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Case Report

The Great Value of Holistic Approach of Transcranial U/S in Management of Stroke in Emergency Room

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Abstract

Introduction: Acute stroke is a common disease presentation in ER. CT imaging is a very important in the acute management of stroke but, unfortunately it is not available in most district areas, and moreover it needs transfer of unstable patient to radiology department.

Trans cranial U/S is a bed side, non-invasive, cheap and repeatable, so, it can play an important role in the management of acute stroke patient in ER.

Case Report: We studied 2 cases of acute loss of consciousness and lateralization in ER by using a combination of:

1. Trans cranial U/S by phase array probe 2MH at temporal approach to study the brain by B- mode for hyper echoic lesions of recent hemorrhage, flow study of middle cerebral artery, and midline shift by measuring the distance from skin to the nearby wall of third ventricle in each side.
2. Optic nerve sheath diameter by high frequency probe 8MH by oblique axial view.

Results: Trans cranial U/S and ONSD in the first case revealed a LT side midline shift of 1.08cm, LT side ONSD 0.61CM, RT side ONSD 0.6cm, LT side MCA PI 1.34, and no hyper echoic lesion of recent hemorrhage, findings in the second case are a 0.68cm LT side midline shift, LT side ONSD 0.65cm, RT side ONSD 0.66cm, LT MCA PI 2.08.

These findings were closely correlated with CT findings as regard midline shift, evidence of brain edema, and presence of hemorrhage.

Conclusion: Combination of Trans cranial ultrasound and ONSD is an effective tool in acute management of stroke in ER and closely correlated with CT findings.

Keywords: *TCD; ONSD; Midline Shift by U/S; Stroke*

Introduction

Stroke is a major cerebrovascular disease resulting in high mortality and persistent disability in adults across the world [1], the Kingdom of Saudi Arabia (KSA) is the biggest country in the Arabian Peninsula, extending over an area of 2,150,000 km^2 and boasting a population of more than 28 million, Stroke is being observed as a rapidly growing problem and an important cause of illness and death in Saudi Arabia. It becomes one of the most imperative social and economic medical issues in the Kingdom [2].

During management of acute stroke in ER, the 2 important questions which affect acute management are:

1- Is it hemorrhagic or ischemic?

2- Is there any increase in intracranial pressure?

For answering the first question, CT brain is the gold standard for the differentiation between the 2 types of stroke, but, unfortunately it is not rapidly accessible in some district Hospitals and when available, still, it is difficult in some situation to shift these critically ill patient to CT because of risk of transfer.

For the second question, Invasive intracranial monitoring is the gold standard to measure the increase of intracranial pressure, but unfortunately it needs neurosurgical expertise which is not rapidly available in most centers in ER.

TCD can be used to elucidate stroke mechanisms, plan and monitor treatment, and determine prognosis. In an era when stroke is increasingly being recognized as an emergency requiring immediate treatment, TCD may be capable of providing rapid information about the hemodynamic status of the cerebral circulation [3].

Seidel., *et al.* at J Neuroimaging on 1996 mentioned in his study for use of TCD in diagnosis of midline shift due to massive stroke that the other uses of TCD are:

1- Visualizing of the blood flow velocity of the basal cerebral arteries and

2- The brain parenchyma as an acoustic impedance image [4].

Despite this expected Holistic approach of use of TCD in the early years, still, most of the recent studies concentrate mainly on the TCD as a tool for investigating the basal cerebral blood flow.

TCD can differentiate between cerebral infarction and cerebral hemorrhage by the appearance of recent hemorrhage as hyper echoic lesion in TCD [5].

TCD can clearly reveal the obstruction of basal cerebral arteries in recent stroke, moreover, it can follow up recanalization [6].

TCD can accurately determine midline shift [7].

By measurement of TCD PI, some studies revealed a very good correlation between increase of PI and high intracranial pressure [8] and some revealed poor association [9].

Recently, Julie., *et al.* revealed in his met analysis that ONSD has a good level of diagnostic accuracy for detecting intracranial hypertension, with a pooled sensitivity of 0.9 [10].

In all previous studies they investigated one aspect of TCD like looking at recent hemorrhage, midline shift, or flow study of cerebral arteries and no study combine TCD with the ONSD at the same time in acute stroke patient.

We use a holistic approach of combined trans cranial Ultrasound and ONSD which include 1- flow study of accessible basal cerebral arteries, 2- looking for hyper echoic lesion of recent hemorrhage, 3- midline shift, and 4- ONSD in both sides in all suspected acute stroke and head trauma patients in ER for years.

We presents 2 cases who were presented to resuscitation room in our hospital because of sudden onset of loss of consciousness and were connected to mechanical ventilation, they were unstable to go to CT, one because of severe hypotension and high inopressor support and the other because of very high BP.

Bed side Holistic Tran cranial U/S revealed a lot of highly beneficial informations which helped us a lot in acute management.

These findings were confirmed later by CT.

Case Presentation 1

A 32-year-old male patient K/C of dilated cardiomyopathy admitted to other Hospital because of recent RT side cerebral infarction, treated with aspirin, anti-failure medications, he did not receive TPA because of late presentation.

24 hrs before presentation to our ER he started to develop fever and worsening of conscious level.

He presented to us deeply comatosed, GCS 4/15.

Hemodynamically unstable with BP 90/55 on 30mic noradrenaline/min, and 20 mic/kg dopamine/min.

Temperature 40 degree Celsius, HR 160/min, sinus tachycardia.

Chest Exam: Bilateral lower lung zones crackles and bronchial breathing.

Abdomen: Distended with sluggish intestinal sounds.

Hematology: CBC, WBCs 14000/cmm, HB 10gm/dl, Plat 209000/cmm, PT 18.9, PTT 30, INR 1.53.

Chemistry: Serum LDH 318 IU/L, CK 437 IU/L, Pro BNP 2703 PG/ML, Albumin 26 g/l, Creatinine 1.7 mg/dl, Urea 67 mg/dl.

Patient condition did not allow transfer to CT department, so we did Holistic Trans cranial U/S, as well as whole body sonar.

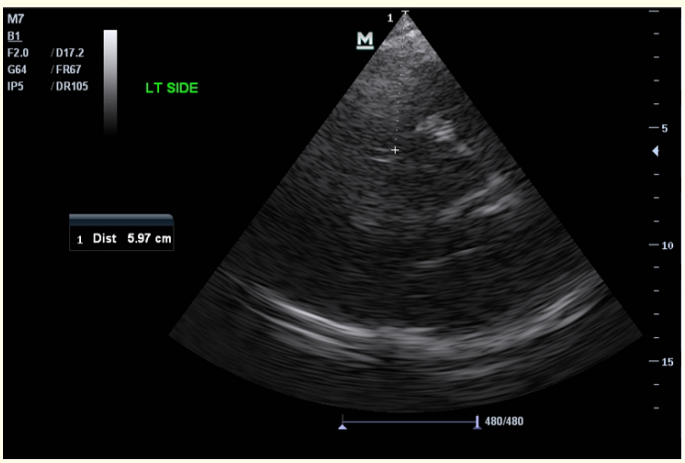

Figure 1: *Distance between skin from the lt temporal window in front of tragus above zygoma to the nearby wall of third ventricle [5.97 cm].*

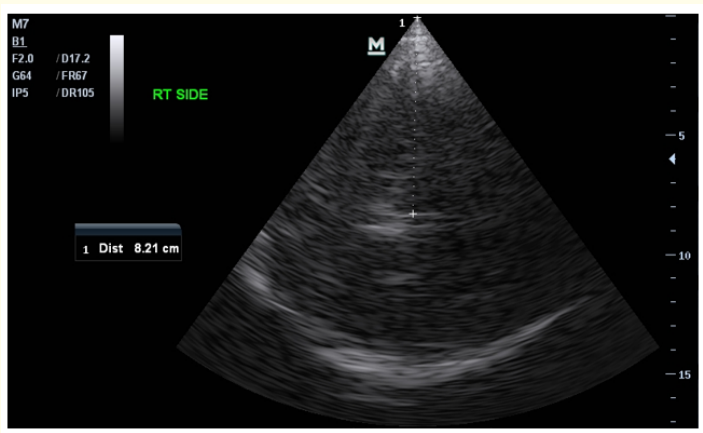

Figure 2: *Distance from the RT side [8.21], Mid line shift towards the short distance = large distance-short distance/2 = 8.21 - 5.97/2 = 1.08 cm towards the lt side.*

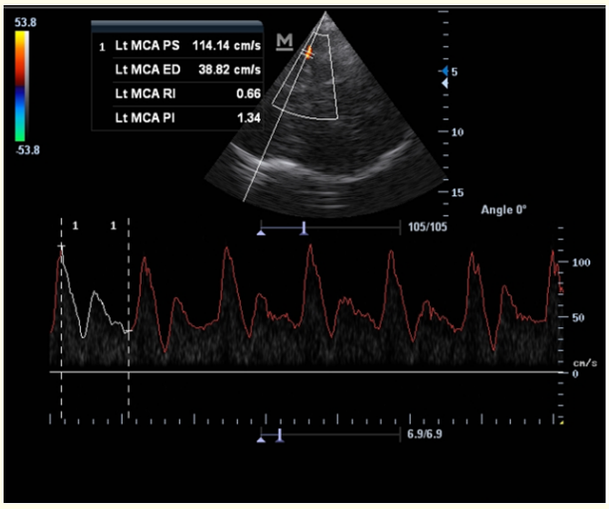

Figure 3: *LT MCA Flow study PI 1.34 is high, normal 1.*

Figure 4: *LT side ONSD 0.61 cm large, normal less than 5.7 cm.*

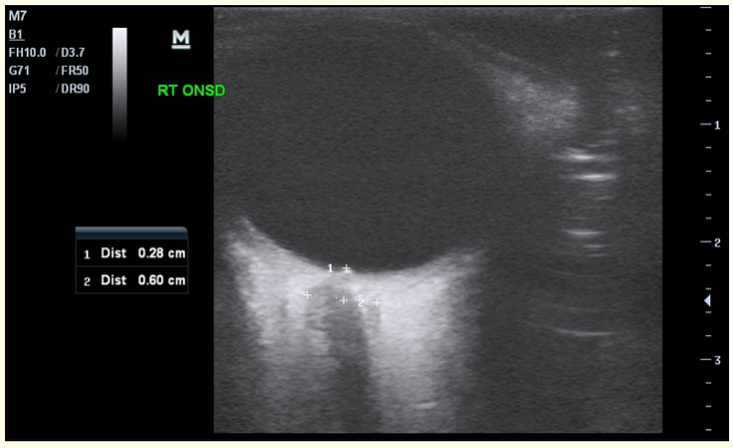

Figure 5: *RT ONSD 0.6 CM.*

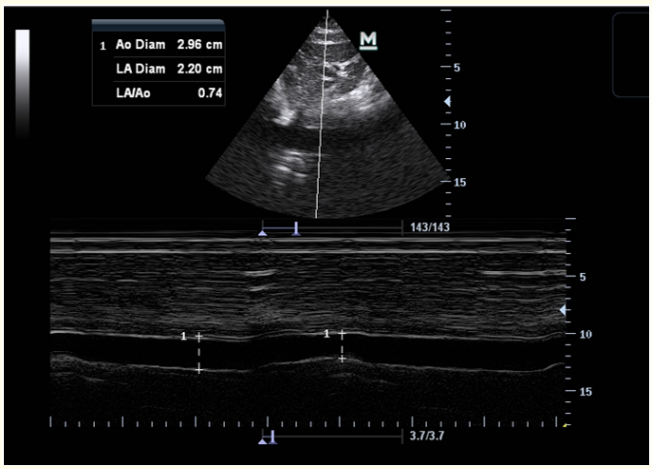

Figure 6: *IVC full because of heart failure.*

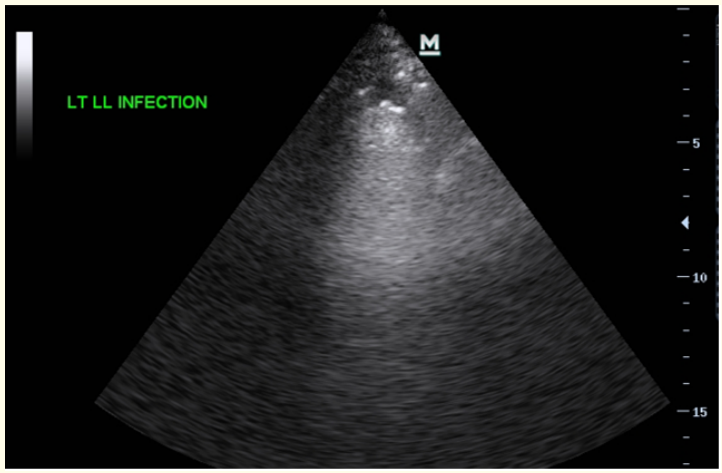

Figure 7: *LT side sub pleural consolidation and B-lines denoting infiltrate.*

Figure 8: *CT scan.*

So, before CT, Holistic trans cranial U/S revealed picture of increased intracranial pressure as evidenced by increased ONSD, increased LT MCA PI, and marked, more than 1 cm LT side midline shift.

We started hypertonic saline and contacted neurosurgery team for possible decompression craniectomy, unfortunately patient died because of severe septic shock due to hospital acquired pneumonia.

Case Presentation 2

A 65-year-old male patient K/C of HTN, DM presented to our ER because of sudden onset of deep coma, relatives mentioned that he complained of severe headache before he lost consciousness.

Temperature 37degree Celsius, HR 65/min, BP 240/150.

Heart: S1S2.

Chest: Clear.

Abdomen: Soft, lax, no organomegaly.

Neurology: Bilateral reactive pupils, GCS 5/15, flexion of Rt side, Lt side hemiplegia.

Patient was sedated, intubated and connected to mechanical ventilation, all chemistry and hematology were sent.

Labetalol IVI started, at that moment patient condition did not allow to go to CT, this is really the golden moment of Holistic approach of Transcranial U/S, we did it.

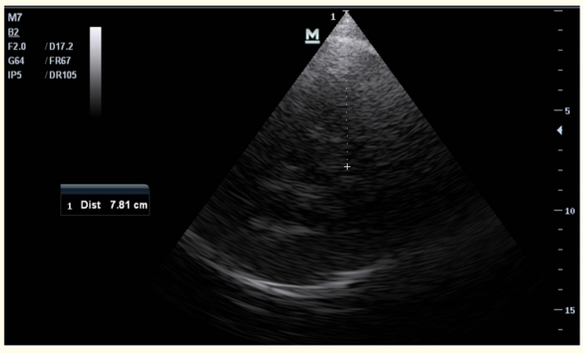

Figure 9: *Rt side trans temporal approach measuring the distance between skin and nearby wall of third ventricle which equal 7.81 cm.*

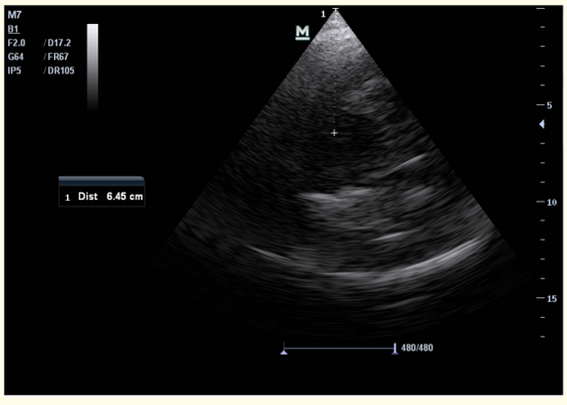

Figure 10: *Lt side trans temporal approach measuring the distance from skin to nearby wall of the third ventricle which equal 6.45, also this view clearly show echogenic lesion in the RT basal ganglion [recent bleed].*

We can measure the midline shift by long distance-short distance/2, and the shift will be towards the short distance.

In our patient there is Lt side midline shift = 7.81 - 6.45/2 = 0.68 cm midline shift towards the Lt side.

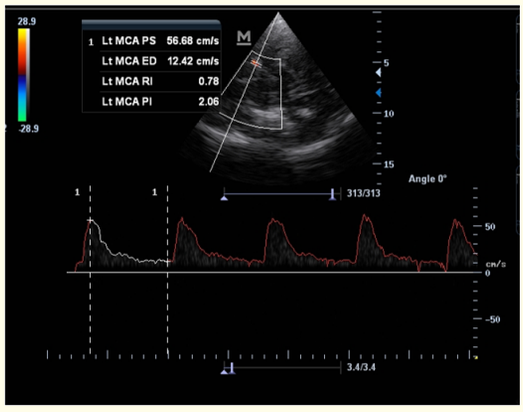

Figure 11: *PI of the LT MCA 2.08 which is high [normal less than 1], denoting increase in intracranial pressure.*

Figure 12: *LT side ONSD 0.65 increased.*

Figure 13: *RT side ONSD 0.66 increased.*

So, amazingly, before we go to CT, we see RT basal ganglion hemorrhage, LT side midline shift of 0.68, and strong evidence of increase intracranial pressure by marked increase of ONSD on both sides, and increased PI of LT MCA.

We started dehydrating measures, diuretics [frusemide] and contacted neurosurgery team.

This all findings were confirmed by CT later.

Patient went to craniotomy and haematoma evacuation.

After stabilization, Brain CT was done.

Figure 14: *Brain CT of the patient showing RT basal ganglion bleed and LT side midline shift.*

We saved the life of this patient by early neurosurgical intervention.

Discussion

We presented 2 cases admitted to our resuscitation room in ER because of sudden onset of loss of consciousness associated with lateralization.

The first case presented with deep coma, he was mechanically ventilated due to HAP, he was on high dose of inopressors and cannot go to CT. we did bed side trans cranial U/S which revealed severe midline shift of the third ventricle to left side, bilateral increase of ONSD, more than 0.59 and increase of PI of MCA more than 1 [1.34], we got all these findings very rapidly and noninvasively, all were going with brain edema and were correlated with each other, this increase the diagnostic power of cranial ultrasound. We started hypertonic saline and contacted neurosurgery team for possible decompression craniectomy.

After stabilization patient went to CT and the findings in CT were closely correlated with our ultrasound study, there was clear brain edema with sulci effacement and severe LT side midline shift.

The same thing happened in the second case, patient was comatosed with very high BP and need stabilization before shifting to CT, so we did bedside Trans cranial U/S and ONSD, and we found a hyper echoic lesion at the RT basal ganglion area going with recent hemorrhage, a 0.68cm midline shift towards LT side, and marked increase of ONSD, more than 0.65 in LT side, 0.65 in RT side and PI of MCA, more than 2, we immediately start dehydrating measures and diuretic frusemide and contact the neurosurgery team, all these findings were closely correlated with CT done later and revealed RT side basal ganglion hemorrhage and LT side midline shift and effacement of sulci on the RT side.

The first case unfortunately died because of septic shock but the second went to decompression craniectomy and he left the ICU with LT side hemiplegia for long term rehabilitation.

An accurate, precise and noninvasive alternative for measurement, and monitoring of ICP/CPP remains a "holy grail" in neurointensive care but unfortunately it is not discovered yet.

TCD FVs and the PI have been considered as potential surrogate candidates with variable success.

A cohort study of 81 adult severe traumatic brain injury (TBI) and subarachnoid hemorrhage (SAH) patients, showing a strong correlation between PI and ICP (r 0.938, *P* .0001) to detect ICP higher than 20 mm Hg [10].

The excitement from this report has since been moderated in view of more recent studies demonstrating poor correlation between PI-based estimations of ICP and invasive ICP measurements; the large prediction confidence intervals and the poor sensitivity has lead authors to discourage the use of ICP-calculating formulas that are based solely on the PI [10].

A another recent trail showed that TCD could detect MLS with reasonable accuracy in neurosurgical ICU patients and that it could serve as a bedside tool to facilitate early diagnosis and treatment for patients with a significant intracranial mass effect [9], moreover studies revealed that TCD can differentiate between ischemic and hemorrhagic stroke, recent hemorrhage appears hyper echoic in ultrasound [10].

A recent met analysis showed that ONSD has a good level of diagnostic accuracy for detecting intracranial hypertension, with a pooled sensitivity of 0.9 [10], so still there is 10% of patients with this dangerous disease can still have increased intracranial pressure despite low ONSD value.

In all previous studies they investigated one aspect of TCD like looking at recent hemorrhage, midline shift, or flow study of cerebral arteries and no study combine TCD with the ONSD at the same time in acute stroke patient.

To our knowledge no one combine the Holistic trans cranial Ultrasound with ONSD in suspected acute stroke patients.

This Holistic approach help us a lot in acute management of these patients in detecting midline shift and other evidence of increase intracranial pressure of TCD like increase ONSD and MCA PI which is later on accurately matched the CT findings.

Conclusion

We believe that this Holistic approach of TCD is very important in the management of suspected acute stroke in ER. We believe that this approach of combined Trans cranial Ultrasound and ONSD may increase the diagnostic power of cranial U/S in confirming the increase of intracranial pressure by combining high PI of MCA, increase ONSD, presence of midline shift and presence of hyperechoic lesion denoting recent hemorrhage. It also can give a clue about prognosis.

Recommendations

We recommend to do a big observational study using this Holistic approach of trans cranial U/S in suspected acute stroke and try to give a score for the presence or absence of the 4 elements of this Holistic approach [1- PI of basal cerebral arteries, 2- presence of hyperechoic lesion, 3- midline shift and 4- ONSD], and correlate this approach with CT Marshal score and invasive ICP monitoring if applicable. It could be a transcranial U/S score like CT marshal score.

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