Open Journal of Modern Neurosurgery, 2026, 16(1), 27-43
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Clinical and CT Outcomes of Endoscopic Evacuation of Intracerebral Hematoma

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How to cite this paper: Hosameldin, A., Diaa, M., Elshafiey, H. and Aly, M.H.M. (2026) Clinical and CT Outcomes of Endoscopic Evacuation of Intracerebral Hematoma. *Open Journal of Modern Neurosurgery*, **16**, 27-43.
https://doi.org/10.4236/ojmn.2026.161004

Received: October 18, 2025
Accepted: November 30, 2025
Published: December 3, 2025

Abstract

Background: Minimally invasive endoscopic hematoma evacuation is a promising management option for intracerebral hemorrhage. However, the technique still needs to be worked on. Methods: This study is a prospective study that included forty-five patients with spontaneous supra-tentorial intracerebral hematoma who were operated on by an endoscopic approach from January 2024 to April 2025. Results: We included the forty-five patients who met inclusion criteria (27 females and 18 males) whose ages ranged from 28 to 70 years. Regarding the location of hematoma, in 30 patients it was cortical, 6 patients it was cortical subcortical, and 9 patients it was in basal ganglia. Regarding complications, 9 patients experienced wound infection; there were no cases of re-bleeding or seizures. According to Glasgow outcome score, we have 15 with good recovery, 18 with moderate disability, 3 with severe disability, 9 patients died. Conclusion: Endoscopic technique is a safe surgical option for evacuation of spontaneous ICH. This minimally invasive technique could be helpful to provide better short-term outcomes. Patient selection is a very important prognostic factor. Using the endoscope can create a better view of hidden angles, reduce craniotomy-associated bleeding, and enhance time efficiency.

Keywords

Intracerebral Hematoma, Endoscopic Evacuation, Glasgow Outcome Score

1. Introduction

Spontaneous Intracerebral Hemorrhage (ICH) represents approximately 15% of all strokes [1] [2]. The risk factors for stroke include: modifiable factors include hypertension, cigarette smoking, diet, alcohol intake, psychological stress, and increased High-Density Lipoprotein (HDL) and non-modifiable factors include old age, male sex, Black and Hispanic ethnicity, Cerebral Amyloid Angiopathy (CAA) and cerebral micro-bleeds [3] [4] Spontaneous supratentorial intracerebral hematomas may be lobar (cortical and subcortical) or deep (in the central core of the cerebrum). Hypertensive spontaneous intracerebral hematoma most commonly affects the basal ganglia and hemorrhage involving a cerebral lobe is usually associated with cerebral amyloid angiopathy [5]. The pathogenesis of intracerebral hematoma formation consists of multiple events; vessel rupture initiates the process and is followed by primary and secondary hematoma expansion [5]. General clinical manifestations include headache, disturbed consciousness, seizures, and vomiting. Other clinical syndromes vary according to the location of hematoma [3] [6]. Computed Tomography (CT) scan is considered the gold standard diagnostic method for ICH with a sensitivity and specificity for acute blood reaching almost 100%. CT is rapid, widely available, and cheaper than MRI [7]. The mortality rate of ICH is approximately 40% at 1 month and 54% at 1 year, with only 12% to 39% of patients achieving functional independence on long-term follow-up [3]. Intracerebral hemorrhage is an emergency that requires rapid diagnosis and prompt management, especially since early deterioration is frequent in the initial few hours following the ictus [8]. Management of ICH includes medical and surgical options that should work in parallel to each other. The medical management includes control of blood pressure, management of the increased Intracranial Pressure (ICP), fits prophylaxis and treatment, and supportive treatment [8] [9]. The benefits of surgical evacuation for spontaneous ICH are controversial [8]. The main goal of surgery is hematoma evacuation with relieving the mass effect to prevent brain damage that would result from compression and herniation as well as from the ischemia and the toxic effects of blood degradation products on the brain [8], however; the prospective randomized controlled trials and the Surgical Treatment for ICH (STICH) trials have failed to prove that craniotomy could improve the functional outcomes [8]. Surgical options for evacuation of ICH, include craniotomy, decompressive craniectomy and minimally invasive procedures including stereotactic aspiration and endoscopic evacuation [8] [10]. However, standard open craniotomy is routinely effective in complete hematoma evacuation and maintenance of hemostasis; the approach commonly causes damage to uninjured brain overlying the hematoma [11]. In contrast, recent studies on minimally invasive treatments, including Endoscopic Surgery (ES) and Stereotactic Aspiration (SA), have designated such surgical techniques as safe and effective in patients with ICH[4]. With the evolution of the neuro-endoscope and hemostatic agents, surgical evacuation of ICH in deep or superficial location is now safer, faster, less tissue trauma and less invasive than before [12] [13]. Clinically, more and more studies illustrated that endoscopic treatment of ICH is superior to conventional craniotomy in terms of modality, motility. The surgery duration and recovery time are shorter than conventional craniotomy, yet with a lower complication rate. Although the difference in endoscopic group has an overall statistically significant better outcome, it is still not statistically significant [12] [13].

2. Methods

This study is a prospective study that included forty-five patients with spontaneous supra-tentorial intracerebral hematoma who were operated on by an endoscopic approach in the neurosurgical department of Fayoum University Hospitals from January 2024 to April 2025. To evaluate the short-term outcomes of endoscopic evacuation of spontaneous intracerebral hematoma using the following variables: hematoma size post-evacuation, operation time, Glasgow Coma Scale (GCS), blood loss, re-bleeding, epilepsy, hospital stay, and Glasgow Outcome Score (GOS).

Inclusion criteria: 1) Age: 18 - 85 years; **2) Sex:** No sexual preference; **3) Clinical Criteria** Glasgow Coma Scale (6 - 14); **4) Radiological Criteria:** A basal ganglia ICH with hematoma volume more than 30 mL, Subcortical haemorrhage > 30 mL with a significant mass effect (midline shift 5 - 15 mm and sulcus effacement), Thalamic ICH with a hematoma volume > 20 mL and acute hydrocephalus, Combined type ICH or large hematoma occupying both the basal ganglia and the thalamus and may be associated with intraventricular hematoma.

Exclusion criteria:

- Age <18 and > 85 years.
- ICH caused by intracranial tumors, aneurysms, infarction, or other intracranial lesions.
- Basal ganglia ICH or subcortical haemorrhage less than 30.
- Midline shift more than 15 ml.
- Thalamic hematoma < 20 ml and no hydrocephalus.
- Multiple intracranial haemorrhage.
- Infra-tentorial spontaneous intracerebral haemorrhage.
- Infectious meningitis and pulmonary or general infection.
- Glasgow coma scale less than 6 or presence of clinical and radiologic signs of cerebral herniation.

All patients were subjected to thorough history taking, neurological examination and investigations. Investigations included routine preoperative labs. Also, radiological in the form of CT (computed tomography) scan pre-operative to assess hematoma site and size with preoperative metallic marker for proper localization of the hematoma. All patients were transferred to the Intensive Care Unit (ICU) where blood pressure was maintained in the high normal range, and antiepileptic drugs and antibiotics were continued. Immediate and early Postoperative clinical evaluation was done for all cases using the GCS on day 1 post-operative. Routine CT brain was performed on day (1) postoperative for all patients. The length of hospital stay was documented for each patient. Assessment of clinical outcome at discharge from the hospital was done using the Glasgow Outcome Score (GOS).

Statistical methods: Data were collected, revised, coded and entered into the Statistical Package for Social Science (IBM SPSS) version 27. The quantitative data were presented as means, standard deviations and ranges when parametric and median, Inter-Quartile Range (IQR) when data were found non-parametric. Also qualitative variables were presented as numbers and percentages. The comparison between two paired groups regarding quantitative data and parametric distribution was done by using ***Paired t-test*** while with non-parametric distribution was done by using ***Wilcoxon Rank test***. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as follows: P-value > 0.05: Non-Significant (NS), P-value < 0.05: Significant (S), P-value < 0.01: Highly Significant (HS).

Surgical technique:

Preoperative Preparation: All patients were given intravenous loading dose of antiepileptic drugs, either in the emergency room or in the operating room. Intravenous antibiotics were given before skin incision.

Time of Surgery: The interval between time of ictus and surgical evacuation was recorded. Patients who were managed conservatively and then developed a drop in conscious level were recorded.

Surgical technique: Patients were operated upon by endoscopic evacuation of the hematoma.

Skin incision: Linear/curved skin incision, average 5 cm in length in a fashion that could be extended to do open microsurgical evacuation if the endoscopic technique fails.

Bur hole location: The burr holes were designed according to the location of hematoma and safe entry points. Preoperative CT-guided metallic marker was done to identify the perfect entry points to make the burr hole. Approaches are carefully designed according to the location of hematoma:

- For hematoma in basal ganglia, 2 - 3 cm anterior to coronal suture and 3 - 4 cm lateral to the midline is preferred as the entry point (Kocher point).
- For thalamic hematoma, a parietal entry point (Keen) is preferred.
- For sub-cortical hematoma, the shortest approach is preferred.
- For occipital hematomas, Fraizer point.

The diameter of burr hole was 1 - 1.5 inches, in some cases we were forced to widen it after we faced cortical vein after dural opening.

Instruments Used: All patients were operated under general anaesthesia and position was according to the hematoma site. We performed surgery under direct vision using endoscopes with a 0.30 rod lens of 4 mm diameter 18 cm in length (Karl Storz, Tuttlingen, Germany) and trans-ventricular lens in some cases using its working channel to introduce suction tube or endoscopic monopolar. Straight, angled suction was used and sometimes, Nelaton catheters were used to evacuate (suction) the hematoma; endoscopic monopolar was also used to coagulate any bleeding vessels. We don't use navigator in any case.

We used a barrel of customized plastic syringe as an endoscopic transparent sheath which was not available.

Evacuation of hematoma and homeostasis: After coagulation of the dura, we opened it with sharp scalpel then a1-cm cortical incision with bipolar cauterization was made. We advanced the endoscope lens guided by the Lotta sheath or plastic syringe barrel or without it; sometimes we used the trans-ventricular (Lotta) lens inside the endoscopic trocar or the skull base lenses 0, 30 degree for inspection of the hematoma. Once the hematoma was reached, the barrel was then fixed in place by the assistant, and the suction was then placed to start evacuation. Cortical hematomas were evacuated starting from the most superficial part while basal ganglia hematomas were evacuated starting from the deepest point. Saline Irrigation was sometimes used as trial to liquify the hematoma to make it easy to be aspirated. If a clot was found adherent to the hematoma cavity wall, we did not try to remove it. Most bleeding from these perforators stopped after gentle compression with cotton and irrigation for 2 min, which is described as wait-and-see saline irrigation. When bleeder is identified with an endoscope, small Surgicel® (Ethicon Inc., Somerville, NJ, USA) micro pieces over the oozing wall of hematoma or gel foam soaked with thrombin were used to stop bleeding and if bleeding failed coagulation was done using the endoscopic mono-polar or the traditional bipolar cauterization if accessible. Then adequate closure in layers was done from dura to skin. No sub-galeal drain was placed in any case.

3. Results

This prospective non-randomized controlled study will be conducted on 45 patients with supra-tentorial intracerebral hematoma admitted to emergency unit of neurosurgery department in Fayoum University Hospital in a period starting from January 2024 till April 2025. There were 27 females (60.0%) and 18 males (40.0%) with ages ranging from 28 - 70 years and with mean ± SD of 49.73 ± 13.08 years. Table 1. Comorbidities and hematoma site are illustrated in Table 2. At the same time, Hematoma size and GCS pre-operative and post-operative among the studied patients are discussed in Table 3. Presence of mortality and morbidity (neurological deficit) among the studied patients and hospital stay, wound status, blood loss, re-bleeding, seizures and surgery time among the studied patients are discussed in Tables 4-6.

Table 1. Demographic data and characteristics of the studied patients.

		Total No. = 45
Age	Mean ± SD	49.73 ± 13.08
	Range	28 - 70
Sex	Female	27 (60.0%)
	Male	18 (40.0%)

Table 2. Medical history and hematoma site of the studied patients.

		Total No. = 45
Medical history	Free	16 (35.5%)
	DM + HTN	9 (20%)
	DM	6 (13.3%)

Continued

	Renal + HTN	8 (17.7%)
	HTN	6 (13.3%)
Hematoma site	**Cortical**	**30 (66.7%)**
	Cortical rt parietal	12 (26.7%)
	Cortical lt parietal	15 (33.3%)
	Cortical lt temporo-patirtal	3 (6.7%)
	Cortical + subcortical	**6 (13.3%)**
	Cortical + subcortical Rt Parietal	*3 (6.7%)*
	Cortical + subcortical Lt Parietal	*3 (6.7%)*
	Basal ganglia	**9 (20.0%)**
	Rt	6 (13.3%)
	LT	3 (6.7%)

Table 3. Hematoma size and GCS pre-operative and post-operative among the studied patients.

		Pre	Post	Test value	P-value	Sig.
Hematoma size (cc)	Median (IQR)	60 (50 - 70)	6 (0.5 - 17)	−3.412≠	0.001	HS
	Range	40 - 120	0 - 27.5			
GCS	Mean ± SD	12 ± 1.07	13.8 ± 1.7	−8.088•	<0.001	HS
	Range	10 - 13	10 - 15			

P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant. •: Paired t-test; ≠: Wilcoxon Ranks test.

Table 4. Presence of mortality and morbidity (neurological deficit) among the studied patients.

		Total No. = 45
Mortality	No	36 (80.0%)
	Yes	9 (20.0%)
Morbidity	No	21 (46.66%)
	Yes	24 (53.33%)

Table 5. Hospital stay, wound status, blood loss, re-bleeding, seizures and surgery time among the studied patients.

		Total No. = 45
Hospital stay (days)	Median (IQR)	5 (3 - 7)
	Range	2 - 9
Wound	Clean	36 (80.0%)
	2ry infected	9 (20.0%)
Blood loss (ml)	Mean ± SD	94.67 ± 44.3
	Range	40 - 200
Re-bleeding	No	45 (100.0%)
	Yes	0 (0.0%)

Continued

Seizures	No	45 (100.0%)
	Yes	0 (0.0%)
Surgery time (min)	Mean ± SD	86.67 ± 22.81
	Range	50 - 130

Table 6. Glasgow outcome score among the studied patients.

		Total No. = 45
Glasgow outcome score	Good recovery	15 (33.3%)
	Moderate disability	18 (40%)
	Severe disability	3 (6.7%)
	Died	9 (20.0%)

4. Case Presentation

Case 1:

65 years old female, Diabetic and Hypertensive. Patient presented to the ER with disturbed conscious level (**GCS 13**). The patient had right-sided weakness G 3. CT brain on admission showed left parietal ICH, 52.5 cc in volume (**Figure 1**). Endoscopic evacuation was performed **12** hours after the ictus due to delayed presentation to the ER (**Figure 2**). Postoperative CT brain revealed complete hematoma evacuation (**Figure 3**). On day one postoperatively the patient had **GCS 14** with persistent hemiplegia. The patient was discharged from the hospital after **2 days**. Glasgow Outcome Score on discharge was **4 (moderate disability)**. 2 weeks later, patient was FC, Right side weakness improved to G4.

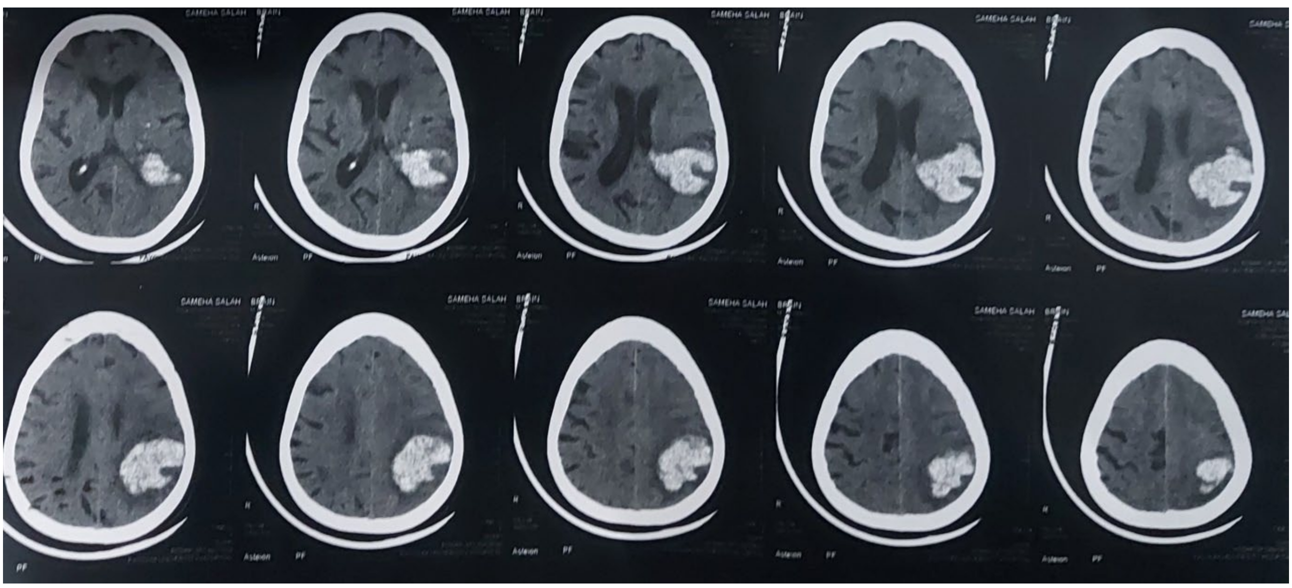

Figure 1. Preoperative CT brain showing Left parietal hematoma.

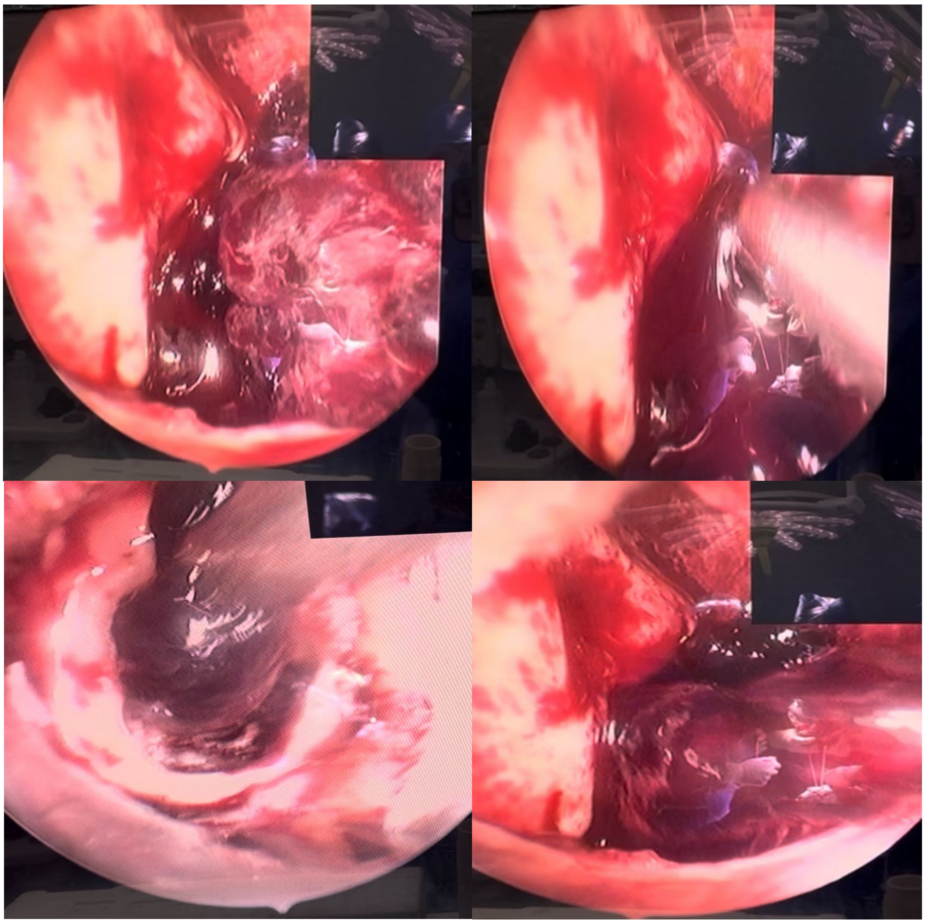

Figure 2. Intraoperative endoscopic view for hematoma evacuation.

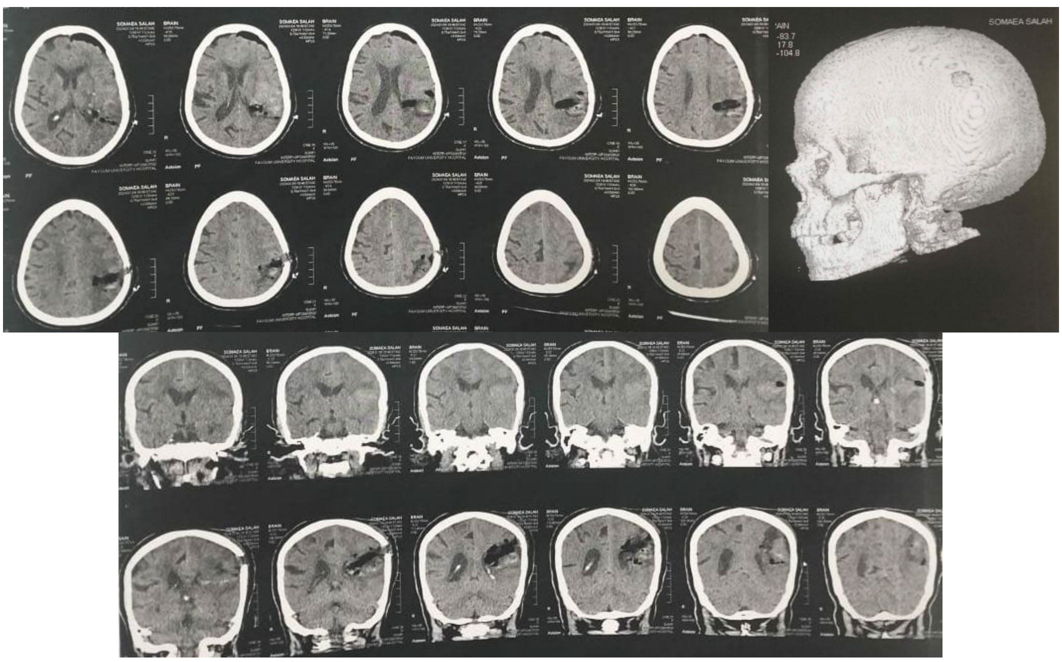

Figure 3. Postoperative CT brain showing ICH evacuated with 3D bone window showing the skull defect of the burr hole.

Case 2:

60-year-old male, no medical history. Patient presented to the ER with disturbed conscious level (**GCS 10**). The patient had right-sided hemiplegia. CT brain on admission showed left Temporo-parietal ICH, 95 cc in volume (**Figure 4**). Endoscopic evacuation was performed **10 hours** after the ictus (**Figure 5**). Postoperative CT brain revealed near complete hematoma evacuation (**Figure 6**). On day one postoperatively the patient had **GCS 10 (FC aphasic)**. After 3 days in ICU patient was re-intubated due to a poor chest condition. After 1 week, patient was extubated and became FC aphasic with right-side weakness G zero. Glasgow Outcome Score at discharge was 3 **(severe disability)**.

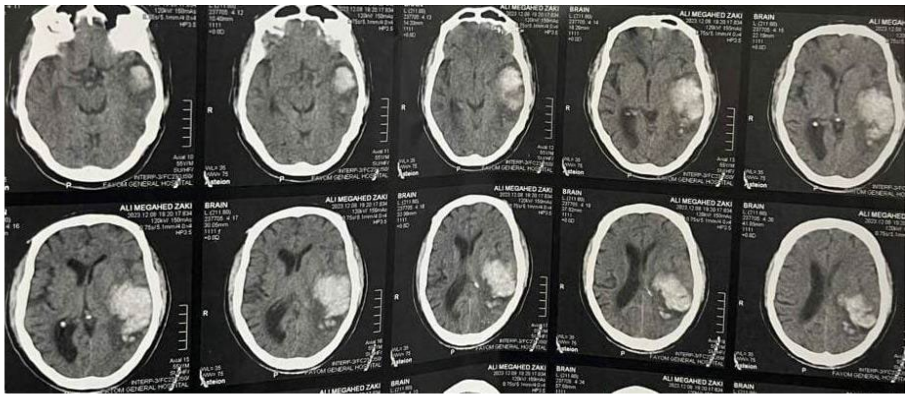

Figure 4. Preoperative CT brain showing left temporo-parietal ICH.

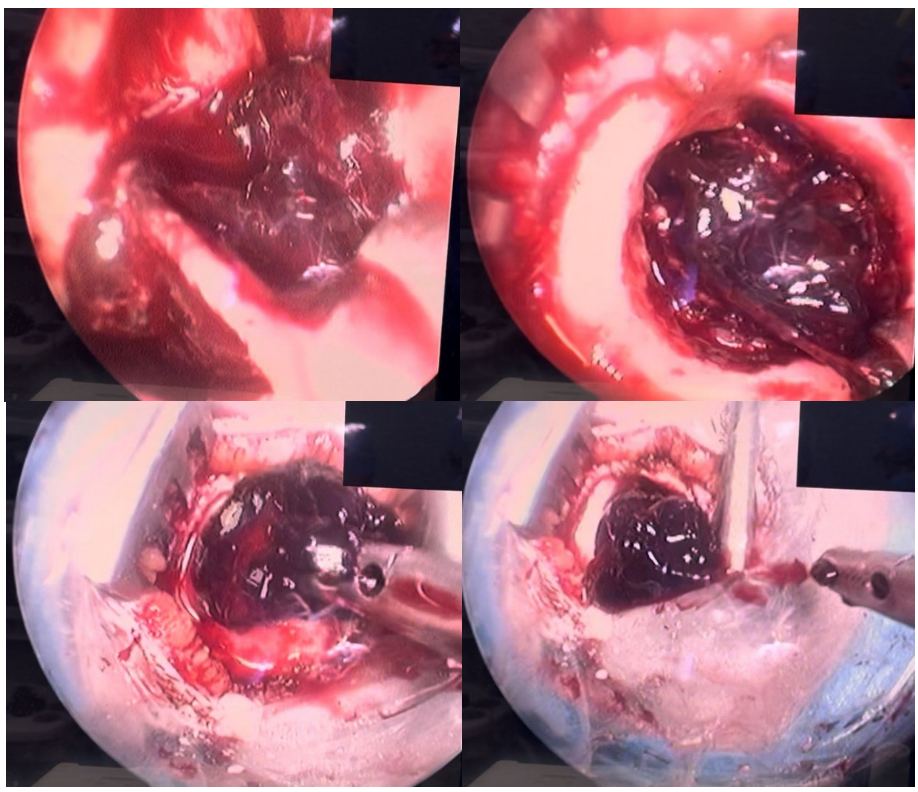

Figure 5. Intraoperative endoscopic view for hematoma evacuation.

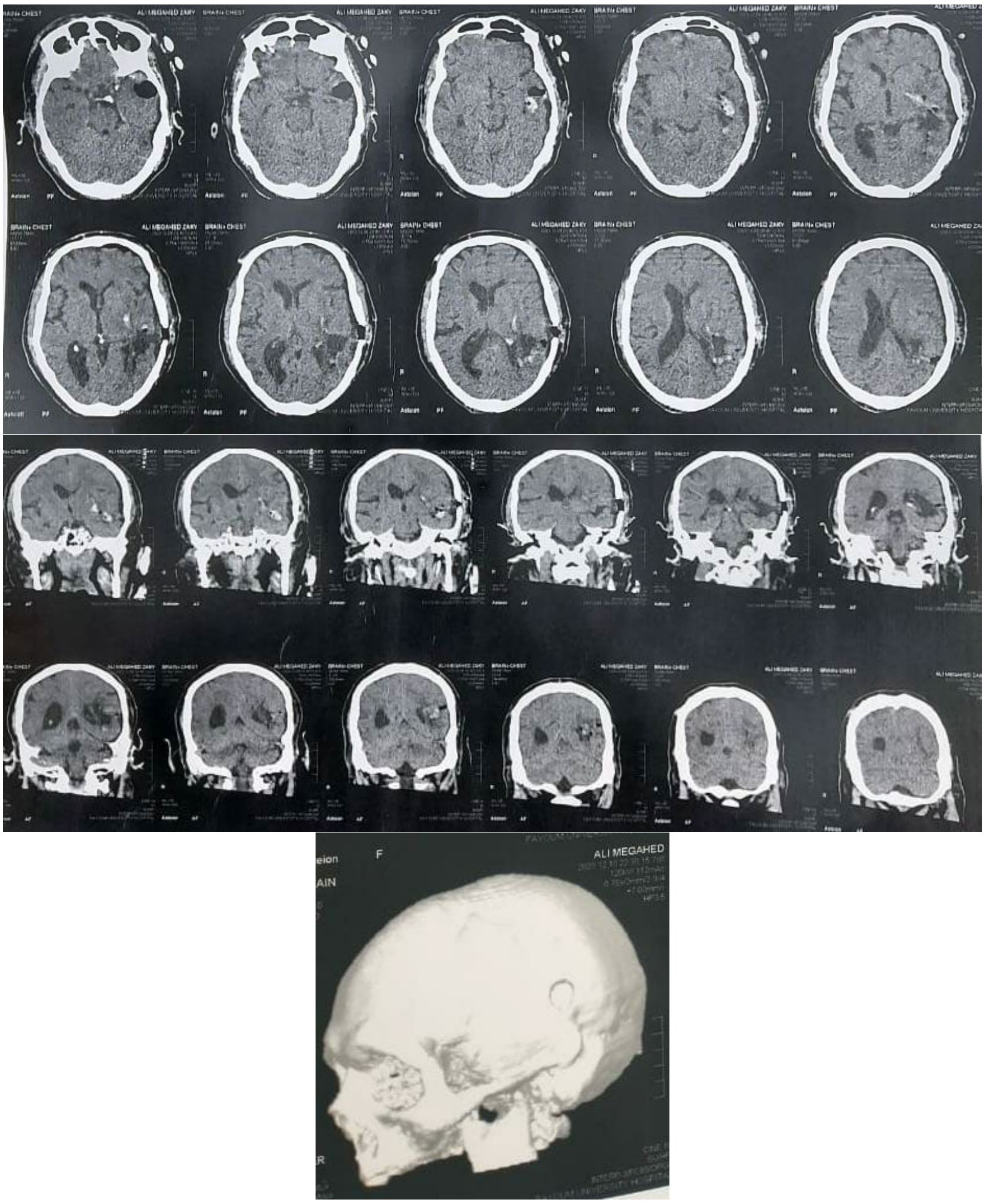

Figure 6. Postoperative CT brain showing ICH evacuated with improved mass effect, and the skull defect of the burr hole.

5. Discussion

Spontaneous intracerebral haemorrhage is a major cause of morbidity and mortality. It was still the focus of many clinical trials aiming to define the best management protocol and to predict and improve the outcome, with a different focus in every trial. The indications for surgical intervention are debatable in many cases; moreover, the exact timing of surgical evacuation of spontaneous intracerebral hematoma and how that would affect the outcome is still controversial [8] [14]. Regarding development of endoscopic technique, the endoscopic hematoma evacuation technique has been under development for nearly 2 decades [15]. Several important technical developments were reported by various groups to enhance its orientation, visualization, and safety [8] [15]. One important improvement is the transparent sheath, which is used as a working channel for the endoscopic and surgical instruments [16] [17]. Compared with the metallic sheath, an obvious advantage of the transparent sheath is that the residual hematoma and hematoma brain border can be easily identified through the transparent wall of the sheath [18]. In our series, we used the barrel of a plastic syringe as a transparent plastic sheath for evacuation of basal ganglia and deep hematomas; we didn't use sheath in case of superficial cortical hematomas. With the development of medical instruments and the deeply rooted "Minimal invasive" concept, endoscopic haemorrhage evacuation for treating hypertensive ICH is becoming more and more popular [19] [20]. With the advancement of the neuroendoscopic system and instruments, recent reports have demonstrated a high rate of ICH evacuation of 84% - 99% [7] [11] [13] [15] [20]-[22]. In addition, several series have reported a lower rate of re-bleeding, morbidity and mortality in endoscopic hematoma evacuation surgery than in traditional craniotomy [23]-[29]. The main reasons were less adjacent tissue injury, less blood loss, and less operation time, additionally true minimally invasive surgery includes not only a minimal wound size but also minimal brain tissue trauma during the surgery [7] [13] [27]. Another advantage of the endoscopic evacuation is the small incision and the delicate craniotomy (a bur hole), which reduces unnecessary blood loss in large craniotomy [13] [20]. One of the difficulties during the endoscopic technique is that some hematoma clots are closely adhered to arteries or located far away from the centre of the hematoma. Removing these clots might require more intensive coagulation attempts or more swinging of the sheath, resulting in damage to brain tissue. Thus, aggressive and radical hematoma removal might not be necessary during endoscopic hematoma evacuation procedures. We have operated upon 45 patients with mean age (49.73 ± 13.08) ranging from 28-70 years old with female predominance 60%, while Kuo *et al.* series was formed of 62 patients with mean age 63 years , range from (42-82) and male sex predominance (70%) [15]. In Nishihara *et al.* study 27 patients were included with mean age 68.8 (50 - 86) with male sex predominance (70.3%) [16]. In Ma *et al.*'s study 24 patients with male sex predominance (70.8%) [17]. According to hematoma site of patients in our study, there were 30 patients (66.7%) who had cortical hematoma; 12 patients (26.7%) right parietal, 15 patients (33.3%) had left parietal (33.3%) and 3 patients (6.7%) left temporo-parietal. Also, 6 patients (13.4%) had cortical and subcortical hematoma 3 patients (6.7%) had right parietal hematoma, 3 patients (6.7%) had left parietal hematoma and 9 patients (20.0%) have hematoma in basal ganglia: 6 patients (13.3%) had right basal ganglia hematoma and 3 patients (6.7%) had left basal ganglia hematoma. In kuo *et al.*'s study, there were 35 cases of putaminal ICH (51.5%), 24 cases of thalamic ICH (35.3%), and 9 cases of subcortical ICH (13.2%) [15]. In Nishihara *et al.*, 17 cases (62.9%) had putaminal hemorrhage, 1(3.7%) had thalamic hemorrhage, three (11.1%) had cerebellar hemorrhage, and 6 cases (22.2%) had subcortical hemorrhage [16]. Management of Spontaneous

Intracerebral Hemorrhage, no clear evidence at present indicates that ultra-early removal of supratentorial ICH improves functional outcomes or mortality rates [15]. Controversially, very early craniotomy may be harmful due to increased risk of recurrent bleeding. However, differences in patient selection, surgical indication, timing, technique, and perioperative care made direct comparison inappropriate and mandate the need for a randomized-controlled study to elucidate this point [30]-[33]. In our series, the mean time interval between ictus and surgery was 10.5 hours ± 12.05 hours. The shortest time interval to surgery was 4 hours and the longest was 72 hours. We have noticed that, the shorter time to ictus, the less solid the hematoma is, while as time passes, the hematoma becomes more organized and we need irrigation with saline to dissolve it. Meanwhile with long interval between ictus and evacuation, haemostasis becomes easier. Zhou Xinyu *et al.*, performed meta-analysis of randomized controlled trials indicating that patients with supra-tentorial intracerebral hemorrhage might benefit more from MIS than other treatment options. They found that Patients with GCS score of ≥ 9, hematoma volume between 25 and 40 ml, and within 72 h after onset of symptoms, would benefit more from MIS [19]. Ma *et al.*, reported the mean time between ictus and surgery was 4 - 50 hours with no statistical significance (P = 0.28) [18]. They assumed that clot might be harder to remove if the time interval to surgery is long, especially longer than 48 hours. Even so, the clot could still be removed by using suction without the need for streptokinase or urokinase [17]. Nishihara *et al.* recommended that it be performed within 24 hours after onset, because intracerebral hematoma usually starts to harden about 24 hours after onset and 48 hours later it cannot be evacuated with a suction tube [20]. Kuo *et al.*, thought that there is a higher evacuation rate when the surgery is performed early (within 12 hours) due to the fact that, within this period, the clot is usually easily suctioned (in contrast to the treatment of subacute hematomas) and this would allow for better outcome [15]. We involved 45 patients who met the inclusion criteria with a mean GCS (12 ± 1.07). In correlation between pre- and post-operative changes in the conscious level on the GCS, there was a statistical significance (P < 0.001). Mean Preoperative GCS was 12 ± 1.07, and the mean postoperative GCS was 13.8 ± 1.7. The 2014 guidelines from the European Stroke Organization indicated that surgery might be of value in patients with a GCS of 9 - 12 [21]. The STICH study involved 1033 patients with spontaneous supra-tentorial ICH enrolled within 72 hours after stroke with the ICH diameter more than 2cm and a GCS of 5 or more was considered [22]. Many studies in the endoscopic technique series involved patients with GCS ≥ 4 [15] [23] [33]-[35]. Li *et al.* conducted study comparing the safety and efficacy of stereotactic aspiration, endoscopic Surgery, and craniotomy in spontaneous ICH over 99 patients with GCS (4 - 14) [24]. Wang *et al.* compared the results of endoscopic Vs craniotomy techniques in spontaneous ICH in 45 patients with GCS (4 - 14) [13]. GCS was important predictor of level of disability and mortality in many published series [25]-[27]. In comparison of efficacy of stereotactic aspiration, endoscopic surgery, and craniotomy, there was no statistical significance of the mean GCS on admission between the 3 groups as mentioned by Li *et al.* [24]. The ICH volume has been consistently associated with the outcome in the ICH prediction models [6]. The preoperative hematoma volume is important variable that was linked to morbidity and poor outcome in many series [23] [27] [29]. The hematoma size in our group on preoperative CT ranged from 40 - 120 cc with median 50 (60 - 70) cc and hematomas size on postoperative CT ranged from 0 - 27.5 cc with median 6 (0.5 - 17) cc. The difference between pre- and post-operative volume was statistically highly significant (P = 0.001). G. Barbara *et al.* could achieve good outcome only with hematoma volume 20 - 50 ml^3 [30]. Bhaskar *et al.*, reported that the mortality rate at 3 months was found to be directly proportional to the volume of hematoma (P = 0.039) with 100% mortality for patients with a volume > 90 ml and the mortality was 56.4% in patients with volume in the range of 31 - 60 ml whereas it was 81% in patients with the volume in the range of 61 - 90 ml^3 [23]. Ma *et al.*, reported in the endoscopic series of 24 patients that, mean hematoma volumes were 45.48 ml preoperatively and 5.51 ml postoperatively (P value = 0), and the mean evacuation rate was 87%. [17] The evacuation rate reported by the published endoscopic series using similar techniques (i.e., transparent sheath and endoscope) ranged from 80% to 99% [11] [15] [31]-[33]. In comparison between stereotactic aspiration, endoscopic and open surgery for ICH, Li *et al.*, reported a much lower GOS score (2.8 ± 1.6 score) in the craniotomy group than the other 2 groups (P = 0.017). For patients with Hematoma volume 30 - 60 mL or GCS score 9 - 14, the GOS score in the craniotomy group was the lowest among the 3 groups with statistically significant (P > 0.05). While for patients with large hematoma (>60 mL) or poor consciousness (GCS score 4 - 8), Endoscopic surgery group exhibited the highest GOS score among the 3 groups (P < 0.05) [24]. Li *et al.* also reported a shorter in-ICU and in-hospital stay in the 2 minimally invasive surgery groups as compared with the craniotomy group because of the lower postoperative comorbidity and immediate release of intracranial pressure after operation [24]. Kuo *et al.*, reported mortality rate of 5.9% (4 of 68 patients) who were endoscopically evacuated and Surgery-related morbidity occurred in 3 cases (4.4%) in the form of wound infections and re-bleeding [15]. Using the criterion of a GOS score > 4, Nishihara *et al.*, reported 55% good outcome in 27 patients who underwent endoscopic evacuation at 6 months' follow-up [16]. Regarding the patients in our series, 15 patients were discharged without deficit 33.33% (GOS 5), 18 patients were discharged with mild weakness-present before evacuation-40% (GOS 4) ,3 patients were discharged with profound weakness (severe disability) 6.67% (GOS 3), 9 patients died 20% (GOS 1) which is not a surgical death. The hospital stay of the studied patients ranged from 2 to 9 days with median (IQR) of 5 (3 - 7), with no statistical significance in relation to mortality. There are a lot of factors reported in literature related to poor outcome or mortality in spontaneous ICH: low GCS score on admission, large hematoma size, intraventricular extension of blood, and patient's age, gender, deep coma, ataxic respiration, abnormal pupils, acute hypertension [27] [29] [34]-[40]. In our series, 9 cases (20%) who died, died from secondary infection, and had hematoma size not exceeding 70 cc. With a pre-operative GCS of at least than 12 which improved after evacuation. We needed to do surgical debridement for only one of the infected cases but without improvement. We didn't re-operate upon any of our cases due to re-bleeding or symptomatizing residual. There were no Intraventricular haemorrhages in our series. No cases of postoperative seizures occurred, CSF leak or recollection of hematoma.

6. Conclusion

Endoscopic technique is a safe surgical option for evacuation of spontaneous ICH. This minimally invasive technique could be helpful to provide better, less invasive, less tissue trauma, shorter surgical duration, and short-term outcomes and recovery. Patient selection is a very important prognostic factor. Using the endoscope can create a better view of hidden angles, reduce craniotomy-associated bleeding, and enhance time efficiency.

Conflicts of Interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

References

[1] Qureshi, A.I., Tuhrim, S., Broderick, J.P., Batjer, H.H., Hondo, H. and Hanley, D.F. (2001) Spontaneous Intracerebral Hemorrhage. *New England Journal of Medicine*, **344**, 1450-1460. https://doi.org/10.1056/nejm200105103441907

[2] Intiso, D., Stampatore, P., Zarrelli, M.M., Guerra, G.L., Arpaia, G., Simone, P., *et al.* (2003) Incidence of First-Ever Ischemic and Hemorrhagic Stroke in a Well-Defined Community of Southern Italy, 1993-1995. *European Journal of Neurology*, **10**, 559-565. https://doi.org/10.1046/j.1468-1331.2003.00648.x

[3] An, S.J., Kim, T.J. and Yoon, B. (2017) Epidemiology, Risk Factors, and Clinical Features of Intracerebral Hemorrhage: An Update. *Journal of Stroke*, **19**, 3-10. https://doi.org/10.5853/jos.2016.00864

[4] O'Donnell, M.J., Xavier, D., Liu, L., Zhang, H., Chin, S.L., Rao-Melacini, P., *et al.* (2010) Risk Factors for Ischaemic and Intracerebral Haemorrhagic Stroke in 22 Countries (the INTERSTROKE Study): A Case-Control Study. *The Lancet*, **376**, 112-123. https://doi.org/10.1016/s0140-6736(10)60834-3

[5] Schlunk, F. and Greenberg, S.M. (2015) The Pathophysiology of Intracerebral Hemorrhage Formation and Expansion. *Translational Stroke Research*, **6**, 257-263. https://doi.org/10.1007/s12975-015-0410-1

[6] Tatu, L., Moulin, T., El Mohamad, R., Vuillier, F., Rumbach, L. and Czorny, A. (2000) Primary Intracerebral Hemorrhages in the Besançon Stroke Registry: Initial Clinical and CT Findings, Early Course and 30-Day Outcome in 350 Patients. *European Neurology*, **43**, 209-214. https://doi.org/10.1159/000008177

[7] Hsieh, P., Cho, D., Lee, W. and Chen, J. (2005) Endoscopic Evacuation of Putaminal Hemorrhage: How to Improve the Efficiency of Hematoma Evacuation. *Surgical Neurology*, **64**, 147-153. https://doi.org/10.1016/j.surneu.2004.11.028

[8] Hemphill, J.C., Greenberg, S.M., Anderson, C.S., Becker, K., Bendok, B.R., Cushman, M., *et al.* (2015) Guidelines for the Management of Spontaneous Intracerebral Hemorrhage. *Stroke*, **46**, 2032-2060. https://doi.org/10.1161/str.0000000000000069

[9] Morgenstern, L.B., Hemphill, J.C., Anderson, C., Becker, K., Broderick, J.P., Connolly, E.S., *et al.* (2010) Guidelines for the Management of Spontaneous Intracerebral Hemorrhage. *Stroke*, **41**, 2108-2129. https://doi.org/10.1161/str.0b013e3181ec611b

[10] Aghi, M.K., Ogilvy, C.S. and Carter, B.S. (2012) Surgical Management of Intracerebral Hemorrhage. In: Quiñones-Hinojosa, A., Ed., *Schmidek and Sweet Operative Neurosurgical Techniques*, Elsevier, 823-836. https://doi.org/10.1016/b978-1-4160-6839-6.10069-3

[11] Miller, C.M., Vespa, P., Saver, J.L., Kidwell, C.S., Carmichael, S.T., Alger, J., *et al.* (2008) Image-Guided Endoscopic Evacuation of Spontaneous Intracerebral Hemorrhage. *Surgical Neurology*, **69**, 441-446. https://doi.org/10.1016/j.surneu.2007.12.016

[12] Beynon, C., Schiebel, P., Bösel, J., Unterberg, A.W. and Orakcioglu, B. (2015) Minimally Invasive Endoscopic Surgery for Treatment of Spontaneous Intracerebral Haematomas. *Neurosurgical Review*, **38**, 421-428. https://doi.org/10.1007/s10143-015-0606-6

[13] Wang, W., Hung, Y., Hsu, S.P.C., Lin, C., Chen, H., Shih, Y., *et al.* (2015) Endoscopic Hematoma Evacuation in Patients with Spontaneous Supratentorial Intracerebral Hemorrhage. *Journal of the Chinese Medical Association*, **78**, 101-107. https://doi.org/10.1016/j.jcma.2014.08.013

[14] Zurasky, J.A., Aiyagari, V., Zazulia, A.R., Shackelford, A. and Diringer, M.N. (2005) Early Mortality Following Spontaneous Intracerebral Hemorrhage. *Neurology*, **64**, 725-727. https://doi.org/10.1212/01.wnl.0000152045.56837.58

[15] Kuo, L., Chen, C., Li, C., Tsai, J., Chiu, H., Liu, L., *et al.* (2011) Early Endoscope-Assisted Hematoma Evacuation in Patients with Supratentorial Intracerebral Hemorrhage: Case Selection, Surgical Technique, and Long-Term Results. *Neurosurgical Focus*, **30**, E9. https://doi.org/10.3171/2011.2.focus10313

[16] Nishihara, T., Morita, A., Teraoka, A. and Kirino, T. (2007) Endoscopy-Guided Removal of Spontaneous Intracerebral Hemorrhage: Comparison with Computer Tomography-Guided Stereotactic Evacuation. *Child's Nervous System*, **23**, 677-683. https://doi.org/10.1007/s00381-007-0325-6

[17] Ma, L., Hou, Y., Zhu, R. and Chen, X. (2017) Endoscopic Evacuation of Basal Ganglia Hematoma: Surgical Technique, Outcome, and Learning Curve. *World Neurosurgery*, **101**, 57-68. https://doi.org/10.1016/j.wneu.2017.01.072

[18] Basaldella, L., Marton, E., Fiorindi, A., Scarpa, B., Badreddine, H. and Longatti, P. (2012) External Ventricular Drainage Alone versus Endoscopic Surgery for Severe Intraventricular Hemorrhage: A Comparative Retrospective Analysis on Outcome and Shunt Dependency. *Neurosurgical Focus*, **32**, E4. https://doi.org/10.3171/2012.1.focus11349

[19] Zhou, X., Chen, J., Li, Q., Ren, G., Yao, G., Liu, M., *et al.* (2012) Minimally Invasive Surgery for Spontaneous Supratentorial Intracerebral Hemorrhage. *Stroke*, **43**, 2923-2930. https://doi.org/10.1161/strokeaha.112.667535

[20] Nishihara, T., Nagata, K., Tanaka, S., Suzuki, Y., Izumi, M., Mochizuki, Y., *et al.* (2005) Newly Developed Endoscopic Instruments for the Removal of Intracerebral Hematoma. *Neurocritical Care*, **2**, 67-74. https://doi.org/10.1385/ncc:2:1:067

[21] Steiner, T., Salman, R.A., Beer, R., Christensen, H., Cordonnier, C., Csiba, L., *et al.* (2014) European Stroke Organisation (ESO) Guidelines for the Management of Spon-

taneous Intracerebral Hemorrhage. *International Journal of Stroke*, **9**, 840-855. https://doi.org/10.1111/ijs.12309

[22] Mendelow, A., Gregson, B., Fernandes, H., Murray, G., Teasdale, G., Hope, D., *et al.* (2005) Early Surgery versus Initial Conservative Treatment in Patients with Spontaneous Supratentorial Intracerebral Haematomas in the International Surgical Trial in Intracerebral Haemorrhage (STICH): A Randomised Trial. *The Lancet*, **365**, 387-397. https://doi.org/10.1016/s0140-6736(05)70233-6

[23] Bhaskar, M., Kumar, R., Ojha, B., Singh, S., Verma, N., Verma, R., *et al.* (2017) A Randomized Controlled Study of Operative versus Nonoperative Treatment for Large Spontaneous Supratentorial Intracerebral Hemorrhage. *Neurology India*, **65**, 752-758. https://doi.org/10.4103/neuroindia.ni_151_16

[24] Li, Y., Yang, R., Li, Z., Yang, Y., Tian, B., Zhang, X., *et al.* (2017) Surgical Evacuation of Spontaneous Supratentorial Lobar Intracerebral Hemorrhage: Comparison of Safety and Efficacy of Stereotactic Aspiration, Endoscopic Surgery, and Craniotomy. *World Neurosurgery*, **105**, 332-340. https://doi.org/10.1016/j.wneu.2017.05.134

[25] Davis, S.M., Broderick, J., Hennerici, M., Brun, N.C., Diringer, M.N., Mayer, S.A., *et al.* (2006) Hematoma Growth Is a Determinant of Mortality and Poor Outcome after Intracerebral Hemorrhage. *Neurology*, **66**, 1175-1181. https://doi.org/10.1212/01.wnl.0000208408.98482.99

[26] Gregson, B.A. and Mendelow, A.D. (2003) International Variations in Surgical Practice for Spontaneous Intracerebral Hemorrhage. *Stroke*, **34**, 2593-2597. https://doi.org/10.1161/01.str.0000097491.82104.f3

[27] Lisk, D.R., Pasteur, W., Rhoades, H., Putnam, R.D. and Grotta, J.C. (1994) Early Presentation of Hemispheric Intracerebral Hemorrhage. *Neurology*, **44**, 133. https://doi.org/10.1212/wnl.44.1.133

[28] Broderick, J.P., Brott, T.G., Duldner, J.E., Tomsick, T. and Huster, G. (1993) Volume of Intracerebral Hemorrhage. a Powerful and Easy-To-Use Predictor of 30-Day Mortality. *Stroke*, **24**, 987-993. https://doi.org/10.1161/01.str.24.7.987

[29] Qureshi, A.I., Safdar, K., Weil, E.J., Barch, C., Bliwise, D.L., Colohan, A.R., *et al.* (1995) Predictors of Early Deterioration and Mortality in Black Americans with Spontaneous Intracerebral Hemorrhage. *Stroke*, **26**, 1764-1767. https://doi.org/10.1161/01.str.26.10.1764

[30] Gregson, B.A., Broderick, J.P., Auer, L.M., Batjer, H., Chen, X., Juvela, S., *et al.* (2012) Individual Patient Data Subgroup Meta-Analysis of Surgery for Spontaneous Supratentorial Intracerebral Hemorrhage. *Stroke*, **43**, 1496-1504. https://doi.org/10.1161/strokeaha.111.640284

[31] Nishihara, T., Teraoka, A., Morita, A., Ueki, K., Takai, K. and Kirino, T. (2000) A Transparent Sheath for Endoscopic Surgery and Its Application in Surgical Evacuation of Spontaneous Intracerebral Hematomas. *Journal of Neurosurgery*, **92**, 1053-1055. https://doi.org/10.3171/jns.2000.92.6.1053

[32] Nagasaka, T., Inao, S., Ikeda, H., Tsugeno, M. and Okamoto, T. (2008) Inflation-deflation Method for Endoscopic Evacuation of Intracerebral Haematoma. *Acta Neurochirurgica*, **150**, 685-690. https://doi.org/10.1007/s00701-008-1561-6

[33] Nagasaka, T., Tsugeno, M., Ikeda, H., Okamoto, T., Inao, S. and Wakabayashi, T. (2011) Early Recovery and Better Evacuation Rate in Neuroendoscopic Surgery for Spontaneous Intracerebral Hemorrhage Using a Multifunctional Cannula: Preliminary Study in Comparison with Craniotomy. *Journal of Stroke and Cerebrovascular Diseases*, **20**, 208-213. https://doi.org/10.1016/j.jstrokecerebrovasdis.2009.11.021

[34] Wang, W., Jiang, B., Liu, g., Li, D., Lu, C., Zhao, Y., *et al.* (2009) Minimally Invasive Craniopuncture Therapy vs. Conservative Treatment for Spontaneous Intracerebral Hemorrhage: Results from a Randomized Clinical Trial in China. *International Journal of Stroke*, **4**, 11-16. https://doi.org/10.1111/j.1747-4949.2009.00239.x

[35] Hallevi, H., Albright, K.C., Aronowski, J., Barreto, A.D., Martin-Schild, S., Khaja, A.M., *et al.* (2008) Intraventricular Hemorrhage. *Neurology*, **70**, 848-852. https://doi.org/10.1212/01.wnl.0000304930.47751.75

[36] Orakcioglu, B., Beynon, C., Bösel, J., Stock, C. and Unterberg, A.W. (2014) Minimally Invasive Endoscopic Surgery for Treatment of Spontaneous Intracerebral Hematomas: A Single-Center Analysis. *Neurocritical Care*, **21**, 407-416. https://doi.org/10.1007/s12028-014-9987-6

[37] Cho, D., Chen, C., Chang, C., Lee, W. and Tso, M. (2006) Endoscopic Surgery for Spontaneous Basal Ganglia Hemorrhage: Comparing Endoscopic Surgery, Stereotactic Aspiration, and Craniotomy in Noncomatose Patients. *Surgical Neurology*, **65**, 547-555. https://doi.org/10.1016/j.surneu.2005.09.032

[38] Oudrhiri, M.Y., Bechri, H., Dokponou, Y.C.H., Arkha, Y. and El Ouahabi, A. (2025) Patient Selection Criteria and Preliminary Outcome of the First 20 Endoscopic Evacuation of Intracerebral Hematoma in a Tertiary Hospital Center. *Surgical Neurology International*, **16**, Article 190. https://doi.org/10.25259/sni_98_2025

[39] Pradilla, G., Ratcliff, J.J., Hall, A.J., Saville, B.R., Allen, J.W., Paulon, G., *et al.* (2024) Trial of Early Minimally Invasive Removal of Intracerebral Hemorrhage. *New England Journal of Medicine*, **390**, 1277-1289. https://doi.org/10.1056/nejmoa2308440

[40] Zhao, Y. and Chen, X. (2016) Endoscopic Treatment of Hypertensive Intracerebral Hemorrhage: A Technical Review. *Chronic Diseases and Translational Medicine*, **2**, 140-146. https://doi.org/10.1016/j.cdtm.2016.11.002