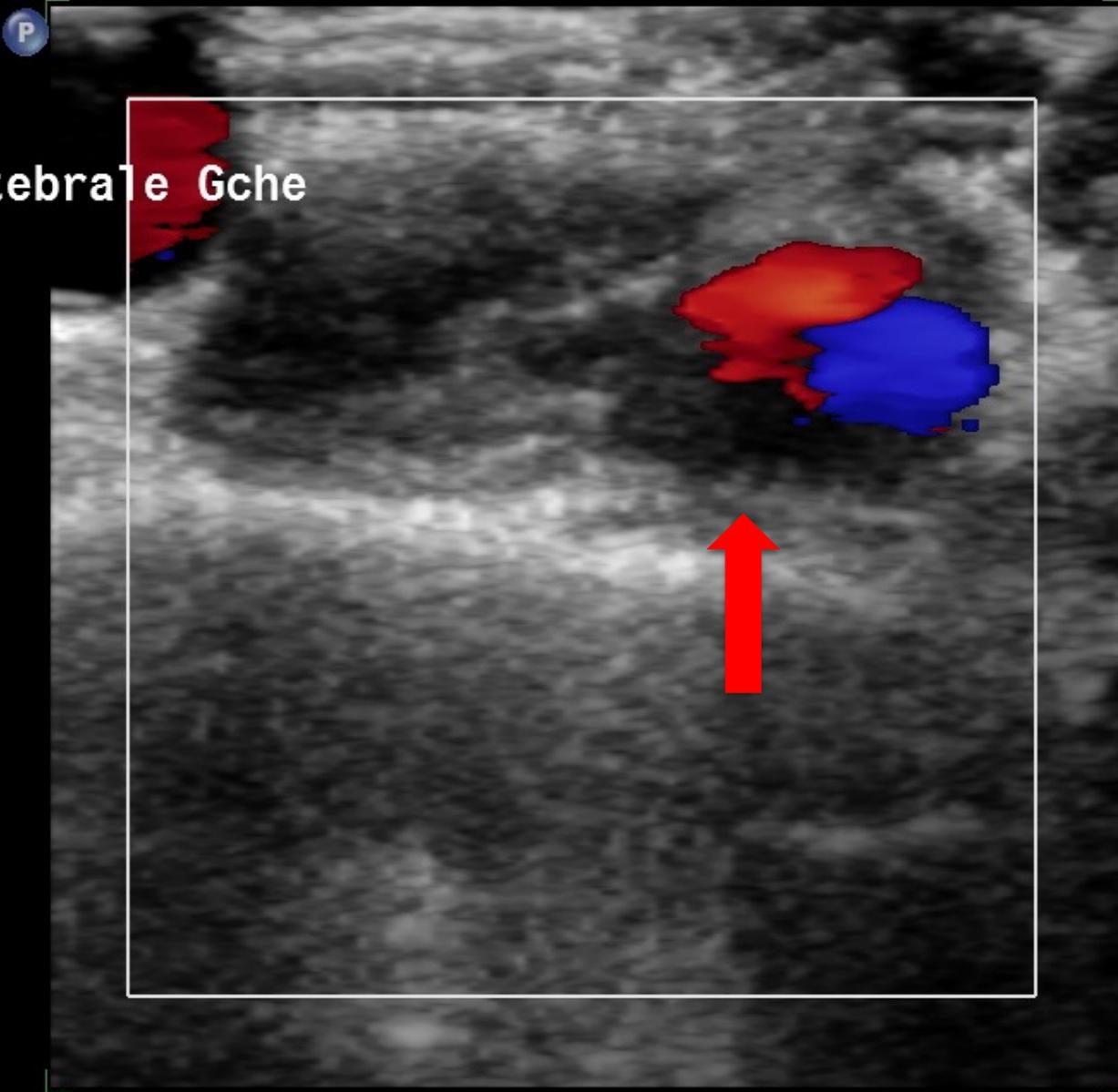
3** bpm

CI 28Hz
R1

2D
72%
C 50
P Bas
Gén

Coul
85%
3500Hz
FP 227Hz
Moy

Vertebral e Gche



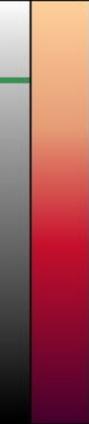
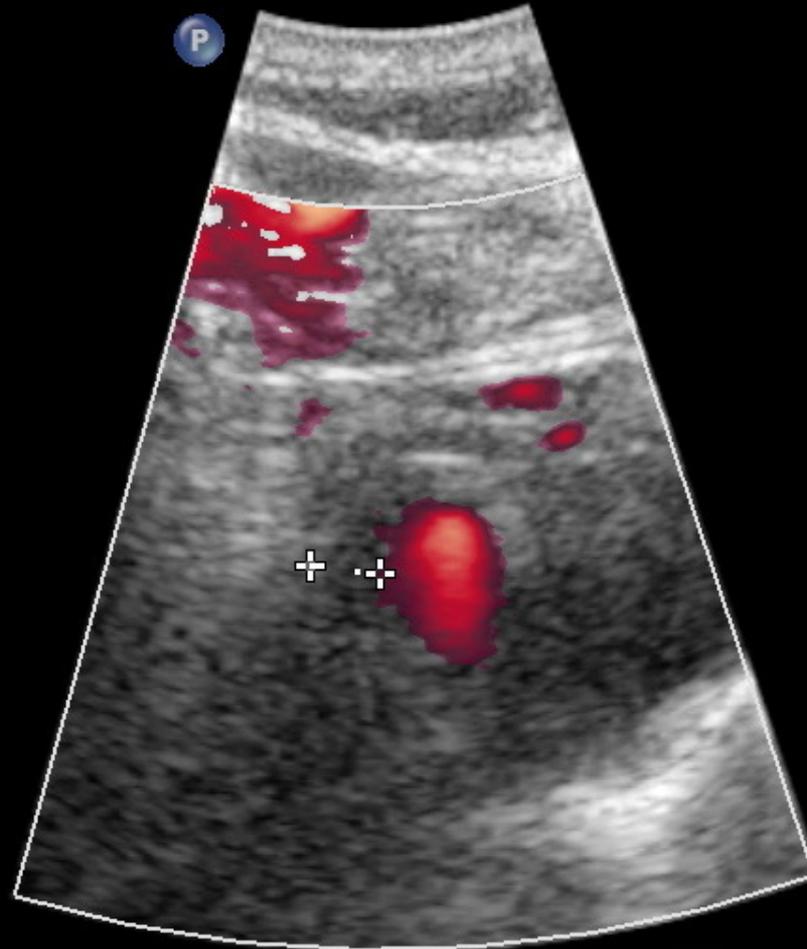
C2 C3
+33.7



CI 24Hz
P1

2D
72%
C 54
P Bas
Rés

CPA
91%
2000Hz
FP 120Hz
Moy



3.0-

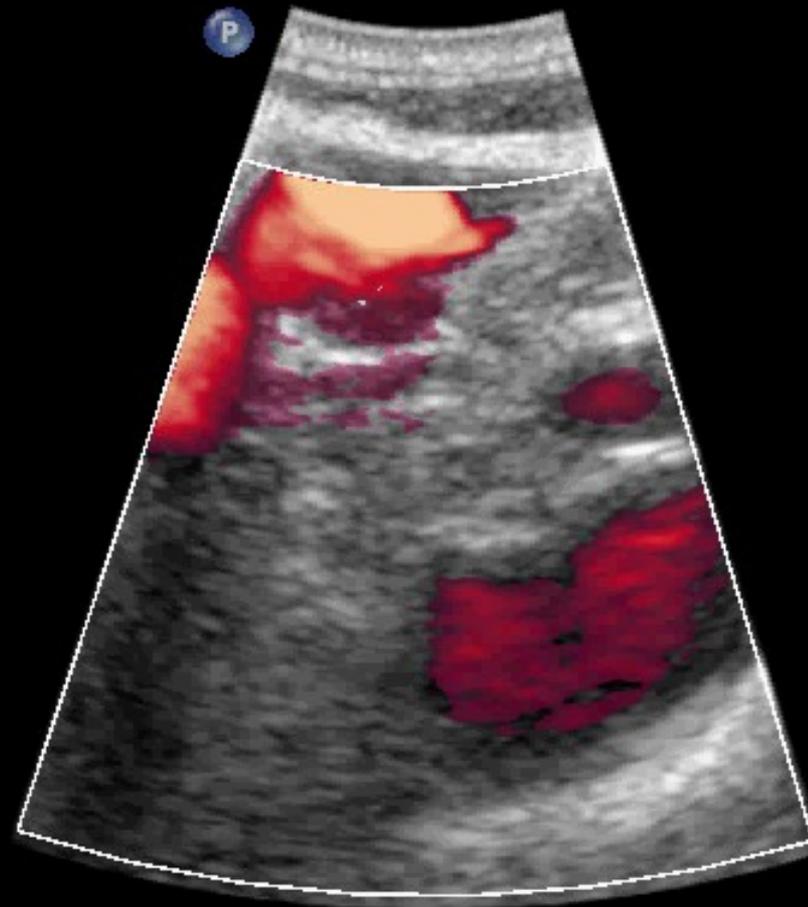
✦ Dist 0.237 cm

CI 24Hz
P1

2D
72%
C 54
P Bas
Res

CPA
91%
2000Hz
FP 120Hz
Moy

C3 C3

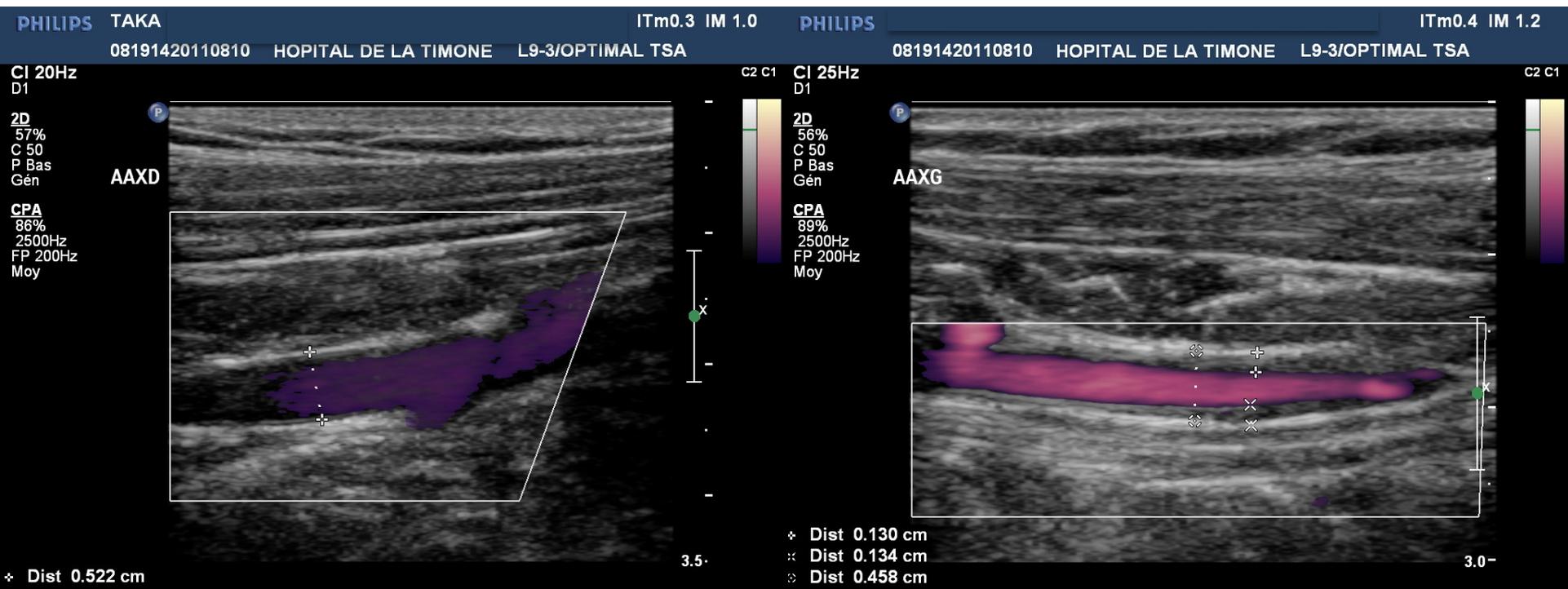


3.0 -
JPEG

*** 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

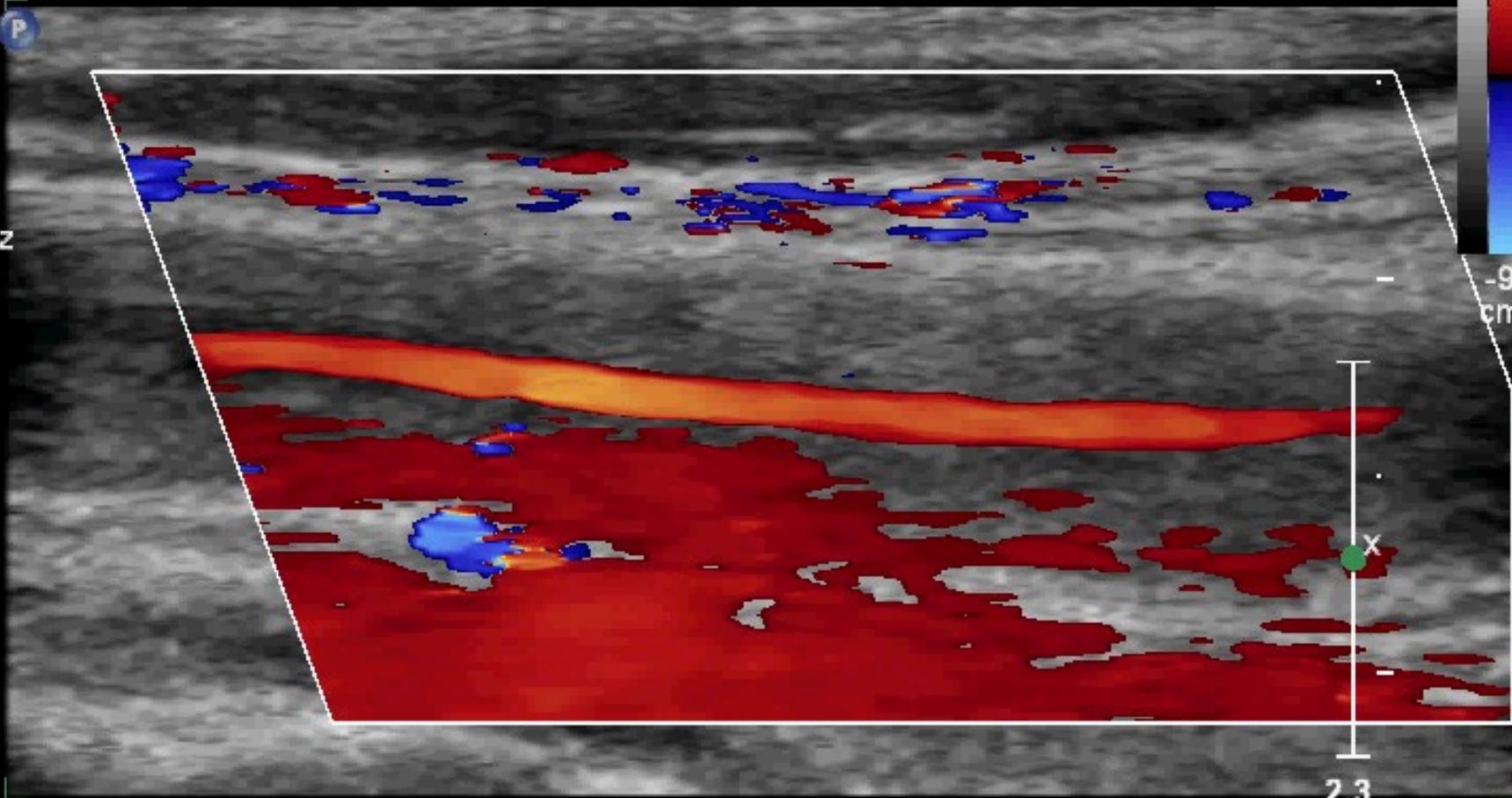
AGC

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

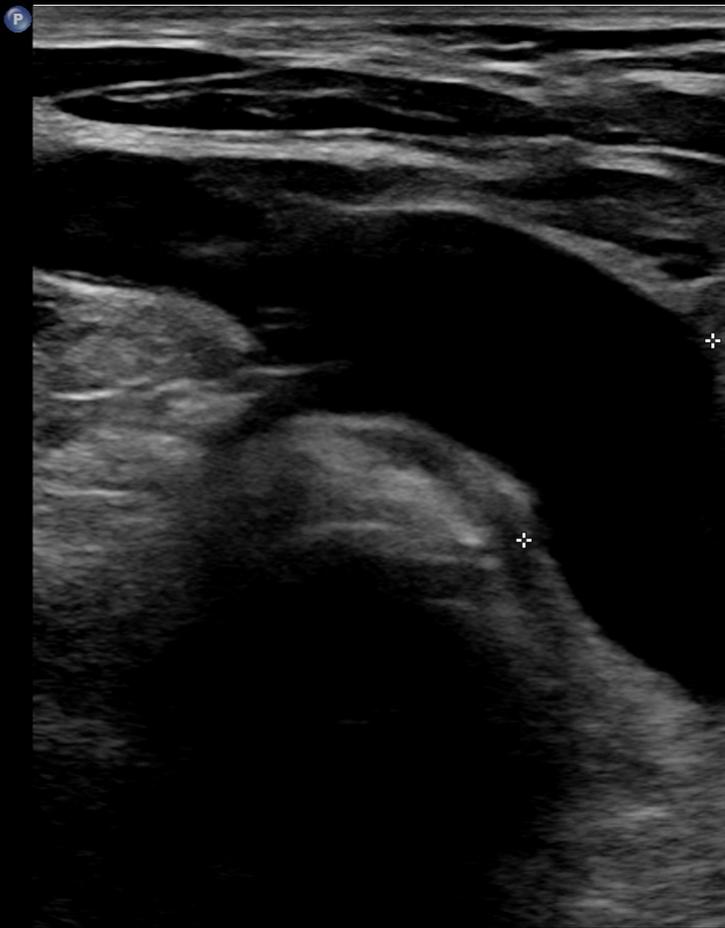
P Bas

HGen

ITm0.3

IM 1.3

M3



Dist 1.48 cm

5.0cm

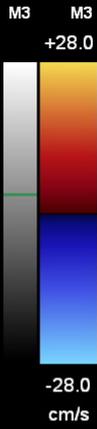
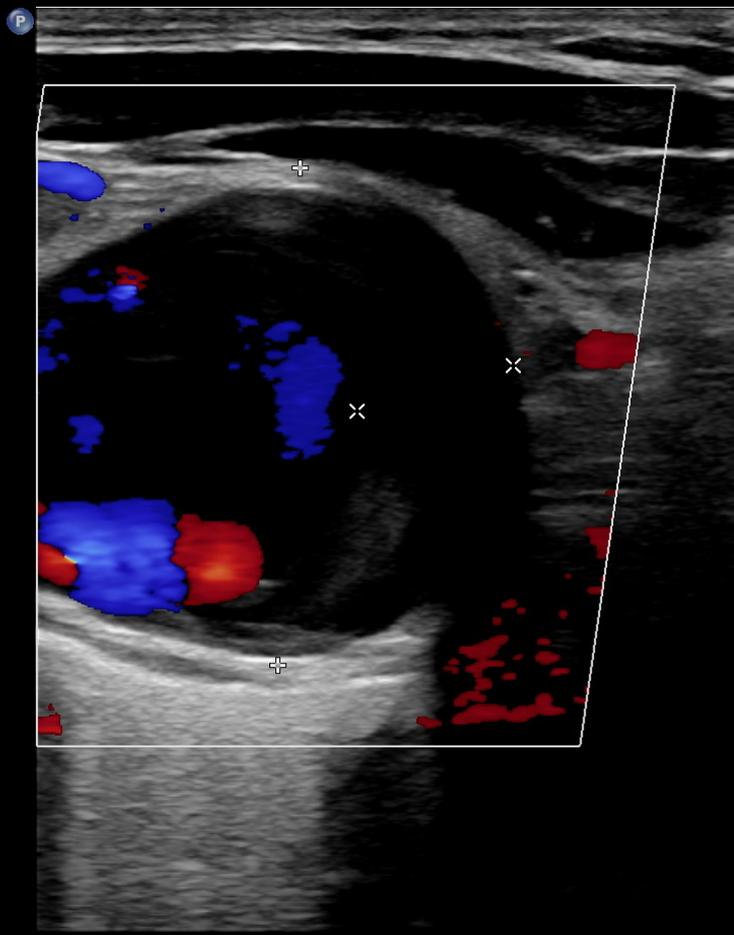
F#249

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



5.0cm

F# 35

Vasc carotide

IM 0.2

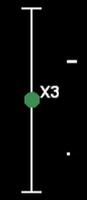
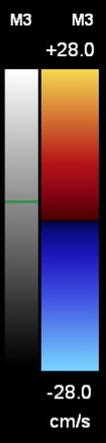
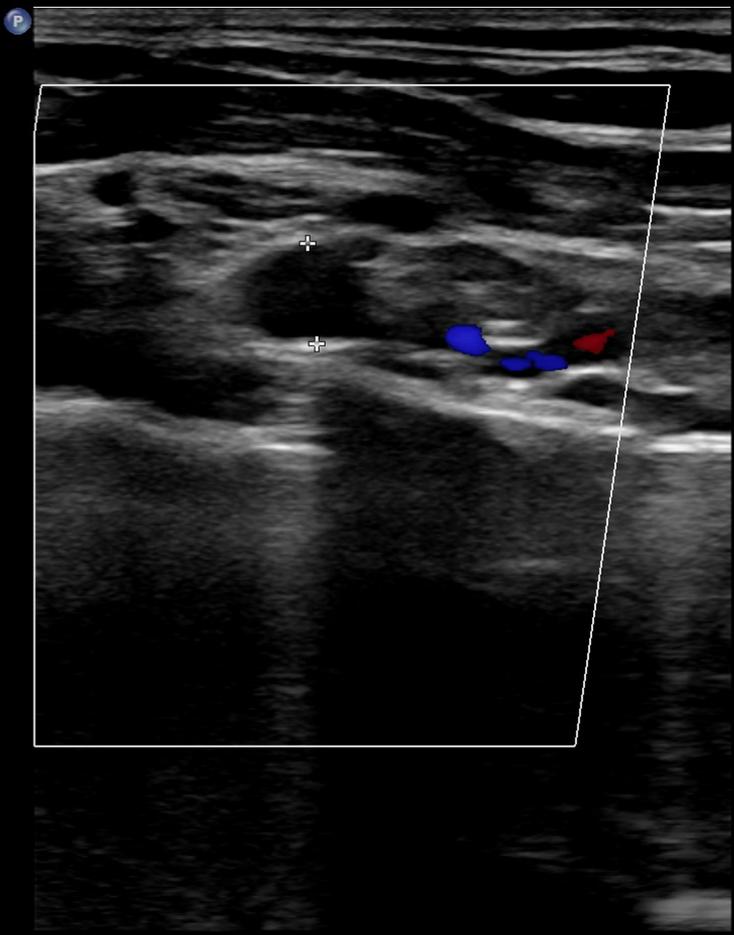
IM 1.3

L12-3
16Hz

2D
46%
R Dyn 56
P Bas
HGén

Coul
51%
2909Hz
FP 130Hz
4.0MHz

Droite



Dist 0.546 cm

5.0cm

F# 46

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