



DETERMINANTS OF SIX-MONTH OUTCOME AFTER SURGICAL EVACUATION OF SPONTANEOUS HYPERTENSIVE BASAL GANGLIA HAEMORRHAGE: INFLUENCE OF OPERATIVE TECHNIQUE, TIMING, HAEMATOMA VOLUME AND ANATOMICAL SITE.

Neurosurgery

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ABSTRACT

Background: Once a decision to operate on a spontaneous basal ganglia haemorrhage has been taken, the surgeon must still choose an approach and a time, and must counsel the family about expected recovery. Evidence on which surgical and radiological variables determine outcome within an operated cohort is far more limited than evidence on whether to operate at all. **Objective:** To identify clinical, radiological and operative determinants of six-month functional outcome and mortality among patients undergoing surgical evacuation of spontaneous hypertensive basal ganglia haemorrhage. **Methods:** Sixty-four consecutive patients aged 30–65 years who underwent operative evacuation of spontaneous basal ganglia haemorrhage at a tertiary care teaching hospital in central India between January 2024 and June 2025 were studied prospectively and followed for six months. Haematoma volume was measured by the ABC/2 method and the ICH score was computed at admission. Outcome was graded on the Glasgow Outcome Scale (GOS), with grades 4–5 defined as favourable. Outcomes were analysed by operative technique, interval from ictus to surgery, haematoma volume stratum and anatomical subsite, and correlated with the ICH score. **Results:** Sixteen patients (25.0%) achieved a favourable outcome and 17 (26.6%) died. Haematoma volume correlated inversely with six-month GOS (Spearman $r = -0.436$, $p = 0.0003$): favourable outcome fell from 35.7% in the 31–50 mL stratum to 9.4% in the 51–70 mL stratum, while mortality rose from 21.4% to 31.3%. Decompressive craniectomy with evacuation, the commonest procedure (48.4%), yielded the highest favourable outcome rate (32.3%) and the lowest mortality among open techniques (25.8%); endoscopic evacuation achieved the lowest mortality overall (12.5%) and the lowest mean residual clot volume (12.45 mL), whereas stereotactic aspiration produced the largest residual volume (19.03 mL) and no favourable outcomes. Putaminal haemorrhage had the best profile by subsite (28.2% favourable, 23.1% mortality). Only 14.1% of operations were performed within six hours, and outcome did not differ between early and late surgery (favourable outcome 22.2% vs 25.5%, $p = 1.000$). The ICH score correlated significantly with six-month GOS ($r = -0.258$, $p = 0.040$). **Conclusion:** Within an operated basal ganglia haemorrhage cohort, haematoma volume, anatomical subsite and completeness of evacuation — not the timing of surgery — were the variables that tracked with outcome. Volumes of 31–50 mL, a putaminal subsite and a technique capable of achieving near-complete clot removal identify the patients most likely to benefit from surgery.

KEYWORDS

basal ganglia haemorrhage; decompressive craniectomy; endoscopic evacuation; ICH score; haematoma volume; surgical outcome

INTRODUCTION

Hypertensive haemorrhage into the basal ganglia is the commonest anatomical subtype of spontaneous intracerebral haemorrhage (ICH) and one of the most lethal.^{1,2} Whether such patients should be operated on at all has occupied four decades of randomised trials, from STICH and STICH II through MISTIE III to the more encouraging recent results of ENRICH and MIND.^{3–7} Comparatively little of that literature addresses the question that a neurosurgeon actually faces at three in the morning once the decision to operate has already been made: which corridor, how much clot must come out, how urgently, and what to tell the family about the likely result.

The variables plausibly governing outcome within an operated cohort are distinct from those governing the decision to operate. Haematoma volume determines the extent of primary destruction of the internal capsule and the magnitude of secondary mass effect.^{8,9} Anatomical subsite determines surgical accessibility and the risk of iatrogenic injury during access, with putaminal clots reachable through standard transcortical or trans-sylvian corridors while thalamic-predominant bleeds sit among structures that tolerate retraction poorly. Operative technique determines how completely the clot can be removed and whether the skull is left decompressed against subsequent oedema — and MISTIE III showed that the degree of clot reduction achieved, rather than the fact of intervention, tracked with recovery.⁷ Timing determines the balance between early relief of mass effect and the recognised risk of rebleeding from a vessel that has not yet secured haemostasis.

We therefore analysed a prospectively collected cohort of 64 patients operated for spontaneous basal ganglia haemorrhage at a tertiary centre in central India, with the specific aim of identifying which clinical, radiological and operative variables were associated with six-month functional outcome and mortality. The comparison of this operated cohort against contemporaneously managed medical patients is reported separately; the present analysis is confined to the surgical arm.

MATERIALS AND METHODS

Design, setting and participants

This prospective observational study was conducted in the Department of Neurosurgery, G.R. Medical College and J.A. Group of Hospitals, Gwalior, Madhya Pradesh, over 18 months from January 2024 to June 2025. Institutional Ethics Committee approval was obtained and written informed consent was taken from each patient or legally authorised attendant, in accordance with the Declaration of Helsinki and Indian Council of Medical Research guidelines.

Sixty-four consecutive patients who underwent operative evacuation formed the study population. Inclusion criteria were spontaneous basal ganglia haemorrhage confirmed on non-contrast computed tomography (NCCT); documented hypertension or hypertensive end-organ damage; age 30–65 years; haematoma volume above 30 mL with radiological mass effect; admission Glasgow Coma Scale (GCS) above 5; and informed consent. Patients with haemorrhage secondary to tumour, aneurysm, vascular malformation or coagulopathy, traumatic or predominantly intraventricular haemorrhage, primary brainstem or isolated thalamic haemorrhage, bleeding diathesis, or severe systemic comorbidity capable of independently determining outcome were excluded.

Operative Management

The choice of procedure rested with the operating team and reflected haematoma volume, degree of cerebral swelling, clot depth and the clinical trajectory. Four techniques were used: decompressive craniectomy with evacuation, craniotomy with evacuation and bone flap replacement, endoscopic evacuation, and stereotactic aspiration. Early surgery was defined as operation within six hours of symptom onset; criteria prompting urgent intervention were a GCS of 5–12 with neurological deterioration, volume above 30 mL with midline shift exceeding 5 mm, obstructive hydrocephalus from intraventricular extension requiring external ventricular drainage, clinical signs of impending herniation, and younger age without major comorbidity.

All patients received uniform perioperative medical care: blood pressure control per AHA/ASA recommendations with intravenous labetalol, nicardipine or hydralazine titrated to a systolic pressure of 140–160 mmHg followed by oral agents; osmotherapy and intracranial pressure management; seizure prophylaxis; and ventilatory and nutritional support. Postoperative NCCT was obtained where clinically indicated, and residual haematoma volume was measured on the first postoperative scan.

Measurements and Outcome

Haematoma volume was calculated by the ABC/2 method¹⁰ and midline shift, intraventricular extension, hydrocephalus and anatomical subsite (putaminal, putamino-capsular, thalamo-capsular, external capsular) were recorded from the admission scan. The ICH score was computed as described by Hemphill *et al.*¹¹ Motor power was graded on the Medical Research Council (MRC) scale at admission and discharge.

Functional outcome was assessed on the Glasgow Outcome Scale¹² at discharge and at one, three and six months. GOS 4–5 was classified as favourable and GOS 1–3 as unfavourable. Mortality was death from any cause within six months.

Statistical Analysis

Analysis was performed in SPSS version 16.0 and Epi Info version 7.0. Continuous variables are expressed as mean $\pm$ standard deviation and categorical variables as frequencies with percentages. Comparison between early and late surgery used Fisher's exact test. The relationship between haematoma volume and six-month GOS, and between ICH score and outcome, was examined by Spearman rank correlation. Outcomes by operative technique, volume stratum and anatomical subsite are presented descriptively, as subgroup sizes were too small for meaningful hypothesis testing. A two-tailed *p* value below 0.05 was taken as significant.

RESULTS

Cohort profile

The 64 operated patients had a mean age of 51.05 ± 7.82 years, and 38 (59.4%) were men (Table 1). Hypertension had been present for a mean of 7.44 ± 5.14 years; 17 patients (26.6%) had diabetes mellitus, 17 (26.6%) were smokers and 14 (21.9%) used alcohol. Mean admission GCS was 9.44 ± 2.03 , with 23 patients (35.9%) in the severe band of 3–8. Mean interval from ictus to hospital arrival was 5.54 ± 2.79 hours.

Mean haematoma volume was 49.75 ± 12.24 mL and mean midline shift 4.58 ± 2.12 mm. Intraventricular extension was present in 23 patients (35.9%) and hydrocephalus in 9 (14.1%). The putamen was the commonest subsite (39 patients, 60.9%). Mean ICH score was 1.72 ± 0.81 .

Table 1. Baseline Profile of the Operated Cohort (n = 64)

Parameter	Value
Age, years (mean $\pm$ SD)	51.05 ± 7.82
Male : female	38 (59.4%) : 26 (40.6%)
Duration of hypertension, years	7.44 ± 5.14
Diabetes mellitus	17 (26.6%)
Smoking	17 (26.6%)
Alcohol use	14 (21.9%)
Antiplatelet use	8 (12.5%)
Admission GCS (mean $\pm$ SD)	9.44 ± 2.03
GCS 3–8 / 9–12 / 13–15	23 (35.9%) / 36 (56.3%) / 5 (7.8%)
Systolic BP, mmHg	176.09 ± 19.58
Diastolic BP, mmHg	105.75 ± 11.63
Onset-to-arrival interval, hours	5.54 ± 2.79
Aphasia	15 (23.4%)
Seizure at onset	9 (14.1%)
Haematoma volume, mL	49.75 ± 12.24
Midline shift, mm	4.58 ± 2.12
Intraventricular haemorrhage	23 (35.9%)
Hydrocephalus	9 (14.1%)
Putaminal / putamino-capsular / thalamo-capsular / external capsular	39 (60.9%) / 16 (25.0%) / 7 (10.9%) / 2 (3.1%)
ICH score	1.72 ± 0.81

Overall Outcome

Mean GOS rose from 2.48 ± 0.91 at discharge to 2.64 ± 1.21 at six months, and the proportion with a favourable outcome increased from 10.9% at discharge to 15.6% at one month, 18.8% at three months and 25.0% at six months (Table 2). At six months 17 patients (26.6%) had died, 8 (12.5%) were vegetative, 23 (35.9%) were severely disabled, 13 (20.3%) had moderate disability and 3 (4.7%) had made a good recovery (Figure 1).

Table 2. Functional Outcome of the Operated Cohort over Time

Time point	Mean GOS $\pm$ SD	Favourable outcome (GOS 4–5)
Discharge	2.48 ± 0.91	7 (10.9%)
1 month	2.47 ± 1.03	10 (15.6%)
3 months	2.55 ± 1.15	12 (18.8%)
6 months	2.64 ± 1.21	16 (25.0%)

Glasgow Outcome Scale grades at six months, operated cohort (n = 64)

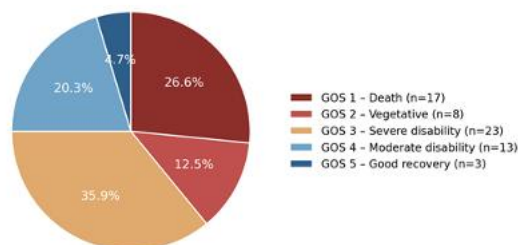


Figure 1. Distribution of Glasgow Outcome Scale grades at six months in the operated cohort.

Haematoma Volume

Haematoma volume showed a strong inverse correlation with six-month GOS (Spearman $r = -0.436$, $p = 0.0003$). Stratified analysis (Table 3, Figure 2) showed favourable outcome in both patients with volumes of 30 mL or less, in 35.7% of the 31–50 mL group and in only 9.4% of the 51–70 mL group; mortality rose correspondingly from 0% to 21.4% and then 31.3% across these strata.

Table 3. Six-month Outcome by Haematoma Volume Stratum

Volume stratum	n	Favourable outcome	Mortality
≤ 30 mL	2	2 (100.0%)	0 (0.0%)
31–50 mL	28	10 (35.7%)	6 (21.4%)
51–70 mL	32	3 (9.4%)	10 (31.3%)
> 70 mL	2	1 (50.0%)	1 (50.0%)

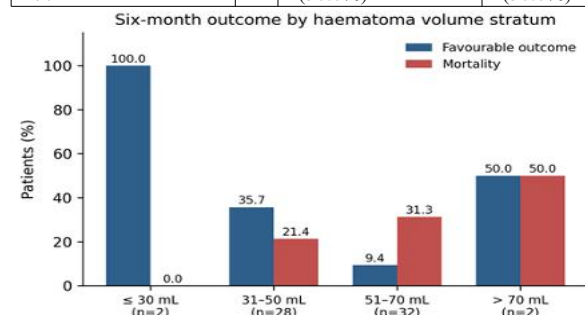


Figure 2. Six-month favourable outcome and mortality by haematoma volume stratum.

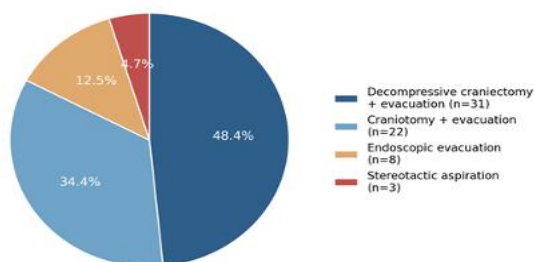
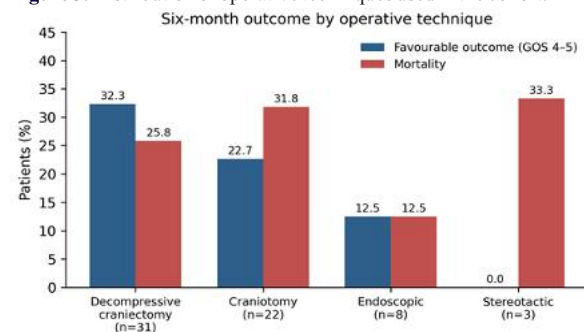
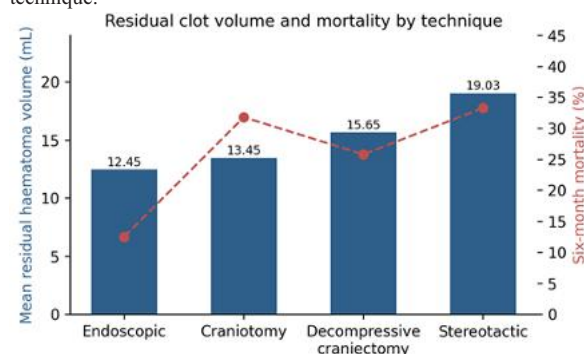
Operative Technique

Decompressive craniectomy with evacuation was performed in 31 patients (48.4%) and produced the highest rate of favourable outcome (32.3%) with a mortality of 25.8% (Table 4, Figures 3 and 4). Craniotomy with evacuation, used in 22 patients (34.4%), gave a favourable outcome rate of 22.7% and mortality of 31.8%. Endoscopic evacuation, performed in 8 patients (12.5%), had the lowest mortality of any technique (12.5%) and the highest mean GOS (2.75) despite a favourable outcome rate of 12.5%. Stereotactic aspiration, used in 3 patients (4.7%) with deep or unfavourably located clots, yielded no favourable outcomes and one death. Mean residual haematoma volume was lowest after endoscopic evacuation (12.45 mL) and craniotomy (13.45 mL), intermediate after decompressive craniectomy (15.65 mL) and highest after stereotactic aspiration (19.03 mL) (Figure 5).

Table 4. Six-month Outcome by Operative Technique

Technique	n (%)	Favourable outcome	Mortality	Mean GOS at 6 months	Mean residual volume (mL)
Decompressive craniectomy + evacuation	31 (48.4%)	10 (32.3%)	8 (25.8%)	2.71	15.65
Craniotomy + evacuation	22 (34.4%)	5 (22.7%)	7 (31.8%)	2.55	13.45
Endoscopic evacuation	8 (12.5%)	1 (12.5%)	1 (12.5%)	2.75	12.45
Stereotactic aspiration	3 (4.7%)	0 (0.0%)	1 (33.3%)	2.33	19.03

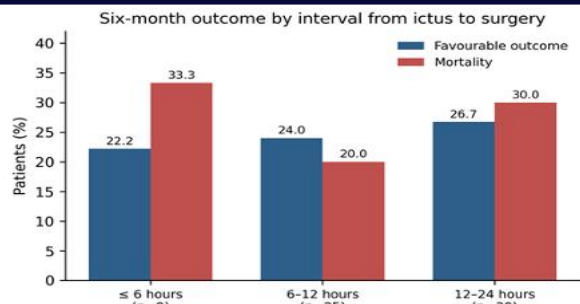
Distribution of operative techniques (n = 64)

**Figure 3.** Distribution of operative techniques used in the cohort.**Figure 4.** Six-month favourable outcome and mortality by operative technique.**Figure 5.** Mean residual haematoma volume on the first postoperative scan and corresponding six-month mortality, by technique.**Timing of Surgery**

Only 9 patients (14.1%) were operated within six hours of ictus; 25 (39.1%) were operated between 6 and 12 hours and 30 (46.9%) between 12 and 24 hours (Table 5, Figure 6). Favourable outcome rates were 22.2%, 24.0% and 26.7% respectively, and mortality 33.3%, 20.0% and 30.0%. The comparison of early (≤ 6 h) with late (> 6 h) surgery showed no difference in favourable outcome (22.2% vs 25.5%, $p = 1.000$).

Table 5. Outcome by Interval from Symptom onset to Surgery

Interval	n (%)	Favourable outcome	Mortality	Mean GOS at 6 months
≤ 6 hours	9 (14.1%)	2 (22.2%)	3 (33.3%)	2.56
6–12 hours	25 (39.1%)	6 (24.0%)	5 (20.0%)	2.80
12–24 hours	30 (46.9%)	8 (26.7%)	9 (30.0%)	2.53

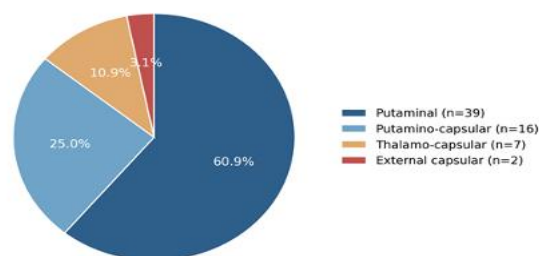
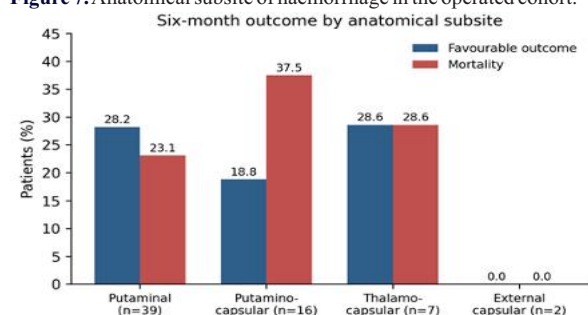
**Figure 6.** Six-month outcome according to the interval from symptom onset to surgery.**Anatomical Subsite**

Putaminal haemorrhage, the commonest subsite, had the most favourable profile, with 28.2% favourable outcome and 23.1% mortality (Table 6, Figures 7 and 8). Putamino-capsular clots had the highest mortality (37.5%), thalamo-capsular clots an intermediate profile (28.6% favourable, 28.6% mortality), and the two external capsular cases both survived without reaching a favourable grade.

Table 6. Six-month Outcome by Anatomical Subsite

Subsite	n	Favourable outcome	Mortality
Putaminal	39	11 (28.2%)	9 (23.1%)
Putamino-capsular	16	3 (18.8%)	6 (37.5%)
Thalamo-capsular	7	2 (28.6%)	2 (28.6%)
External capsular	2	0 (0.0%)	0 (0.0%)

Anatomical subsite of haemorrhage (n = 64)

**Figure 7.** Anatomical subsite of haemorrhage in the operated cohort.**Figure 8.** Six-month favourable outcome and mortality by anatomical subsite.**Ich Score and Motor Recovery**

The admission ICH score correlated inversely and significantly with six-month GOS in the operated cohort ($r = -0.258$, $p = 0.040$); its correlation with mortality did not reach significance ($r = 0.188$, $p = 0.137$).

Mean MRC grade at discharge was 3.30 ± 1.18 in the upper limb and 3.53 ± 1.12 in the lower limb, representing a mean improvement of 0.94 ± 0.53 grades in each. Useful power (MRC grade 3 or better) was regained by 33 patients (51.6%) in the upper limb and 40 (62.5%) in the lower limb.

DISCUSSION

Three findings emerge from this operated cohort, and each has a direct bearing on case selection and counselling.

The first is the dominance of haematoma volume. The inverse correlation with six-month GOS ($r = -0.436$, $p = 0.0003$) is among the

strongest relationships in the dataset, and the stratified data locate the inflection point between 50 and 70 mL: favourable outcome fell almost fourfold, from 35.7% to 9.4%, across that boundary. This reproduces one of the most consistent observations in the ICH literature and reflects the fact that volume indexes both the primary destruction of the internal capsule at the moment of rupture and the subsequent burden of mass effect and oedema.^{8,9,11} For the operating surgeon this suggests a practical corollary: a patient with a 40 mL putaminal clot has roughly a one-in-three chance of independence with surgery, while a patient with a 65 mL clot has less than one in ten, and the operation in the latter case is being performed principally to prevent death rather than to restore function. That distinction belongs in the preoperative conversation with the family.

The second is that the technique data are best read through the lens of clot clearance rather than invasiveness. Decompressive craniectomy achieved the highest favourable outcome rate, which is unsurprising given that it combines evacuation with an outlet for the oedema that follows over the ensuing days, a mechanism well established in traumatic brain injury and malignant middle cerebral artery infarction.¹³ Endoscopic evacuation, though performed in only eight patients, produced the lowest mortality and the smallest mean residual volume, in line with a growing literature suggesting that minimal-access corridors spare the overlying cortex and white matter traversed by open approaches.¹⁴⁻¹⁶ Stereotactic aspiration produced the largest residual clot (19.03 mL) and the poorest outcomes; the small number of cases and their selection — deep, unfavourably located clots in patients considered poor candidates for open surgery — preclude any conclusion that the technique is inherently inferior, but the residual volume data are consistent with the known limitation of simple aspiration in clearing an organised clot. The parallel with MISTIE III, in which outcome improved when residual volume was brought to 15 mL or below,⁵ is difficult to ignore: across four very different operations in this series, the techniques achieving the smallest residual volumes were also those with the lowest mortality. Completeness of evacuation, rather than the size of the craniotomy, appears to be the variable that matters.

The third finding is negative. Timing made no measurable difference: favourable outcome was 22.2% after early surgery and 25.5% after late surgery ($p = 1.000$), and mortality was, if anything, numerically higher in the early group. Only nine patients were operated within six hours, so this comparison is severely underpowered and should not be read as evidence against urgent decompression in a deteriorating patient. It is nonetheless worth noting that it is directionally consistent with the rebleeding risk associated with very early evacuation, before the ruptured lenticulostriate perforator has achieved secure haemostasis — a concern that led ENRICH to adopt a 24-hour window rather than an ultra-early one.⁶ In a health system where most patients reach a tertiary neurosurgical unit only after transport from a peripheral facility, the practical message is reassuring: operating at eight or twelve hours does not appear to forfeit the benefit of surgery.

The subsite data align with anatomical expectation. Putaminal clots, which lie within reach of standard transcortical and trans-sylvian corridors and lateral to the descending motor fibres, had both the highest favourable outcome rate and the lowest mortality, and ENRICH similarly included anterior basal ganglia haemorrhage among the subgroups contributing to its treatment effect.⁶ Putamino-capsular extension carried the highest mortality, consistent with greater involvement of the capsule and greater medial mass effect. The ICH score retained prognostic value within the operated cohort ($r = -0.258$, $p = 0.040$), confirming that surgery does not abolish the predictive gradient of admission severity and that the score remains a legitimate bedside instrument for counselling operated patients — a point worth making, since the score was derived in an unselected ICH population.¹¹

Finally, the motor data deserve comment. Just over half of survivors regained useful upper limb power and about two-thirds regained useful lower limb power, with a mean improvement of only about one MRC grade over the hospital stay. Surgery relieves compression; it does not repair the corticospinal fibres torn at the moment of the bleed. Realistic counselling should frame the operation as a means of surviving with reduced dependency, with limb recovery determined largely by the primary injury and by the intensity of subsequent rehabilitation.

LIMITATIONS

This is a single-centre observational study of 64 patients, and the subgroup analyses that constitute its principal content involve small numbers — three patients in the stereotactic aspiration group, eight in the endoscopic group, nine in the early surgery group and two in each of the extreme volume strata. These subgroups were not compared by

formal hypothesis testing, and the descriptive differences between them must be regarded as hypothesis-generating. Technique was not randomly assigned but chosen by the operating team according to clot characteristics and patient condition, so comparisons between techniques are confounded by indication in a way that cannot be resolved within this dataset. Residual volume was recorded from the first postoperative scan only, and delayed re-accumulation was not systematically quantified. Perihæmatoma oedema, rehabilitation intensity and cognitive and language outcomes were not measured, and outcome was assessed on the GOS rather than the modified Rankin scale used by recent trials, which limits direct comparison. Follow-up was limited to six months, beyond which further recovery may occur.

CONCLUSION

Among 64 patients operated for spontaneous hypertensive basal ganglia haemorrhage, one quarter achieved functional independence and just over a quarter died by six months. Outcome was governed principally by haematoma volume, which correlated strongly and inversely with six-month GOS, by anatomical subsite, with putaminal clots faring best, and by the completeness of evacuation, with the techniques achieving the smallest residual clot volumes showing the lowest mortality. The interval from ictus to surgery, within the range observed here, showed no relationship with outcome. Patients with clots of 31–50 mL in a putaminal location, operated by a technique capable of near-complete evacuation, represent the group in whom surgery is most likely to deliver an independent survivor; beyond 50 mL, the realistic aim of operation shifts from restoring function to preventing death. Larger, preferably randomised, comparisons of operative techniques within the basal ganglia population are needed to confirm these observations.

- **Ethical approval:** Obtained from the Institutional Ethics Committee, G.R. Medical College, Gwalior.
- **Informed consent:** Written informed consent was obtained from all participants or their legally authorised representatives.
- **Conflict of interest:** None declared.
- **Funding:** None.

REFERENCES

1. Qureshi AI, Mendelow AD, Hanley DF. Intracerebral haemorrhage. *Lancet*. 2009;373(9675):1632–44.
2. An SJ, Kim TJ, Yoon BW. Epidemiology, risk factors, and clinical features of intracerebral hemorrhage: an update. *J Stroke*. 2017;19(1):3–10.
3. Mendelow AD, Gregson BA, Fernandes HM, Murray GD, Teasdale GM, Hope DT, et al. 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. *Lancet*. 2005;365(9457):387–97.
4. Mendelow AD, Gregson BA, Rowan EN, Murray GD, Gholkar A, Mitchell PM. Early surgery versus initial conservative treatment in patients with spontaneous supratentorial lobar intracerebral haematomas (STICH II): a randomised trial. *Lancet*. 2013;382(9890):397–408.
5. Hanley DF, Thompson RE, Rosenblum M, Yenokyan G, Lane K, McBee N, et al. Efficacy and safety of minimally invasive surgery with thrombolysis in intracerebral haemorrhage evacuation (MISTIE III): a randomised, controlled, open-label, blinded endpoint phase 3 trial. *Lancet*. 2019;393(10175):1021–32.
6. Pradilla G, Ratcliff JJ, Hall AJ, et al. Trial of early minimally invasive removal of intracerebral hemorrhage. *N Engl J Med*. 2023;389(14):1277–89.
7. Arthur AS, et al. Minimally invasive surgery vs medical management alone for intracerebral hemorrhage: the MIND randomized clinical trial. *JAMA Neurol*. 2025;82(3):258–68.
8. Keep RF, Hua Y, Xi G. Intracerebral haemorrhage: mechanisms of injury and therapeutic targets. *Lancet Neurol*. 2012;11(8):720–31.
9. Urdas S, Kimberly WT, Beslow LA, Vortmeyer AO, Sims JR. Targeting secondary injury in intracerebral hemorrhage — perihæmatoma oedema. *Nat Rev Neuro*. 2012;9(11):657–66.
10. Kothari RU, Brott T, Broderick JP, Barsan WG, Sauerbeck LR, Zuccarello M, et al. The ABCs of measuring intracerebral hemorrhage volumes. *Stroke*. 1996;27(8):1304–5.
11. Hemphill JC 3rd, Bonovich DC, Besmertis L, Manley GT, Johnston SC. The ICH score: a simple, reliable grading scale for intracerebral hemorrhage. *Stroke*. 2001;32(4):891–7.
12. Jennett B, Bond M. Assessment of outcome after severe brain damage: a practical scale. *Lancet*. 1975;1(7905):480–4.
13. Kolias AG, Kirkpatrick PJ, Hutchinson PJ. Decompressive craniectomy: past, present and future. *Nat Rev Neuro*. 2013;9(7):405–15.
14. Guo W, Liu H, Tan Z, et al. Comparison of endoscopic evacuation, stereotactic aspiration, and craniotomy for treatment of basal ganglia hemorrhage. *J Neurointerv Surg*. 2020;12(1):55–61.
15. Fu C, Wang N, Chen B, et al. Surgical management of moderate basal ganglia intracerebral hemorrhage: comparison of safety and efficacy of endoscopic surgery, minimally invasive puncture and drainage, and craniotomy. *World Neurosurg*. 2019;122:e995–e1001.
16. Jianhua X, Zhenying H, Bingbing L, et al. Comparison of surgical outcomes and recovery of neurologic and linguistic functions in the dominant hemisphere after basal ganglia hematoma evacuation by craniotomy versus endoscopy. *World Neurosurg*. 2019;129:e494–e501.
17. Choo YS, Chung JJ, Joo JY, Kim YB, Hong CK. Borderline basal ganglia hemorrhage volume: patient selection for good clinical outcome after stereotactic catheter drainage. *J Neurosurg*. 2016;125(5):1242–8.
18. Tang Y, Yin F, Fu D, Gao X, Lv Z, Li X. Efficacy and safety of minimal invasive surgery treatment in hypertensive intracerebral hemorrhage: a systematic review and meta-analysis. *BMC Neurol*. 2018;18:136.
19. Greenberg SM, Ziai WC, Cordonnier C, Dowlatshahi D, Francis B, Goldstein JN, et al. 2022 Guideline for the management of patients with spontaneous intracerebral hemorrhage. *Stroke*. 2022;53(7):e282–e361.
20. Wang GQ, Li SQ, Huang YH, Zhang WW, Ruan WW, Qin JZ, et al. Can minimally invasive puncture and drainage for hypertensive spontaneous basal ganglia intracerebral