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Original Article

Early versus delayed surgical evacuation of spontaneous supratentorial intracerebral hematoma: A prospective cohort study

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ABSTRACT

Background: The optimum timing for surgical evacuation of spontaneous supratentorial intracerebral hematoma (ICH) is still controversial. The aim of this study was to compare the clinical outcome following early versus delayed surgical evacuation of spontaneous supratentorial ICH.

Methods: This is a prospective cohort study including 70 patients with spontaneous supratentorial ICH ≥ 30 cc in volume and Glasgow Coma Scale 8–12. Patients were divided into two groups based on the time interval between ictus and surgery; Group A (evacuated within 8 h from ictus) and Group B (evacuated >8 h from ictus). Outcome was assessed at discharge and at 2 months postoperative using extended Glasgow Outcome Scale.

Results: The early evacuation group (Group A) included 44 patients and the late evacuation group (Group B) included 26 patients. Favorable outcome was achieved in 20.5% of the patients in Group A and in 11.5% of the patients in Group B. Mortality rate was 18.2% in Group A and 26.9% in Group B. Three patients in Group A and one patient in Group B required reoperation. The mean hospital stay was 17.18 days and 14.54 days in Groups A and B, respectively.

Conclusion: Early surgical evacuation of spontaneous supratentorial ICH in patients with good preoperative conscious level is associated with better clinical outcome, particularly in the early postoperative period. Early surgical evacuation has no significant impact on the rate of reoperation or the length of hospital stay.

Keywords: Extended Glasgow Outcome Scale, Intracerebral hematoma, Supratentorial, Surgical evacuation

INTRODUCTION

Spontaneous intracerebral hematoma (ICH) represents approximately 10–20% of all strokes.^[3,13] It represents an emergency that requires rapid diagnosis and prompt management since early deterioration is frequent in the initial few hours following the ictus. Management of ICH includes medical and surgical options that should work in parallel. Possible surgical interventions include hematoma evacuation through craniotomy or minimally invasive procedures such as stereotactic and endoscopic evacuation. Decompressive craniectomy may be performed in cases with elevated intracranial pressure.^[5,11] The benefit of surgical evacuation in cases with spontaneous

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supratentorial ICH has been controversial. The main goal of surgery is hematoma evacuation with consequent relief of mass effect, reduction of intracranial pressure, and prevention of herniation, in addition to prevention of brain damage that would result from ischemia and the toxic effects of blood degradation products on the brain.^[5]

The optimum timing for surgical evacuation of spontaneous supratentorial ICH remains controversial. Various clinical studies have reported a wide variability in the timing of surgical evacuation, ranging from 4 h to 96 h.^[8,9,12,16] Some studies found that surgery performed within 8 h of the ictus was associated with better outcome.^[4,12] On the other hand, the American Heart Association/American Stroke Association guidelines could not establish clear benefit from early surgery as compared to surgery after patients' clinical deterioration in the majority of the patients.^[5]

The aim of the study was to compare the clinical outcome following early versus delayed surgical evacuation of spontaneous supratentorial ICH in patients with good clinical status.

MATERIALS AND METHODS

This study is a prospective cohort study including 70 patients with spontaneous supratentorial ICH that has been operated on in the neurosurgical departments of Cairo University Hospitals and Beni-Suef University Hospital in the period between May 2017 and December 2018, and 15 surgeons were involved. Patients with spontaneous supratentorial ICH ≥ 30 cc in volume in the initial computed tomography (CT) brain and Glasgow Coma Scale (GCS) 8–12 were included in this study after signing an informed consent as a study participant. Patients with spontaneous ICH due to bleeding disorders (including patients on anticoagulation therapy), patients with hematoma due to underlying vascular malformation, and patients with hemorrhage inside a tumor were excluded from the study. Patients with progressive conscious level deterioration after being initially managed conservatively and patients with progressive enlargement of a hematoma that was < 30 cc in the initial CT brain were not included in the study. Patients with pure basal ganglia ICH were also not included in the study.

All patients were subjected to thorough history taking with special emphasis on the time of the ictus, presence of history of trauma, history of recent and past illness, especially hypertension, bleeding tendency or previous ischemic stroke, history of antiplatelet or anticoagulant drugs administration, and history of smoking. Detailed clinical examination with blood pressure measurement, conscious level assessment by GCS at time of presentation, examination for neurological deficits, particularly weakness and aphasia, and cranial nerves examination, particularly the 3rd and 7th cranial nerves, was

conducted for all patients. Analysis of the preoperative CT scan findings included several aspects as the side, location, and size of the ICH. The frequency of intraventricular hemorrhage (IVH) was also documented. Preoperative ICH score was documented for every patient.

The time interval between the ictus and the surgical evacuation was recorded. Patients were divided into two groups based on that interval. The time limit between the groups was 8 h. Group A included cases that were operated on within 8 h from the ictus and were considered as early evacuation cases, while Group B included cases that were operated > 8 h from the ictus and were considered as late evacuation cases. The cause of delayed evacuation was documented in every case. Patients were operated on by evacuation of the hematoma through a craniotomy or decompressive craniectomy. The choice of decompressive craniectomy was individualized based on several factors including extensive hematomas, midline shift more than 5 mm, patients with lower GCS, and surgeon's preference. The approach was either transcortical or transsylvian based on the distance of the hematoma from the cortex as well as the surgeon's preference.

On postoperative day 1, clinical assessment was done using the GCS, and CT brain was performed for all patients. The need for reoperation based on clinical and radiological findings was documented for all cases that were reoperated. The length of hospital stay was documented for each patient. Assessment of clinical outcome on discharge from the hospital was performed using the extended Glasgow Outcome Scale (GOS-E).

Patients were scheduled for follow-up after 2 months following surgery for the assessment of clinical outcome utilizing the GOS-E. Clinical outcome was based on GOS-E at discharge and after 2 months; GOS-E ≥ 6 after 2 months was considered as favorable outcome.

Statistical methods

Data of the seventy patients were coded and entered using the Statistical Package for the Social Sciences version 25. Data analysis included mean, standard deviation, median, minimum and maximum for quantitative data, and using frequency (count) and relative frequency (percentage) for categorical data. Comparison between quantitative variables was performed using the nonparametric Mann-Whitney U-test. For comparing categorical data, Chi-square test was performed. Exact test was used instead when the expected frequency was less than 5. $P < 0.05$ was considered as statistically significant.

RESULTS

This study included 70 patients with spontaneous supratentorial ICH that has been operated upon in Cairo

University Hospitals (38 patients) and Beni-Suef University Hospital (32 patients). Group A with early surgical evacuation (within 8 h) included 44 patients and Group B with delayed surgical evacuation (>8 h) included 26 patients. Patients' demographic and clinical data are shown in [Table 1], while CT findings and ICH score are shown in [Table 2].

In Group A, the mean time between the ictus and surgical evacuation was 6.55 ± 1.53 h, while in Group B, the mean time between the ictus and surgical evacuation was 10.85 ± 2.09 h [Table 3]. Six patients (13.6%) in Group A were operated upon within 4 h from the ictus, which was defined as ultra-early evacuation. Regarding the whole study group,

62.9% of the patients were operated on by craniotomy for evacuation of the hematoma, while 37.1% were operated on by decompressive craniectomy. Comparison between both groups showed no statistically significant difference ($P = 0.861$). The transcortical approach was used in 85.7% of the patients and the transsylvian approach was used in 14.3% of the patients with no statistically significant difference between both groups ($P = 0.734$).

Better GCS on presentation was associated with better outcome as assessed by GCS in day 1 postoperative and by GOS-E at discharge and GOS-E 2 months postoperative, with the correlation being statistically significant ($P < 0.001$).

Table 1: Patients' demographic and clinical data.

	Group A	Group B	P-value	Significance
Age (years)	57.48 ± 10.14	58.12 ± 8.52	0.669	NS
Gender				
Male	27 (61.4%)	17 (65.4%)	0.737	NS
Female	17 (38.6%)	9 (34.6%)		
Hypertension				
Yes	36 (81.8%)	24 (92.3%)	0.303	NS
No	8 (18.2%)	2 (7.7%)		
Antiplatelet medications				
Yes	26 (59.1%)	10 (38.5%)	0.095	NS
No	18 (40.9%)	16 (61.5%)		
Previous ischemic stroke				
Yes	16 (36.4%)	7 (26.9%)	0.416	NS
No	28 (63.6%)	19 (73.1%)		
Smoking				
Yes	16 (36.4%)	14 (53.8%)	0.153	NS
No	28 (63.6%)	12 (46.2%)		
GCS	10.11 ± 1.63	9.92 ± 1.85	0.609	NS
Neurologic deficit				
Weakness and aphasia	8 (18.2%)	7 (26.9%)	0.379	NS
Weakness	33 (75%)	19 (73.1%)		
No deficit	3 (6.8%)	0 (0%)		

NS: Nonsignificant, GCS: Glasgow Coma Scale

Table 2: CT findings and ICH score.

	Group A	Group B	P-value	Significance
Side				
Right	20 (45.5%)	11 (42.3%)	0.480	NS
Left	24 (54.4%)	15 (57.7%)		
Location				
Extending to basal ganglia	28 (63.6%)	15 (57.7%)	0.622	NS
Lobar	16 (36.4%)	11 (42.3%)		
Size (in cc)	40.98 ± 8.74	42.23 ± 9.02	0.590	NS
IVH				
Yes	15 (34.1%)	11 (42.3%)	0.492	NS
No	29 (65.9%)	15 (57.7%)		
ICH score	2.34 ± 0.48	2.42 ± 0.50	0.495	NS

NS: Nonsignificant, IVH: Intraventricular hemorrhage, ICH: Intracerebral hematoma

Increased size of ICH was associated with worse outcome and correlations between the size of ICH and GOS-E at discharge and GOS-E 2 months postoperatively were statistically significant ($P = 0.008$ and 0.007 , respectively). The correlations between the clinical outcome and other factors such as the hematoma location, the presence of IVH, and the surgical approach were not statistically significant.

Regarding the clinical outcome in both groups, conscious level assessment by GCS on day 1 postoperative showed better outcome in the early evacuation group in comparison to the late evacuation group, with the difference being statistically significant ($P = 0.016$). Group A was also associated with statistically significant improvement in clinical outcome in the early postoperative period on the basis of GOS-E at discharge ($P < 0.001$). However, there was no statistically significant difference in outcome between both groups based on GOS-E 2 months postoperative ($P = 0.819$). Favorable outcome defined as GOS-E score ≥ 6 was achieved in 17.1% of the patients in the whole study group (12 patients); 20.5% of the patients in Group A (9 patients) and 11.5% of the patients in Group B (3 patients). Summary of clinical outcome is shown in [Table 4].

Overall mortality rate was 21.4% (15 patients); 73.3% of the mortalities (11 patients) occurred within 1 month (operative mortality), while 26.7% (4 patients) occurred in the period between 1 and 2 months. The mortality rate was 18.2% in Group A (8 patients) and 26.9% in Group B (7 patients). The difference between the two groups was not statistically significant ($P = 0.389$).

Three patients (6.8%) in Group A required reoperation, while only 1 patient (3.8%) in Group B required reoperation;

however, the difference between both groups was not statistically significant ($P = 1$). Out of the four patients that required reoperation, three showed radiological evidence of rebleeding within 12 h following evacuation due to persistent elevation of blood pressure, while one case had inadequate evacuation and persistent mass effect that required reevacuation after 2 h. Two out of the three patients that required reoperation in Group A have been initially operated on within 4 h (ultra-early evacuation).

In Group A, the duration of hospital stay ranged between 4 and 50 days (mean: 17.18 ± 12.99 days). In Group B, the duration of hospital stay ranged between 5 and 40 days (mean: 14.54 ± 8.92) days. There was no statistically significant difference between the two groups regarding the duration of hospital stay ($P = 0.680$).

DISCUSSION

Spontaneous intracerebral hemorrhage is a major cause of morbidity and mortality. It has been the focus of many clinical studies aiming at defining the best treatment protocol and to predict and improve the outcome. The indications for surgical intervention are debatable in many cases; moreover, the optimum timing for surgical evacuation is still controversial.^[1,5]

Pantazis *et al.* compared early surgical intervention within 8 h from the ictus to conservative management for patients with ICH >30 cc.^[12] In a meta-analysis of 2186 cases from eight surgical studies including the International Surgical Trial in Intracerebral Hemorrhage (STICH), the authors focused on the impact of early surgical evacuation on the clinical outcome as compared to initial conservative management, with 34.4% of their patients randomized to surgical evacuation within 8 h from the ictus.^[4] In the STICH trial, 73% of the patients in the early surgery group had surgery within 12 h from randomization, with only 16% of these patients being operated on within 12 h from the ictus.^[8] Regarding the STICH-II trial, the time interval between the ictus and surgery in the early surgery group ranged between

Table 3: Timing of surgical evacuation.

Timing (h)					
	Mean	SD	Median	Minimum	Maximum
Group A	6.55	1.53	6	4	8
Group B	10.85	2.09	10	9	18

SD: Standard deviation

Table 4: Summary of the clinical outcome.

	Mean	SD	Median	Minimum	Maximum	P-value
GCS day 1 postoperative						
Group A	10.80	1.49	10.00	8.00	13.00	0.016
Group B	9.65	2.02	10.00	6.00	12.00	
GOS-E at discharge						
Group A	3.59	1.35	4.00	1.00	5.00	< 0.001
Group B	2.42	1.06	2.00	1.00	5.00	
GOS-E 2 months postoperative						
Group A	4.32	1.58	4.00	1.00	7.00	0.819
Group B	4.19	1.66	5.00	1.00	7.00	

SD: Standard deviation, GCS: Glasgow Coma Scale, GOS-E: Extended Glasgow Outcome Scale

2.5 and 69 h (mean: 26.7 ± 13.6 h), while in the initial conservative group, the time interval ranged between 5 and 266 h (mean: 64.2 ± 58.9 h). Only 17% of the patients in the early surgery group have been operated on within 12 h from ictus, due to the long duration between the ictus and randomization (up to 48 h from the ictus).^[9]

The results of both STICH and STICH-II trials showed that early surgery (within 12 h from the ictus and not randomization) was performed in only a minority of the patients, with most of their patients operated on within a time frame similar to that of our delayed group.^[8,9] Kuo *et al.* reported the outcome in 68 patients who were all operated upon by endoscopic assisted evacuation of the hematoma within 12 h of the ictus (84% were operated within 4 h), with a mean interval of 5.8 h between the ictus and surgery.^[6] Wang *et al.* compared the outcome of surgery and conservative treatment in ultra-early (<7 h), early (7–24 h), and late (>24 h) groups. Around 47% of their surgical cases were operated on within 7 h, 34.2% were operated on between 7 and 24 h, and only 18.8% were operated on later than 24 h.^[15]

Different from most major studies, ours focuses solely on those patients who were operated by surgical evacuation of their ICHs. Trials including STICH and STICH-II compared a group with early surgical evacuation to a group with initial conservative treatment that included patients who required surgery later on.^[8,9] In contrast to both trials, patients who were initially managed conservatively then later on required surgical evacuation were excluded from our study. Patients with initially small hematomas (<30 cc) that progressed later on requiring surgical evacuation were excluded from the study.

Our study, similar to others, focused on assessing the effect of timing of surgical intervention on outcome; 62.9% of the patients had early surgical evacuation (Group A) and 37.1% had delayed surgical evacuation (Group B). Many factors contributing to delayed surgical evacuation included lag of diagnosis due to lack of facilities in the referring hospital, prolonged transfer time from distant hospitals, lack of beds in the intensive care unit, initial control of blood pressure for few hours, and the need for perioperative dialysis in renal patients. Various patient and hematoma criteria were compared between Group A and Group B to detect the possible influence of any of these criteria on outcome. There was no statistically significant difference between both groups regarding any of the patients and hematoma criteria [Tables 1 and 2].

GCS and GOS-E showed statistically significant improvement in the early evacuation group in comparison to the delayed evacuation group, being on day 1 postoperative ($P = 0.016$) and at discharge ($P < 0.001$), but not at 2 months postoperative ($P = 0.819$). Favorable outcome was achieved in 20.5% and 11.5% of the patients in Groups A and B,

respectively. Pantazis *et al.* reported significantly better clinical outcome in the early surgery group as compared to the conservative group, with no significant difference regarding survival.^[12] Similarly, the results of Gregson *et al.* approved that early surgical evacuation within 8 h for patients with GCS ≥ 9 having ICH 20–50 cc in volume was associated with improved outcome.^[4] Kuo *et al.* reported good neurological outcome in patients operated on within 12 h of the ictus.^[6] The results of Wang *et al.* showed that the optimal time window for surgical evacuation of ICH was between 7 and 24 h.^[15] Similarly, Luzzi *et al.* in their systematic review concluded that the optimal timing for ICH evacuation was found to be between 7 and 24 h.^[7] In contrast to these findings, Sirh and Park found that patients with ICH aspiration performed after 7 days of the ictus had significantly better outcome after 1 month with no significant difference after 6 months.^[14]

In the STICH-II trial, patients were randomly allocated to either early surgery or initial conservative treatment. Unlike our time limit of 8 h from the ictus, patients who had surgery within 12 h from randomization were considered as the early surgery group. Similar to our study, the GOS-E has been used by the STICH-II trial among other outcome scores; however, we recorded the outcome twice at discharge and at 2 months postoperative, while they recorded the outcome once at 6 months postoperative. Their results confirmed that early surgery for patients with spontaneous superficial ICH without associated IVH was associated with small but clinically relevant survival advantage. Subgroup analysis of patients included in the STICH-II trial suggested a trend toward more favorable outcome in patients with lobar hematomas and GCS 9–12 operated on within 21 h from randomization, which means that a substantial group of the patients has been operated on within our time frame of delayed surgery making the comparison inaccurate. According to their results, GOS-E ≥ 6 was achieved in 29% and 27% of the patients in the early surgery and the initial conservative groups, respectively, which is higher than our reported outcome; however, around two-thirds of the included patients in the STICH-II trial had initial GCS >12.^[9]

The overall mortality rate was 21.4% in the whole study group. It was 18.2% in Group A and 26.9% in Group B, and the difference between the two groups was not statistically significant ($P = 0.89$). The STICH-II trial reported similar results despite including patients with better initial GCS scores; 18% of the patients in the early surgery group died by 6 months, while 24% of the patients in the initial conservative group died by 6 months.^[9] The STICH trial reported higher mortality rates of 36% at 6 months for the early surgery group and 37% for the initial conservative treatment group; however, a substantial number of their patients had GCS ≤ 8 .^[8] Bhatia *et al.* reported 32.7% mortality rate during the

hospital stay; however, their study included patients with both supratentorial and infratentorial with clot evacuation performed in only 22.9% of their patients.^[2] It is important to emphasize that in contrast to our study, all the above-mentioned studies included large numbers of patients who were managed conservatively. Wang *et al.* reported mortality in 15.8%, 8.9%, and 8% of their surgical patients in the ultra-early, early, and delayed groups, respectively.^[15]

In our study, 3 patients (6.8%) in Group A required reoperation, while only 1 (3.8%) patient in Group B required reoperation, with no statistically significant difference found between both groups ($P = 1$). Six patients in Group A were operated on within 4 h following the ictus (ultra-early evacuation), and 2 of them (33.3%) required reoperation within 12 h postoperative. Morgenstern *et al.* found that ultra-early evacuation within 4 h of the ictus was associated with increased risk of rebleeding (40%) as compared to evacuation within 12 h (12%).^[10] Similarly, Wang *et al.* reported higher incidence of rebleeding in their ultra-early group (<7 h).^[15] On the other hand, Kuo *et al.* had very low incidence of rebleeding (1.5%) despite that 84% of their patients had ultra-early surgery.^[6]

The length of hospital stay was higher in Group A (mean: 17 ± 13 days) as compared to Group B (mean: 14.5 ± 9 days); however, no statistically significant difference was found between both groups ($P = 0.680$). This might be explained by the higher survival rate in Group A as compared to Group B. Furthermore, Bhatia *et al.* have mentioned that survival was associated with increased length of hospital stay.^[2] On the other hand, the STICH trial reported a nonsignificant shorter hospital stay with the early surgery group.^[8]

Limitations of our study include short follow-up period and the nonrandomization of the patients. Further randomized studies with larger number of patients and longer follow-up are needed.

CONCLUSION

Early surgical evacuation of spontaneous supratentorial ICH in patients with good preoperative conscious level is superior to delayed surgical evacuation regarding the clinical outcome, especially in the early postoperative period. Early surgical intervention might be associated with lower mortality rate although no statistically significant difference has been shown. Ultra-early surgical evacuation appears to be associated with higher reoperation. The length of hospital stay is comparable between both groups of early and delayed surgical evacuation.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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