Feasibility of jugular bulb venous monitoring in patients with acute ischemic stroke

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Introduction

- The jugular bulb is the final common pathway for venous blood that drains from the cerebral hemispheres, cerebellum, and brainstem. Jugular bulb venous monitoring can provide information about global cerebral hemodynamics and metabolism. Therefore, it can be an important tool in the clinical management of neurologically injured patients.
- Jugular venous oxygen saturation (SjvO₂): Reflects the balance between supply and consumption of oxygen by the brain; Normal SjvO₂ values range between 55% and 75%.: Single episode of desaturation below 50% is associated with a doubling of the mortality rate.
- Arteriovenous oxygen content (or saturation) difference can be used to relate for changes in metabolism with alterations in CBF. CMRO₂ (VO₂) = CBF x (SaO₂ – SjvO₂)
- Lactate has long been viewed as a waste product of oxygen-limited glycolysis and ischemia. Lactate has become a key component of neuromonitoring for metabolic crisis through cerebral microdialysis.
- Therefore, we investigated the feasibility and clinical application of jugular bulb venous monitoring in acute ischemic stroke patients at neurocritical care unit.

Methods

- Patients were recruited from March 2015 to June 2017. A total of 28 consecutive patients were analyzed with following inclusion criteria: (1) Acute ischemic stroke, (2) NIHSS > 10, (3) Mechanical ventilation with sedation
- Jugular venous catheters were placed in internal jugular vein by ultrasonography-guided method. Lactate, venous oxygen saturation (SjvO₂), and arteriovenous oxygen saturation differnece (AVDO₂) were measured every 4 hours.
- Metabolic derangement was defined when lactate level was more than **2.0 mmol/l**, and venous desaturation group was allocated if SjvO₂ had ever fallen below **60%**.
- Patients were divided according to presence of clinical deterioration. Clinical deterioration included neurologic and medical complication after stroke: early neurological deterioration, cerebral edema, requiring surgical intervention, hypotension, cardiac problems (myocardial infarction, arrhythmia), respiratory failure, renal failure. **mRS 5-6 at 3 months** were defined as poor outcome.

Results

Table 1. Overall patients in this study

Overall patients characteristics (n = 28)	
General demographics	
Age, years, mean (range)	56.7 (33-80)
Sex, male, n (%)	22 (78.6)
Stroke location, n (%)	
Rt MCA	10 (35.7)
Lt MCA	14 (50.0)
Posterior circulation	4 (14.3)
Baseline NIHSS, median (range)	
20 (12-28)	
Treatment, n (%)	
Endovascular recanalization treatment	12 (42.9)
Therapeutic hypothermia	15 (53.6)
Bypass surgery	5 (17.9)
Decompressive craniectomy	1 (3.6)
Metabolic derangement, n (%)	
12 (42.9)	
Venous desaturation, n (%)	
13 (46.4)	
Clinical deterioration, n (%)	
14 (50.0)	
3mo mRS 5-6, n (%)	
12 (42.9)	

- Twelve patients (42.9%) showed metabolic derangement and experienced more frequent clinical deteriorations than patients without metabolic derangement (n=9, 64.3% vs. n=3, 21.4%, p=0.022).
- Clinical deterioration was noted in 14 patients, and lactate level was significantly higher (1.44±0.48 vs. 1.04±0.20mmol/l, p=0.009).

Table 2. Clinical deterioration

	Clinical deterioration		P	Estimated OR		P
	Yes (n = 14)	No (n =14)		crude	adjusted	
General demographics						
Age, years, mean (range)	60.3 (33-79)	53.1 (37-80)	0.227	1.04 (0.98-1.10)	—	—
Sex, male, n (%)	11 (78.6)	11 (78.6)	1.000	1.00 (0.16-6.08)		
Stroke location, n (%)			0.387			
Rt MCA	4 (28.6)	6 (42.9)		(reference)		
Lt MCA	9 (64.3)	5 (35.7)		2.70 (0.51-14.37)		
Posterior circulation	1 (7.1)	3 (21.4)		0.50 (0.04-6.68)		
Baseline NIHSS, median (range)	21 (14-26)	18 (12-28)	0.511	1.06 (0.87-1.30)	—	—
Jugular bulb monitoring						
Mean SvO2, mmHg (SD)	73.3 (5.4)	69.9 (6.5)	0.140			
AVDO2, mmHg (SD)	25.1 (5.2)	28.7 (6.3)	0.113			
Mean lactate, mmol/l (SD)	1.4 (0.5)	1.0 (0.2)	0.009			
Venous desaturation, n (%)	4 (28.6)	7 (50.0)	0.246	0.40 (0.08-1.91)	—	—
Metabolic derangement, n (%)	9 (64.3)	3 (21.4)	0.022	6.60 (1.23-35.44)	6.60 (1.23-35.44)	0.028
3mo mRS 5-6, n (%)	6 (42.9)	6 (42.9)	1.000			

- Adjusting other potential variables, metabolic derangement was an independent factor associated with clinical deterioration (OR 6.60, 95% CI 1.23-35.44, p=0.028). Meanwhile, poor outcome group (n=12) showed no difference on lactate level, but AVDO₂ were higher in poor outcome group (29.54±5.51 v. 24.95±5.65, p=0.041). AVDO₂ remained an independent factor for poor outcome after adjusting other factors (OR 3.68, 95% CI 1.08-12.55, p=0.038).

Table 3. Clinical outcome

	3 mo mRS		P	Estimated OR		P
	Good, 0-4 (n = 16)	Poor, 5-6 (n = 12)		crude	adjusted	
General demographics						
Age, years, mean (range)	54.9 (33-80)	59.1 (36-78)	0.463	1.02 (0.97-1.08)	—	—
Sex, male, n (%)	14 (87.5)	8 (66.7)	0.354	0.29 (0.04-1.92)		
Stroke location, n (%)			0.124			
Rt MCA	8 (50.0)	2 (16.7)		(reference)		
Lt MCA	7 (43.8)	7 (58.3)		4.00 (0.62-25.96)		
Posterior circulation	1 (6.2)	3 (25.0)		12.00 (0.77-186.36)		
Baseline NIHSS, median (range)	18.5 (14-28)	20(12-24)	0.873	0.97 (0.79-1.18)	—	—
Clinical deterioration, n (%)	8 (50.0)	6 (50.0)	1.000	1.00 (0.22-4.47)		
Jugular bulb monitoring						
Mean SvO2, mmHg (SD)	73.2 (6.0)	69.4 (5.8)	0.098	0.88 (0.77-1.03)		
AVDO2, mmHg (SD)	25.0 (5.7)	29.5 (5.5)	0.041	1.17 (1.00-1.37)	1.25 (1.04-1.51)	0.018
Mean lactate, mmol/l (SD)	1.2 (0.5)	1.2 (0.3)	0.873	0.83 (0.13-5.33)	—	—
Venous desaturation, n (%)	4 (25.0)	7 (58.3)	0.074	4.20 (0.84-21.05)		
Metabolic derangement, n (%)	7 (43.8)	5 (41.7)	0.912	0.92 (0.20-4.18)		

- Meanwhile, poor outcome group (n=12) showed no difference on lactate level, but AVDO₂ were higher in poor outcome group (29.54±5.51 v. 24.95±5.65, p=0.041). AVDO₂ remained an independent factor for poor outcome after adjusting other factors (OR 3.68, 95% CI 1.08-12.55, p=0.038).

Conclusion

- Jugular bulb venous monitoring is a feasible tool as point-of-care in patients with acute ischemic stroke at neurocritical care unit.
- No complication or adverse events related with the insertion of jugular venous catheter and jugular bulb monitoring (average period = 4.9 days)
- Lactate elevation was associated with clinical deterioration during neurocritical care.
- Venous desaturation contributed to long-term prognosis.
- Limitations: Relative small sample size; Retrospective analysis from a single referral center;Various factors can affect jugular bulb measurements.