

## Research Paper

# A Comparative Study on Therapeutic Modalities of Spontaneous Supratentorial Intracerebral Hemorrhage at a Teaching Institute



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## ABSTRACT

**Background and Aim:** To evaluate immediate outcomes and prognostic factors in surgical and medical treatment for spontaneous supratentorial intracerebral hemorrhage (SICH).

**Methods and Materials/Patients:** We prospectively investigated the two treatment groups, medical (88 patients) and surgical (40 patients), based on standard guidelines between May 2018 and November 2019. Immediate outcomes in the two groups were measured using the Glasgow outcome scale (GOS) at three months. Prognostic factors in the two groups were compared using the chi-square test.

**Results:** Of 128 patients with spontaneous SICH, 88 were in the medical group, and 40 were in the surgical group. The mean age of the medical group was 57±13 years, and that of the surgical group was 53.7±12 years. In both groups, the predominant bleeding site was the left capsuloganglionic region. Hypertension was the most common risk factor in both groups (90%). In the medical group (n=88), 57 patients (65%) had good outcomes, and 31 patients (35%) had poor outcomes. In the surgical group (n=40), 19 patients (48%) had good outcomes, and 21 patients (35%) had poor outcomes. Mortality rates were 25% (n=22) in the medical group and 30% (n=12) in the surgical group till 3 months. Patients in our surgical group with intracerebral hemorrhage (ICH) score of 3 had a poorer outcome (68%) and lower mortality (46%) than those in the medical group (66% poor outcome and 55% mortality). The medical group with intraventricular hemorrhage (IVH) (n=28) had poor and good outcomes in 71% and 29% of cases, respectively. The surgical group with IVH (n=20) had poor outcomes in 85% of cases and good outcomes in 15% of cases. The medical and surgical groups without IVH had similar good outcomes in 80% of the cases.

**Conclusion:** The surgical group had improved outcomes compared to the medical group containing patients with midline shift >6 mm, >30 cc of bleed, and Glasgow coma scale (GCS) 8-12. With higher ICH scores and IVH, the surgical group showed poorer outcomes and fewer deaths.

### Keywords:

Supratentorial, Intracerebral hemorrhage, Glasgow coma scale, Glasgow outcome scale (GOS), Decompressive craniectomy (DC)

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## Highlights

- We studied various prognostic factors and immediate outcomes in two treatment groups of spontaneous supratentorial intracerebral hemorrhage (SICH).
- The surgical treatment group had better outcomes than the medical treatment group if SICH patients had a Glasgow coma scale (GCS) 8-12, >30 cc of bleed, and a midline shift of >6 mm.
- If associated with intraventricular hemorrhage (IVH) and higher intracerebral hemorrhage (ICH) but with greater survival, the surgical treatment group had poor outcomes than the medical treatment group.

## Plain Language Summary

We enrolled all patients with spontaneous SICH and created two groups based on treatments, that is, medical and surgical, to evaluate various prognostic factors and outcomes. We did not observe surgical or medical treatment superiority in low-income countries when compared. The surgical group showed fewer deaths but had poor outcomes if associated with a higher ICH score and IVH. The medical group showed improved outcomes overall, but not if associated with midline shift >6 mm, >30 cc bleed, and GCS of 8-12. We highlight the importance of individualized treatment protocols based on assessing various prognostic factors.

### 1. Introduction

**S**pontaneous supratentorial intracerebral hemorrhage (SICH) accounts for 10%-15% of all strokes [1]. Intracerebral hemorrhage (ICH) appears to be more common in Eastern countries, accounting for up to 30% of strokes, with an overall mortality rate of 40% to 50% [2, 3]. The treatment of patients with ICH is complex in many ways. Apart from standard medical treatments, no novel therapies have been introduced to improve outcomes. Despite preventing hematoma enlargement, recombinant activated factor VII treatment showed no beneficial effect on outcome in a randomized placebo-controlled clinical trial [4]. Surgery has the potential to reduce the volume of intracerebral hematomas. Clinical and experimental evidence suggests that mass removal may reduce damage to nervous tissue. There are also wide variations in surgical practices among countries. Trials in specific populations of ICH patients have focused on hematoma evacuation alone, such as the International Surgical Trial in ICH (STICH) [5]. This landmark trial demonstrated that emergent surgical hematoma evacuation of superficial lobar hemorrhages within 72 h of onset failed to improve outcomes compared with standard medical management. The results of the International Surgical Trial in ICH (STICH)-II demonstrated that early surgery did not improve the rate of death or disability at 6 months but suggested a slight survival advantage for patients with ICH who did not have intraventricular hemorrhage (IVH) or hydrocephalus [6].

We aimed to study prognostic factors and immediate outcomes in surgical and medical treatment groups of patients with SICH because these health data are vital for individualized stroke management protocols, as no universal recommendation exists. In lower middle-income countries (LMIC), there is wide variation in healthcare infrastructure and availability of timely healthcare for emergencies, such as brain stroke. Hence, identifying definite prognostic factors, designing and implementing policies of stroke management, making prompt and accurate diagnoses, stratifying patients according to outcome predictors, and thus ensuring prompt referral of deserving critical patients to tertiary centers for intensive management may be the need of the hour as we wait to embrace the newer advances into our management protocol. This study aimed to compare the various prognostic factors in both medical treatment and surgical treatment groups. The immediate outcomes of the best medical management and surgery treatment groups were also estimated.

### 2. Methods and Materials/Patients

The study was conducted after approval by the Institutional Scientific Committee and Institutional Ethical Committee (AS/11/IEC/SVIMS/2017 vide IEC No 762). Written informed consent was obtained from all patients before the study. All patients diagnosed with spontaneous SICH who presented to the Department of Neurology and Neurosurgery at Tertiary Medical College and met the inclusion criteria between May 2018 and November 2019 were included in the study.



Our study is a prospective observational study, and the study population is mentioned below.

#### Inclusion criteria

1. Diagnosed spontaneous SICH on plain computed tomography (CT) brain scans
2. Age range of 18 to 80 years
3. Supratentorial ICH

#### Exclusion criteria

1. Age <18 and >80 years of age
2. ICH secondary to trauma, tumor, arterial venous malformation, aneurysm rupture, and cerebral sinuous venous thrombosis
3. Cerebellar hematoma
4. Unwillingness to participate in the study

#### Data collection

Detailed clinical history was recorded, including demographic data, presenting complaints, history of present illness, personal history, and drug history. All participants underwent detailed physical and neurological examinations. Glasgow coma scale (GCS) score, ICH score were also recorded.

The selected patients performed all necessary blood examinations, and the functional outcome of surgical and medical treatment was measured using the Glasgow outcome scale (GOS) at 3 months.

#### Medical treatment

The appropriate feasible medical treatment was administered according to American Heart Association/ American Stroke Association guidelines. In conscious patients, a systolic blood pressure of 160 mm Hg was used. Patients with a GCS  $\leq 8$  are ventilated and sedated. Management of increased intracranial pressure included cerebrospinal fluid drainage using an external ventricular drain (EVD), neuromuscular blockade, and sedation. Anticoagulant treatment was stopped and reversed with clotting factors, vitamin K, and protamine. Intermittent pneumatic compression was used to prevent venous thrombosis, and after 36 hours, low-dose fractionated heparin was used.

#### Surgical treatment

The surgical approach was individualized based on the site and size of the ICH due to the lack of standardized guidelines for the allocation of operative treatment. The allowed techniques included open decompressive craniectomy (DC) and hematoma evacuation. Surgical treatment intends to remove the clot completely. Surgery was performed in patients with impending cerebral herniation, as indicated by abnormal pupil response, abnormal posture, or CT findings of absence of ambient cistern or severe midline shifting ( $>6$  mm). Patients with IVH with hydrocephalus underwent EVD insertion.

#### Outcomes

All prognostic factors were measured in both treatment groups. Their immediate outcomes at 3 months were measured using GOS.

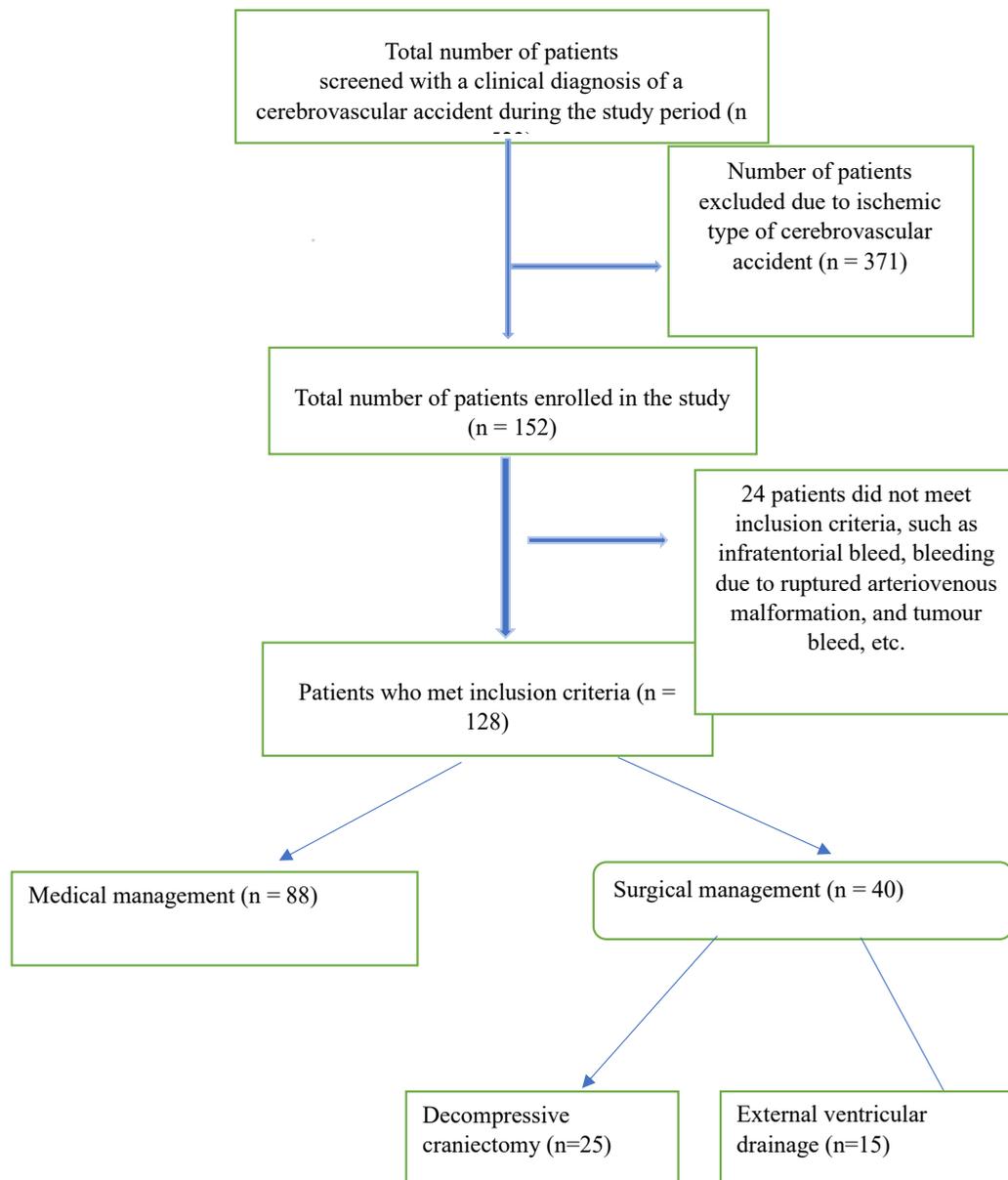
#### Statistical analysis

The data were recorded on a predesigned performance, managed using Microsoft Excel 2007 (Microsoft Corp, Redmond, WA), and analyzed using SPSS software, version 20. Descriptive statistics, such as percentages and frequencies, and inferential statistics, such as the chi-square test, were used during the analysis. The primary analysis was categorical frequency comparison using the chi-square test for prognosis based on favorable and unfavorable outcomes.

### 3. Results

In this prospective observational study, 523 patients with features suggestive of cerebrovascular accidents were screened and subjected to brain CT. A total of 152 patients with spontaneous SICH were identified, of whom 24 were excluded because they did not meet the inclusion criteria. We studied 125 patients with spontaneous SICH, and the data were stratified into two groups based on treatment to evaluate the outcome. Among the 128 patients, 88 underwent medical treatment, 40 underwent surgical management, and among surgery, 25 underwent DC, and 15 underwent (EVD) (Figure 1).

The mean age of the medical group was  $57 \pm 13$  years, while the mean age of the surgical group was  $53.7 \pm 12$  years. Our study included 85 male (66.4%) and 43 female patients (33.6%) (Table 1).



**Figure 1.** Flow diagram of the study



Male/female ratio (M:F) in medical group was 1.6:1; in surgical group, it was 2.6:1 and in total, M:F ratio was 1.9:1 (Figure 2).

#### The laterality and location of ICH

In the medical treatment group, 53 patients (60%) had left-sided bleeding, and the rest, 35 patients (40%), had right-sided bleeding, while in the surgical group, 22 patients had left-sided bleeding (55%), and 18 patient (45%) had right-sided bleeding. In both treatment groups, the bleeding locations were almost similar; capsuloganglionic region (CG) bleeding was 50% in each group, followed by 30% to 35 %

thalamic region bleeding. The lobar location of bleeding was 15% and 10% in the medical group and surgical group, respectively. In the surgical treatment group, 23% of patients had bleeding in the mixed parts of the cerebrum, whereas mixed bleeding cases were less common in the medical treatment group (7%) (Figures 3 and 4).

#### Clinical profile

The range of the clinical spectrum was similar between groups. In our study of 128 patients, 109(85.1%) had headache, 104(81.2%) had altered sensorium, 88(68%) had cranial nerve palsy, 90(70%) had motor deficit, 72(56%)

**Table 1.** Frequency distribution of patient demographic characteristics

Line	Age (y)	No. (%)		
		Male	Female	Total
1	<30	3	0	3(2.3)
2	31-40	11	3	14(11.1)
3	41-50	16	10	26(20.3)
4	51-60	23	11	34(26.5)
5	61-70	23	13	36(28.1)
6	70-80	9	6	15(11.7)
Total		85(66.4)	43(33.6)	128(100)



had aphasia, 68(53%) had convulsions, and 66(51.5%) had vomiting (Table 2).

#### The risk factors with their immediate outcomes

In the medical group, the most common risk factor was hypertension in 78 patients (88%), diabetes in 35 patients (40%), smoking in 42 patients (47%), and alcohol in 38 patients (43%). In the surgical group, hypertension was the most common risk factor observed in 36 patients (90%), diabetes in 30 patients (75%), and alcohol and smoking in 25 patients (62%) and 23 patients (57%), respectively (Tables 3 and 4).

#### GCS range

In the medical group, GCS scores were normal or mild derangement in 50% (44 patients) of SICH cases, moderate derangement in 40% (36 patients), and severe derangement (<8) in 9% of cases. In the surgical group, 37 patients (92.5%) had moderate to severe derangement in scores, among

which 55% (22 cases) had GCS <8 and 38% (15 cases) had GCS 8-12. In the surgical group, the GCS score was normal or mildly deranged in only three patients (7.5%) (Figure 5).

#### The outcomes

In a study of 128 patients, 76 patients (59.3%) had good outcomes, and 52 patients (40.7%) had poor outcomes, 57 patients (64.7%) had good outcomes, and 31 patients (35.3%) had poor outcomes. We observed mortality rates of 25% (22 deaths) in the medical group and 30% (12 deaths) in the surgical group until 3 months.

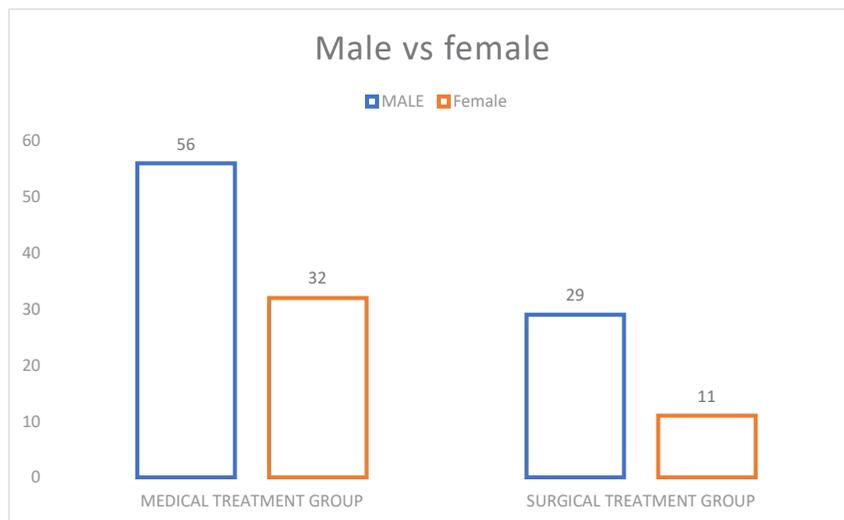
In the surgical group of 40 ICH cases, 19 patients (47.5%) had good outcomes, and 21 patients (52.5%) had poor outcomes; among the surgical group, 25 patients underwent DC, of whom 16(64%) had good outcomes, and 9 patients (36%) had poor outcomes; 15 patients underwent EVD, of whom only three patients had good outcomes, and 12 patients had poor outcomes (Figure 6).

**Table 2.** The clinical profile in both treatment groups

Line	Clinical Features	No. (%)		
		Medical (n=88)	Surgical (n=40)	Total (n=128)
1	Headache	74(84)	35(88)	109(85.1)
2	Altered sensorium	68(77)	36(90)	104(81.2)
3	Motor deficit	55(62.5)	35(88)	90(70)
4	CN palsy	56(63)	32(80)	88(68)
5	Aphasia	48(54)	24(60)	72(56)
6	Convulsion	40(45)	28(70)	68(53)
7	Vomiting	36 (41)	26 (65)	66(51.5)

CN: Cranial nerve.





**Figure 2.** The sex distribution in both treatment groups



### The comparison of prognostic factors

#### Midline shift >6 mm

In our study, 48 patients with midline shifts >6 mm were not eligible for surgical interventions; therefore, among 48 patients, 80% had poor, and 20% had good outcomes. In the surgical group, 52% of patients had good outcomes, and 48% had poor outcomes ( $P<0.005$ ) (Table 5).

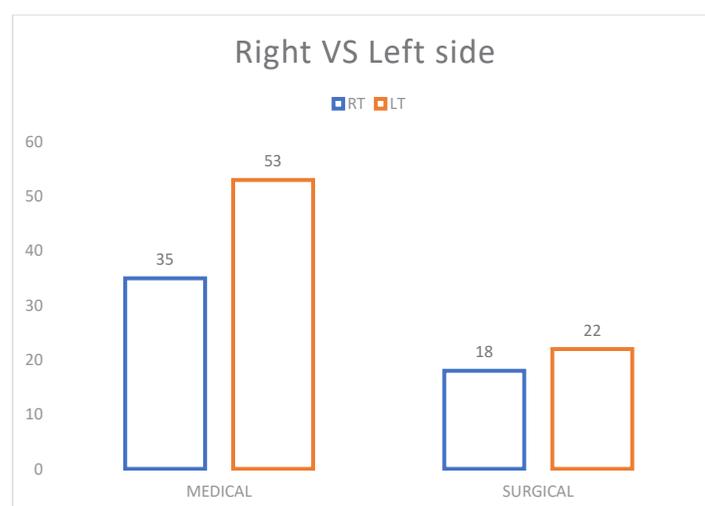
#### >30 cc size of hematoma

In our study, 45 patients with >30 cc hematoma were not included in the surgical intervention. Among 45 patients, 77% had poor and 23% had good outcomes. In the surgical

group, 52% of patients had good outcomes, and 48% had poor outcomes ( $P<0.005$ ) (Table 5).

#### GCS 8-12

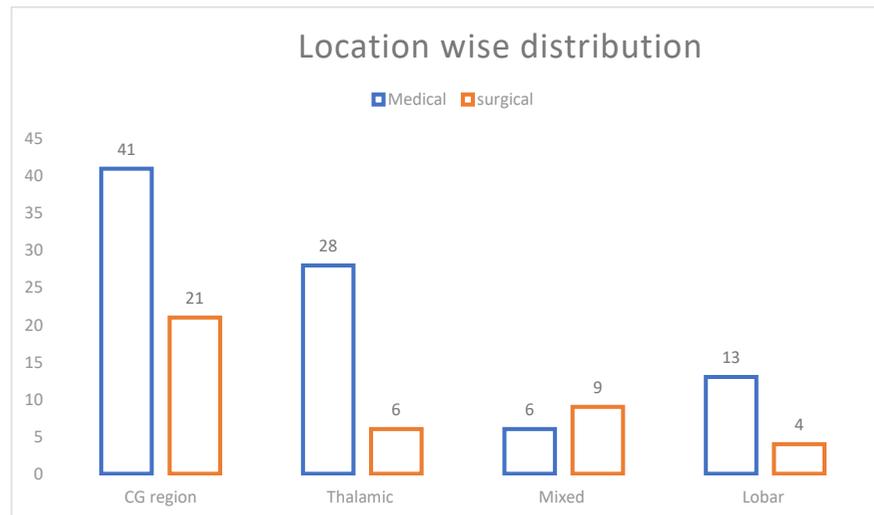
A total of 51 patients had GCS 8-12; 36 patients did not present for surgical interventions; among 36 patients, 52% had poor outcomes, and 48% had good outcomes. A total of 15 patients underwent surgical intervention; among them, 11 patients (73%) had good outcomes, and 4(27%) had poor outcomes. Among the surgical group, 73% of patients had a good outcome, and 27% had a poor outcome ( $P<0.005$ ) (Table 5).



**Figure 3.** The laterality of intracranial bleed in both treatment groups

RT: Right; LT: Left.





**Figure 4.** The location of intracranial hemorrhage s in both treatment groups

CG: Capsuloganglionic.



### The effect of the prognostic scores and sign-in each treatment group on immediate outcome

#### ICH score

**a) Medical group:** ICH score was used to predict the outcome of ICH. In our study, in the medical group, the ICH score was 1 in 25 patients, of whom 23 had a good outcome and 2 had a poor outcome. An ICH score of 2 was observed in 45 patients, of whom 28 had a good outcome, and 17 had a poor outcome. In 18 patients, the ICH score was three among 18 patients; 12 patients had a poor outcome, and six patients had a good outcome.

**b) Surgical group:** In the surgical group, 18 of 18 patients had an ICH score of 2. Twelve patients had a good outcome, and 6 had a poor outcome. In 22 patients, the ICH score

was 3. Among the 22 patients, 15 had poor outcomes, and only 7 had good outcomes.

#### GCS score

The GCS scores of patients on admission GCS was calculated, and patients were grouped into four groups: Patients with GCS <8, 8-12, 13-14 and 15.

**a) Medical group:** In our study, among 88 medically treated patients, eight had GCS <8, 36 had GCS 8-12, 35 had GCS 13-14, and 9 had GCS 15. Eight patients had a GCS <8, among which seven had poor outcomes and one had a good outcome. Among 36 patients in groups 8-12, 17 had good outcomes and 19 had poor outcomes. In the GCS group 13-14, 35 patients were included, among which 32 had good outcomes and only three had poor outcomes.

**Table 3.** The risk factors in medical groups with their immediate outcome

Sr No.	Risk Factors	No.			P
		Good Outcome (n=57)	Poor Outcome (n=31)	Total	
1	Hypertension	49	29	78	0.52
2	Diabetes	12	23	35	0.0003
3	Smoking	30	12	42	0.21
4	Alcoholic	16	22	38	0.004
5	Anticoagulant use	1	7	8	0.001
6	Amyloid angiopathy	5	1	6	0.3



**Table 4.** The risk factors in surgical groups with immediate outcome

Line	Risk Factors	No.			P
		Good Outcome (n=19)	Poor Outcome (n=21)	Total	
1	Hypertension	16	20	36	0.24
2	Diabetes	12	18	30	0.009
3	Smoking	12	13	25	0.93
4	Alcoholic	10	13	23	0.553
5	Anticoagulant use	1	3	4	0.342



**b) Surgical group:** In our study, among 40 patients in the surgical group, 22 patients had GCS <8, 15 patients in the 8-12 groups, and three patients had GCS 13-14.

Among patients with GCS <8, 16 had poor outcomes, and 6 had good outcomes. In the 8-12 groups, 11 patients had good outcomes, and 4 patients had poor outcomes.

#### SICH with IVH

**a) Medical group:** A total of 28 cases were found to be associated with IVH, of whom 71% had poor outcomes and the remaining 29% had good outcomes. The medical group without IVH had good outcomes in 82% of cases.

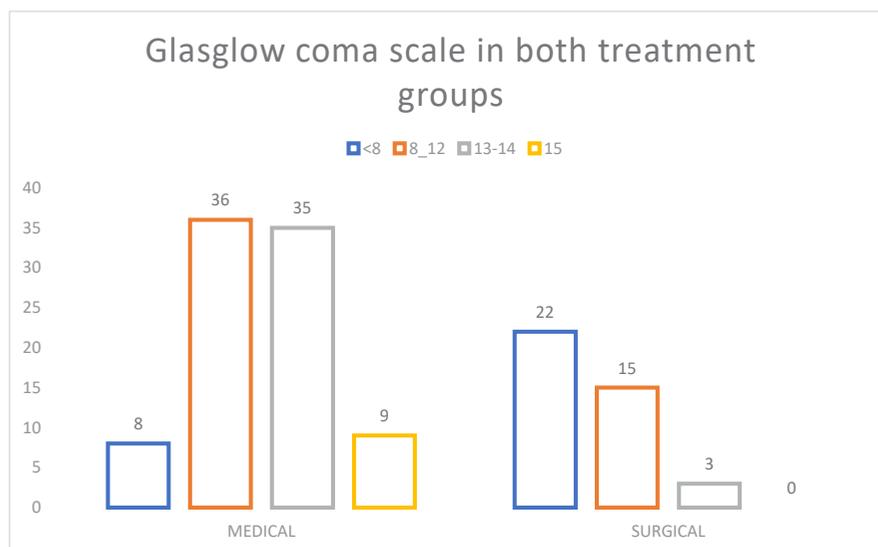
**b) Surgical group:** In the surgical group, 20 cases had IVH. The surgical group with IVH had 85% poor outcomes and

15% good outcomes, while the surgical group without IVH had good outcomes in 80% of cases (Tables 6 and 7).

#### The comparison of the health complications

**a) Medical group:** The common complications in the surgical group were respiratory infection (39%), hyponatremia (39%), urinary tract infection (UTI): 34%, ventilator-associated pneumonia (VAP): 20%, and 2% cases observed to have rebleeding.

**b) Surgical group:** Hyponatremia was observed in maximum patient (85%). Respiratory tract infections were also observed in most cases (70%), followed by UTI (63%), VAP (55%), and hyperglycaemia (40%). The number of rebleeding cases was higher than in the medical group (10%) (Figure 7).

**Figure 5.** GCS range in both treatment groups

**Table 5.** The prognostic factors in both groups

Prognostic Factors	Treatment Group	No. (%)		No. Total Patients	P
		Good Outcome	Poor Outcome		
The midline shift >6 mm	Medical treatment	10(20)	38(80)	48	0.005
	Surgical treatment	13(52)	12(48)		
>30 cc of hematoma	Medical treatment	11(23)	34(77)	45	0.005
	Surgical treatment	13(52)	12(48)		
GCS scale 8-12	Medical treatment	17(48)	19(52)	36	0.004
	Surgical treatment	11(73)	4(27)		

GCS: Glasgow coma scale.



**The factors affecting the immediate outcomes irrespective of treatment received**

When all ICH cases had poor outcomes compared with good outcomes regardless of the treatment group, hypertension (mean arterial pressure >130), midline shift (>30 cc), and hydrocephalus were significant risk factors. We have observed that any hospital-acquired infection or ventilator support requirement also affected the outcome irrespective of the treatment group (Table 8).

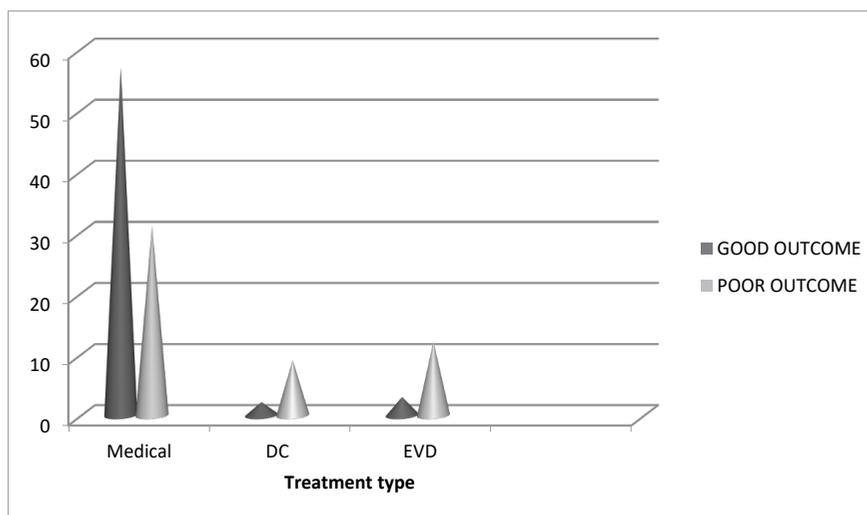
**4. Discussion**

The maximum number of patients was in the age group 51-60 years and 61-70 years (54%) in our study. The mean age of patients in the medical group was 57±13 years, while the mean age in the surgical group was 53.7±12 years. In the study by Hu et al., the mean age was 57.9 years,

similar to our study [7]. Wasay et al. also showed a mean age of 55 in their study [8]. The age of presentation also plays a pivotal role in spontaneous stroke, with a higher age indicating a higher risk of poor prognosis. However, findings of most studies from lower-middle-income countries reported that the younger patients with stroke suggested modification in age for risk calculation [9]. In our study, 85 patients (66.4%) were men and 43(33.6%) were women. Our M:F ratio was 1.9:1. In a study by Bhatia et al., male preponderance (65.4%) was observed [10]. Sang Joon An et al., in this review, concluded that the male sex is a nonmodifiable risk factor for ICH [11].

**Location and laterality of spontaneous SICH**

The timely management of stroke patients and prognostication require vital information about the site of ICH and, to some extent, the laterality of intracranial



**Figure 6.** Treatment type and their immediate outcome

DC: Decompressive craniectomy; EVD: External ventricular drainage.



**Table 6.** The prognostic score and sign-in medical treatment group

The Prognostic Score in the Medical Treatment Group					
Name	Score	Good Outcome	Poor Outcome	Total	P
ICH	1	23	2	25	0.0001
	2	28	17	45	
	3	6	12	18	
GCS	<8	1	7	8	0.0032
	8-12	17	19	36	
	13-14	32	3	35	
	15	7	2	9	

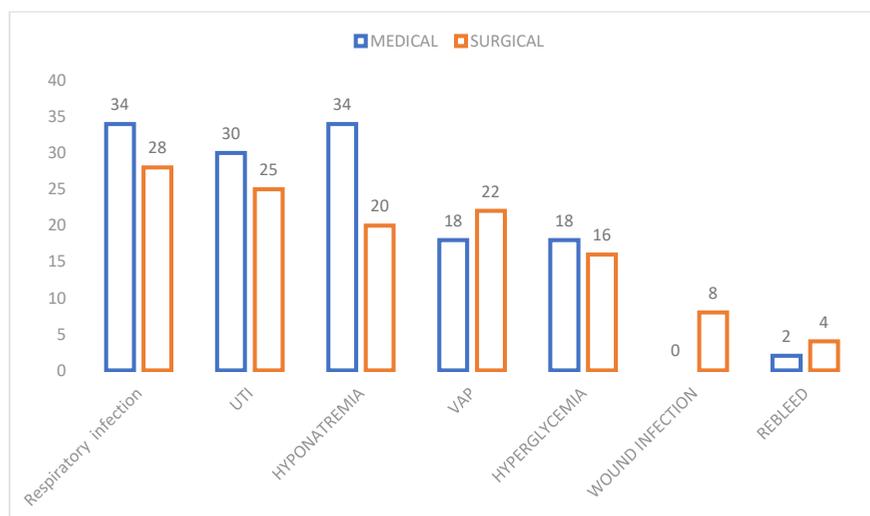
  

The Prognostic Sign-in Medical Treatment Group					
Name	Present/Absent	Good Outcome	Poor Outcome	Total	P
IVH	Present	8	20	28	0.0002
	Absent	49	11	60	

Abbreviations: ICH: Intracranial hemorrhage; GCS: Glasgow coma scale; IVH: Intraventricular hemorrhage.

bleeding. The infratentorial location is a proven poor prognostic factor for ICH, but the supratentorial location still varies in type and prognosis. The most common areas of spontaneous SICH were the capsuloganglionic region (48%), thalamic region (26%), and lobar region (13%) in our study. Bhatia et al. found that the most common sites of hematoma were capsuloganglionic (70.6%), thalamic (16.8%), and lobar (4.2%), similar to ours [10]. In a study

by Moussa and Khedr, the most common site for SICH was the basal ganglia (55%), and lobar bleeding was observed in 10% of cases [12]. An international multicenter randomized control trial (RCT) titled “intensive blood pressure reduction in acute cerebral hemorrhage trial (INTERACT)” by Anderson et al. showed that the posterior limb of the internal capsule and thalamus carries a high risk of mortality and significant follow-up disability [13,

**Figure 7.** The comparison of the health complications in both treatment groups

UTI: Urinary tract infection; VAP: Ventilator-associated pneumonia.

**Table 7.** The prognostic score and sign-in surgical treatment group

The Prognostic Score in the Surgical Treatment Group					
Name	Score	Good Outcome	Poor Outcome	Total	P
ICH	1	0	0	0	0.02
	2	12	6	18	
	3	7	15	22	
GCS	<8	6	16	22	0.01
	8-12	11	4	15	
	13-14	2	1	3	
	15	0	0	0	

The Prognostic Sign-in Surgical Treatment Group					
Name	Present/Absent	Good Outcome	Poor Outcome	Total	P
IVH	Present	3	17	20	0.0003
	Absent	16	4	20	

Abbreviations: ICH: Intracranial hemorrhage; GCS: Glasgow coma scale; IVH: Intraventricular hemorrhage.



14]. The INTERACT showed higher mortality in right-sided ICH. We observed a similar profile of location and laterality in both treatment groups, except for the predominance of mixed-type bleeding in the surgical group, even though the number of patients was less in a single-center study.

**Clinical profile:** Headache was the predominant symptom in both groups of patients. Patients in the surgical group had a higher percentage of encephalopathy, focal neurological deficits, and seizures compared to the medical group, but this difference was insignificant. There is a crossover of patients from the medical group to the surgical groups as per the progress of ICH and the need for surgical intervention for patients from the medical group. The selection of spontaneous ICH patients for surgery and the ideal timing of surgical intervention is still unknown; hence, the results of most ICH surgical randomized trials are inconclusive [15].

#### The risk factors for spontaneous SICH

Risk factors for spontaneous SICH have been extensively studied. The literature on risk factors for spontaneous SICH reported two major categories, lobar and non-lobar ICH. A systematic review and meta-analysis (SRMA) on the risk factors of ICH by Jolink et al. involving 26174 patients has shown that hypertension is a risk factor for both types of

spontaneous ICH whereas various modifiable risk factors, such as diabetes mellitus, alcohol, lesser weight, and non-modifiable risk factors, such as male sex and black race for non-lobar ICH. Factors, such as smoking, hyperlipidemia, and obesity did not affect the risk of spontaneous SICH [16]. Hypertension (89%) was a significant risk factor in our study. We also observed no significant effect of smoking on either group. Al-Shahi Salman et al., in their patient data SRMA involving 5,076 on predictors and absolute risk of spontaneous SICH, showed that anticoagulant use is an independent predictor of ICH [17]. We observed a statistically significant effect of anticoagulant use in the medical group but not in the surgical group.

#### GCS range in spontaneous SICH

GCS has been a part of most of the prognostic scores used in managing ICH. Severe low GCS (<8) during ICH diagnosis is associated with poor outcomes, ranging from 60% to 100% in LMIC studies. With severely low GCS scores, we observed a poor outcome in 87% of cases in the medical group, with a slightly poorer outcome in 73% of the surgical group. Our results are consistent with those of previous studies in similar populations from LMIC [9, 18]. Compared to the medical group, a surgical group with a low GCS score had a poorer outcome, indicating that GCS alone may not be valid for the prognostication of surgical patients.



**Table 8.** The factors affecting the immediate outcomes irrespective of treatment received

Line	Factors	Good Outcome (n=76)	Poor Outcome (n=52)	P	
1	Age (median)	54.6	60.7	-	
2	Sex	Male	46	39	-
		Female	30	13	
3	MAP >130	22	47	0.0001	
4	Midline shift presence (n=74)	16	38	0.00001	
5	Hydrocephalus (n=18)	4	14	0.0005	
6	Volume of clot	>30	24	46	0.0001
		RS infection	28	34	0.001
		UTI	29	32	0.009
		VAP	20	30	0.0003
		Fever	26	24	0.173
		Hyponatremia	16	38	0.0001
		Hyperglycemia	18	30	0.0009
		Wound infection	5	3	-
7	Complication	Rebleed	2	4	0.9
		Need of ventilatory support	21	47	0.0003

Abbreviations: MAP: Mean arterial pressure; UTI: Urinary tract infection; VAP: Ventilator-associated pneumonia.



### Treatment type and outcome at 3 months by GOS

In our surgical group, most patients underwent DC (63%), and the rest underwent EVD (37%). Despite advancements in the medical management of spontaneous SICH, the optimal surgical strategy remains unknown. Gregson et al.'s meta-analysis of 8 RCT concluded that patients with a GCS between 9 and 12 demonstrated a significantly improved outcome with surgery [19]. Prasad et al., in their meta-analysis of 10 RCT, concluded that surgery was associated with a statistically significant reduction in the odds of being dead or dependent on follow-up [20]. Takeuchi et al. concluded that DC with hematoma evacuation for large ICH may be a safe and effective procedure in patients with severely disturbed consciousness [21]. Moussa and Khedr, in their study on the outcomes of DC with clot evacuation, concluded that patients with high admission GCS, younger age, smaller hematoma volume, subcortical hematoma location, absent or minimal preoperative and postoperative midline shift as well as the absence of IVH had contributed significantly to a better outcome in the surgical group [12]. Various randomized trials comparing

surgical treatment with medical management in the past have shown no clinical benefit (Table 9).

The best-designed trial, such as the surgical trial in intracerebral hemorrhage 2 (STITCH II), also showed no superiority for surgical treatment [22-25]. In STITCH II, no clinical benefit from early surgery was observed compared with medical treatment with delayed surgery if necessary [6]. The surgical trial findings may not apply to all settings because a high crossover of patients was observed. Gregson et al. performed a new analysis of all crucial surgical RCT and showed clinically relevant survival benefits in patients with GCS 9-12 (conscious patients) and large ICH [26]. In our study, the surgical group had good and poor outcomes in 48% and 52% of cases, respectively. Our patients with DC had good outcomes in 64% of cases, similar to the medical group outcomes at 3 months. In contrast, EVD surgical patients had a poorer outcome than the medical group.

**Table 9.** The surgical vs. medical management or placebo in spontaneous ICH

Investigators	Type (Year) of the Study)	Type of Surgery	Outcome and Time of Assessment	Results
Juvela et al. [22]	Single centre RCT (1989)	Craniotomy	GOS at 1, 6, and 12 months	No extra benefits over medical management, and morbidity was higher in surgical patients.
Batjer et al. [23]	Single centre RCT (1990)	Craniotomy	GOS at 12 months	Surgery was not proven useful. 50% mortality and 25% in surgical group
Zuccarello et al. [24]	3 centre RCT (1999)	Craniotomy	GOS at 3 months	No difference in the outcome of either group
STITCH trial [5]	83 centre RCT (2005)	Craniotomy (75% cases)	GOS at 6 months	No benefits to early surgery
Pantazis et al. [25]	Single centre RCT (2006)	Craniotomy	GOS at 12 months	Surgical group patients have poorer outcomes compared to the medical group Mortality has not decreased in surgical patients
STITCH II trial [6]	78 centers RCT (2013)	Craniotomy	Extended GOS at 6 month	No benefits to early surgery

Abbreviations: ICH: Intracerebral hemorrhage; RCT: Randomized control trial; GOS: Glasgow outcome scale; STITCH: Surgical trial in intracerebral hemorrhage.



The reported death rate at 3 months for spontaneous ICH cases is approximately 30% or more [27-31]. We also have a mortality rate of 25% in the medical group and 30% in the surgical group at 3 months.

### The comparison of prognostic factors

The volume of spontaneous ICH is a radiological marker of a poor prognosis. Evidence suggests that mortality increases with increasing ICH [32]. Hegde et al., in their study on spontaneous SICH outcome predictors, have made two groups, <30 mL and >30 mL ICH volume, to see the effect. They reported 54% mortality and 5% rebleeding in the >30 volume group of patients with ICH [9]. We observed that the surgical treatment group with >30 cc size of ICH had better outcomes than the medical treatment group.

Kim showed that <5 mm midline shift patients had 10.9% mortality, and >5 mm midline shift had 34.4% mortality [31]. We observed an overall mortality rate of 30% in ICH cases with a midline shift >6 mm, whereas better outcomes were observed in the surgical treatment group.

Hayes et al. found that DC improves the outcome for putaminal spontaneous SICH [33]. Seeruch observed improved outcomes with DC for basal ganglia hemorrhage with midline shift [34]. In contrast, Shimamura et al. found that DC was not useful in spontaneous SICH cases [35]. The existing evidence available for the surgical outcomes may not be conclusive because the surgical treatment

outcomes of spontaneous SICH vary based on the type of surgery and mostly on individual patient variables like the location of the bleed, the volume of SICH, and severity of midline shift. In spontaneous ICH with a midline shift, we observed better outcomes than the medical treatment group.

The consensus guidelines on stroke management by various associations, such as those in America and Europe, have suggested that for most SICH cases, surgical treatment benefits are not well proven, and surgery may reduce deaths in a subset of patients with comatose condition, large hematoma, or unresponsive medical treatment [36, 37]. It is a well-accepted fact that a GCS 9-12 in spontaneous ICH cases may predict good outcomes, especially with surgical treatment [38]. Gregson et al., in his meta-analysis of 8 RCT, concluded that patients with a GCS between 9 and 12 demonstrated a significantly improved outcome with surgery [19]. We also observed statistically significant improved outcomes in surgical patients with a GCS 9-12 score, suggesting that the timing of surgery may play a role in the outcomes.

### The effect of the prognostic scores and sign

Various variables have been tested by estimating mortality and morbidities and are part of the different prognostic scores used in spontaneous SICH [39-41]. The ICH score is an easy clinical score used for risk assessment of ICH and a tool for choosing the treatment modality

in the past at 30-day mortality [42, 43]. All our patients were below 80 years, and supratentorial location of ICH; therefore, our maximum ICH score was 3, and minimum was 0. The ICH score is estimated to have a specificity of 91.5% with a negative predictive value of 0.94 for mortality assessment. In contrast, for a good outcome, it has a sensitivity of 93.4% with a negative predictive value of 0.93 [44]. In contrast, Parry –jones et al. showed that the ICH score proposed by Hemphill is not superior to the GCS score for 30 days mortality [45]. We observed that patients with ICH scores of 1 and 2 had similar outcomes in treatment groups. Patients with ICH grade 3 in our surgical group showed higher poor outcomes (68%) and lower mortality (46%) than those in the medical group (66% poor outcome and 55% mortality), which is similar to the findings of other studies [10, 46]. In contrast, an SRMA of 21 studies with four studies of the highest quality involving spontaneous ICH by Sondag et al. concluded that surgical treatment, especially minimally invasive and early timed intervention, may be beneficial for good outcomes, and they also reported no effect of age, GCS, and volume of ICH on surgical outcomes [47].

Spontaneous SICH is frequently associated with IVH and an independent predictor of poor outcomes. Halleivi et al. have shown that patients with IVH are twice as likely to have a poor outcome compared to patients without IVH [29]. In our study, 73% of the patients had poor outcomes associated with IVH, similar to previous studies.

A SRMA done by Yuping Li et al in 2013 involving 11 trials with 680 patients showed that under EVD treatment of SICH with IVH, a newer surgical procedure such as neuroendoscopy may improve IVH evacuation, functional outcome and decrease mortality when compared to EVD with rt PA treatment but also emphasized limited data to support treatment modality directly [48, 49]. On a similar note, we had SICH with IVH in all 48 patients (37.5%). The number of patients having IVH with SICH in surgical group was more which had higher survival but showed poor outcome.

### Health complications

Rebleeding events in ICH are widespread, particularly when associated hypertension is poorly controlled [50]. The estimated incidence of rebleeding is 15.4% in conventional neurosurgical cases and 10% in minimally invasive neurosurgeries [51]. Our surgical group had a higher incidence of rebleeding events than the medical group. It is well-accepted that post-neurosurgical patients have higher infection rates [52]. In their study, Lo et al. showed that DC significantly improved survival compared

with medical treatment with good outcomes but had longer hospital stays and hospital-acquired infections. The hospital-acquired infections (76%) was higher in the surgical group than in the medical group (33%) [53]. Our surgical group also had higher health complications, such as pneumonia and UTI, with an almost similar percentage.

## 5. Conclusion

In LMIC, supratentorial SICH has predominant left-sided bleeding, with hypertension being the highest risk factor involving younger age groups with higher males. The surgical group has improved outcomes compared to the medical group, containing patients with midline shift >6 mm, >30 cc of bleed, and GCS 8-12. With a higher ICH score and IVH, the surgical group showed a poorer outcome and fewer deaths.

## Ethical Considerations

### Compliance with ethical guidelines

The Institutional Ethical Committee of [Sri Venkateswara Institute of Medical Sciences \(SVIMS\)](#), Tirupati, India, approved the study (AS/11/IEC/SVIMS/2017 vide IEC No. 762). Patients or legal representatives were explained about the risks and benefits of available advised treatment options, that is, medical and surgical treatment. They were then given written informed consent before enrolment in the study.

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### Authors' contributions

Conceptualization and design of study: Ramesh Candra VV, Nitin Barde, Dattatray Kulkarni, Meghraj Chawada; Data collection: Nitin Barde, Ramesh Candra VV; Data analysis and interpretation: Nitin Barde, Dattatray Kulkarni, Meghraj Chawada; Writing manuscript: Dattatray Kulkarni, Ramesh Candra VV, Nitin Barde, Meghraj Chawada; Critical review of article: Ramesh Candra VV, Nitin Barde; Supervision and Materials: Nitin Barde, Dattatray Kulkarni, Meghraj Chawada; Review and approve the final version of the manuscript: All authors.

### Conflict of interest

The authors declared no conflict of interest.



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