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BACKGROUND

Patients presenting with large ischemic strokes may develop uncontrollable, progressive brain edema that risks compression of brain parenchyma and cerebral herniation.¹ Edema that does not respond to medical treatment necessitates decompressive hemicraniectomy (DH) as a life-saving procedure. The functional outcome of patients is uncertain and the patient's family is presented with the difficult decision of intervention with DH. While the functional outcome of patients is not worsened by DH,² neurological deficit is likely as a result of initial large-territory ischemia. The correlation of specific clinical variables preceding DH to patient outcome helps inform clinicians and families about prognosis.³ This study identifies an array of clinical variables in patients who underwent DH for ischemic stroke in order to investigate potential predictors of functional outcome.

METHOD

A total of 1,624 subjects that underwent any type of craniectomy from 2006 to 2014 were retrospectively screened via electronic medical record. The specific selection criterion was DH secondary to ischemic stroke involving the middle cerebral artery (MCA), internal carotid artery (ICA), or both. Subjects were excluded if they underwent craniectomy for any reason other than DH for ischemic stroke; or if the MCA or ICA were not implicated. The clinical variables that were collected may be divided into pre-DH and post-DH. The pre-DH variables involve patient demographics and past medical history, in addition to clinical variables during the period of presentation and clinical management leading up to DH. The post-DH variables describe the in-patient recovery period and discharge status. The primary outcome was functional status assessed by the Modified Rankin Scale (MRS) score at 90 days post-DH. The MRS ranges from 0 (no symptoms) to 6 (death) with intermediate values (1-5) representing increasing functional and cognitive disability.

RESULTS

There were N = 95 subjects who presented with ischemic stroke involving the MCA (72%), ICA (7%), or both MCA+ICA (21%) and underwent DH. Mean age was 57 ± 12 years, 60% were male, and the mean BMI was 28.3 ± 7.4 kg/m². Atrial fibrillation was diagnosed in 25%, hypertension 80%, and prior stroke 20% of subjects. The mean National Institutes of Health Stroke Scale (NIHSS) score was 16 ± 5 . Tissue plasminogen activator (tPA) was administered in 29% of subjects and 19% underwent endovascular intervention prior to DH. The mean peak midline shift was 9 ± 5 mm. Time from stroke onset to DH was 3

± 3 days. Tracheostomy was performed in 36% and percutaneous endoscopic gastrostomy (PEG) 63% of subjects. An IVC filter was placed in 25% of subjects. Overall, subjects were hospitalized for 22 ± 17 days. The mean MRS score at 90 days post-DH was 4 ± 1 characterized as moderately severe disability. Mortality (MRS = 6) at 90 days post-DH was 18%.

DISCUSSION

Background

The present analysis describes the clinical variables and functional outcome in patients who underwent DH subsequent to severe cerebral edema that resulted from ischemic stroke. The characteristic patient was male, clinically overweight with a history of hypertension, and presenting with an NIHSS > 10 implicating the right MCA. Cases involving intervention with tPA or endovascular therapy did not preclude the need for DH. The midline shift is serially monitored by neuroradiology for patients with cerebral edema. The peak value was collected, with a mean shift of 9 mm prior to intervention with DH. Although the mean time from stroke onset to DH was 3 days, it was possible for DH to occur at a max of 35 days. Depending on the severity of stroke patients required tracheostomy for ventilator assistance, and PEG tube placement to provide a route for adequate nutrition. The incidence of deep vein thrombosis (DVT) and requirement for placement of an IVC filter was not uncommon during the in-patient recovery period, which is likely related to venous blood stasis and comorbidity in the setting of prolonged immobilization. After total hospitalization for nearly a month subjects were typically discharged to a rehabilitation center or nursing home. At 90 days post-DH most patients had disability requiring assistance (MRS 3 - 5), a minority of patients (4%) were considered functionally independent (MRS = 2), and 18% of patients

Table 1: Patient Characteristics

Demographics/comorbidities	N=95	Percent (%)	
Gender			
Males	57	60	
Females	38	40	
Age (yr) – Mean (max/min)	Mean	Max	Min
	57 ± 12	88	22
BMI (kg/m ²)	28.6 ± 7.4	66.9	14.5
Comorbidities			
Smoking	37	39	
Atrial Fibrillation	24	25	
Hypertension	77	81	
Hyperlipidemia	39	39	
Diabetes	31	33	
Myocardial Infarction	13	14	
Seizures	12	13	
Past Strokes	19	20	

Table 2: Subject stroke presentation characteristics

Infarct Site		N=95 (%)
Middle Cerebral Artery (MCA)	Right	43 (46)
	Left	21 (22)
	Bilateral	4 (4)
Internal Carotid Artery (ICA)	Right	2 (2)
	Left	3 (3)
	Bilateral	2 (2)
MCA + ICA		20 (21)
Intervention		Yes (%) No (%)
tPA Administered	28 (29)	67 (71)
Endovascular intervention	18 (19)	77 (81)
Clinical Parameters		Mean Max/Min
Midline shift (mm)	9 ± 5	19/0
NIHSS	16 ± 5	32/1
Time onset to DH (days)	3 ± 3	35/0

Table 3: Subject outcomes

	Yes (%)	No (%)	
Tracheostomy	35 (36)	61 (64)	
Gastrostomy	60 (63)	33 (35)	
IVC filter	24 (25)	71 (75)	
	Average	Max	Min
Hospital stay duration (days)	22 ± 17	101	3
Modified Rankin Scale (MRS) score, 90 days post-DH	4 ± 1	6	2
	Yes (%)	No (%)	
Mortality, 90 days post-DH	17 (18)	78 (82)	

were deceased (MRS = 6). An MRS of 0 (no symptoms) or 1 (no disability despite symptoms) was not observed. The relationship of clinical variables to functional outcome will be investigated further in a secondary analysis. Identifying or ruling out such relationships might prove beneficial to clinicians and families in estimating functional outcome for individual patients prior to performing DH.

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