

ULTRASOUND GUIDED CENTRAL VENOUS ACCESS in NEONATES

Christian Breschan

Klinikum Klagenfurt, Austria

breschan.ch@chello.at

Gavecelt; Florence 2017



WHICH CENTRAL VENOUS ACCESS *to choose in* NEONATES/PREMIES?

- **Peripheral *i.e. ECC*** ***No USG required!***
 - via basilic, cephalic, saphenous veins
 - *small bore*
- **Pericalvicular *i.e. CICC*s**
 - *relatively large bore i.e. 2 French*

Breschan; Anesthesiology 2017

Montes-Tapia; J Pediatr Surg 2016

ADVANTAGES of CICC lines

Relatively large bore

– *5-6 weeks if non-tunneld*

- **blood sampling**
- **haemodynamic monitoring**
- **high flow infusion**

mortality?

→ *reduction of*

→ *stressreduction*

→ *improved neurocognitive outcome?*

Ahn Y; J Trop Pediatr 2006

Stevens B; Nurs Res 1999

Breschan; Pediatr Anesth 2000

PERICLAVICULAR RELATIVELY LARGE BORE CENTRAL VENOUS CATHETERS

Nowadays possible even in premies < 1kg
via USG

- 540g for IJV

Montes-

- 590g for

Tapia; J Pediatr Surg 2016
BCV

IJV vs BCV vs SCV vs FEM

- IJV, BCV **larger** than SCV, femoral vein

Breschan; Br J Anaesth 2010

Eifinger; Clin Anatomy 2011

- Femoral venous catheters
 - **catheter obstruction**
 - **high thrombosis-/**

CAI rates

Neonates

- IJV **higher CAI** risk than SCV



Higher CAI rate with IJV vs SCV in neonates
Breschan; Anesthesiology 2007

PARTICULARITIES in PREMIES and NEONATES

- **Small veins**
→ **decreased cannulation success**

2016

Anesthesiology 2017

Breschan; Pediatr Anesth 2012, 2015

*Montes Tapia; J Pediatr Surg
Breschan;*

- **Poor palpation of landmarks**

Anatomy 2011

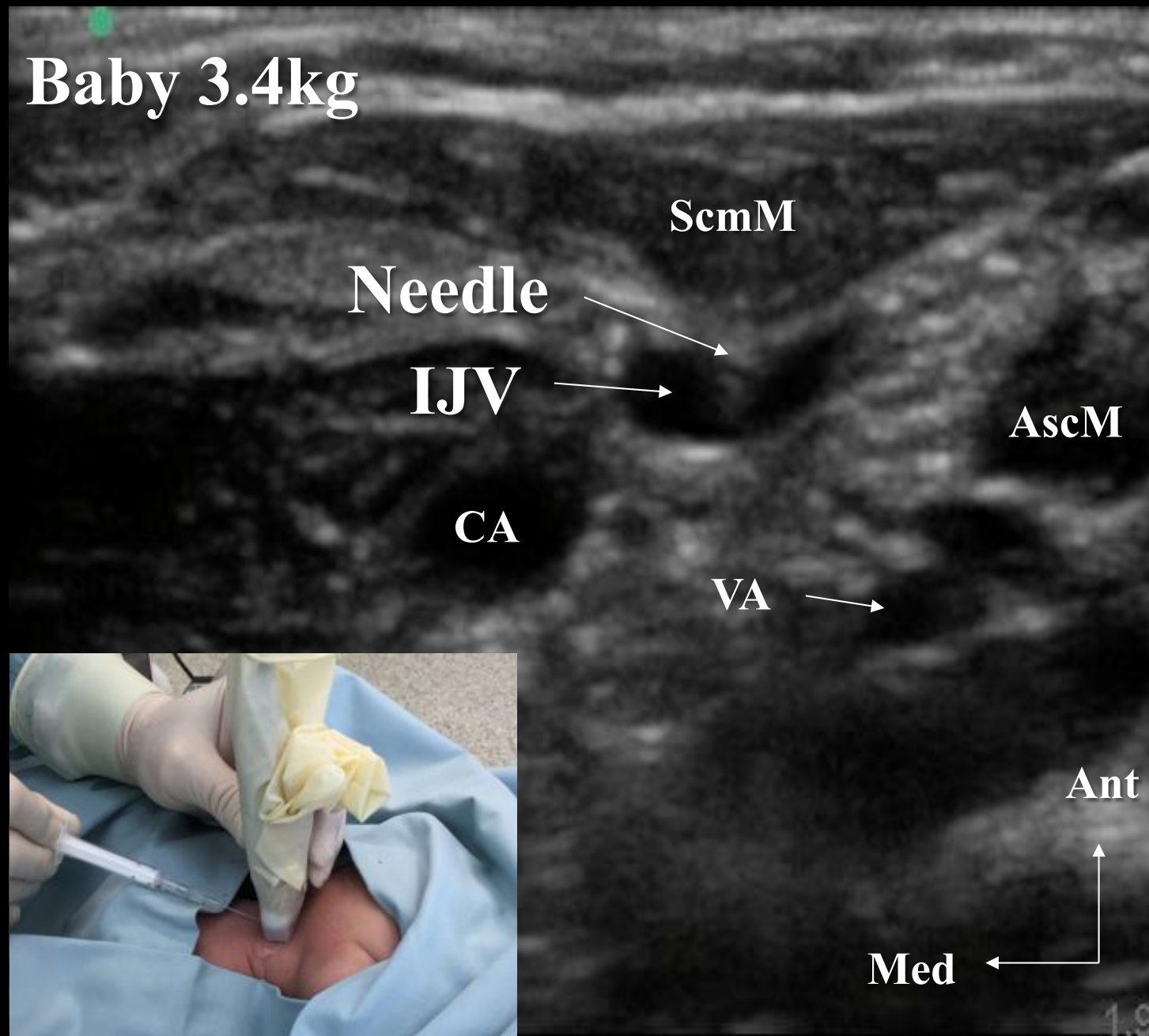
Eifinger; Clin
→ **USG**

PARTICULARITIES in PREMIES and NEONATES

Int. jug., femoral, axillary veins

- **Mobile**
- **Compressible**
- **Collapse by needle approach**

Baby 3.4kg



PARTICULARITIES in PREMIES and NEONATES

- Small vessel calibre
+
 - Immature thrombolytic system
→ catheter related
thromboembolism↑
- Catheter smaller than $1/3$ of vessel
 - *subjective*
 - *ellipsoidal shape*



Baby 3.2kg

SCM

CA

IJV

Ant



Lat

A 0,46cm

B 0,60cm A:0,22cm² C:1,69cm C 0,63cm

1,9



PARTICULARITIES in PREMIES and NEONATES

- Left-sided catheters > right-sided catheters
– thrombosis?

*in Astuto, Ingelmo; 2016
Blood 2003*

*Pirotte
Male;*

- Tip location

echocardiography

ECG

– intracavitary

PARTICULARITIES in PREMIES and NEONATES

Good news: **BCV and SCV**

- More cephaled run
→ **good supraclavicular view via US**
- Fixed to surrounding tissue
 - **non compressible/non collapsible**
 - **patent in hypovolaemia**

PERICLAVICULAR CATHETERS in NEONATES/ PREMIES

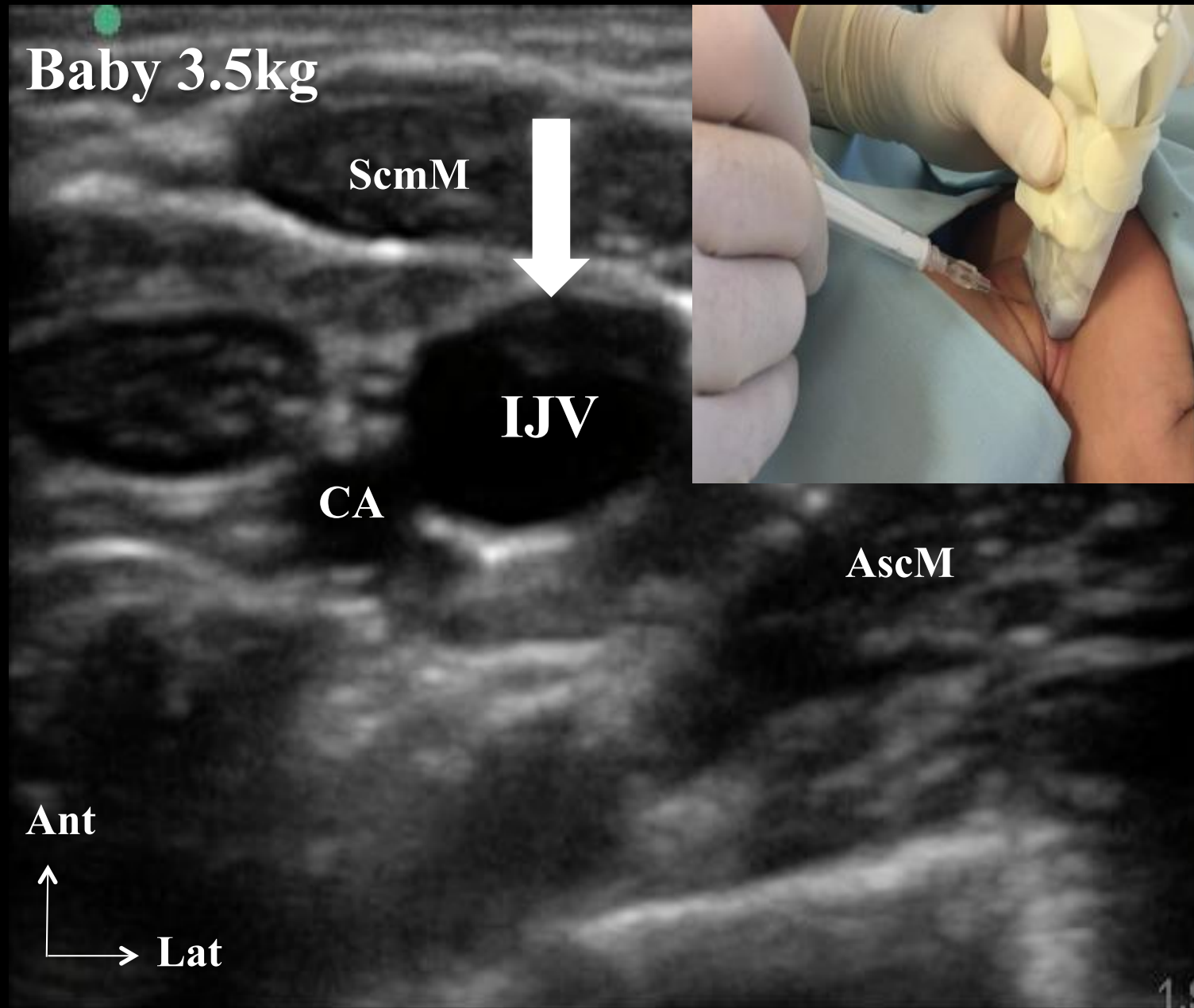
- **Puncture under deep sedation/GA**
- **Appropriate material**
- **Positioning**







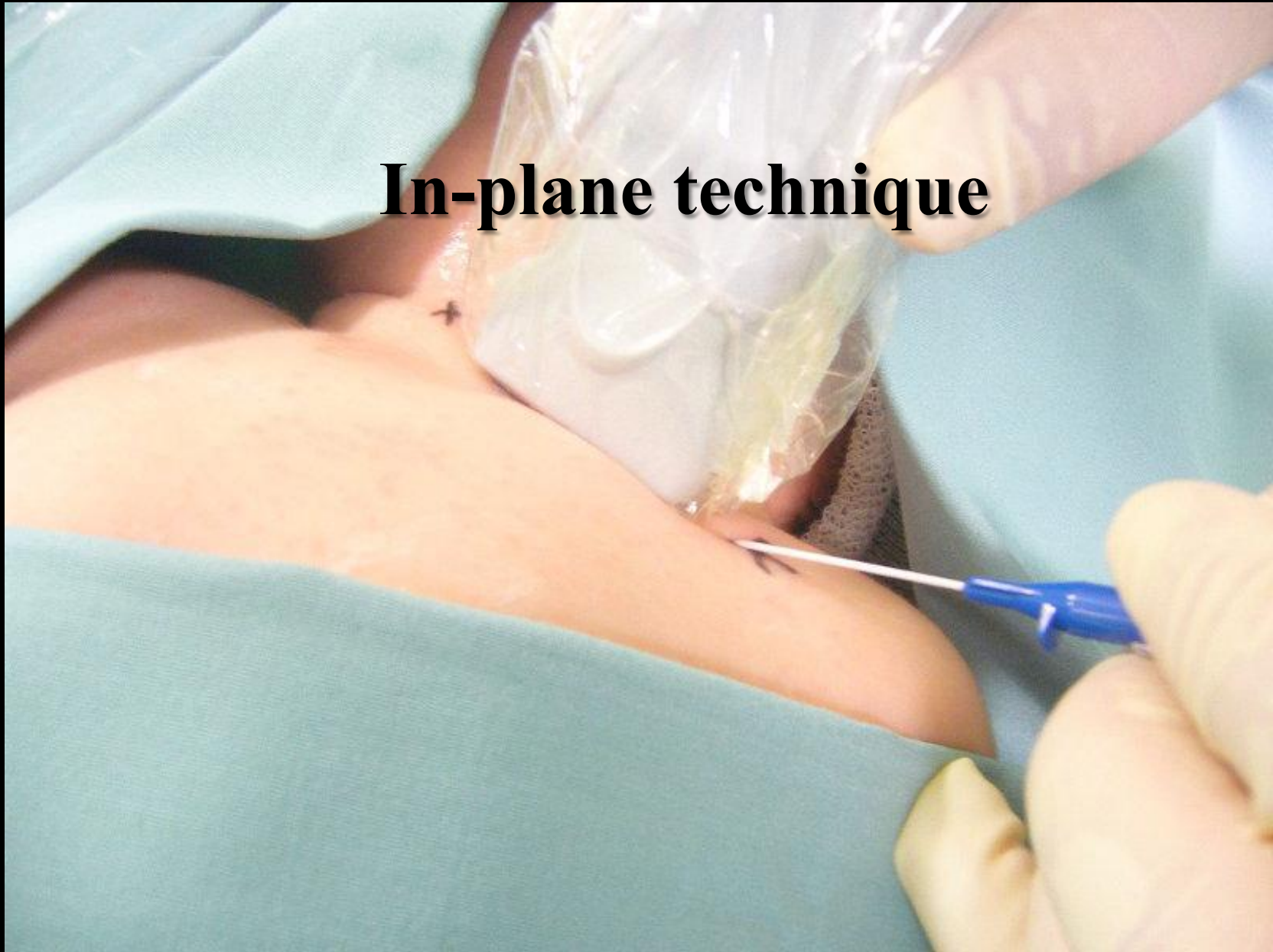
Out-of-plane technique



OOP

- Good anatomical overview
- Easy hand-eye coordination
- Only tip of the needle visible
 - *tissue distortion*
 - *vessel compression*
- Used for internal jugular and femoral veins

In-plane technique



IP

- Needle insertion visible over the entire distance
 - *surrounding structures*
- Difficult hand-eye coordination
 - perfect alignment of probe, vessel and needle
- Used for subclavian and brachiocephalic veins

INTERNAL JUGULAR VEIN

- Most popular „central“ vein

- Relatively large in neonates

Cobb; Surg Gynecol Obstetr 1987

Breschan; Br J Anaesth 2010

- Easy to scan

– *sig. anatomical variations*

INTERNAL JUGULAR VEIN

- Mobile, compressible, collapsible
- Approach as low as possible
- Indirect immobilisation
 - positioning of the baby
 - skin traction

Goldstein SD; J Laparaendosc Adv Surg Tech A 2015

Morita M; Anesth Analg 2009

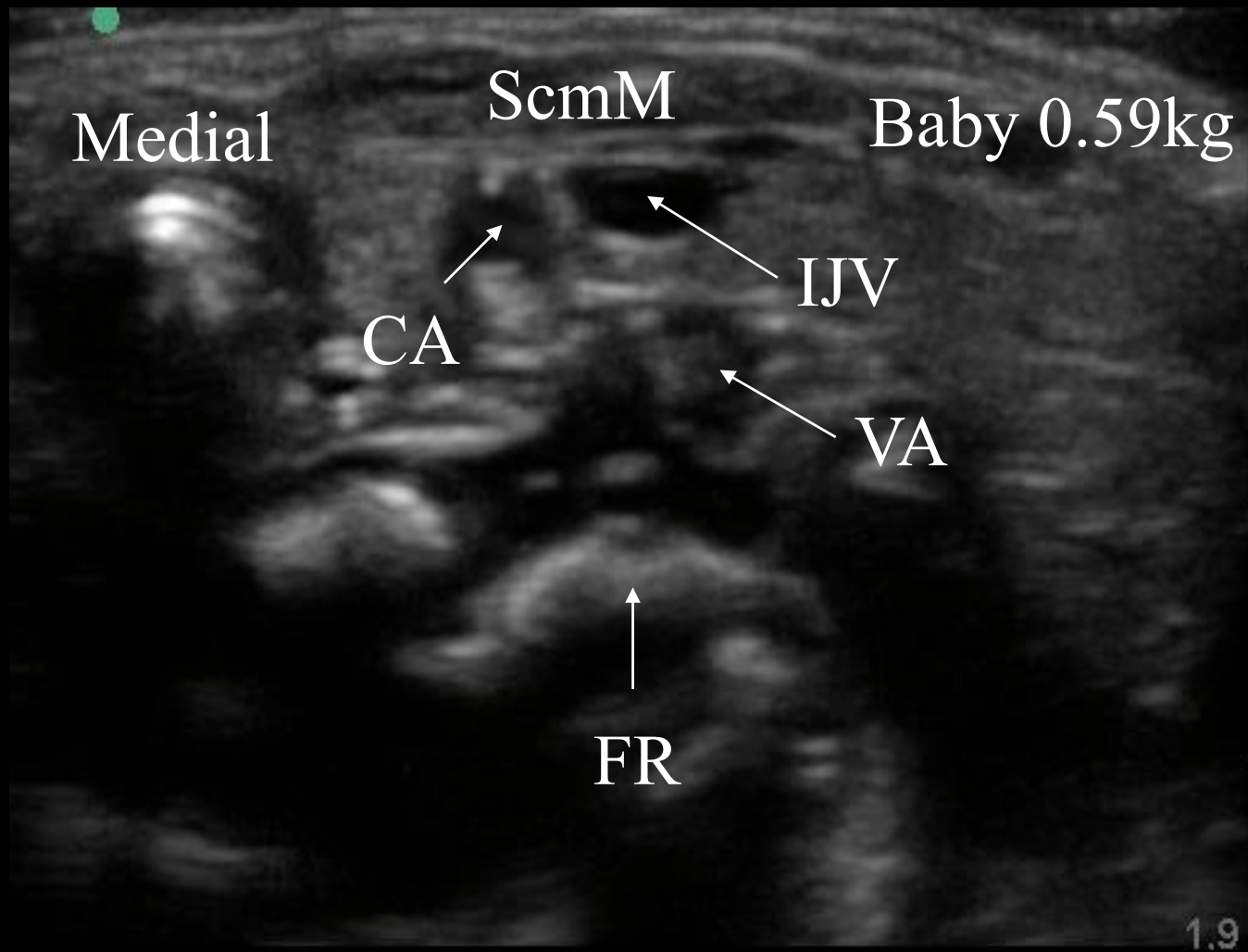
Breschan; Anesthesiology 2017



Skin Traction: IJV



Low approach: 0.59kg INFANT



OOP cannulation of IJV: 3.4 kg Baby



INFRACLAVICULAR CANNULATION of SUBCLAVIAN VEIN

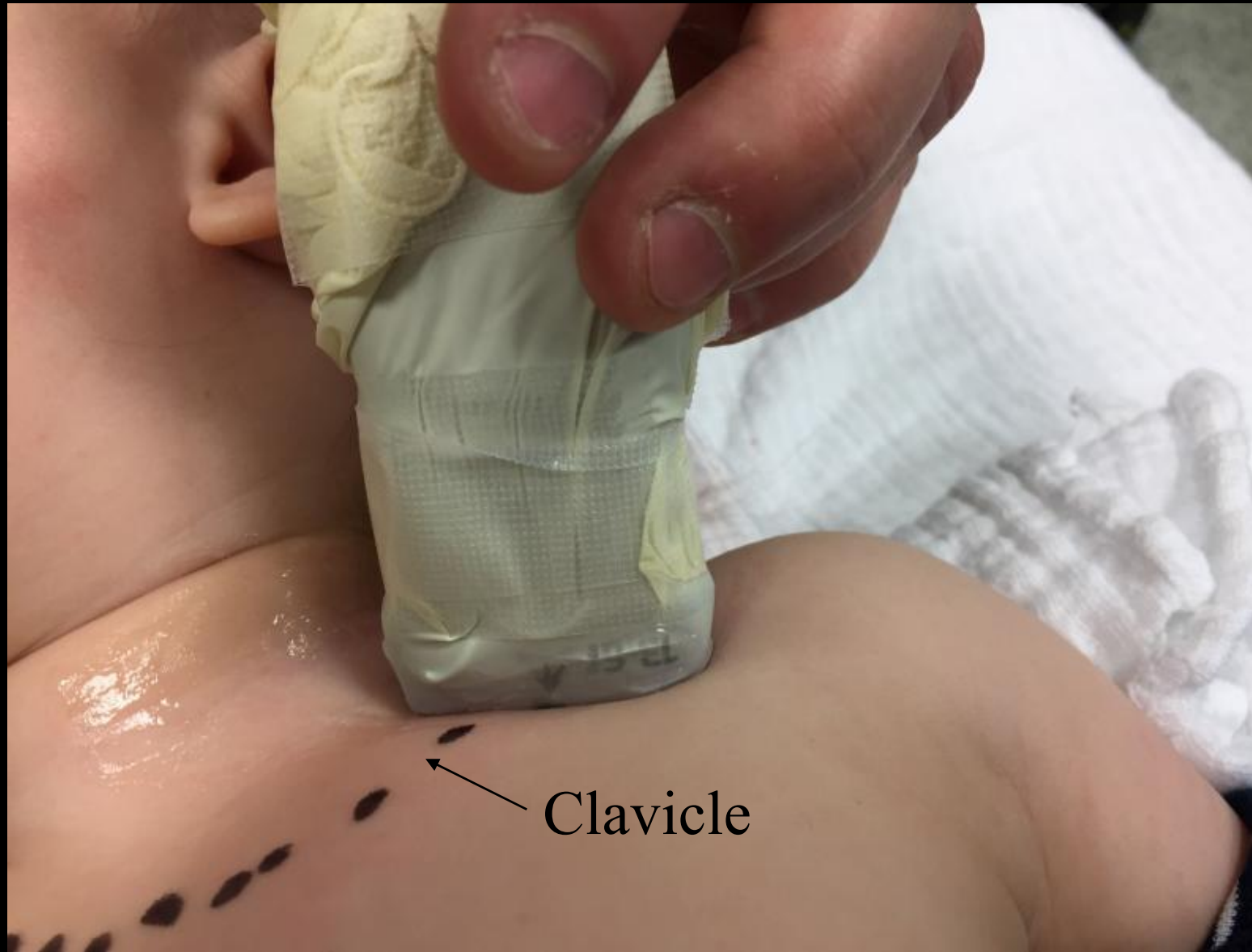
- Non-compressible/non-collapsible, patent in hypovolaemia
- More cephaled run

However

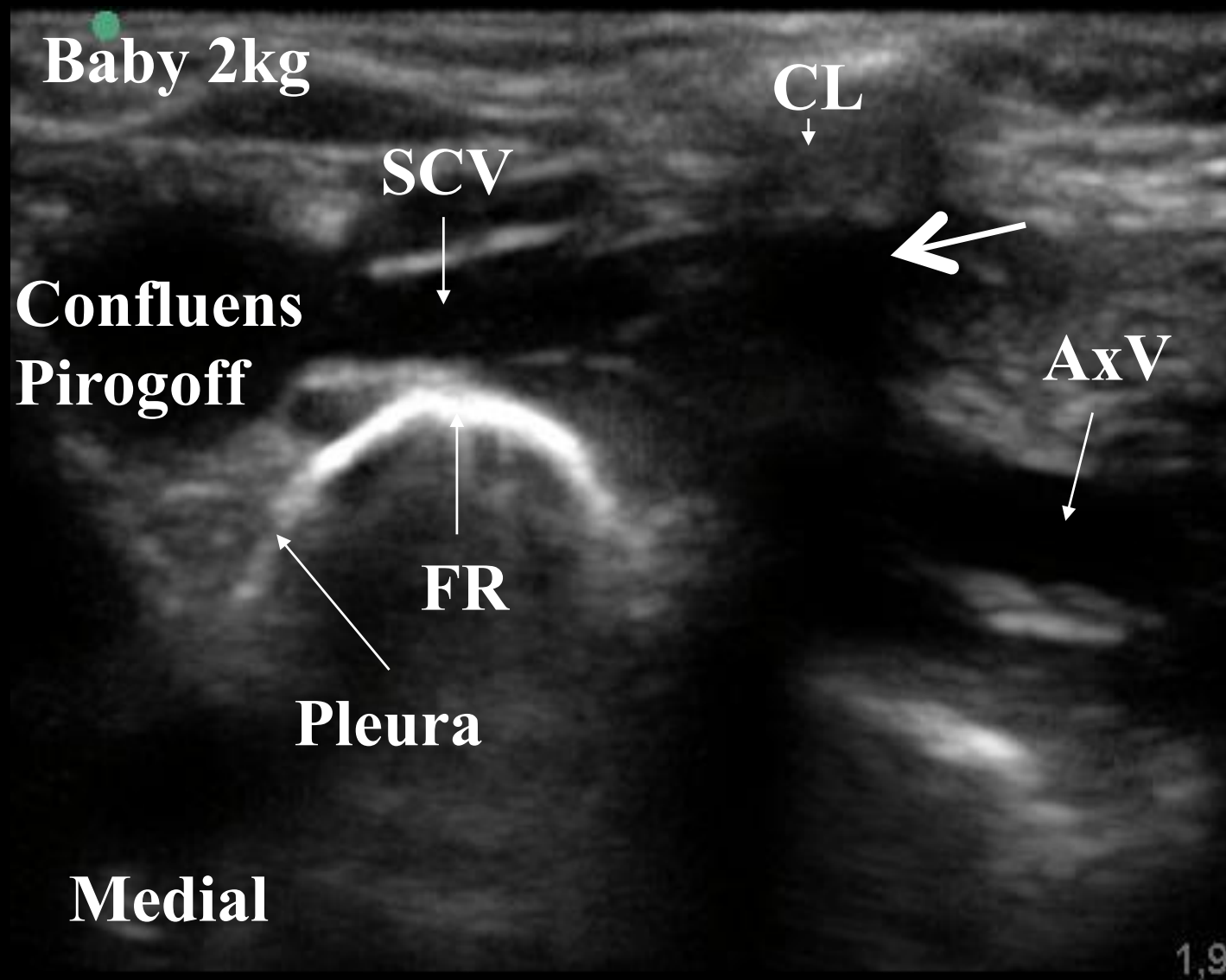
- Small
- US shadow of clavicle
- *difficult approach!*

Pirotte; Br J Anaesth 2007

SONOANATOMY of SCV



SONOANATOMY of SCV: 2kg Baby



Infraclav. cannulation of SCV: 3kg Baby



SUPRACLAVICULAR CANNULATION of BRACHIOCEPHALIC VEIN

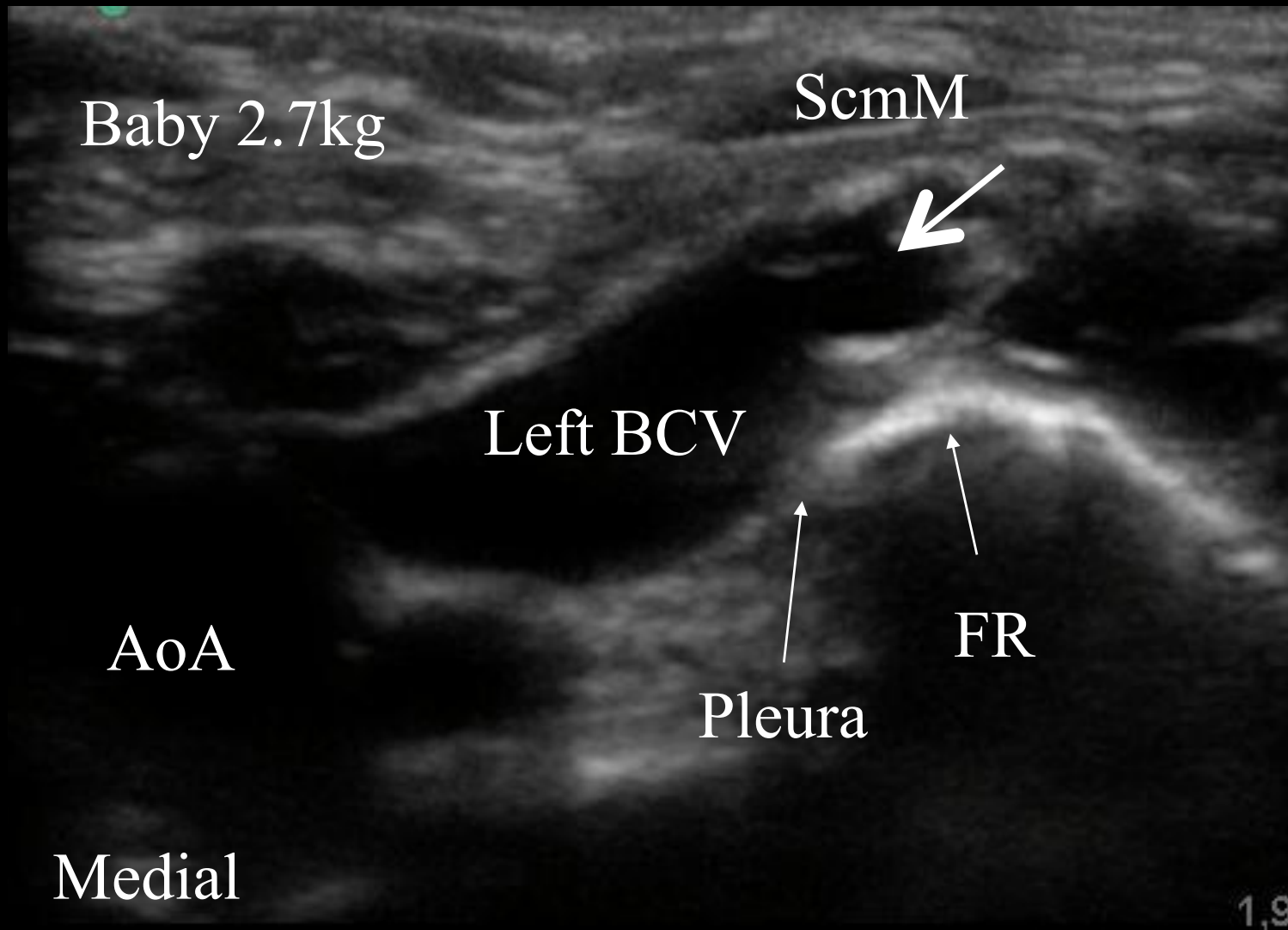
Good option *Option vs. subclavian vein*

- *Easier to scan*
- *Larger than subclavian vein*
- *More direct access to V.cava sup.*
- *No disturbing US shadow of clavicle!!*
 - *needle visibility over entire insertion distance*

SONOANATOMY of BCV: 3 kg Baby



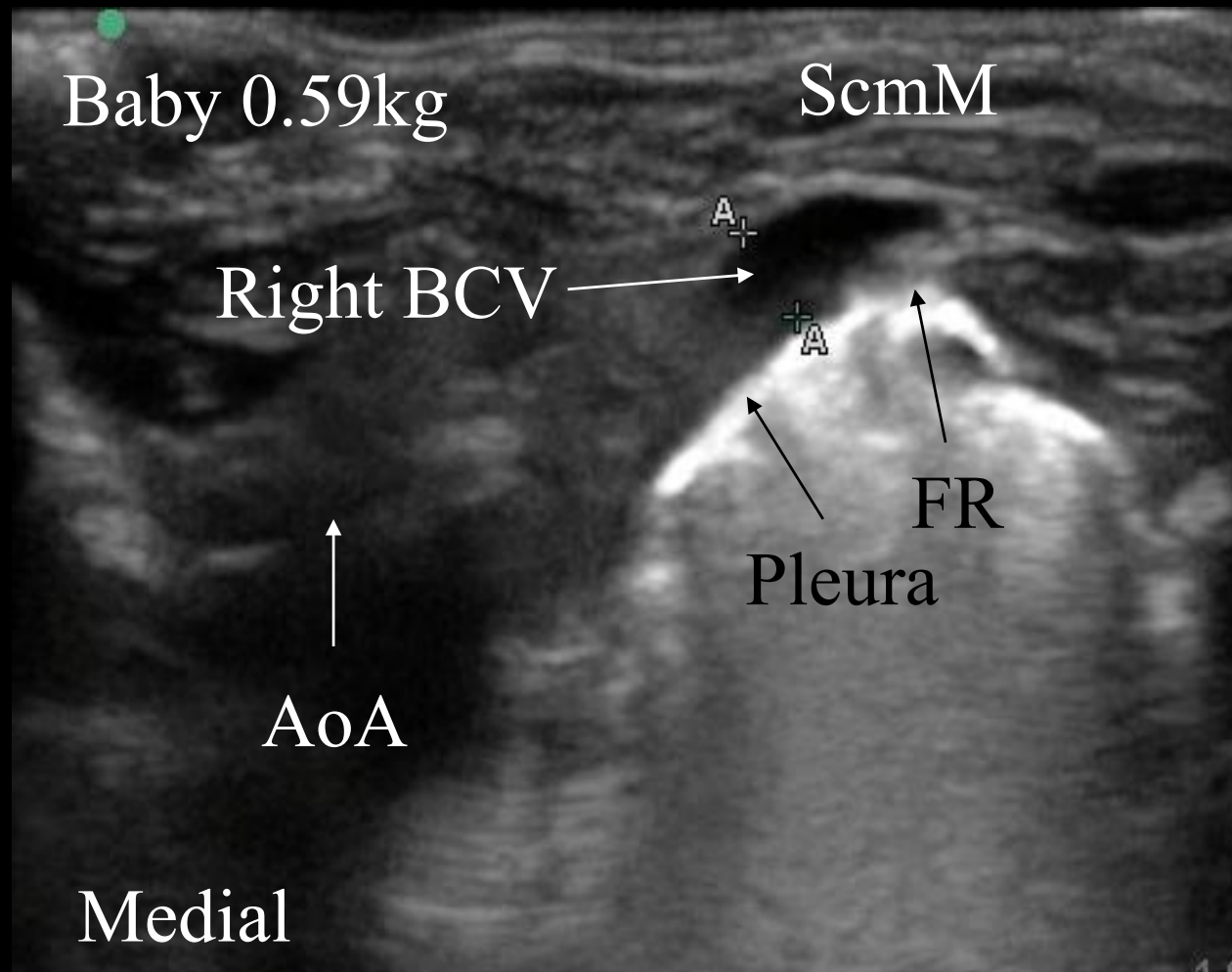
SONOANATOMY of BCV: 2.7kg Baby



IJV running into BCV



INFANT 0.59kg



IP cannulation of right BCV: 1.2kg Baby



**ALTERNATIVE in
DIFFICULT PERIPHERAL
VENOUS ACCESS
SITUATION ?**

IP cannulation of BCV: 2kg Baby



US-Guided Supraclav. Cannulation of the Brachiocephalic Vein PREMIES/NEONATES

Aug 09 – Nov 17

- $n = 369$
- Weight: Median: 2.6 ± 0.59 kg
 Range: $0.59 - 3.5$ kg
- *< 1kg:* *n = 11*

US-Guided Supraclav. Cannulation of the Brachiocephalic Vein

NEONATES + PREMIES: 0.59 – 3.5 kg

SUCCESS RATE

n = 369

Aug 09 – Aug 17

Success rate

359 (97%)

• 1.Attempt

268 (72.6%)

• 2.Attempt

57 (15.4%)

• 3.Attempt

24 (6.5)

USG SUPRACLAV. BCV CANNULATION

NEONATS: 0.59 – 3.5 kg

SUCCESS RATE

Aug 09 – Nov 17: n = 369

Left BCV: n = 167

Successful: n=165(98.8%)

Right BCV: n = 202

n=195(96.5%)

- 1.Attempt**

Left 126 (75.4%)

Right 149 (73.7%)

- 2.Attempt**

Left 30 (18%)

Right 28 (13.8 %)

- 3.Attempt**

Left 8 (4.8 %)

Right 19 (9.4 %)

**USG SUPRACLAV. BCV CANNULATION
NEONATES/PREMIES**

SUCCESS RATE

Aug 09 – Nov 17

n = 369

- **Complications**

*- 2 x subclavian
artery injuries (0.56%)*

- **10x placement of catheter not possible in the
primarily targeted vein (2.7%)**

USG SUPRACLAV. CANNULATION of the INT. JUG. VEIN OOP

NEONATES + PREMIES: 0.7 – 3.5 kg

SUCCESS RATE

n = 9

Aug 09 – Nov 17

Success rate

9 (100%)

• 1.Attempt

7 (78%)

• 2.Attempt

2 (22%)

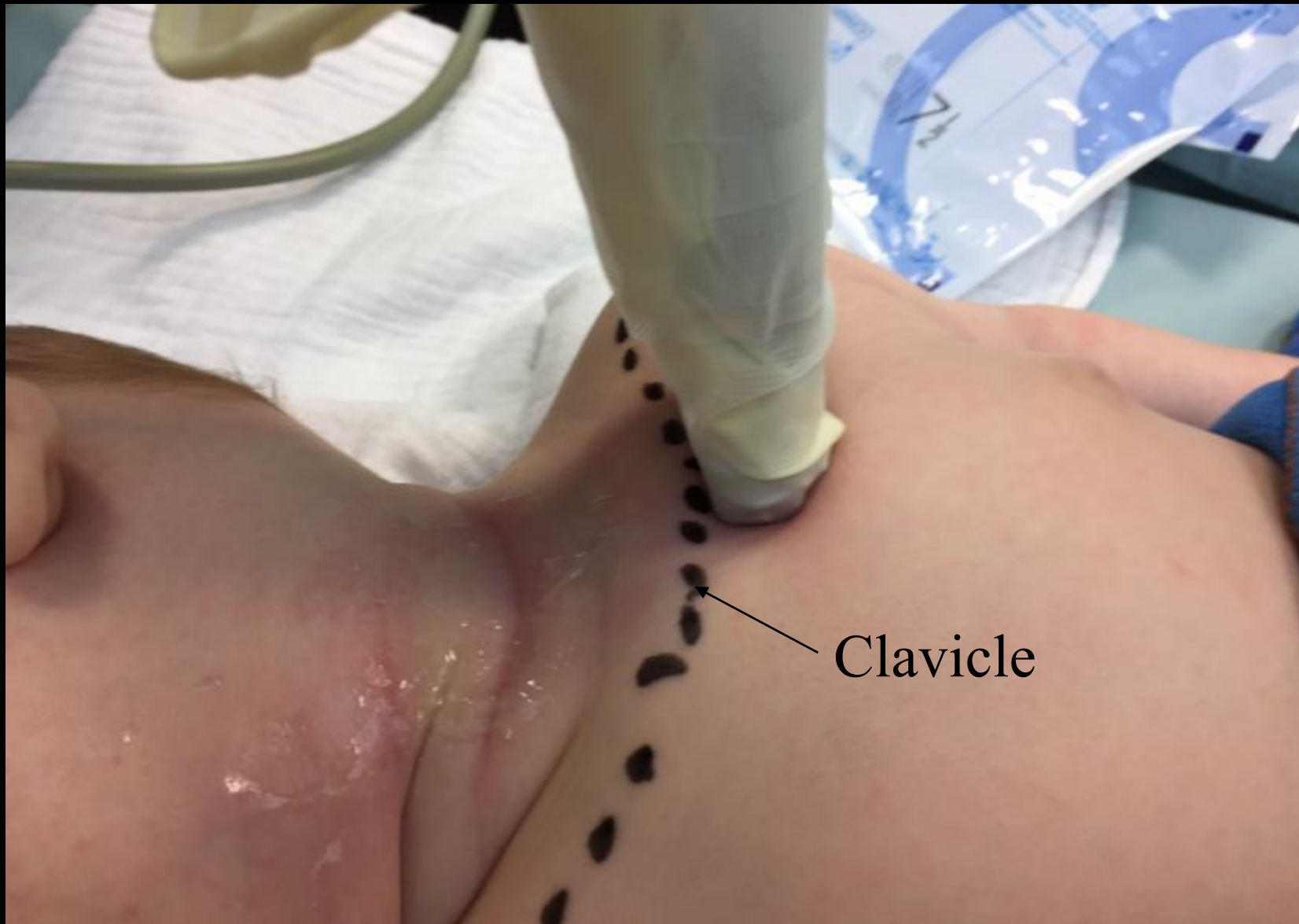
OOP cannulation of IJV: 3.6 kg Baby



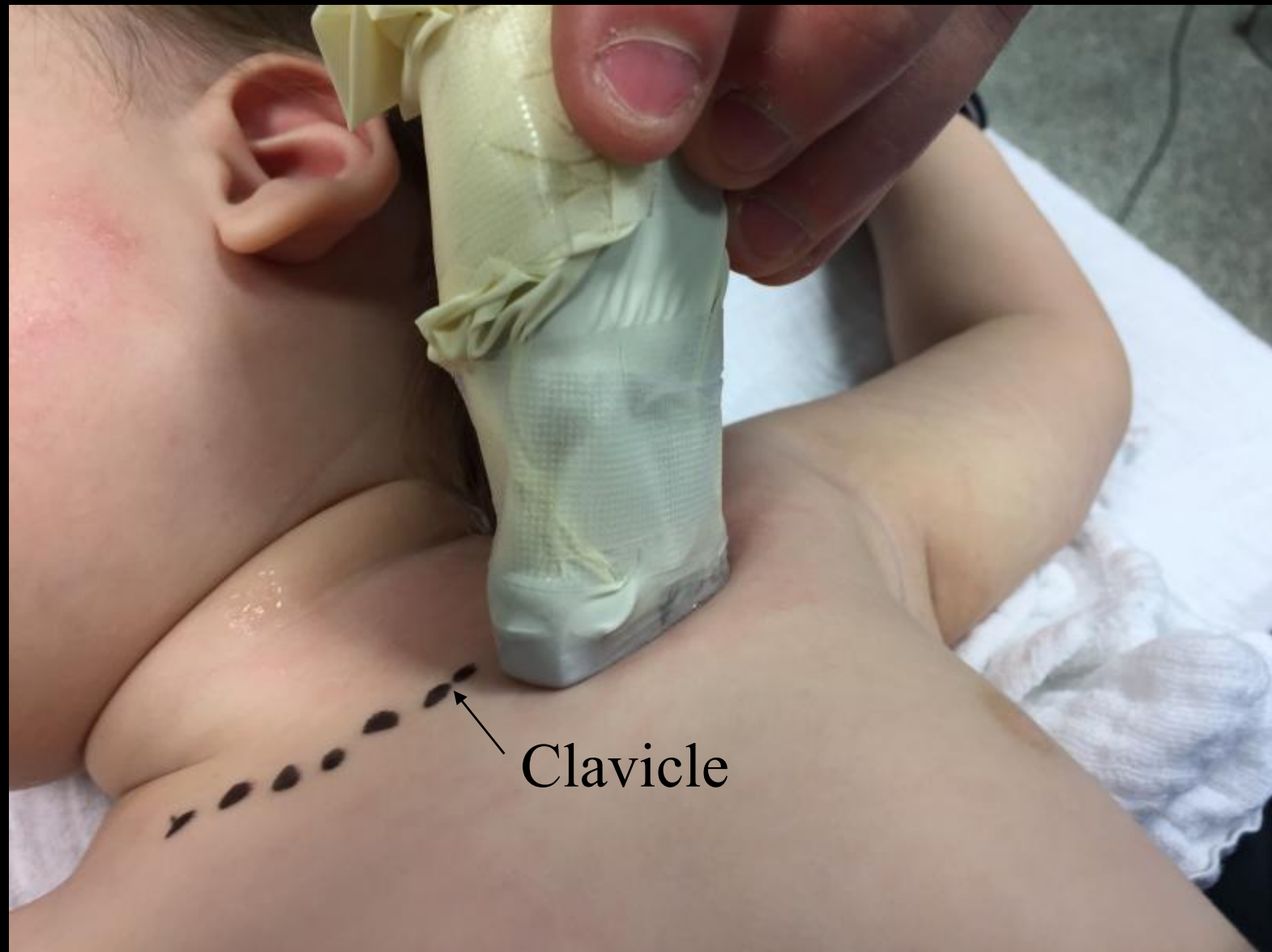
TRANSPECTORAL CANNULATION of AXILLARY VEIN

- Small, compressible, collapsible
- Difficult to scan
 - *deep*
 - location*
- Puncture needle aims directly at pleura

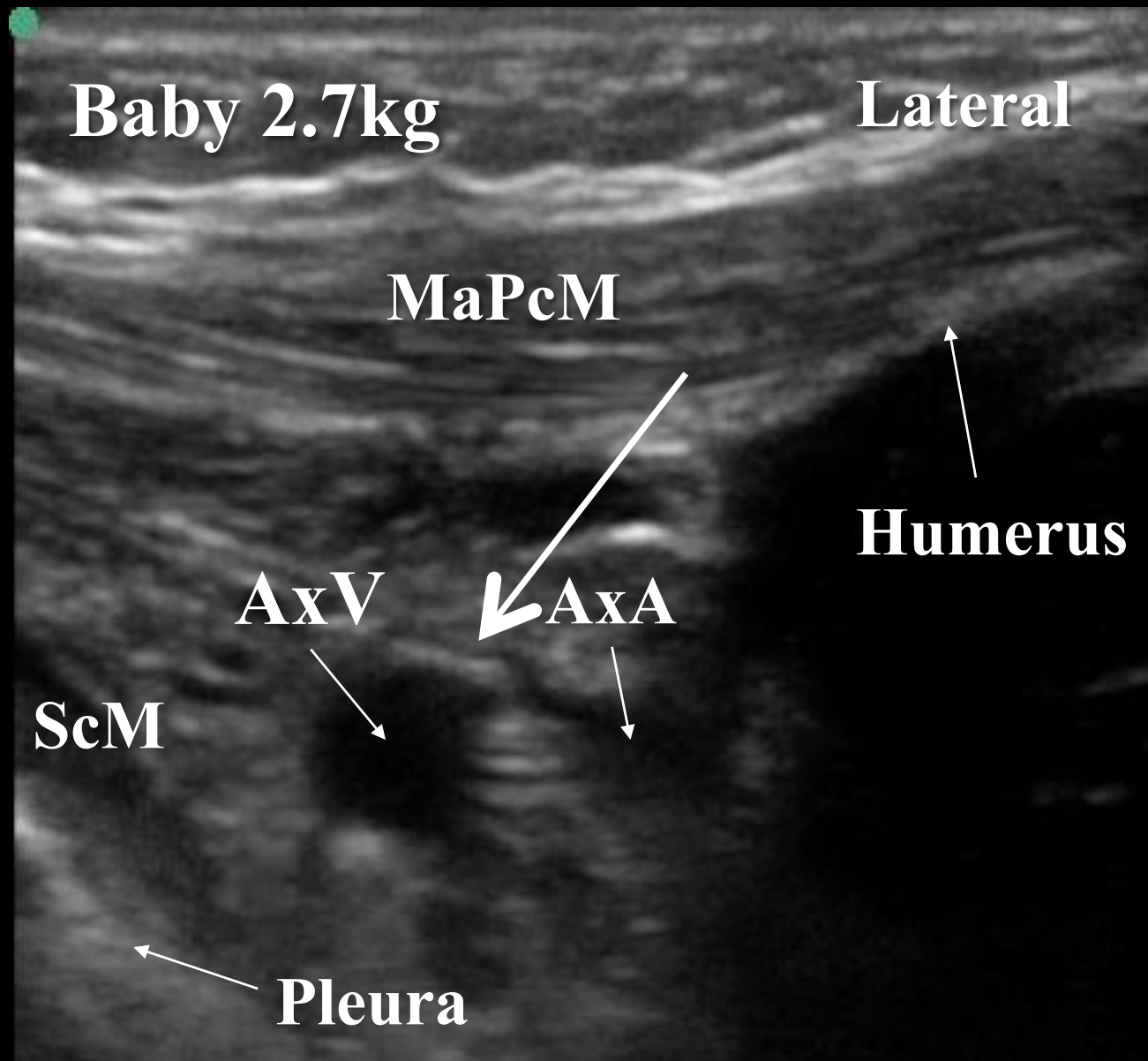
SONOANATOMY of AxV



SONOANATOMY of AxV



SONOANATOMY of AxV

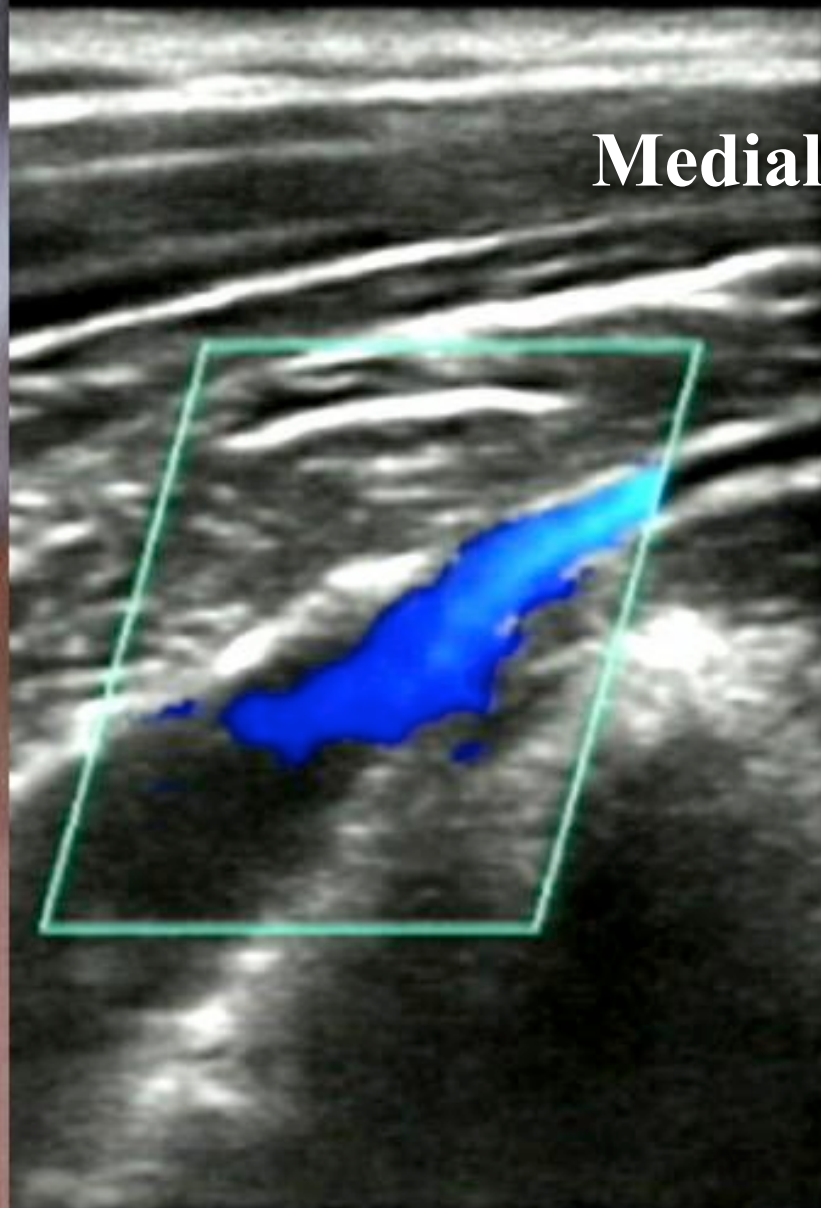


AXILLARY VEIN at CHEST



TRANSPECTORAL CANNULATION of AXILLARY VEIN

- Impossible in neonates?
 - no space in the
infraclav. region for US probe
- No studies/case reports in neonates as yet
- Fairly reasonable access in adults
 - no US shadow



CANNULATION of FEMORAL VEIN

- Fairly easy to scan
- Few major puncture complications

However

- Small, compressible, collapsible
- Narrow angle
 - *difficult guide-wire insertion*
- High kinking-, infection-, thrombosis rate

OOP cannulation of FV: 5kg Baby



USG CANNULATION including *NEONATES*

Studies

- *IJV:*
- 20
- *BCV supraclavicular:* -
15
- *SCV infraclavicular:* -
2
- *Femoral vein*
- 6 mainly in cardiac patients

CANNULATION SUCCESS RATES *in CHILDREN*

	LM	vs	USG
eventual	~80%		>95%
1.attempt	~65%		~70-80%

Care Med 2016
Anesthesiology 1999
Anesthesiology 2007 and 2017

Alderson; Br J Anaesth 1993
Camkiran; Pediatr Crit
Vergehese;
Breschan;

PUNCTURE COMPLICATIONS without USG

- Inadvertent artery injuries: **children**

– *CA, VA, SCA*

– *8-25%*

Chuan; Pediatr

Anesth 2005

Vergheze; Anesthesiol 1999

Camkiran; Pediatr Crit care Med 2016

- Pneumo-, Haematothorax: **neonates**

– *1-2%*

PUNCTURE COMPLICATIONS using USG in NEONATES

- IJV, BCV
 - **<1%** inadvertent artery injuries in neonates

Breschan; Anesthesiology 2017

Montes-Tapia; J Pediatr Surg 2016

- No reported major puncture complications in neonates as yet?
 - *reduced need of puncture attempts via USG*

LUNG SLIDING



CATHETER RELATED THROMBOSIS



BCV FIRST CHOICE?

- **USG**
 - *high success rate*
 - *low complication rate*
- **Low CAI rate**
 - Oulego-Erroz; Am J Perinatol 2017*
- **Not prone to kinking**
- **Little discomfort to patient**
- **Easy nursing**
- **No interference with CPAP mask**

PITFALL: 630g Baby



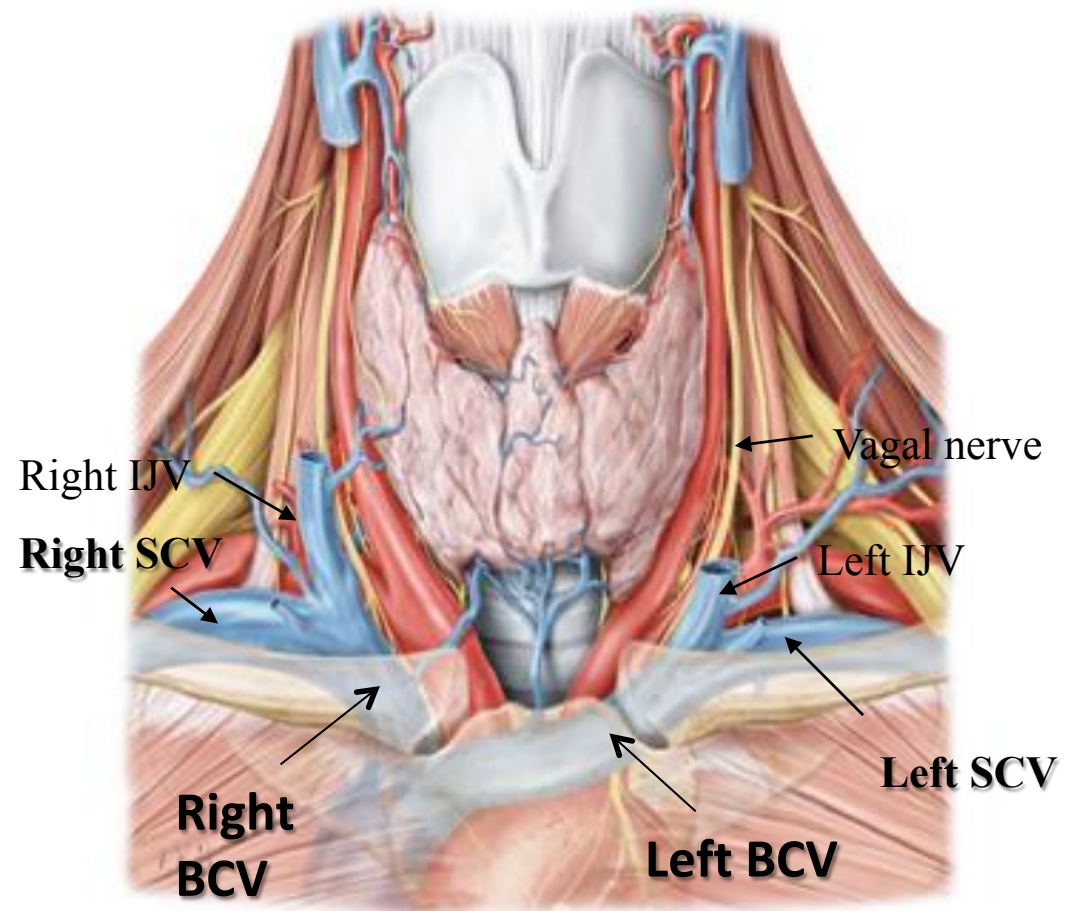
PITFALL: 630g Baby



IP cannulation of left BCV: 630g Baby



Left vs right BCV



NEONATES < 3.6kg

SUCCESS RATE

Left BCV: n = 79

Right BCV: n = 10

- **1.puncture attempt**

Left	61(77.2%)
<i>Right</i>	<i>3(30%)</i>

- **2.puncture attempt**

Left	13 (16.5 %)
<i>Right</i>	<i>2 (20%)</i>

- **3.puncture attempt**

Left	5 (6.3 %)
<i>Right</i>	<i>5 (50%)</i>

Chi-square analysis: $p < 0.01$ Breschan; Pediatr Anesth 2012



Baby 2.1kg

SCM

Catheter



AScM

SCA



Left BCV

FR



Lung

Ant



Med



Baby 2.1kg

ScmM

AscM



CI

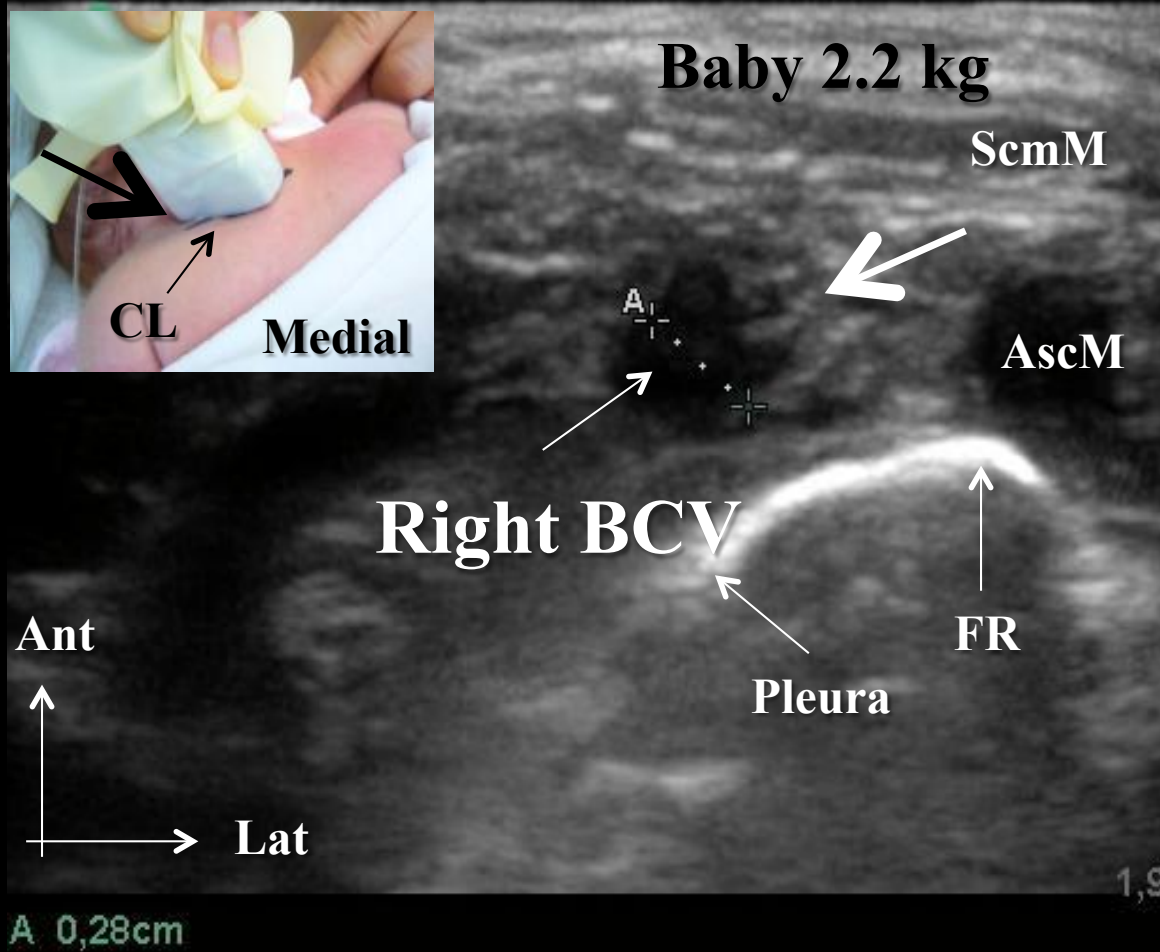
Right BCV

↑
FR

Lung

Ant

↑
Lat ←



USG SUPRACLAVICULAR CANNULATION of the RIGHT BRACHIOCEPHALIC in SMALL INFANTS: a CONSECUTIVE, PROSPECTIVE CASE SERIES

- 79 neonates: 0.8-4.5 kg 3.4 ± 0.09 kg

Optimum sonographic view of the right BCV

- *Complete long-axis view:* **63.3%**
- **Circular appearance:** **36.7%**

Breschan; Pediatr Anesth 2015

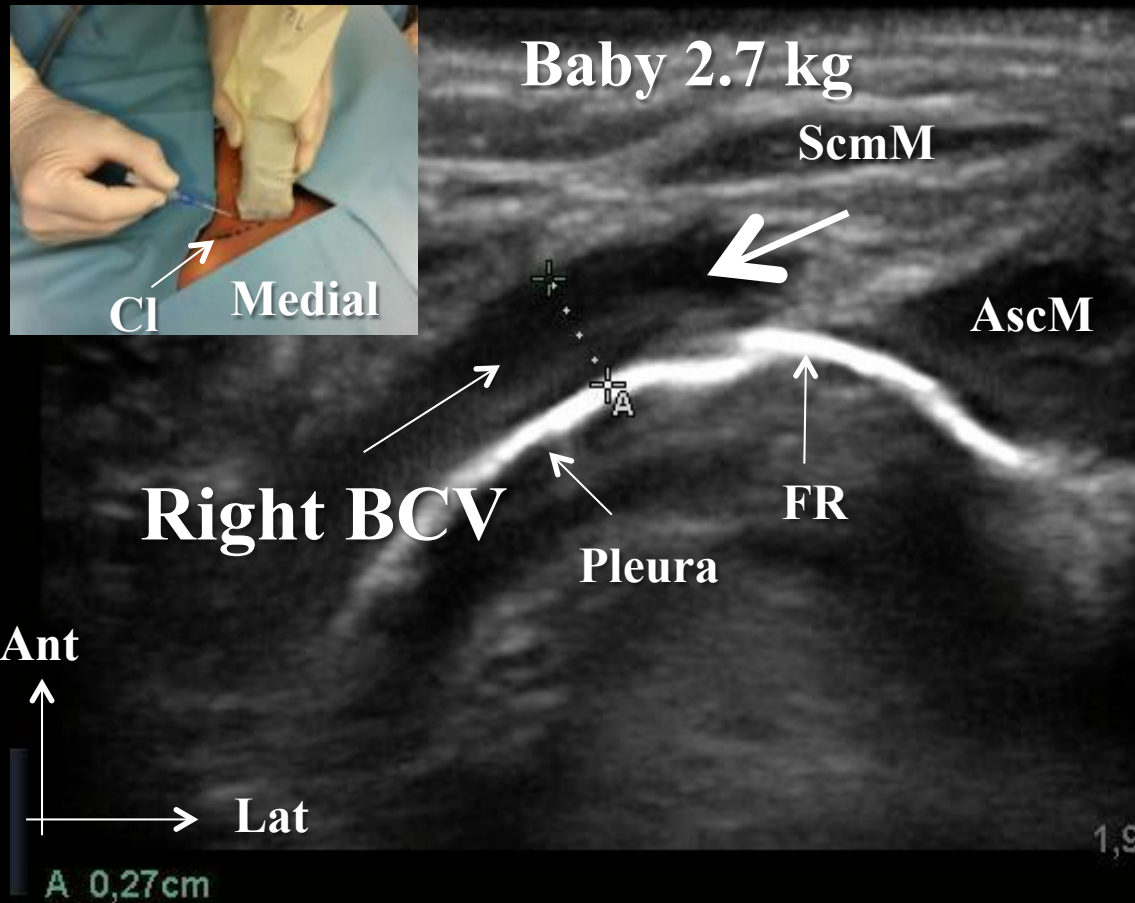
USG SUPRACLAVICULAR CANNULATION of the RIGHT BRACHIOCEPHALIC in SMALL INFANTS: a CONSECUTIVE, PROSPECTIVE CASE SERIES

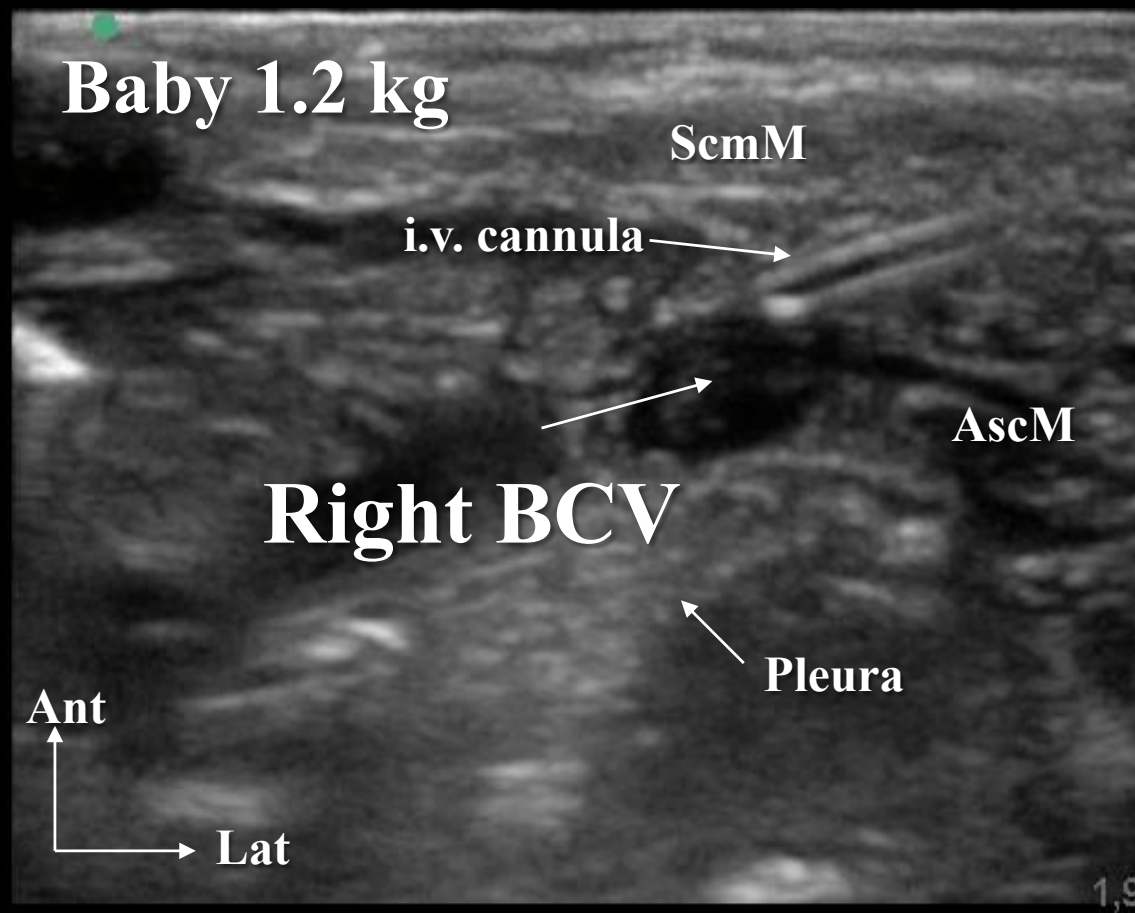
N=79

- 1 attempt: *complete long-axis view*: **90%**
vs.
• 1 attempt: *circular appearance*: **41%**

Chi-square analysis: $p < 0.01$

Breschan; Pediatr Anesth 2015





Ultrasound-guided supraclavicular cannulation of the right brachiocephalic vein in small infants: a consecutive, prospective case series

WHY ?

- **Hypothesis**

- in ~ 1/3 of neonates the right BCV disappears behind the sternoclavicular joint



invisible via a linear US probe

→ ***circular sonographic appearance***

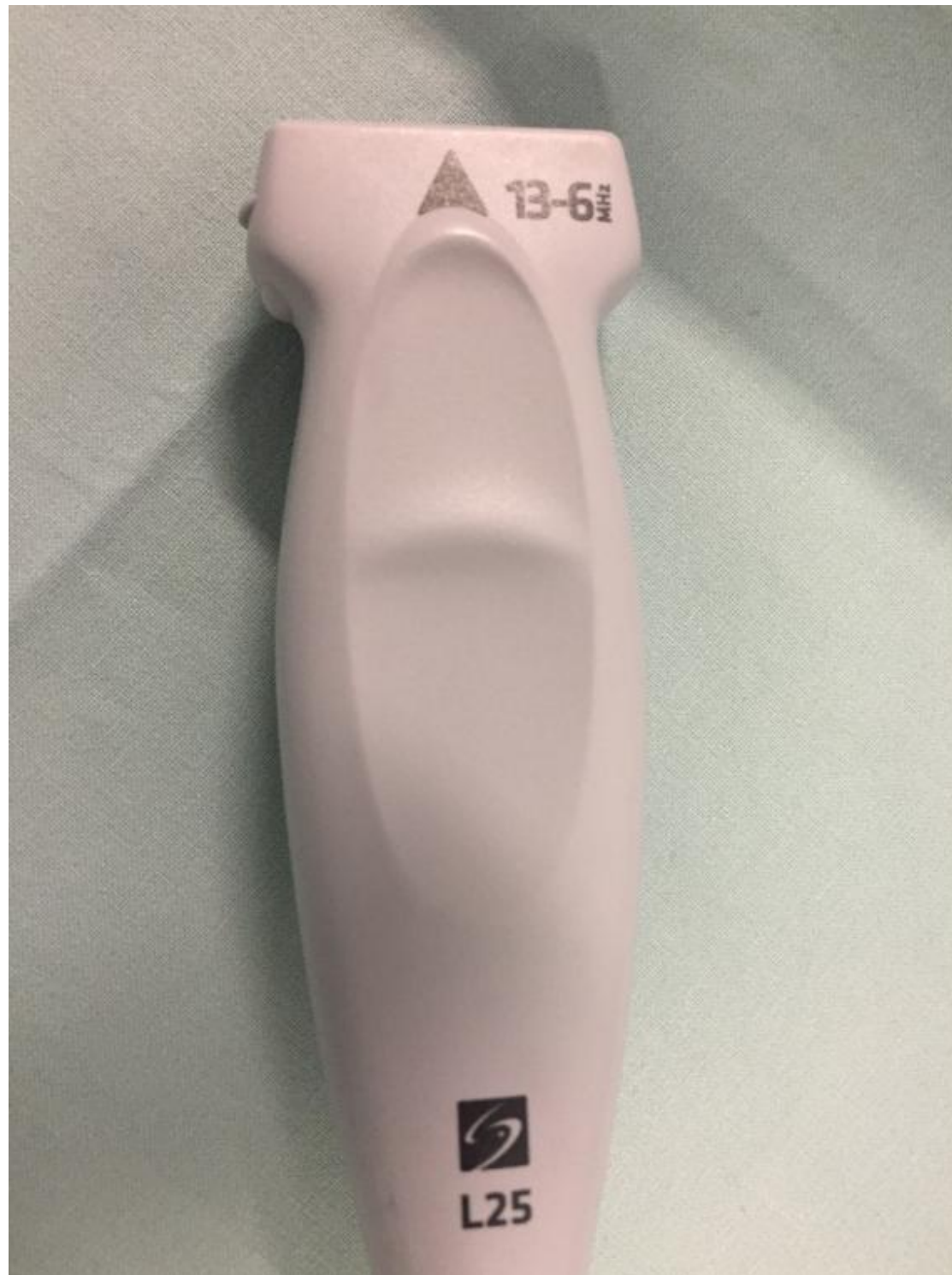
Noteworthy Observation in ELBW babies
IP cannulation of left BCV: 610g Baby



***M-Turbo
Sonosite®***



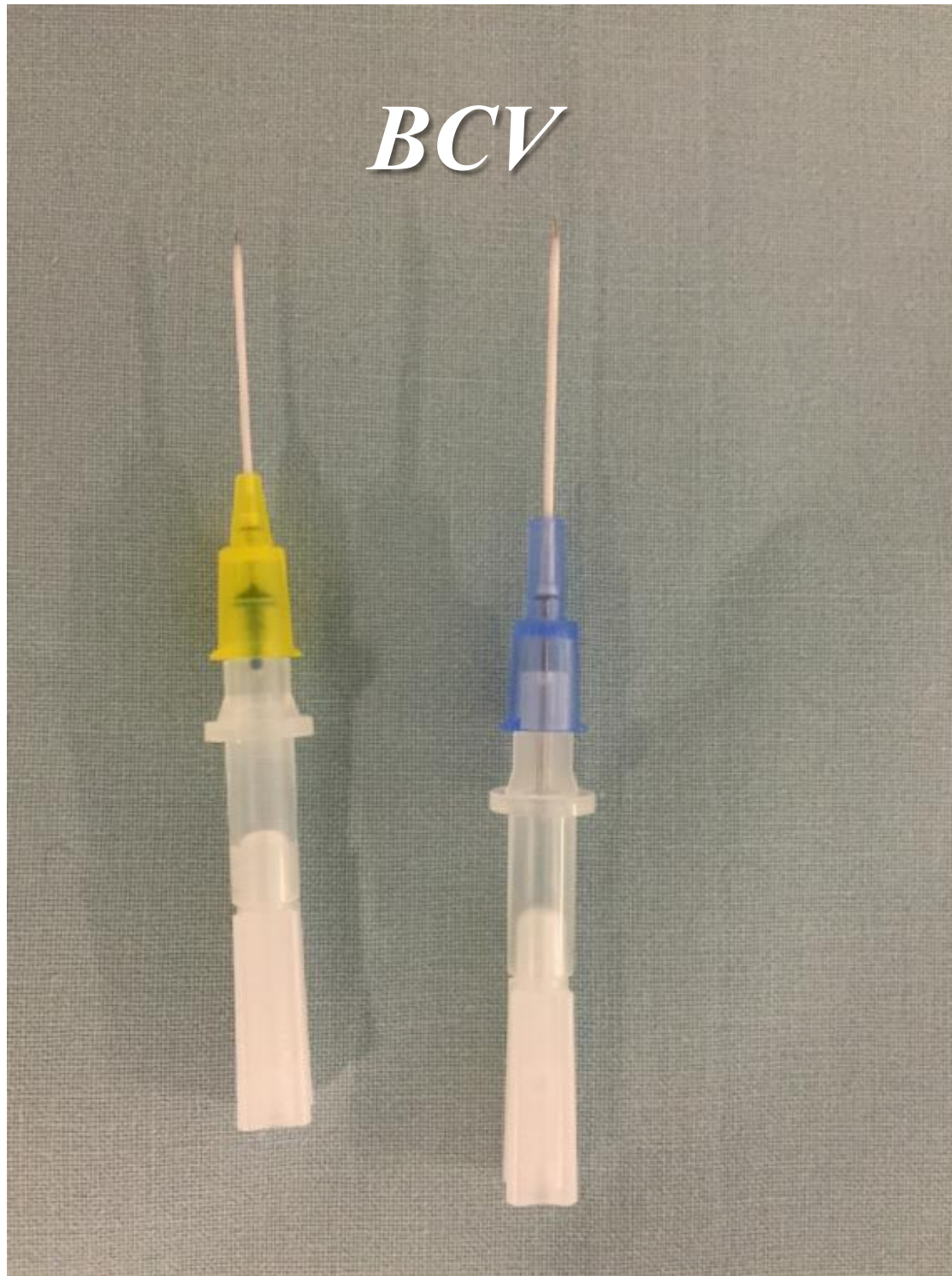
13–6 MHz
25 mm
1.9 cm depth



BCV

***< 1.5kg:
24 G Jelco***

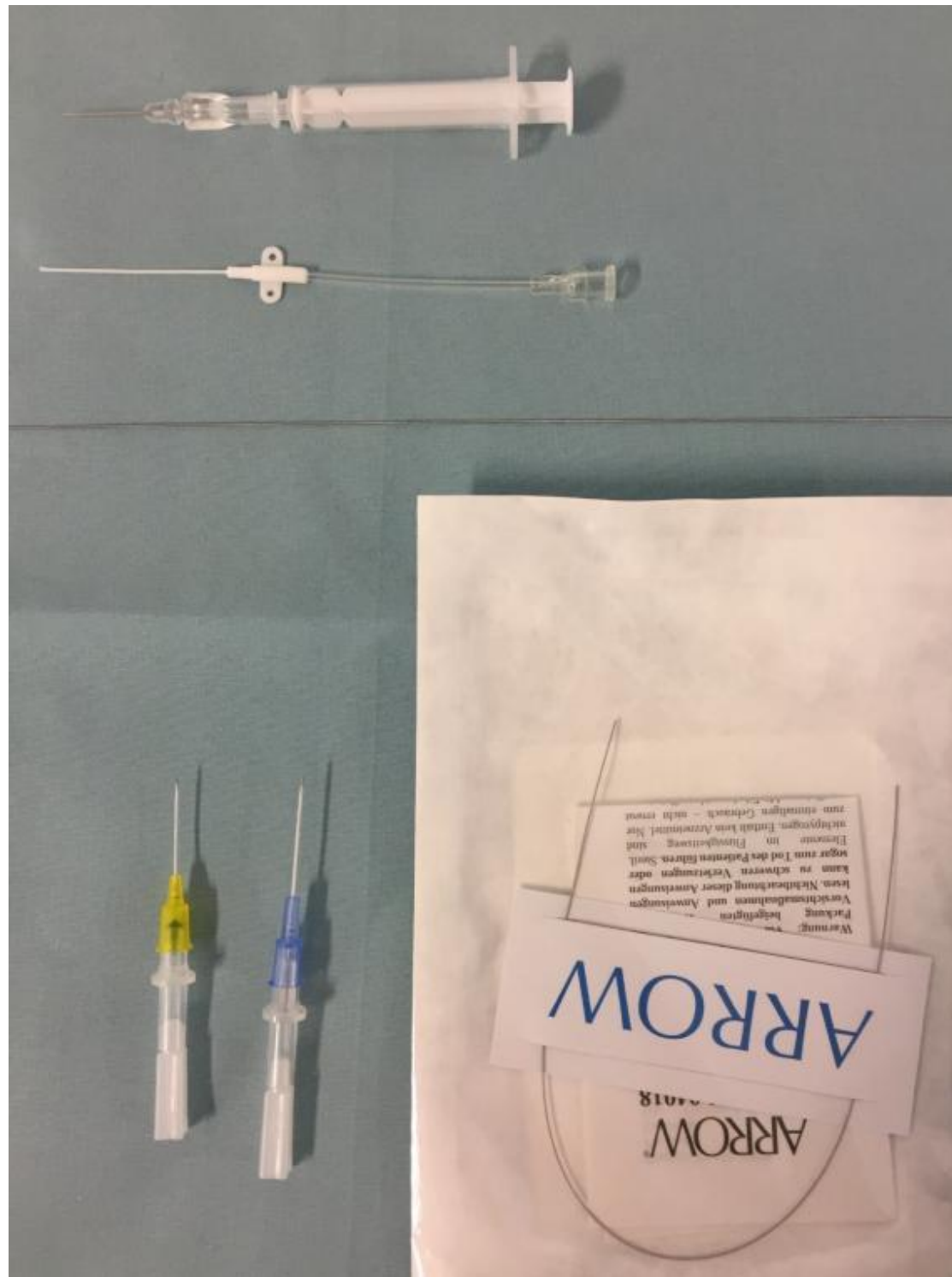
***> 2.5kg:
22 G Jelco***



IJV

*22 G needle
2 ml syringe*





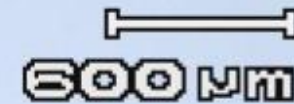
***Straight
Nitinol
0.018inch
Guidewire***

2 Fr Seldiflex[®] (Polyurethane)

OD: 0.8mm



2 Fr Vygon®
Silicone



„cut“
2 Fr Seldiflex®

„original“
2 Fr Seldiflex®

SUMMARISING

- **Real-time USG** for all central venous lines in neonates
except for ECC
- **Surgical cutdown techniques are obsolete?**

Blum LV; J Pediatr Surg 2017

HSU CC; Cochrane Database 2016

Pandit PB; J Perinatol 1999

Lamperti; Int Care Med 2012

WoCoVa, Lissabon 2017

www.gavecelt.it

PERSONAL PREFERENCE

- **Supraclavicular route**
 - veins are much easier to scan
- **IJV**
 - easiest to scan
 - collapsible
 - lowest possible approach
- **BCV**

SUMMARISING

- Periclavicular insertion of 2 Fr catheters is possible in extreme premies
 - *reduction of mortality/morbidity?*

- USG

– *1.choice:* *BCV* *IP*

– *2.choice:* *IJV*

OOP

Breschan; Anesthesiology 2017

Montes-Tapia; J Pediatr Surg

SUMMARIZING CICC lines in PREMIES

- Under deep sedation/GA
- Minimally invasive
 - *no tunneling*
 - *minimal*
 - *dilatation*
 - *quicker*
- Suturing of catheters

CONCLUSION

USG SUPRACLAVICULAR BCV ACCESS

- Fairly safe
- More difficult the smaller the weight
- Good option

IP cannulation of left BCV: 1.6kg Baby



IP cannulation of right BCV: 590g Baby



CONCLUSION

USG SUPRACLAVICULAR BCV ACCESS

- Easier for the left BCV *in neonates*
- Prescanning of the right BCV
 - **difficult: yes/no**
- Learning curve

RESPECT!!



Noteworthy Observation in ELBW babies
IP cannulation of left BCV: 610g Baby







IP cannulation of left BCV: 750g Baby



IP cannulation of left BCV: 2.5kg Baby



IP cannulation of left BCV: 1.8kg Baby
NEC: septic shock



IP cannulation of right BCV: 1.6kg Baby



OOP cannulation of right IJV: 1.4kg Baby

