Outcome of decompressive craniectomy and hematoma evacuation treatment for spontaneous supratentorial intracerebral hemorrhage

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Summary

Background: Patients with spontaneous supratentorial intracerebral hemorrhage who had large hematomas, seriously edema and high intracerebral pressure showing a poor prognosis, with mortality rate is very high. Surgical decompressive craniectomy evacuation hematoma treatment (DCEH) effectively reduce high intracranial pressure. However, some studies show that have no overall benefit of functional outcome and mortality. *Objective:* To assess some prognostic factors and outcome of surgical decompressive craniectomy evacuation hematoma treatment (DCEH) for spontaneous supratentorial intracerebral hemorrhage. *Subject and method:* Observational study in 30 patients with supratentorial intracerebral hemorrhage who were performed DCEH at Stroke Center - 108 Military Central Hospital from 1/2016 to 7/2020. Outcome was evaluated in the 6th months after stroke. *Result and conclusion:* The mean age in study was 55.8 ± 10.7 years, which age under 60 was 73.3%. The mortality rate after 6 months was 29.4% while the survival rate was 60%. Favourable outcome was shown in mRS range from 0 to 3, accounted for 33.3% compared with 66.7% in the unfavourable outcome group. Main factors which affected to the results were the volume of the hematoma, the midline compression, the damage of internal capsule, the level of blood in ventricles, the Graeb, ICH, and mICH scales.

Keywords: Intracerebral hemorrhage, decompressive craniectomy, hematoma evacuation.

1. Background

Intracerebral hemorrhage (ICH) accounts for 10% to 20% of all strokes. The mortality rate is 35% to 52% of the patients surviving through the first month, and only 21% of patients are able to have function independently after six months. Although there have been advantages in diagnosis and treatment recently, the mortality and disability rates in patients with cerebral hemorrhage have not improved significantly compared with patients with cerebral infarction. After the hemorrhagic event, the mass effect of the growing hematoma lead to increased intracranial pressure (ICP), this is the main cause of death and disability. The treatments to decrease intracranial pressure are very important in the emergency and treatment regimen, including the role of decompressive craniectomy and evacuation of the haematomas. However, the choice of craniectomy for hematoma in each particular patient is controversial. Many previous clinical trials showed no significant effect of craniectomy except in cases of posterior fossa hemorrhage and bleeding on the superficial supratentorial intracerebral hemorrhage. Nowadays, with the great

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advancement of technology, it is possible to surgically remove most of the hematoma without causing huge damage to the normal brain tissue. In fact, the indication for surgery for these patients is still difficult, not because of the surgical technique, but mainly related to the results of rehabilitation after surgery. Thus, this problem also needs to be further studied to contribute to the guidance in clinical practice.

As a result, we carried out this study with the goal: *Evaluation of rehabilitation and some prognostic factors in patients with supratentorial ICH who underwent decompressive craniectomy and hematoma evacuation.*

2. Subject and method

2.1. Subject

The study subjects included 30 patients with spontaneous supratentorial ICH underwent decompressive craniectomy and hematoma evacuation at Stroke Center of 108 Military Central Hospital from 1/2016 to 7/2020.

Exclusion criteria: 1. Hemorrhage caused by brain injury, 2. Intracranial aneurysm or cerebral arteriovenous malformations.

2.2. Method

Study design: Retrospective combined prospective, cross-sectional description.

Research content: Evaluation of treatment results: Mortality, proximal complications after surgery. Outcome was assessed by the modified Rankin Scale (mRS), when patients returned to our outpatient clinic after 6 months. Good outcome was defined as mRS of 0 to 3, poor results with mRS of 4 to 6. Evaluation of prognostic factors: ICH scale, mICH, Graeb, Glasgow scale (GCS), NIHSS scale; Neuroradiological findings were determined in the initial CT scan and classified according to localization, volume of hematoma and midline shift.

2.3. Statistical analysis

Using IBM SPSS 22.0 software for analyzing data. Differences at $p<0.05$ were regarded as statistically significant.

3. Result

Table 1. Baseline characteristics of the registry patient series

Characteristic	Quantity (n = 30)		Rate (%)
Age, years	< 60	22	73.3
	> 60	8	26.7
	Average: 55.8 ± 10.7		
Sex,	Male	23	76.7
	Female	7	23.3
Hypertension	22		73.3
Alcoholism	8		26.7
Use anticoagulants	2		6.67
Normal	3		10
Glasgow before surgery	3 - 5	1	3.3
	6 - 8	25	83.3
	9	4	13.3
	Average: 7.23 ± 1.04		

Comment: The common age was ≤ 60, accounting for 73.3%. The mean age was 55.8 ± 10.7. Hypertension was a comorbid disease accounting for the largest proportion of 73.3%. Glasgow point preoperative 7.23 ± 1.04 average, the highest proportion of 83.3% in the 6 - 8 points.

Table 2. CT scan characteristics

Characteristics		Quantity	Ratio (%)
Location	Lobar	11	36.7
	Basal ganglia	19	63.3
ICH volume (ml)	<30	1	3.3
	30 - 60	5	16.7
	> 60	24	80
		Average: 86.9 ± 31.94	
Midline shift (cm)	<1	10	33.3
	>1	20	66.7
Vetricular hemorrhage	Yes	21	70
	No	8	26.7
Inner capsule damage	Yes	14	46.7
	No	16	53.3

Comment: Location hemorrhage in basal ganglia had a higher proportion of 63.3%. The hematoma volume greater than 60ml accounted for the highest proportion of 80%, with an average

volume of 86.9 ± 31.94ml. The rate of midline shift > 1cm was 66.7%. In most cases, there was blood into the ventricles accounting for 70%.

Table 3. Outcomes after 6 months

Outcome	Value (n = 30)	Ratio %
Alive	18	60
Dead	12	40
Favourable (mRS = 0 - 3)	10	33.3
Unfavourable (mRS = 4 - 5)	8	26.7

Comment: The mortality rate at 6 months was 60%, the prognosis-based Rankin showed favourable outcome in 33.3% of the patients and unfavourable outcome in 26.7%.

Table 4. Characteristics of the subjects in the alive and dead groups

Variables	Alive (n = 18)	Dead (n = 12)	Total	p-value
Age (years)	56.88 ± 7.25	54 ± 14.7		>0.05
Sex Male Female	 16 (88.9%) 2 (11.1%)	 7 (58.3%) 5 (41.7%)	 23 7	>0.05
Glasgow before surgery	7.44 ± 1.04	6.91 ± 0.99		>0.05
Hemorrhagic location Right Left	 8 (44.4%) 10 (55.6%)	 7 (58.3%) 5 (41.7%)	 15 15	>0.05
ICH volume	80 ± 29.1	97.25 ± 34.44		>0.05
Midline shift (cm) < 1 > 1	 8 (44.4%) 10 (55.6%)	 2 (16.7%) 10 (83.3%)	 10 20	>0.05
Internal capsule damage Yes No	 7 (38.9%) 11 (61.1%)	 7 (58.3%) 5 (41.7%)	 14 16	>0.05
Blood in ventricles Yes No	 9 (50%) 9 (50%)	 12 (100%) 0%	 21 9	<0.05
Location Deep Lobar	 12 (66.7%) 6 (33.3%)	 7 (58.3%) 5 (41.7%)	 19 11	>0.05
Graeb's score Mean 0 - 4 5 - 8 ≥ 9	 2.33 ± 1.86 14 (77.8%) 4 (22.2%) 0%	 8.66 ± 2.3 1 (8.3%) 3 (25%) 8 (66.7%)		<0.05
ICH	2.61 ± 0.607	3		<0.05
mICH Mean ≤ 6 > 6	 5.61 ± 1.24 13 (72.2%) 5 (27.8%	 7.83 ± 0.83 1 (8.3%) 11 (91.7%)		<0.05

Comment: Graeb score ≥ 9: 91% up to 100% of deaths. The mean ICH, mICH score in the mortality group was higher than that in the surviving group with p<0.05, mICH > 6 up to 91% of deaths.

Table 5. Characteristics of the subjects in the favourable and unfavourable groups

Value	Favourable (mRS: 0 - 3)	Unfavourable (mRS: 4 - 6)	Total	p-value
Age	54.8 ± 8.06	56.3 ± 11.98		>0.05
Glasgow before surgery	7.5 ± 1.26	7.1 ± 0.91		>0.05
Hemorrhagic location				
Right	6 (60%)	9 (45%)	15	>0.05
Left	4 (40%)	11 (55%)	15	
ICH volume (ml)				
Mean	64.2 ± 22.83	98.25 ± 30.06		
< 30	3 (30%)	0%	3	<0.05
30 - 60	7 (70%)	13 (65%)	20	
> 60	0%	7 (35%)	7	
Midline Shift (cm)				
< 1	7 (70%)	3 (15%)	10	<0.05
> 1	3 (30%)	17 (85%)	20	
Internal capsule damage				
Yes	1 (10%)	13 (65%)	14	<0.05
No	9 (90%)	7 (35%)	16	
Blood in ventricles				
Yes	3 (30%)	18 (90%)	21	<0.05
No	7 (70%)	2 (10%)	9	
Location				
Deep	6 (60%)	13 (65%)	19	>0.05
Lobar	4 (40%)	7 (35%)	11	
Graeb's score				
Mean	1.60 ± 0.93	6.5 ± 0.80		
0 - 4	8 (80%)	7 (35%)	15	<0.05
5 - 8	2 (20%)	5 (25%)	7	
≥ 9	0 (0%)	8 (40%)	8	
ICH	2.4 ± 0.69	2.9 ± 0.22		<0.05
mICH				
Mean	5 ± 1.05	7.2 ± 1.16		<0.05
≤ 6	9 (90%)	5 (25%)	14	
> 6	1 (10%)	15 (75%)	16	

Comment: The results were different between two groups. With factors such as the volume of the hematoma, midline shift compression, the damage to the internla capsule, blood in ventricles, Graeb's score, ICH score, mICH score, the favourable outcome group had a lower rate than the mRS 4 - 6 group with p<0.05.

Table 6. Complication after surgery

Complication	Quantity	Rate %
Sepsis	2	6.7
Pneumonia	5	16.7
Epilepsy	2	6.7
Continued bleeding	0	0
Surgical site infections	0	0
Meningitis	0	0

Comment: Complications of pneumonia had the highest rate with 16.7%.

4. Discussion

4.1. Characteristics of patients

The mean age of the patients was 55.8 ± 10.7 years, of which < 60 years was 73%, lower than the mean age in STICH II study was 63. Hypertension was the comorbid disease with the largest proportion of 73.3%. This was also consistent with the major bleeding location in the basal ganglia accounting for 63%. The mean preoperative GOS was 7.23 ± 1.04, of which 6 - 8 group accounted for the highest rate 83.3%. We found that the hematoma volume greater than 60ml accounted for the highest percentage of 80%, with an average volume of 86.9 ± 31.94ml higher than in previous studies such as Godoy et al. The hematoma volumes in these studies less than 30ml accounted for the majority of 59.6% whereas the patients had hematomas more than 50ml accounted for only 24.5%. The proportion of midline compression over 1cm accounted for 66.7%. In most severe cases, there was blood into the ventricles, accounting for 70%.

4.2. Operative treatment

The results in Table 3 shown that the mortality rate was 12/30 (40%), the survival rate was 18/30 (60%). In comparison with some other authors such as Le Xuan Long, Vo Van Nho, Le Dien Nhi, the mortality rate in our study was higher due to the selection of severe patients, large hematoma causing mass effect. Glasgow score ≤ 9 in our study, while in other studies, the patients had a Glasgow score ≤ 12. In the group of patients with small hematoma volume and mild mass effect, the clinical status was not too severe, we often prefer minimally invasive surgery with draining the hematoma under Navigation system.

Authors	Year	Sample size	Mortality rate
Lê Xuân Long	2003	31	32.26
Lê Điển Nhi	2004	44	31.82
Võ Văn Nho	2004	23	18.75
Fung C	2012	12	25
Maira G	2002	50	22
Research	2020	30	40

Regarding to the results of rehabilitation after 6 months:

The group with favourable outcome with mRS (0 - 3) accounted for 33.3%, lower than the group with unfavourable outcome with mRS scores (4 - 6) accounting for 66.7%. Compared with other studies, the STICH II had 41% good results mRS ≤ 3 in the surgical group, 38% higher than the conservative group with p=0.367 [6]. Study MISTIE III [3] applied the method of minimally invasive surgery with thrombolysis in intracerebral haemorrhage evacuation. The result shown 45% of surgery group had favorable outcomes compared with 41% in the conservative group. Some other studies only applied craniectomy to evacuate hematomas. In the study of Zuccarello M [8], there was no difference between the conservative and surgical groups after 3 months. Morgenstern LB [7] showed that the conservation group had a better result. The rate of complications was mainly pneumonia, accounting for 16.7%, while the epilepsy accounting for 6.7%. Patients with a Glasgow score of 9 or less require mechanical ventilation for several days after surgery, thus increasing the incidence of pneumonia.

4.3. Factors affecting surgical outcome

The factors affected to the outcome were analyzed in Tables 4 and 5. Although the number of studies was limited, the results also shown that some factors can affect the surgical results. These factors were the volume of the hematoma, the midline compression, the damage of internal capsule, the level of blood in ventricles, the Graeb, ICH, and mICH scales.

The level of blood entering the ventricles: The group of patients with intraventricular hemorrhage (IVH) had a higher mortality rate than those with non-ventricular bleeding, 90% of poor prognosis group had blood into the ventricles. The severity of IVH extension was calculated using the Graeb scale. The mortality group had a higher mean Graeb score than the surviving group at the median Graeb score of 8.66. Similar findings were seen in the study of Godoy et al, patients with IVH extension severity as measured on Graeb scale ≥ 5, were two times more likely to have poor outcome at time of hospital discharge compared with ICH patients

without IVH extension, at 47% and 22.5% respectively.

Clinical and imaging severity by ICH and mICH scores: The median ICH score in the mortality group was 3, which was higher than that in the surviving group (2.6) with p<0.05. The median ICH score in the poor prognosis group was 2.9, higher than the good prognosis group with p<0.05. The mICH scale has a more detailed calculation than the ICH scale. The mean mICH score in the mortality group was higher than in the surviving group, of which 91.7% in the death group had an mICH score > 6. Thus, the more severe the clinical status and the lesions on imaging by the ICH and mICH scores, the higher the mortality and poor prognosis rate. Our study results are similar with Godoy et al, 100% of mortality rate with ICH ≥ 5.

The volume of the hematomas: The study showed that there was a difference in the volume of hematoma between the dead and surviving groups of 97ml and 80ml, respectively, with p<0.05. The result was similar with the good and poor outcome. So that, the larger hematomas volume, the higher the mortality and disability rate.

The midline compression, and internal capsule damage: Our study shown that the midline shift in the group with poor outcome was greater than in the good outcome. This is also consistent with the pathogenesis when the large volume of the hematoma causes a large space-occupying effect, the large amount of midline compression will cause greater brain damage leading to poor recovery. In particular, we found that when the hematoma causes damage to the internal capsule causing a much worse recovery rate. In details, 90% of the good outcome group having no damage to the internal capsule whereas the poor outcome group had 65% of internal capsule lesions. However, the limitation in our study is that we can only evaluate the lesions on CT scan without functional MRI.

5. Conclusion

In this study, 30 patients with supratentorial intracranial hemorrhage underwent decompressive craniectomy, we found that: The mean age was 55.8 ± 10.7 years, of which < 60 year was 73.3%. The mean preoperative Glasgow score was 7.23 ± 1.04. The mean hematoma volume was 86.9 ± 31.9ml, with the volume larger than 60ml accounted for 80%. The mortality rate after 6 months was 40% while the survival figure accounted for 60%. Favourable outcome with mRS (0 - 3) accounted for 33.3% whereas unfavourable outcome with mRS score (4 - 6) was 66.7%. The results also shown that some factors can affect the surgical results. These factors were the volume of the hematoma, the midline compression, the damage of internal capsule, the level of blood in ventricles, the Graeb, ICH, and mICH scales. Graeb score ≥ 9 was a severe prognostic factor, with 100% mortality in this study. Similarly, 91.7% of patients died in the mICH group ≥ 6. In the poor recovery group, the midline compression > 1cm appeared in 85%. Internal capsule lesions in 65% of unfavourable outcome patients.

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