SUMMARY

Intracerebral hemorrhage (ICH) has a higher prevalence in Eastern Asian countries compared to Western countries. The standard surgical approach at our institution for the management of ICH is to perform a decompressive craniectomy (DC) with intra-parenchymal clot evacuation. In patients who have favorable functional recovery, a cranioplasty is performed usually after three months.

Based on our first year experience, the adoption of minimally invasive parafascicular surgery (MIPS) has led to significant reduction in the mean operating time (19% shorter than DC alone).

The mean length of stay (LOS) was significantly reduced with MIPS in the neurointensive care unit (50% shorter than DC alone) and total acute hospital stay (52% shorter than DC alone, 61% shorter than DC with delayed cranioplasty). The shorter LOS with MIPS resulted in a smaller room bill in the acute hospital stay (42% lower than DC alone, 51% lower than DC with delayed cranioplasty).
Intracerebral hemorrhage (ICH) is the most common type of hemorrhagic stroke and has a higher prevalence in Eastern Asian countries (18-24% of all strokes, 19% in Singapore) compared to Western countries such as the USA, UK and Australia (8-15%)\textsuperscript{1-5}. In addition, the age-standardized incidence rates of hemorrhagic stroke among Singaporeans have shown an increasing trend in the last decade from 64.3 per 100,000 to 65.5 per 100,000\textsuperscript{1}.

The standard surgical approach at our institution for the management of ICH is to perform a decompressive craniectomy (DC) followed by delayed cranioplasty. DC has been found to significantly reduce mortality by 18% compared to medical management in our patient cohort, although benefit for functional outcomes with DC was not observed\textsuperscript{6}. A recent meta-analysis of randomized controlled trials demonstrated that select patients with supratentorial ICH benefited from minimally invasive surgery over conventional treatment and craniotomy\textsuperscript{7}.

### BACKGROUND

Intracerebral hemorrhage (ICH) is the most common type of hemorrhagic stroke and has a higher prevalence in Eastern Asian countries (18-24% of all strokes, 19% in Singapore) compared to Western countries such as the USA, UK and Australia (8-15%)\textsuperscript{1-5}. In addition, the age-standardized incidence rates of hemorrhagic stroke among Singaporeans have shown an increasing trend in the last decade from 64.3 per 100,000 to 65.5 per 100,000\textsuperscript{1}.

The standard surgical approach at our institution for the management of ICH is to perform a decompressive craniectomy (DC) followed by delayed cranioplasty. DC has been found to significantly reduce mortality by 18% compared to medical management in our patient cohort, although benefit for functional outcomes with DC was not observed\textsuperscript{6}. A recent meta-analysis of randomized controlled trials demonstrated that select patients with supratentorial ICH benefited from minimally invasive surgery over conventional treatment and craniotomy\textsuperscript{7}.

### OBJECTIVES

We aim to assess the impact of minimally invasive parafascicular surgery (MIPS) on the length of acute hospital stay and model its economic impact.

### METHODOLOGY

Historical cohorts of patients with supratentorial ICH who underwent surgery with clot evacuation were analyzed as three groups, namely DC (n=11), DC with delayed cranioplasty (n=5), and MIPS (n=12). Non-survivors were excluded. All groups had comparable baseline ICH-GS score, which has been validated as a prognostic model for ICH in our patient cohort\textsuperscript{8,9}. The median ICH-GS score in all three groups was 9, corresponding to a predicted mortality of 57% in hospital and 71% at 30 days. Patients' mean LOS in neurointensive care unit, high dependence and intermediate care units, as well as the total acute hospital stay, were reviewed. The actual costs of the procedures were calculated based on the estimated costs normalized to hospital rates for the year 2018. Surgical costs were estimated and all costs were converted to USD (1 USD=1.4 SGD).
INNOVATION IN HEMORRHAGIC STROKE MANAGEMENT USING MINIMALLY INVASIVE PARAFASCICULAR SURGERY

RESULTS

SHORTER OPERATING TIME

-58%
-19%

FASTER SURGERY

The mean surgery duration decreased by 19% from 276 minutes (±55) for DC to 223 minutes (±46) for MIPS.

Patients who have favorable functional recovery from DC will undergo a second surgery for cranioplasty, which leads to additional operating time of 254 minutes (±59).

REDUCED COSTS

The mean surgery-related cost* was 42% lower for DC with cranioplasty (USD 21,300 ± 4,600) compared to MIPS (USD 12,300 ± 3,100).

However, the cost of MIPS was 48% higher compared to DC alone (USD 8,300 ± 1,700).

LOWER OVERALL SURGICAL COSTS

-42%
+48%

*Composite cost estimation for the surgical procedure. In the figures (top and bottom), the dots represent the overall means and the whiskers, standard deviations.
**RESULTS**

**REDUCED LENGTH OF STAY**

The mean length of acute hospital stay decreased by 61% from 38 days (±19) for DC with cranioplasty, and decreased by 52% from 31 days (±18) for DC only, to 15 days (±7) for MIPS.

In the neurointensive care unit, the mean length of stay decreased by 50% from 6 days (±2) for DC to 3 days (±1) for MIPS.

**Smaller Room Bill for Acute Hospital Stay***

The modeled room-related costs based on the mean length of stay in the acute hospital showed a 51% decrease from USD 12,800 (95% UCI 22,600) for DC with cranioplasty, and 42% decrease from USD 10,800 (95% UCI 19,900) for DC only, to USD 6,300 (95% UCI 10,700) for MIPS.

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* Modeled room costs excludes medication, imaging, additional therapies and other miscellaneous costs. In the figures, the dots represent the overall means and the whiskers, standard deviations (top figure) or 95% upper confidence limit (bottom figure).
CONCLUSION

The standard surgical approach at our institution for the management of ICH is to perform a DC with intra-parenchymal clot evacuation. In patients who have favorable functional recovery a cranioplasty is performed usually after three months.

Based on our first year experience, compared to DC with delayed cranioplasty, MIPS has resulted in shorter operation time, neurointensive care unit LOS, and total acute hospital LOS, leading to cost savings.

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REFERENCES


