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Role of Ultrasound in Diagnosis and Prediction of Outcome in Patients with Spontaneous Intracerebral Hemorrhage

Sandra M Ahmed[1,2], Hanan A Amer[1], Hadeer M Hassan[1] and Dalia M Labib[1]

[1]Department of Neurology, Cairo University, Egypt
[2]Cairo University Neurosonology Unit (CUNU), Cairo University, Egypt

Abstract

Background Intracerebral hemorrhage, despite being less frequent than ischemic stroke, has a worst early outcome and poorer prognosis. Intracerebral hematoma (ICH) size is one of the important predictors of outcome. CT scan is the gold standard for diagnosis and follows up of ICH yet needs the patient to be moved to radiology department which can be difficult for some ICU patients. Bedside ultrasound can be a potential reliable tool for assessing ICH size. Aim Assessing the utility of ultrasound in diagnosing and predicting outcome of ICH Subjects and method Thirty patients with spontaneous ICH has been selected and diagnosed by CT scan of the brain. Brain transcranial sonography (TCS) was done just after the CT. Multiple clinical scales were done and correlated to hematoma size detected by TCS. Results The results showed excellent reliability for hematoma volume assessment using CT and TCS, intra-class correlation coefficient (ICC) 95% CI 0.963 (0.923-0.983). Hematoma size by TCS showed a very good correlation to most of the clinical scales. Conclusion Bedside TCS can be a reliable tools for diagnosis and prediction of outcome of patients with ICH specially those who are difficult to be transported.

Keywords: Intracerebral haemorrhage • Ultrasound

Introduction

Despite being less frequent than ischemic stroke, the global burden of disability in hemorrhagic strokes remains higher [1] The high rate of early neurological deterioration after ICH is related in part to active bleeding that may progress for hours after symptom onset and increases risk of poor functional outcome and death [2] Computed tomography (CT) and magnetic resonance imaging (MRI) remains the gold standard imaging for intracerebral hemorrhage [3] Yet, CT and MRI can be a problem if the patient can't be transported to radiology department, be exposed to radiation or patients with cardiac pacemakers [4]. Bedside transcranial ultrasound offers a good alternative to follow intracerebral hemorrhage (ICH) in critically ill patients when all conditions are favorable (good transcranial window, visualized site by ultrasound) [4].

The aim of the study is to evaluate the role of transcranial ultrasound in imaging of intracerebral hemorrhage. Also, to evaluate its possible role in follow up and outcome prediction of these patients.

Subjects and Methods

This is a prospective study conducted in kasralainy stroke unit, Neurology Department, Cairo University between July 2018 and January 2019. The study included 30 patients diagnosed with non-traumatic spontaneous intracerebral hemorrhage. Patients from both sexes were included, age ranged from 18 to 70 years.

Clinical examination included; National institutes of Health Stroke Scale (NIHSS) [5] at admission and follow up at 7 days, Glasgow coma scale (GCS) [6], Intracerebral hemorrhage (ICH) score [7] and FUNC score for prediction of outcome [8].

All patients at admission underwent a CT scan at radiology department, Cairo University. CT slices thickness was 0.5 cm. Hematoma volume (V) was measured according to the following formula:

V=Longitudinal measure × Sagittal measure × Coronal measure ÷2 [9].

Major longitudinal and sagittal diameter represents the largest perpendicular diameters through the hyperdense area in axial plane. Coronal diameter represents the thickness of the hematoma.

Transcranial ultrasound was performed at bedside as soon as the patient was admitted to the Stroke Unit, Cairo University using ultrasound machine (GE Healthcare Ultrasound LOGIQTM V2/ LOGIQ V1, CHNA) equipped with a 3 MHZ phased array transducer. The examination was performed contralateral to the side of bleeding. The depth was increased until the contralateral skull bone was visualized. The axial plane used was the thalamic plane to measure the maximal longitudinal and sagittal measures. Then Coronal plane was used to assess the maximal coronal measure by tilting the probe 90° to the axial plane. Brain hematoma appears as an echodense parenchymal lesion in the acute phase with progressive decrease in the central echogeneicity as the time passes. The three measures were multiplied to obtain the hematoma volume as done with CT measures (Figure 1).

Statistical Analysis

Data was entered on the computer using "Microsoft Office Excel Software" program (2010) for windows. Data was then transferred to the Statistical Package of Social Science Software program, version 23 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp) to be statistically analyzed.

Data presented using range, mean, standard deviation, median and interquartile range for quantitative variables and frequency and percentage for qualitative ones. Comparison between groups was conducted using Chi square test for qualitative variables and Mann Whitney test or Kruskal Wallis test (due to data skewness) for quantitative ones. Spearman correlation coefficients were calculated to estimate the association between different quantitative variables. Paired measures were assessed through Wilcoxon test. Two-way mixed model with consistency type was performed to explore the

***Address for Correspondence:** Sandra M Ahmed, Department of Neurology, Cairo University, Egypt, Tel: + 201005162225; E-mail: sandra.ahmed@kasralainy.edu.eg*

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reliability (concordance) of Duplex measures against that of CT findings. P values less than 0.05 were considered statistically significant. Figures were used to illustrate some information.

Results and Discussion

The patients included thirteen males (43.3%) and seventeen females (56.7%). Mean age was 58.2 ± 9.9 years. The major risk factor was hypertension as shown in Figure 2.

The size of hematoma measured by CT or TCS did not show significant statistical difference when compared to each other. Mean Paired differences was (1.7 ± 5.1), 95% confidence interval (CI) (-0.223 to 3.598) and P value (0.171). The results showed excellent reliability for hematoma volume assessment using CT and TCS, intra-class correlation coefficient (ICC) (Table 1). The hematoma volume detected by TCS was well correlated to the clinical functional scales especially the follow up scales as shown in Table 2.

In the study, the ultrasound examination of the brain parenchyma in patients with intracerebral hemorrhage showed good visualization of the hematoma size compared to conventional CT scan imaging of the brain. Follow up of the hematoma size by TCD was well correlated to the clinical scales.

Cairo University Stroke Unit has been receiving, since its opening in 2016, all kind of strokes (including hemorrhages), with high flow of patients and a wide variability of patient's severity. The stroke Unit includes intermediate care and intensive care beds. Critical patients represent a great challenge in daily care and follow up. Transportation to radiology department can be, in some cases, challenging due to ventilation or hemodynamic instability. Bed side clinical tests and imaging is preferred in such patients.

Ultrasound has been largely used in the past two decades for diagnosis of different diseases affecting brain parenchyma; Movement disorders, Parkinson's disease, Multiple sclerosis etc. [10-12].

Ultrasound role in surveillance of vasospasm in subarachnoid hemorrhage has been largely approved and added to guidelines [13] yet its role in intracerebral hemorrhage remained uncertain and has recently been revisited. Sonography of the hematoma size, volume and effect on brain parenchyma showed excellent correlation with CT scan and showed good accuracy in predicting poor outcome [14]. It has even proved its utility in differentiating between primary intracerebral hemorrhage and cerebral infarction with hemorrhagic transformation [15].

Our patients showed a higher proportion of females. Sex differences are

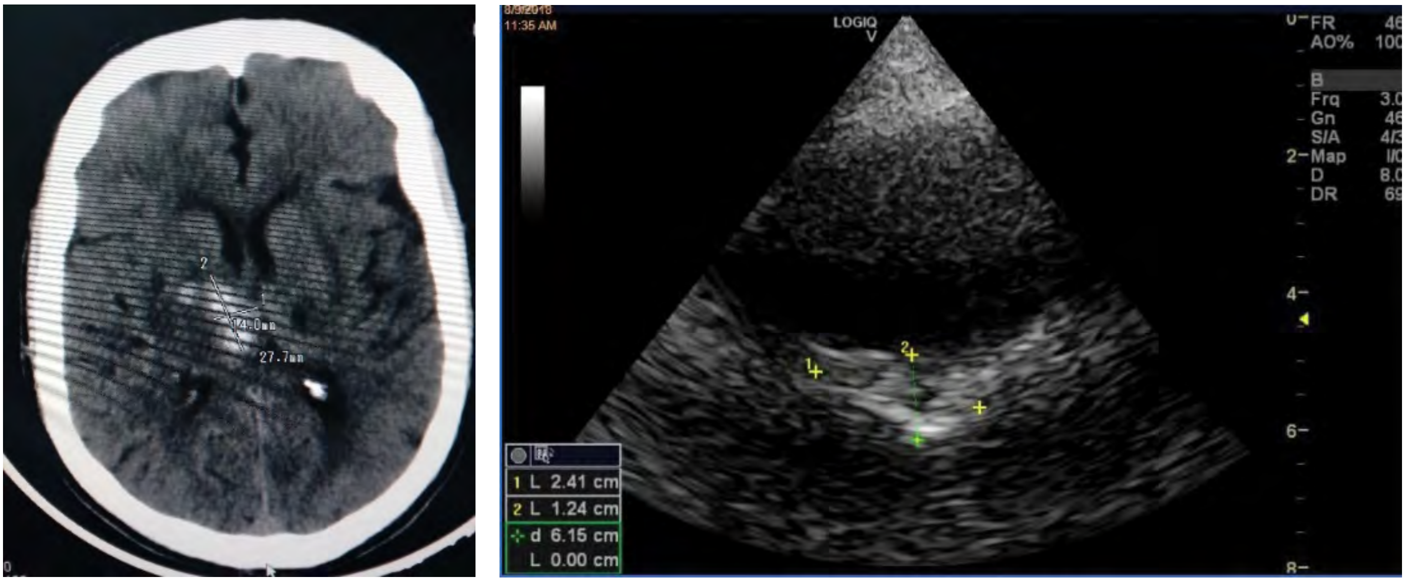

Figure 1. Longitudinal distance in CT and Ultrasound 1.4 cm and 1.24 cm respectively. Sagittal distance in CT and Ultrasound 2.77 cm and 2.41 cm respectively.

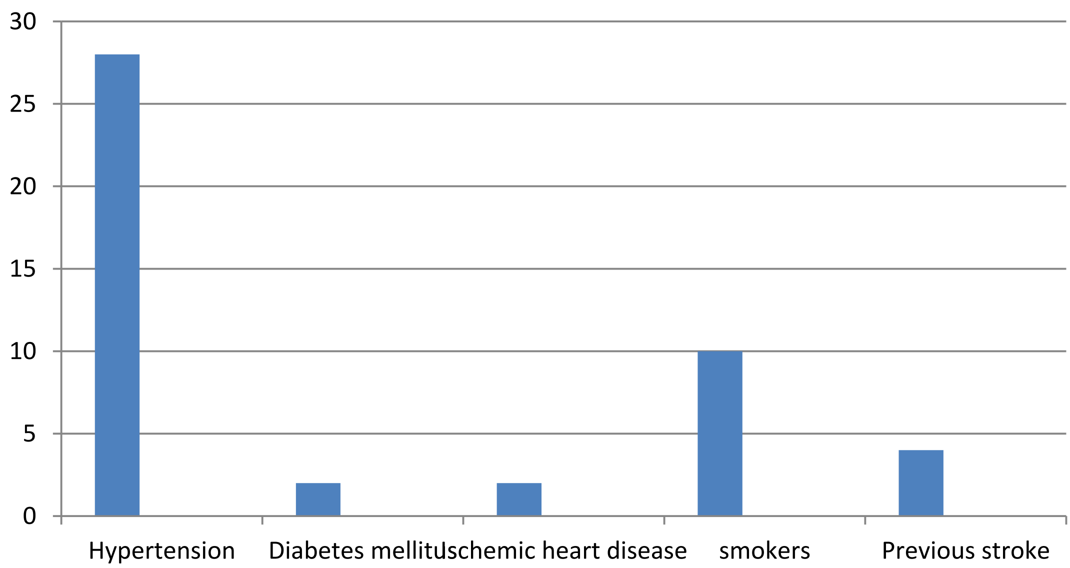

Figure 2. Risk factors and comorbidities among patients.

Table 1. Reliability analysis between CT and TCS regarding hematoma diameters.

Hematoma diameters	ICC (95% CI)
Transverse diameters	0.635 (0.232-0.826)
Longitudinal diameters	0.895 (0.778-0.950)
Coronal diameters	0.401 (-0.258 – 0.0.715)
Hematoma volume	0.963 (0.923-0.983)

Table 2. Correlation hematoma size measured by TCS and other parameters.

Variables	TCS hematoma size	
	r	P-value
Age	0.294	0.115
Symptoms days before admission	-0.112	0.554
Mean blood pressure (MBP)	0.115	0.546
RBS at admission	0.176	0.351
GCS at admission	-0.267	0.153
NIHSS at admission	0.478	0.008
GCS FU*	-0.362	0.049
NIHSS FU*	0.503	0.005
ICH Score (6 points)	0.671	<0.001
ICH FUNC score	-0.261	0.164
Hb	-0.214	0.256
HCT	-0.283	0.13
TLC	0.386	0.035
PLT	-0.046	0.807
PT	-0.096	0.612
PC%	-0.16	0.4
NA	-0.342	0.065
K	0.154	0.418
Ca	0.024	0.9

not straightforward risk for ICH because interaction of sex, ethnicity, and age [16]. The most common risk factor for our patients was hypertension. This later risk remains the most important through time and different populations [17,18]. Smoking came second in classification for our patients and alcohol was not a risk at all due to cultural issue.

Our study showed excellent reliability of ultrasound to detect hematoma dimensions and volume (ICC 95% CI 0.963 (0.923-0.983)) as compared to CT confirming previous study and following same methodology as Matsumoto (2011) [19]. He used the same dimensions in both CT and ultrasound and used the same formula for calculating the volume. The method was simple and showed very good accuracy.

There was a very good correlation between hematoma size detected by ultrasound and clinical scales used for initial evaluation and follow up of the patients (NIHSS, GCS, ICH score). The use of scores and hematoma volume are important in risk stratification on presentation of ICH and can improve standardization of clinical treatment protocols [20]. The hematoma volume rather than localization was noted to be a better indicator of six-months prognosis [21].

An important limitation of the study, that posterior fossa ICH is more difficult to assess that is why they were excluded. Also, too small hematoma size can be missed. That is why this method would be utile mostly for large supratentorial ICH for follow up of expansion rather than for diagnosis.

Conclusion

In conclusion, ultrasound can be used in diagnosis of intracerebral hemorrhage, prediction of outcome and potentially follow up of the hematoma size. Yet, its role will be limited to large supratentorial hematoma. Its utility is to be saved for unstable ICU patients who are difficult to be transported to radiology department.

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