

## The Great Value of Brain U/S in Diagnosis of almost all Causes of Central Coma [COMA Protocol]

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### Abstract

In the last years, Critical Care U/S has become an essential branch of critical care Medicine and has gained general acceptance. Its use, both as a diagnostic tool and for hemodynamic monitoring, has increased markedly, greatly influencing contemporary cardiorespiratory management.

The RUSH Protocol for undifferentiated shock was first introduced in 2006 by Weingart SD., et al. and later published in 2009. It was designed to be a rapid and easy to perform US protocol (< 2 minutes) by most emergency physicians.

Daniel A. Lichtenstein invented the BLUE- protocol for the management of acute respiratory failure, In the BLUE-protocol, profiles have been designed for the main diseases (pneumonia, congestive heart failure, COPD, asthma, pulmonary embolism, pneumothorax), with an accuracy. 90%, Moreover, As judged by the American College of Radiology Appropriateness Criteria, renal Doppler ultrasonography is the most appropriate imaging test in the evaluation of AKI and has the highest level of recommendation.

So, we have now a RUSH protocol for shock, BLUE-Protocol for Acute respiratory failure. The most important question here, could we have a critical care U/S Protocol for coma?

Brain ultrasonography can be used to evaluate cerebral anatomy and pathology, as well as cerebral circulation through analysis of blood flow velocities, so it has a great role in diagnosing structural causes of coma.

Trans cranial color-coded duplex sonography is a generally safe, repeatable, non-invasive, bedside technique that has a strong potential in neurocritical care patients in many clinical scenarios.

Here, we will illustrate a proposed protocol to use Brain U/S for diagnosing almost all causes of coma of central causes.

**Keywords:** RUSH Protocol; BLUE- Protocol; TCD; Brain U/S; COMA

### Abbreviations

PI: Pulsatility Index; MCA: Middle Cerebral Artery; ACA: Anterior Cerebral Artery; BA: Basilar Artery; TCD: Trans Cranial Doppler; ONSD: Optic Nerve Sheath Diameter

### Introduction

In the last years, Critical Care U/S has become an essential branch of critical care Medicine and has gained general acceptance. Its use, both as a diagnostic tool and for hemodynamic monitoring, has increased markedly, greatly influencing contemporary cardiorespiratory management. Recent studies suggest that the use of CCE may have a positive impact on outcomes. CCE may be used in critically ill patients

in many different clinical situations, both in their early evaluation of in the emergency department and during intensive care unit (ICU) admission and stay. CCE has also proven its utility in perioperative settings, as well as in the management of mechanical circulatory support. CCE may be performed with very simple diagnostic objectives.

The RUSH Protocol for undifferentiated shock was first introduced in 2006 by Weingart SD, *et al.* and later published in 2009. It was designed to be a rapid and easy to perform US protocol (<2 minutes) by most emergency physicians [1,2].

This protocol is sufficiently reliable to rule out hypovolemic, cardiogenic or obstructive subtypes of the shock (NPV above 97% for all of them).

Agreement of sonography findings with final diagnosis was 89% ( $P < 0.001$ ) for obstructive and cardiogenic shock, 92% [ $P < 0.001$ ] in hypovolemic shock, and 81% [ $P < 0.001$ ] in distributive shock [3].

Daniel A. Lichtenstein invented the BLUE- protocol for the management of acute respiratory failure, In the BLUE-protocol, profiles have been designed for the main diseases (pneumonia, congestive heart failure, COPD, asthma, pulmonary embolism, pneumothorax), with an accuracy 90% [4]. Moreover, As judged by the American College of Radiology Appropriateness Criteria, renal Doppler ultrasonography is the most appropriate imaging test in the evaluation of AKI and has the highest level of recommendation.

So, we have now a RUSH protocol for shock, BLUE-Protocol for Acute respiratory failure.

The most important question here, could we have a critical care U/S Protocol for coma.

We can divide the causes of COMA into metabolic causes of coma and central causes of coma.

The most commonly accepted pathophysiology of coma is due to a decrease in the supply of glucose to the brain and oxygen diffuse neuronal dysfunction from either structural or nonstructural causes. A myriad of medical physiologies may lead to substrate disruption and central nervous system (CNS) dysfunction, with coma as the extreme clinical condition. For example, any clinical process that causes circulatory collapse or profound hypoxemia may manifest as coma. Fifteen seconds of circulatory [collapse will result in loss of consciousness. If the cause of the circulatory collapse is brief and promptly restored, such as from a simple faint, consciousness is regained. If hypotension or hypoxemia continues, the altered mental state continues, and secondary CNS damage will occur [5-7].

Critical care U/S is very important tool in management of shocked and hypoxic patient through RUSH and BLUE protocols respectively, so, Critical care U/S can be a very important in management of the comatose patient due to cardiorespiratory causes.

Metabolic causes of coma like [hypoglycemia, hepatic failure, renal failure, electrolytes disturbances, and drug intoxication] can be diagnosed by biochemical screen.

Brain ultrasonography can be used to evaluate cerebral anatomy and pathology, as well as cerebral circulation through analysis of blood flow velocities, so it has a great role in diagnosing structural causes of coma.

Trans cranial color-coded duplex sonography is a generally safe, repeatable, non-invasive, bedside technique that has a strong potential in neurocritical care patients in many clinical scenarios.

Here, is a proposed step by step protocol to use for diagnosing almost all causes of coma of central causes.

### Discussion

Brain ultrasonography can be used in a wide range of clinical applications in neurocritical care, and the main ones are intracranial hemorrhage, midline shift, and vasospasm in subarachnoid hemorrhage, recent CVS and increased ICP. In general, although we recommend implementation of this technique in clinical practice, we also suggest that it should not replace invasive neuromonitoring techniques [such as invasive intracranial pressure (ICP) monitoring] or substitute diagnostic tools such as computed tomography (CT) or magnetic resonance imaging (MRI).

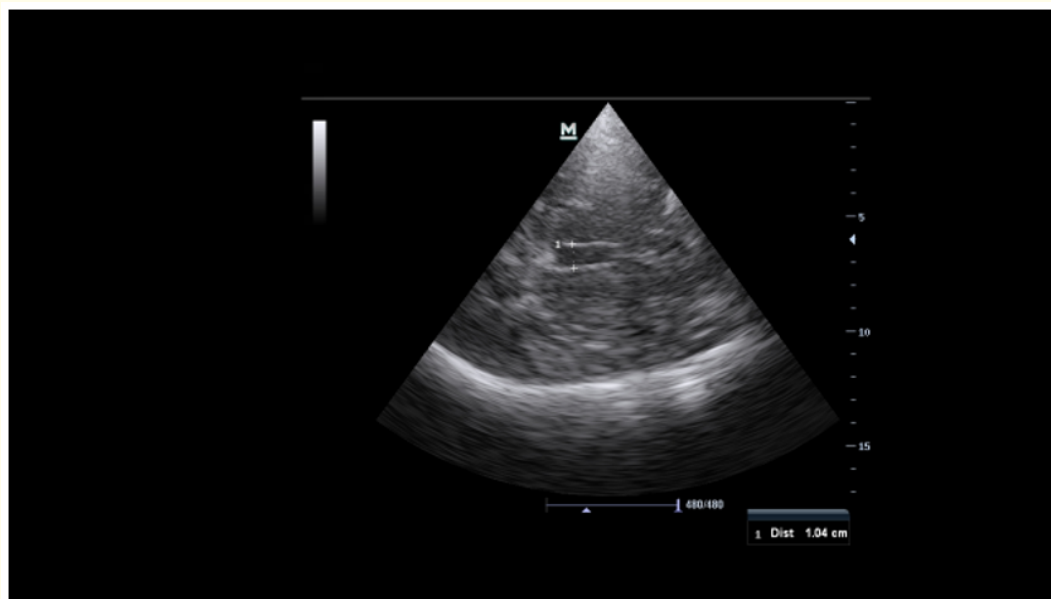
We discuss here a proposed protocol for the use of Brain U/S in management of comatose patient of central origin.

To our knowledge, there is no article mention a protocol for use of Brain U/S in comatose patient.

### First step

Look at the ventricular system [lateral and third ventricle].

Normal sizes of the ventricles on CT and MRI shows the third ventricle to be < 5 mm in children, <7 mm in adults < 60 years of age and < 9 mm in adults above 60 years [8]. You will look at the size and the presence of blood inside, TCD has been validated against the gold standard [CT] for proper assessment of ventricular system [9-11].



**Figure 1:** Clear measurement of third ventricle by TCD.

### Second step

You measure midline shift, TCD has been validated against CT for accurate measurement of midline shift [12,13].

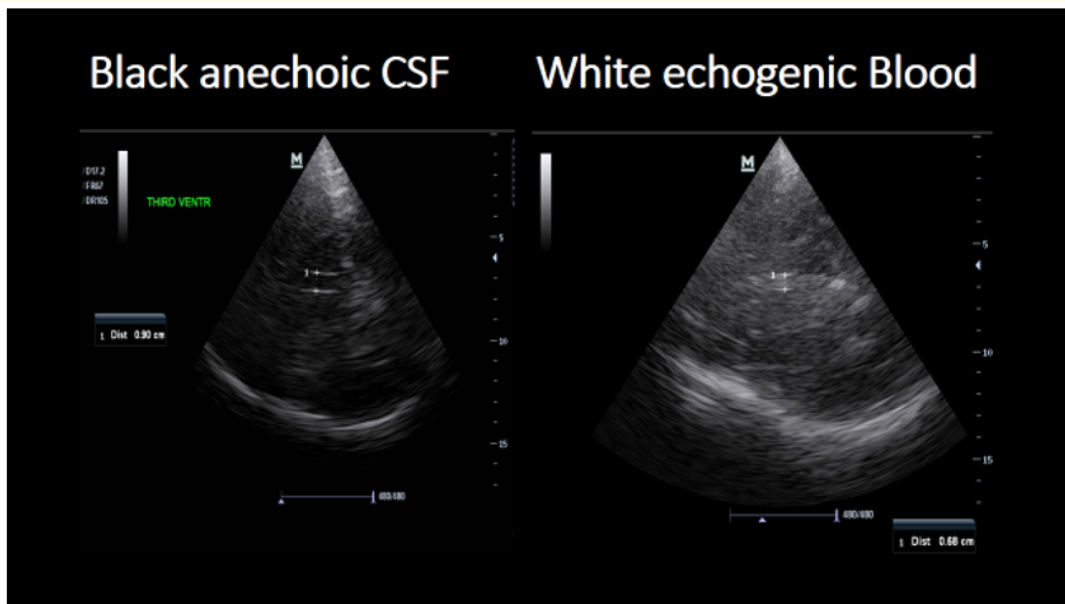


Figure 2: Normal CSF appear anechoic and ventricular hemorrhage appear echogenic.

This is a link demonstrating how you can measure midline shift with TCD <https://www.youtube.com/watch?v=Sd4PFrEzrGo&t=937s>.

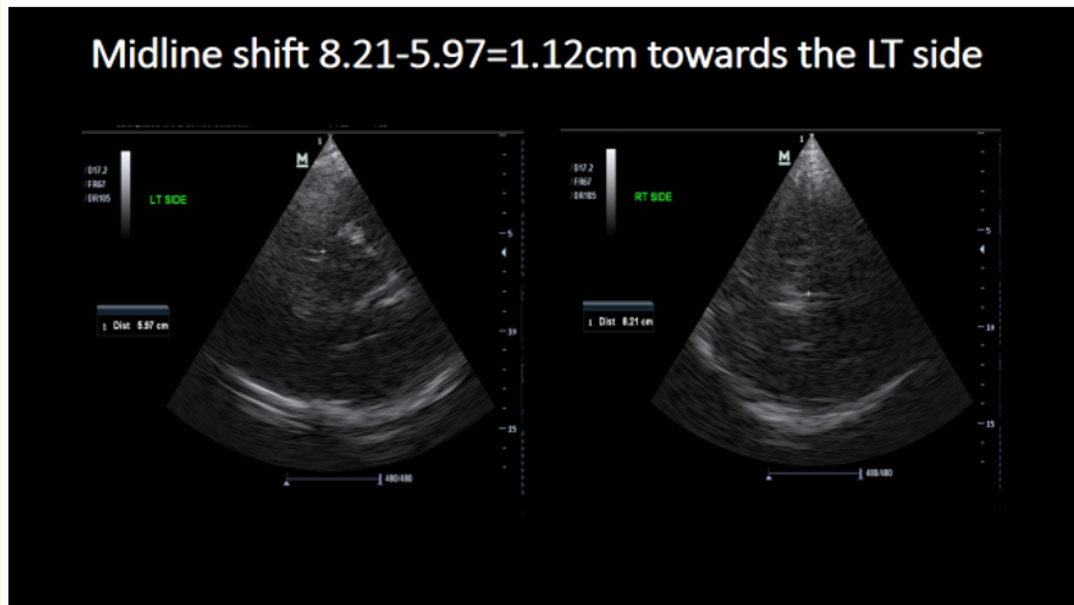


Figure 3: You will measure the distance from the skin to the wall of third ventricle from each side [left and right], the midline shift will equal long distance-short distance/2.

Third step

If you find midline shift, screen the brain tissue for presence of hyper echoic masses indicating brain hemorrhage, TCD has been validated against the gold standard CT in diagnosing brain hemorrhage [14,15].

This is a link demonstrating how you can use Brain U/S in diagnosis of Brain Hemorrhage. <https://www.youtube.com/watch?v=5tzZ3GNvtFs>.

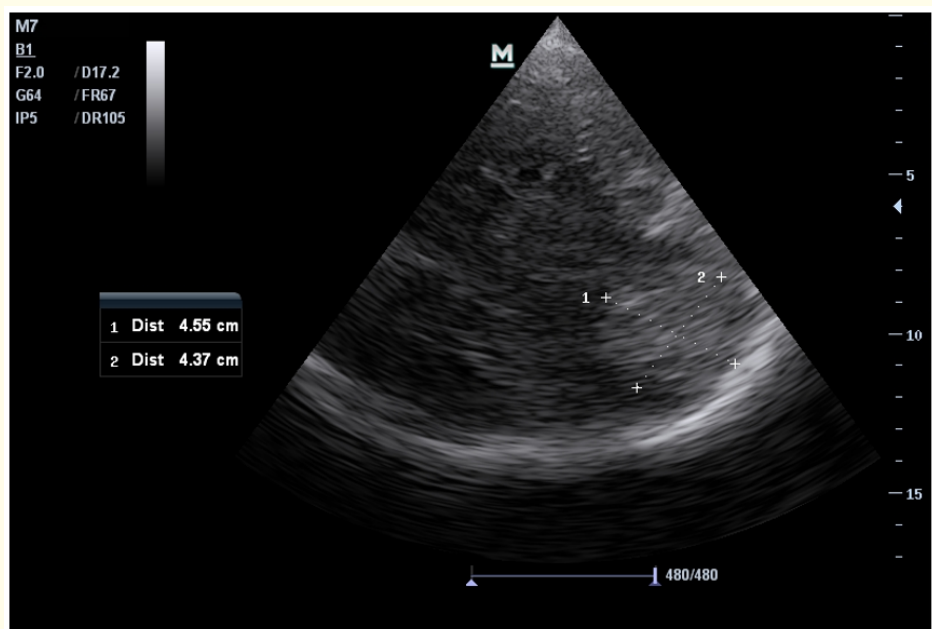


Figure 4: Very clear haemorrhage of the LT frontal area instead of RT frontal area.

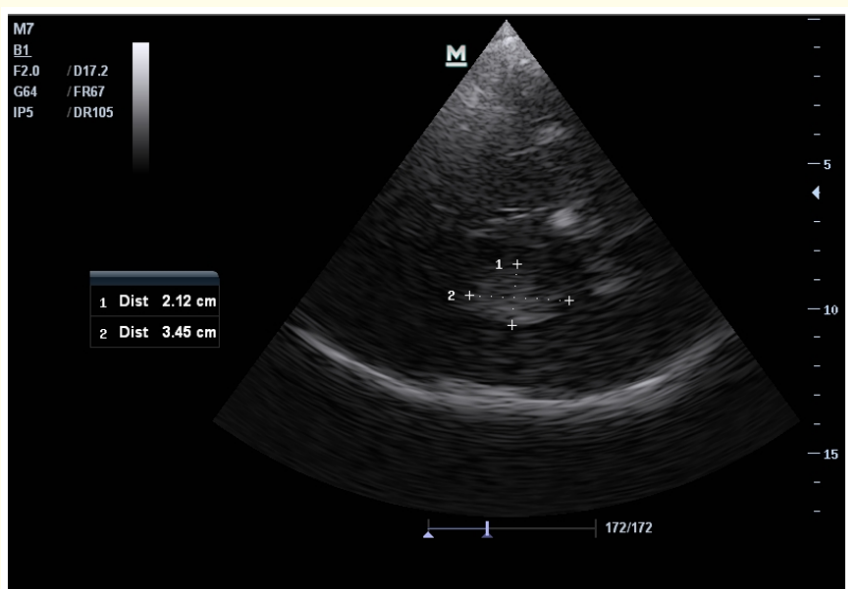


Figure 5: Very clear RT basal ganglion hemorrhage which you can measure by TCD.

So, within few minutes you can accurately diagnose hydrocephalus, intraventricular bleed, brain hemorrhage, and midline shift.

If you find any one of these diagnosis, first, you will confirm a central structural cause of coma, second, you will arrange for confirmatory CT brain and call neurosurgery.

#### Fourth step

Look at the TCD signs of increased ICP, bilateral dilatation of ONSD and increased MCA PI.

ONSD has a great role of diagnosis of increased ICP [16,17].

Methods based on the TCCD-/TCD-derived PI, defined as the difference between maximum and minimum blood flow velocity normalized to the average velocity. The usefulness of this index for predicting ICP is controversial, as changes in PI are not dependent solely on changes in ICP, but also on cerebral perfusion pressure (CPP), arterial blood pressure and its pulsatility, and variations in partial pressure of CO<sub>2</sub>, heart rate, but, PI has been indicated as possible non-invasive estimator of ICP, although accuracy of estimation is low (above 15 to 20 mmHg) [6]. However, if PI > 1.5, ABP pulsation is not elevated (< 60 mm Hg), PaCO<sub>2</sub> is not hypocapnic (< 3.7 kPa) and mean ABP is in norm (> 80 mmHg), PI may be interpreted as indicator for possibly raised ICP.

Finally, Schmidt, *et al.* using the formula nCPP = MAP \* FVd/FVm + 14 mmHg, demonstrated a good correlation between nCPP estimation and invasive CPP measurement (R = 0.61; p = 0.003), with a 95% confidence limit range no greater than ±12 mmHg, and with CPP ranging from 70 to 95 mmHg [18].

If there is TCD signs of increased ICP plus TCD evidence of hydrocephalus, midline shift, or brain hemorrhage give dehydrating measures.

If there is TCD signs of increased ICP alone without any structural abnormalities look for recent major stroke [MCA and BA flow] because in this situation you can find TCD signs of increased ICP but for midline shift to occur needs a few days, so the next step will be assess the flow in major brain arteries [MCA, ACA,BA] and arrange for MRI brain, TCD is very important in early diagnosis of CVS [19].

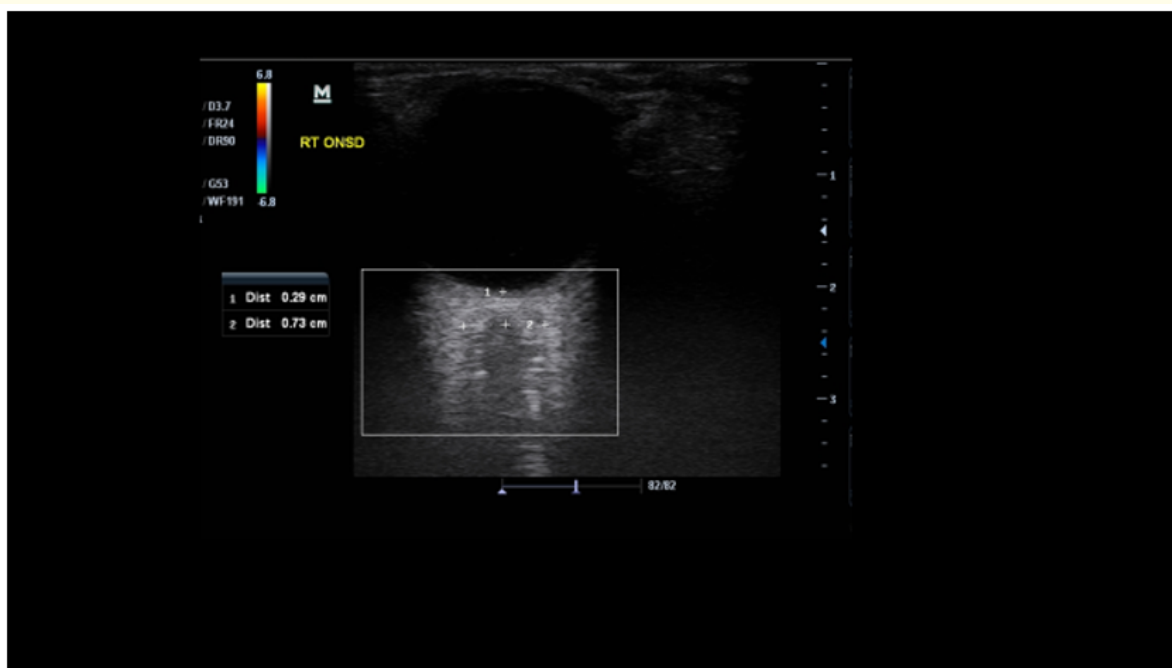


Figure 6: ONSD is more than 0.58 cm denoting increased ICP.

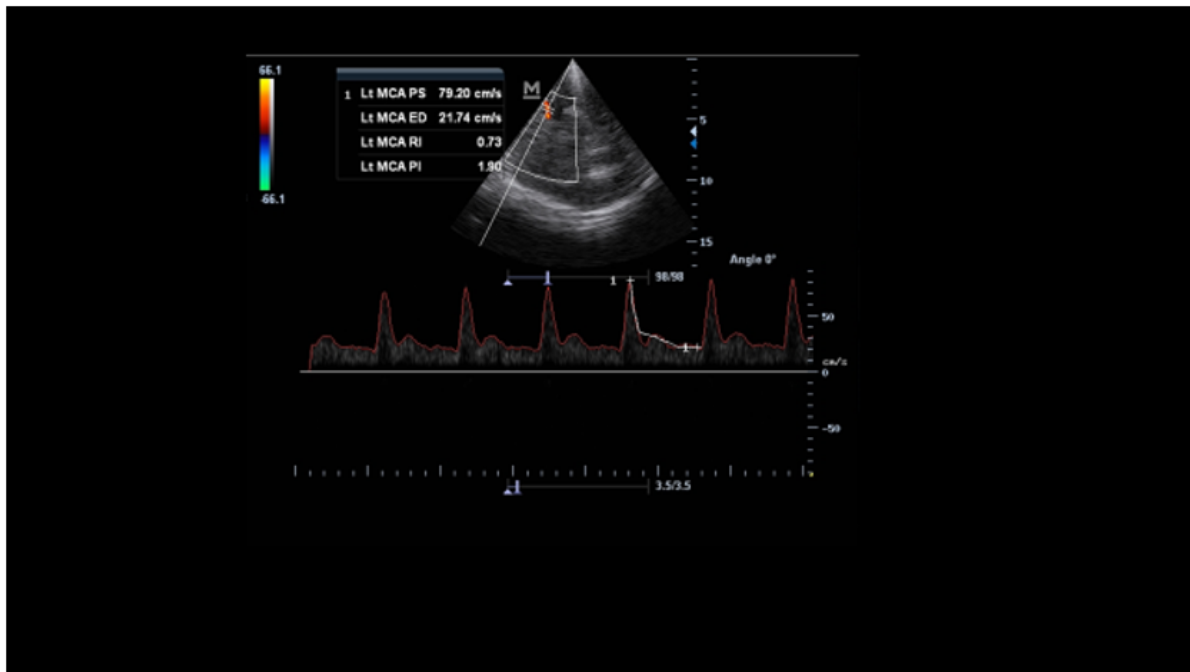


Figure 7: LT MCA PI is 1.9 [normal 1], denoting increased ICP.

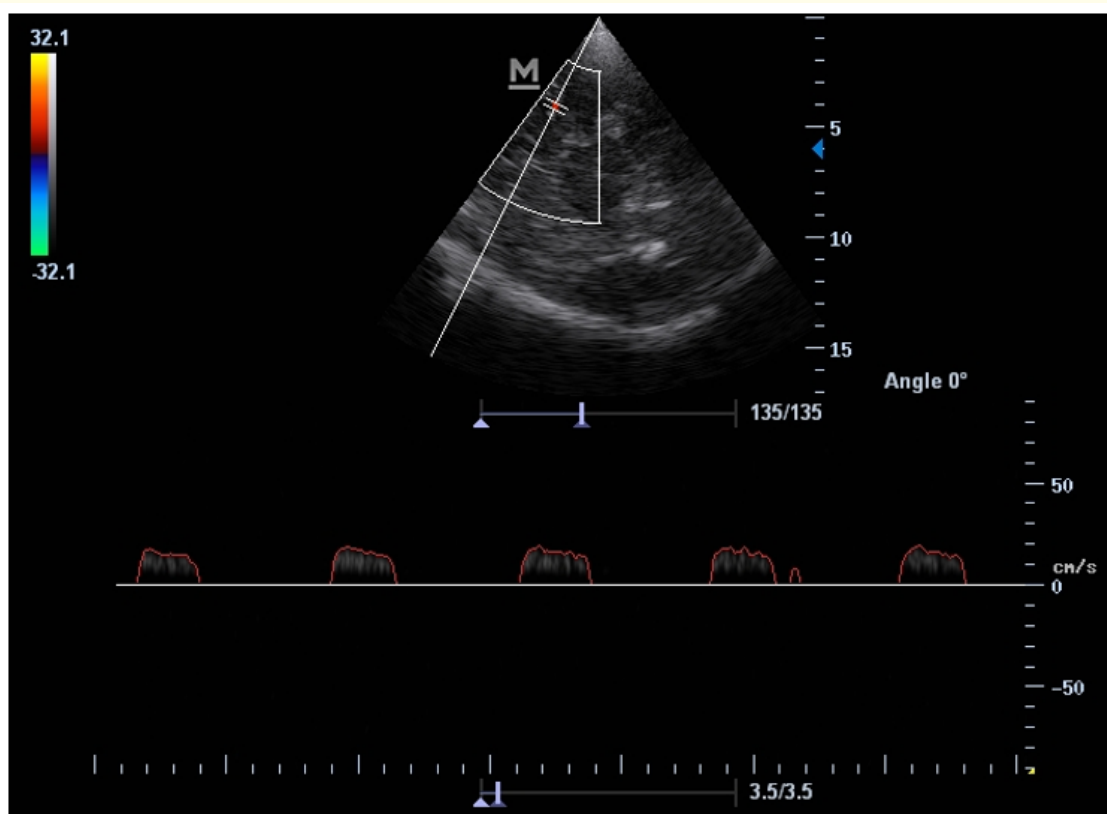


Figure 8: Very bad flow of LT MCA with sys velocity of 20 cm/sec and absent diastolic flow in recent stroke which was starting recanalization see figure 9.

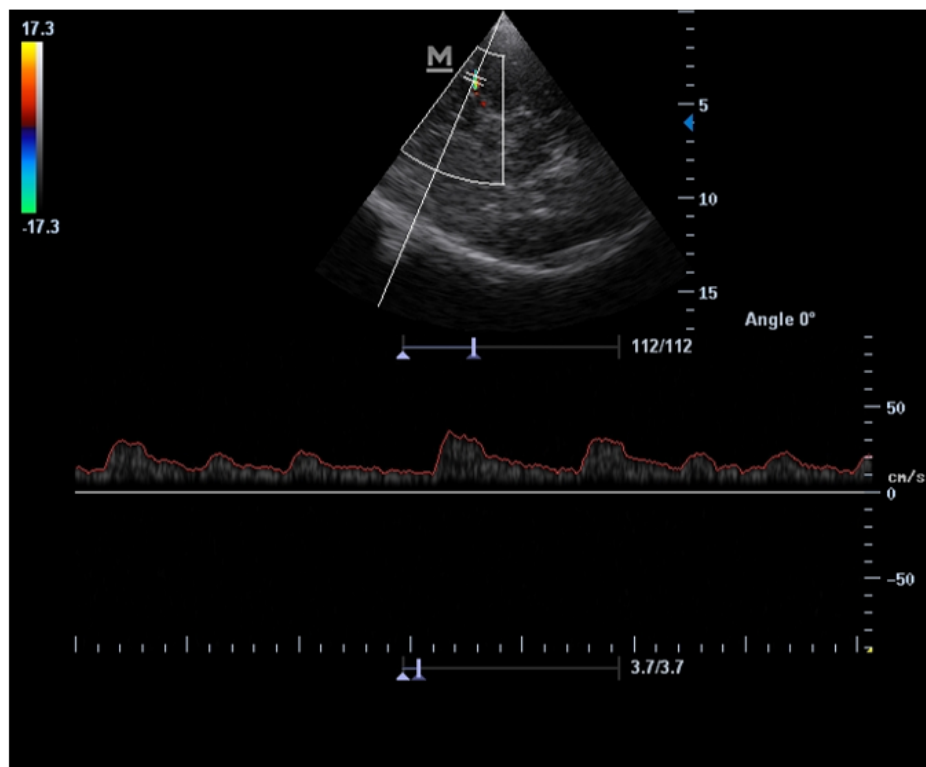


Figure 9: Starting recanalization in LT MCA in recent CVS.

This is a link for clearly demonstrating the protocol with a simplified case study. <https://www.youtube.com/watch?v=eL13lMW2jp0&t=205s>.

### Conclusion

Brain U/S is a non-invasive, accessible, cheap, and safe investigative tool, and use of Brain U/S early in the workup of coma is very important and can have great consequences in the management of coma, especially, in poor areas without facilities for CT and MRI, moreover it can be applied safely in a critically ill patient who cannot be transferred to radiology department.

### Bibliography

1. Perera P, et al. "The RUSH Exam: Rapid Ultrasound in Shock in the Evaluation of the Critically Ill". *Emergency Medicine Clinics of North America* 28 (2010): 29-56.
2. Rose JS, et al. "The UHP Ultrasound Protocol: A Novel Ultrasound Approach to the Empiric Evaluation of the Undifferentiated Hypotensive Patient". *The American Journal of Emergency Medicine* 19 (2001): 299-302.
3. Mohammad Reza Ghane, et al. "Accuracy of Rapid Ultrasound in Shock (RUSH) Exam for Diagnosis of Shock in Critically Ill Patients". *Trauma Monthly* 20.1 (2015): e20095.
4. DA Lichtenstein. "BLUE-Protocol and FALLS-Protocol. Two Applications of Lung Ultrasound in the Critically Ill". *Chest* 147.6 (2015): 1659-1670.



5. Ren H., *et al.* "Emergency bedside evacuation of a subset of large postoperative epidural hematomas after neurosurgical procedures". *Medicine (Baltimore)* 97.30 (2018): e11475.
6. Guo H., *et al.* "Evaluation of Prognosis in Patients with Severe Traumatic Brain Injury Using Resting-State Functional Magnetic Resonance Imaging". *World Neurosurgery* 121 (2019): e630-e639.
7. Rizvi T., *et al.* "Brain Death: Diagnosis and Imaging Techniques". *Seminars in Ultrasound CT MR* 39.5 (2018): 515-529. .
8. Meese W., *et al.* "CT evaluation of the cerebrospinal fluid spaces of healthy persons". *Neuroradiology* 19 (1980): 131-136.
9. Becker G., *et al.* "Identification of ventricular enlargement and estimation of intracranial pressure by transcranial color-coded real-time sonography". *Journal of Neuroimaging* 4.1 (1994): 17-22.
10. Seidel G., *et al.* "Evaluation of the ventricular system in adults by transcranial duplex sonography". *Journal of Neuroimaging* 5.2 (1995): 105-108.
11. Kiphuth IC., *et al.* "Sonographic monitoring of ventricle enlargement in posthemorrhagic hydrocephalus". *Neurology* 76.10 (2011): 858-862.
12. Gerriets T., *et al.* "Sonographic monitoring of midline shift in hemispheric infarctions". *Neurology* 52.1 (1999): 45-49.
13. Gerriets T., *et al.* "Sonographic monitoring of midline shift in space-occupying stroke: an early outcome predictor". *Stroke* 32.2 (2001): 442-447.
14. Mäurer M., *et al.* "Diferentiation between intracerebral hemorrhage and ischemic stroke by transcranial color-coded duplex-sonography". *Stroke* 29.12 (1998): 2563-2567.
15. Pérez ES., *et al.* "Transcranial duplex sonography for monitoring hyperacute intracerebral hemorrhage". *Stroke* 40.3 (2009): 987-990.
16. Geeraerts T., *et al.* "Ultrasonography of the optic nerve sheath may be useful for detecting raised intracranial pressure after severe brain injury". *Intensive Care Medicine* 33.10 (2007): 1704-1711.
17. Geeraerts T., *et al.* "Noninvasive assessment of intracranial pressure using ocular sonography in neurocritical care patients". *Intensive Care Medicine* 34.11 (2008): 2062-2067.
18. Schmidt EA., *et al.* "Preliminary experience of the estimation of cerebral perfusion pressure using transcranial Doppler ultrasonography". *Journal of Neurology, Neurosurgery, and Psychiatry* 70.2 (2001): 198-204.
19. Sanjukta Sarkar., *et al.* "Role of transcranial Doppler ultrasonography in stroke". *Postgraduate Medical Journal* 83.985 (2007): 683-689.

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