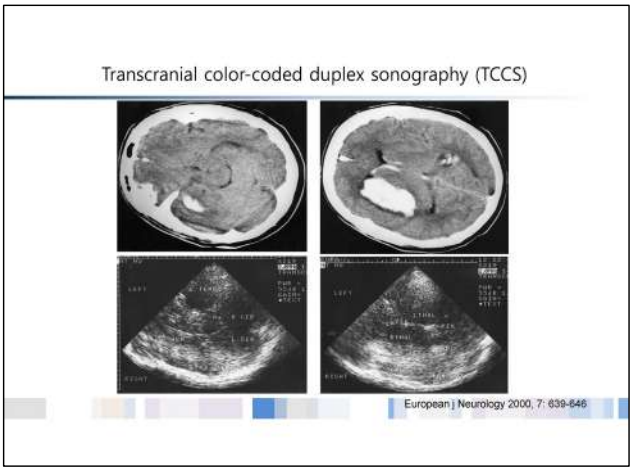
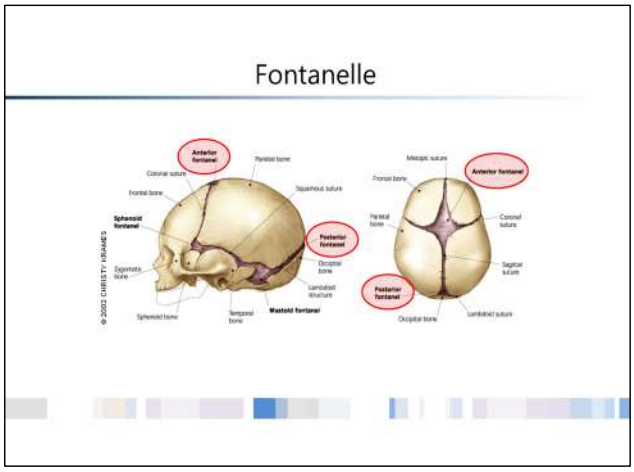
신경중환자의 초음파 모니터링

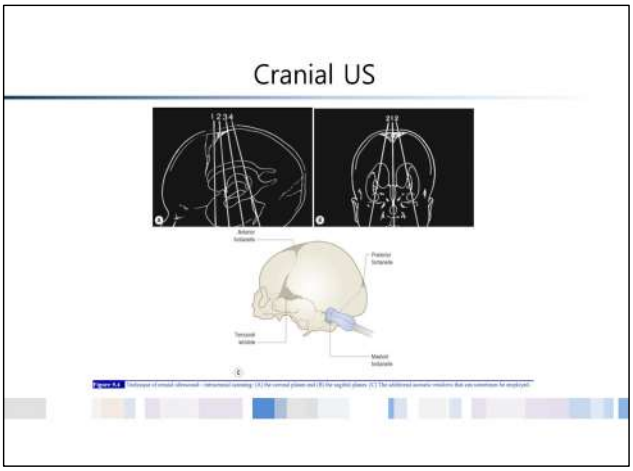
유 정 암
성균관의대 중환자의학과, 신경외과

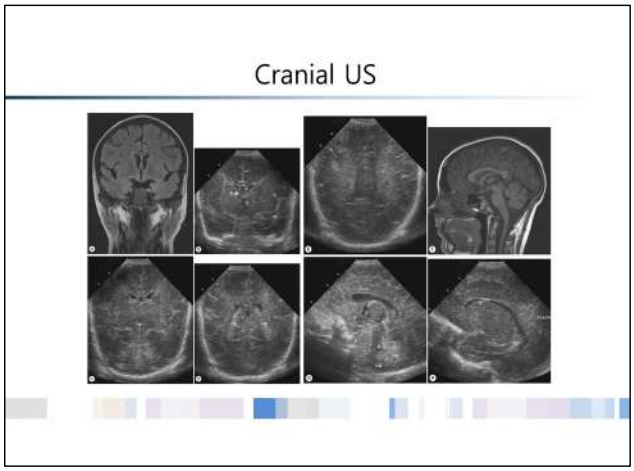
Ultrasound monitoring of neurocritical patients

Jeong-Am Ryu, MD, PhD
Department of Critical Care Medicine and Department of Neurosurgery, Samsung Medical Center, Sungkyunkwan University School of Medicine



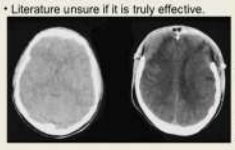


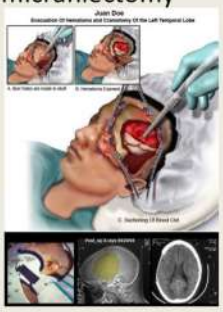




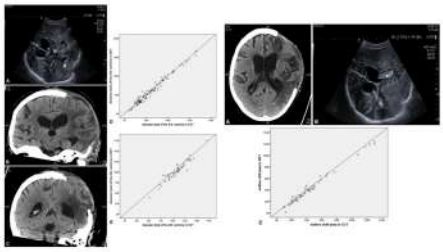
Craniectomy/Hemicraniectomy

- Used when brain is not responsive to conventional measures in the face of intractable intracranial hypertension
- Bone flap is removed and stored to be replaced when swelling subsides. Usually weeks to months
- Store flap in abdomen due to vascular supply bed, or in freezer.
- Literature unsure if it is truly effective.



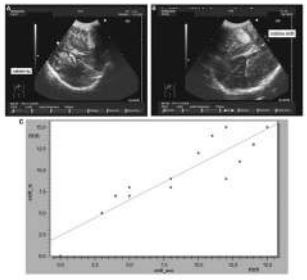


Ventricle diameter



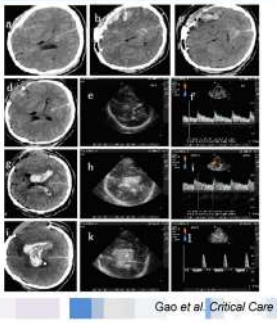
Neurocrit Care DOI 10.1007/s12028-016-0359-2

Midline shifting



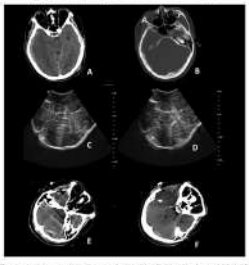
Crit Care Med 2012 Vol. 40, No. 6

Rapid detection of recurrent IVH in TBI

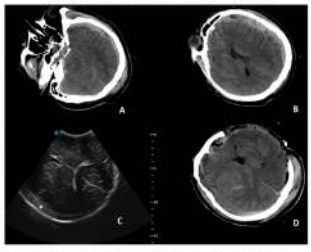


Gao *et al. Critical Care* 2012, **16**:459

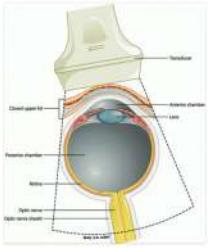
Intraoperative US in intraoperative acute brain swelling



Intraoperative US in intraoperative acute brain swelling



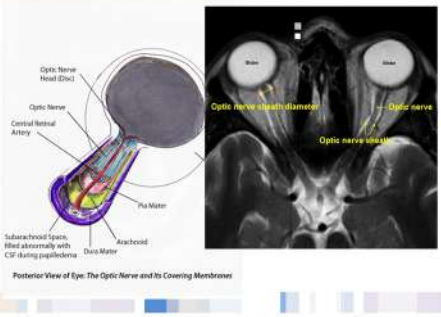
Optic Nerve Sheath Diameter (ONSD)



Anatomy of optic nerve sheath

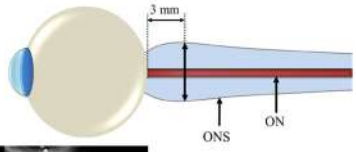
- Optic nerve sheath complex
  - **Optic nerve**
    - White matter tract of CNS
  - **Perioptic nerve sheath**
    - Leptomeninges로 구성됨
    - Dura mater
      - Subarachoind compartment를 갖고 있다
      - Approximately 0.1 ml of CSF

Optic nerve sheath diameter (ONSD)



Posterior View of Eye: The Optic Nerve and Its Covering Membranes

Figure 1. Reference location of Optic Nerve Sheath Diameter (ONSD) measurement for determining risk of elevated Intracranial Pressure (ICP).



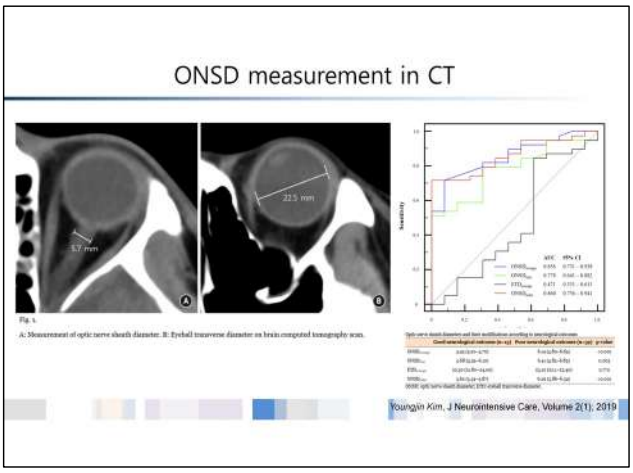
Critical Care Horizons 2015; **1**: 22-30

Equipment

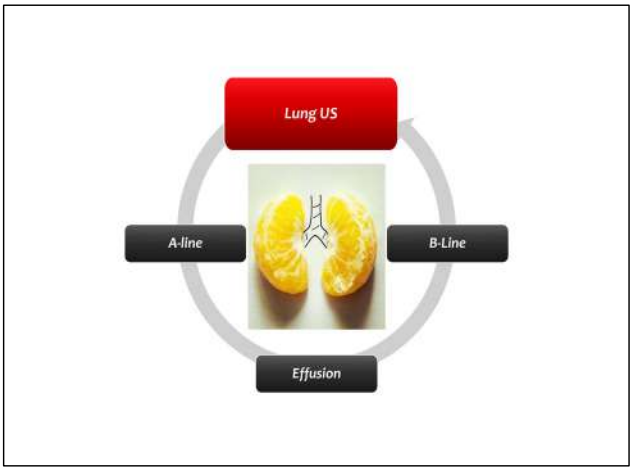
- The intrinsic performance of the ultrasound unit is of paramount importance for the accuracy of the test, as older equipment and a lower frequency ultrasound probe (<7.5 MHz) may lead to an unacceptably high interobserver ONSD variability.

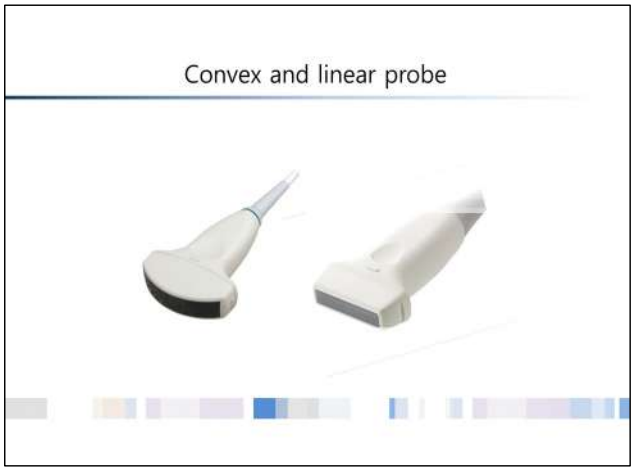
Acta Anaesthesiol Scand 2011; 55: 644–652

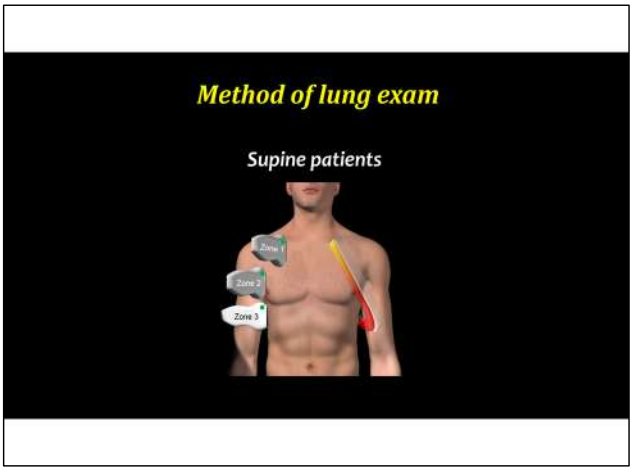
실제 측정 예

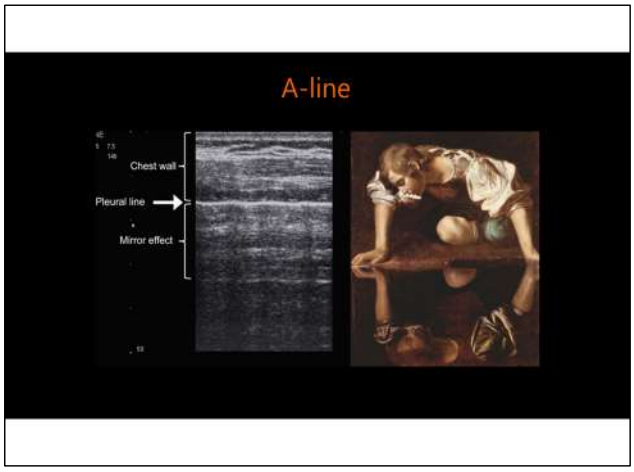

ONSD measurement in CT
5.7 mm
22.5 mm
Youngjin Kim, J Neurointensive Care, Volume 2(1), 2019

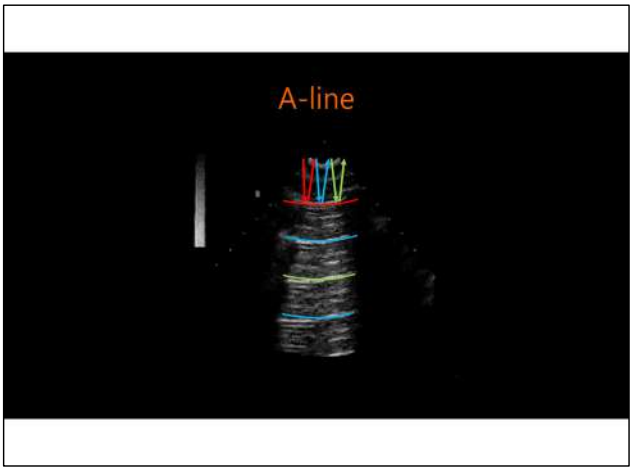

Chest wall
Pleural line
Mirror effect
Lung sono
2D echo

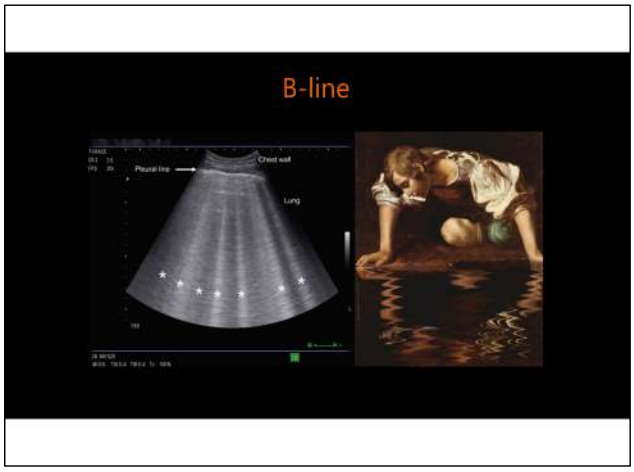

Lung US
A-line
B-Line
Effusion


Convex and linear probe


Method of lung exam
Supine patients
Zone 1
Zone 2
Zone 3


A-line
Chest wall
Pleural line
Mirror effect





B-lines

- Arise from pleural line, extend to the bottom of the screen
- Efface A lines at their point section
- Correlate with the alveolar interstitial pattern on CXR or CT
- Normally seen in the lower lateral lung zones (3-4 lines)
- **Water ↑**

Pleural effusion

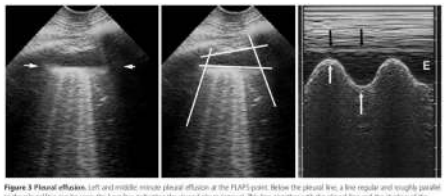
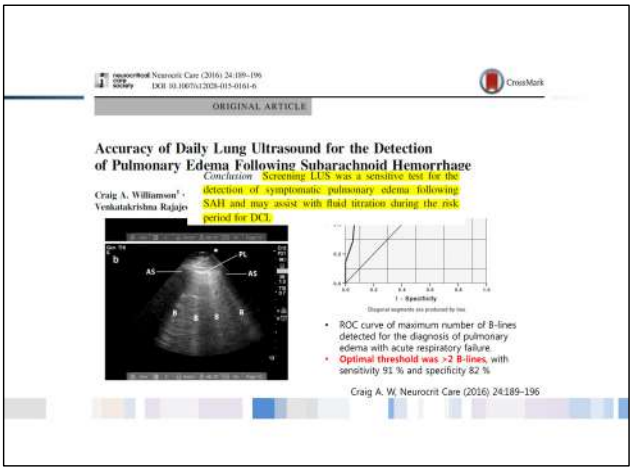


Figure 3 Pleural effusion. Left and middle: minute pleural effusion at the PLAPS point. Below the pleural line, a line regular and roughly parallel to the pleural line can be seen: the lung line, indicating the visceral pleura (arrows). This line, together with the pleural line and the shadow of the ribs, display a kind of quad: the quad sign. Right: M-mode shows a movement of the lung line (white arrows) toward the pleural line (black arrows) on inspiration—the sinusoid sign, indicating also a free pleural effusion, and a viscosity enabling the use of small caliper needle if thoracentesis is envisaged. E, expiration. Quantitative data: this effusion found at the PLAPS point has an expiratory thickness of roughly 13 mm, i.e., an expectedly small volume (study in progress). A 15-mm distance is our minimum required for safe diagnostic or therapeutic puncture, allowing to simplify the problem of modeling the real volume of an effusion (Ref. 14) Extract from "Whole body ultrasonography in the critically ill" (2010 Ed, Chapter 13), with kind permission of Springer Science



Neurocrit Care (2016) 24:189–196
DOI 10.1007/s12028-015-0161-6

CrossMark

ORIGINAL ARTICLE

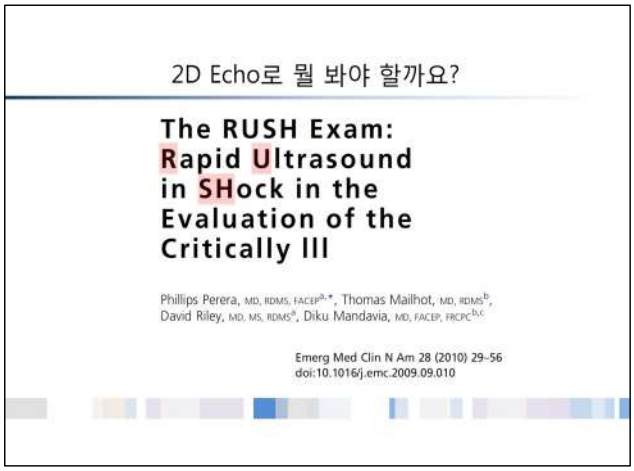
Accuracy of Daily Lung Ultrasound for the Detection of Pulmonary Edema Following Subarachnoid Hemorrhage

Craig A. Williamson[1] · Venkatakrishna Rajajee

Conclusion Screening LUS was a sensitive test for the detection of symptomatic pulmonary edema following SAH and may assist with fluid titration during the risk period for DCI.

- ROC curve of maximum number of B-lines detected for the diagnosis of pulmonary edema with acute respiratory failure.
- Optimal threshold was >2 B-lines, with sensitivity 91 % and specificity 82 %

Craig A. W. Neurocrit Care (2016) 24:189–196



2D Echo로 뭘 봐야 할까요?

The RUSH Exam: Rapid Ultrasound in SHock in the Evaluation of the Critically Ill

Phillips Perera, MD, RDMS, FACEP[b,*], Thomas Mailhot, MD, RDMS[b], David Riley, MD, MS, RDMS[a], Diku Mandavia, MD, FACEP, FRCPC[b,c]

Emerg Med Clin N Am 28 (2010) 29–56
doi:10.1016/j.emc.2009.09.010

RUSH Protocol: 3 Step

RUSH protocol

- 3 Step Algorithm
  - **The Pump**: cardiac evaluation
    - LV contractility, RV strain, pericardial effusions
  - **The Tank**: volume status
    - IVC variation, leaks, tank compromise
  - **The Pipes**: vascular system
    - Aortic dissection, aneurysms, DVT

Step 1

Pump

Cardiac evaluation

RUSH Step 1

A) Parasternal Views
Long / Short Axis
B) Subxiphoid View
C) Apical View

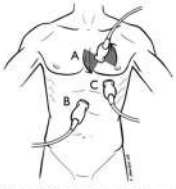
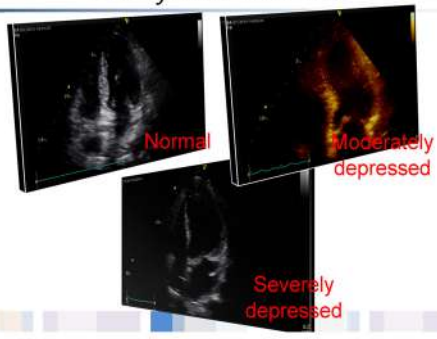


Fig. 1. *R*apid *U*ltrasound in *SH*ock (RUSH) step 1. Evaluation of the pump.

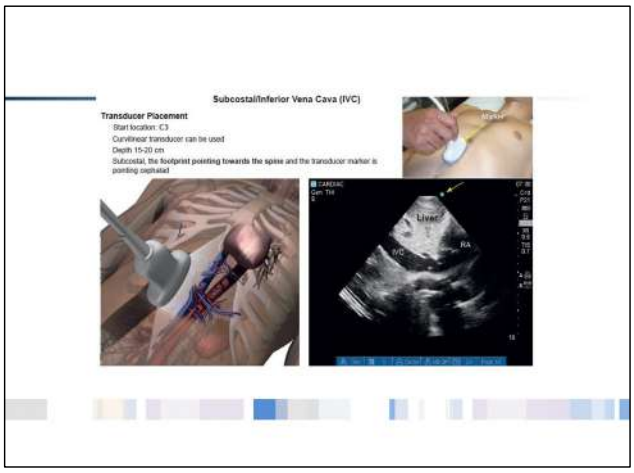
The eyeball method

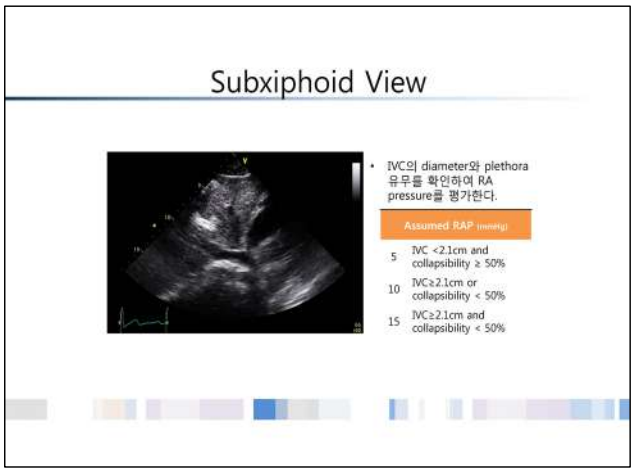


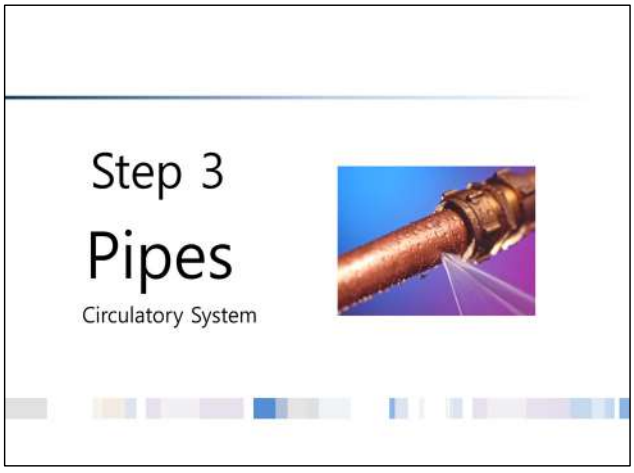
Step 2

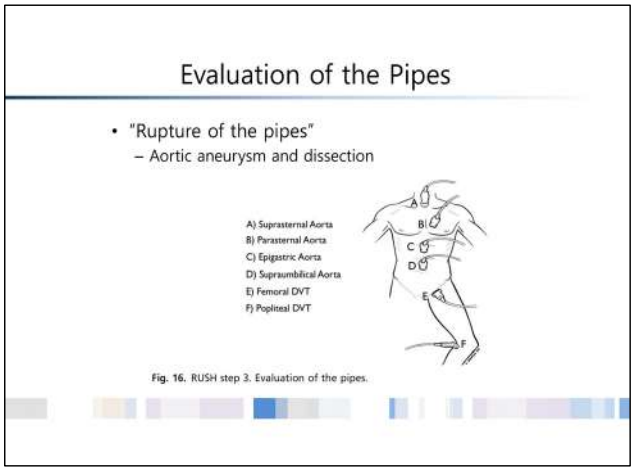
Tank

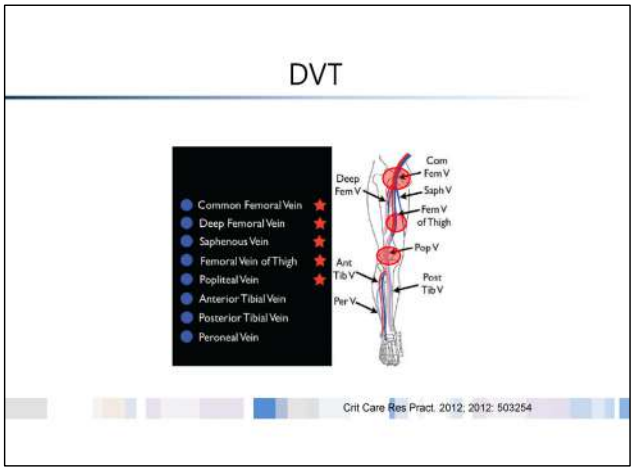
Volume Status

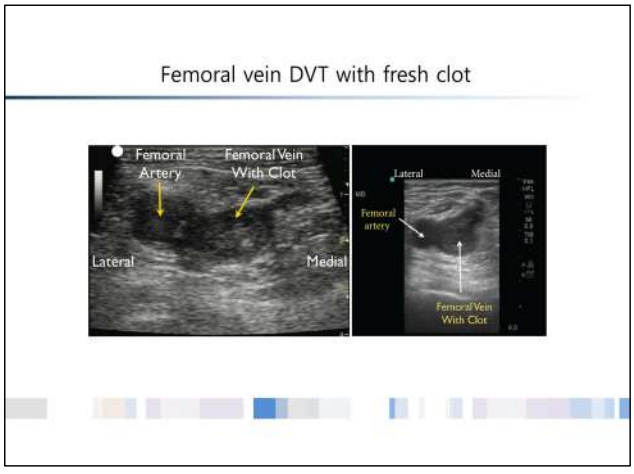

Subcostal/Inferior Vena Cava (IVC)
Transducer Placement
Start location: C3
Curvilinear transducer can be used
Depth 15-20 cm
Subcostal, the footprint pointing towards the spine and the transducer marker is pointing cephalad
Liver
IVC
RA

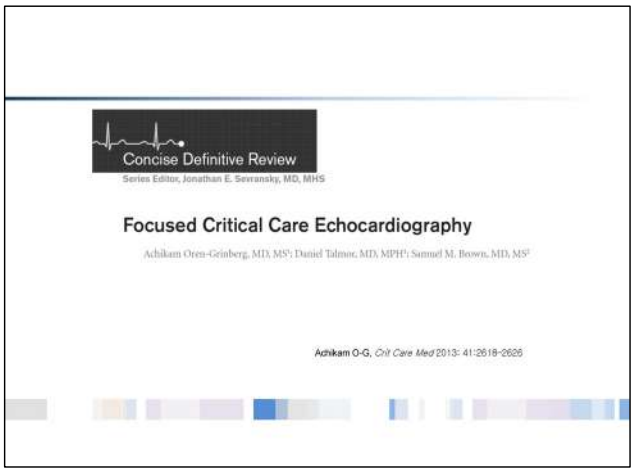

Subxiphoid View
IVC의 diameter와 plethora 유무를 확인하여 RA pressure를 평가한다.
Assumed RAP (mmHg)
5 IVC <2.1cm and collapsibility ≥ 50%
10 IVC≥2.1cm or collapsibility < 50%
15 IVC≥2.1cm and collapsibility < 50%

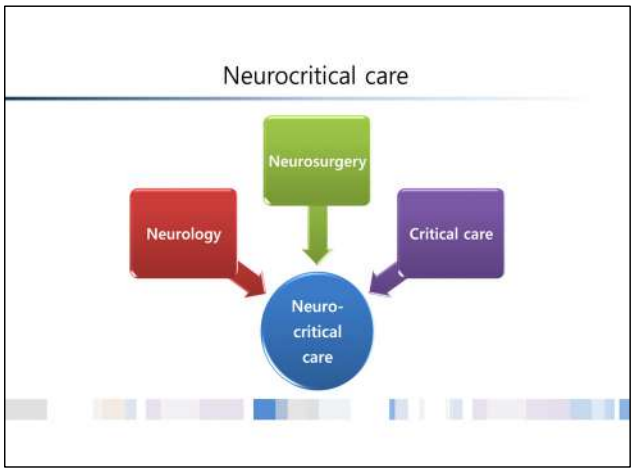

Step 3
Pipes
Circulatory System


Evaluation of the Pipes
"Rupture of the pipes"
– Aortic aneurysm and dissection
A) Suprasternal Aorta
B) Parasternal Aorta
C) Epigastric Aorta
D) Supraumbilical Aorta
E) Femoral DVT
F) Popliteal DVT
Fig. 16. RUSH step 3. Evaluation of the pipes.


DVT
Common Femoral Vein
Deep Femoral Vein
Saphenous Vein
Femoral Vein of Thigh
Popliteal Vein
Anterior Tibial Vein
Posterior Tibial Vein
Peroneal Vein
Com Fem V
Deep Fem V
Saph V
Fem V of Thigh
Pop V
Ant Tib V
Post Tib V
Per V
Crit Care Res Pract. 2012; 2012: 503254


Femoral vein DVT with fresh clot
Femoral Artery
Femoral Vein With Clot
Lateral
Medial
Femoral artery
Femoral Vein With Clot


Concise Definitive Review
Series Editor, Jonathan E. Sevransky, MD, MHS
Focused Critical Care Echocardiography
Achikam Oren-Grinberg, MD, MS[1]; Daniel Talmor, MD, MPH[1]; Samuel M. Brown, MD, MS[2]
Achikam O-G, Crit Care Med 2013; 41:2618-2626


Neurocritical care
Neurosurgery
Neurology
Critical care
Neuro-
critical
care