NeuraSignal™

NG2 Intelligent Ultrasound

for the Detection of Vasospasm after Subarachnoid Hemorrhage

Background

Vasospasm is a pathological, diffuse, and long-lasting narrowing of a vessel lumen that can occur after Subarachnoid Hemorrhage (SAH) and result in Delayed Cerebral Ischemia (DCI).[1] Occuring between 4 and 15 days after initial hemorrhage, it is thought to be a result of pathological signaling secondary to hemorrhagic vessel injury and requires emergency detection and treatment.[1,2] Vasospasm has been reported in as many as 70% of SAH patients and results in morbidity and mortality rates of approximately 30%.[1,3] Detection of vasospasm is critical but difficult as only 20-30% of cases present with notable clinical deficits.[1]

"TCD is of established value in the detection and monitoring of angiographic vasospasm after spontaneous subarachnoid hemorrhage"[5]

American Academy of Neurology

"Transcranial Doppler is reasonable to monitor for the development of arterial vasospasm"[4]

American Heart Association

A pooled analysis of 17 studies found that TCD detected DCI from vasospasm with 90% sensitivity and 71% specificity[6]

Journal of Neurosurgery

Westchester Medical Center Study[7,8]

Methods

This study evaluated the safety and efficacy of the NG2 Intelligent Ultrasound in the evaluation of vasospasm. Investigators used NG2 to scan SAH patients with External Ventricular Drain (EVD) over the course of two months. They quantified the number of patients who experienced EVD complications from the use of NG2. Efficacy was evaluated according to the level of agreement between gold-standard CTA and NG2 in the indication of vasospasm.

Vasospasm Agreement	CTA Positive	CTA Negative
NG2 Positive	n=10	n=2
NG2 Negative	n=2	n=20
	SEN = 83%	SPE = 91%

Table 1: The NG2 Intelligent Ultrasound agrees with CTA in the indication of vasospasm

Results

Of the seven patients with EVD, a total of 20 NG2 scans were performed with no EVD complications. There was substantial agreement between CTA and NG2 confirmation of vasospasm (Table 1). NG2 demonstrated a sensitivity of 83% and specificity of 91% for the indication of vasospasm using a cutoff value of maximum CBFV > 120 cm/s.

Beth Israel Deaconess Medical Center Study[9]

Methods

This study examined the feasibility and accuracy of NG2 for measuring cerebral blood flow velocities in the Anterior Cerebral Artery (ACA) and Middle Cerebral Artery (MCA) in patients with high-grade SAH and angiographic vasospasm. Investigators reviewed clinical data, TCD results, and imaging reports from two patients with high-grade SAH who required external ventricular drain (EVD) for hydrocephalus management due to intraventricular blood. Blood flow velocities in bilateral ACA and MCA were captured and evaluated both manually and with NG2. Measured velocities and duration of imaging were compared between the two modalities. NG2's machine learning search algorithm autonomously investigated and located bilateral MCA signals, independent of an operator. Manual selection and adjustment of probes allowed for partially-autonomous identification and measurement of bilateral ACA. NG2 and manual TCD showed moderately-increased mean flow velocities indicative of vasospasm (Figure 1) which were confirmed by cerebral angiogram.

Results

There was no significant difference in duration of imaging between autonomous and manual TCD exams, regardless of vessel. Overall, robotically-measured MCA velocities were comparable to those measured by an expert sonographer (P=0.001). While ACA measurements differed, robotically-measured velocities were higher. Bland-Altman plots showed overall agreement within 95% CI between the techniques in measurements of both vessels (Figure 2).

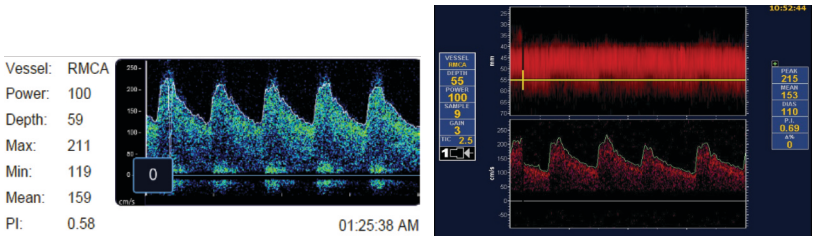

Figure 1: NG2 (left) and manual TCD (right) waveform of the right MCA of patient 1 on post-ictus day 10 demonstrating elevated right MCA mean flow velocity, consistent with vasospasm in both techniques

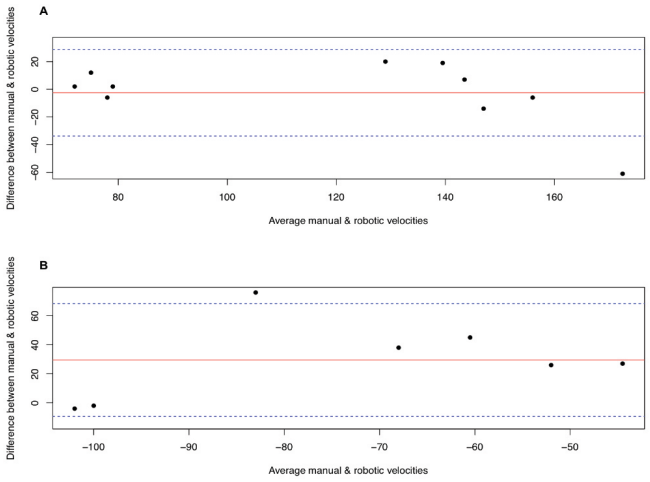

Figure 2: Bland-Altman plot shows no proportional bias, indicating agreement between the two methods for the MCA (A) and ACA (B)

Conclusion

Transcranial Doppler (TCD) ultrasound is an important tool for detection of cerebral vasospasm after subarachnoid hemorrhage, but is limited by availability of skilled operators. These demonstrations show the AI-driven, robotic NG2 Intelligent Ultrasound to be a safe and accurate solution for vasospasm monitoring.

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