Research Article

Comparative Evaluation Of Perioperative Complications In General Versus Spinal Anaesthesia For Cesarean Delivery: A Prospective Observational Study

Shamim Parwez[1], Mr. Ritik Kaushik[2], Mr. Sameer Ahmad[3], Ms. Marngam Gameh[4], Ms. Arpita[5], Ms . Diana Teli[6], Raj Hasan[7]

[1]Assistant Professor, Techno India University, Kolkata, West Bengal
[2]Assistant Professor, Government Institute of Medical Sciences, Greater Noida.
[3]Assistant Professor Government Institute of Medical Sciences, Greater Noida.
[4]Assistant Professor, Sikkim Manipal College of Allied and Healthcare Professions , SMU, Gangtok , Sikkim
[5]Assistant Professor,Government Institute of Medical Sciences, Greater Noida.
[6]Assistant professor, Department of Emergency and Critical care, Assam Down Town University , Guwahati , Assam
[7]Tutor, Government Institute of Medical Sciences, Greater Noida.

Abstract

Background: Cesarean section (C-section) is one of the most frequently performed surgical procedures globally. The choice between Spinal Anaesthesia (SA) and General Anaesthesia (GA) is governed by clinical urgency, maternal anatomical considerations, and systemic stability. While SA is widely recognised as the gold standard for elective procedures, GA remains vital in emergency or high-risk scenarios. This study aims to prospectively evaluate and compare the nature, frequency, and severity of anaesthetic complications associated with General versus Spinal Anaesthesia in parturients undergoing C-section.

Methods: A prospective observational study was conducted among N = 60 parturients aged 25 to 40 years with American Society of Anesthesiologists (ASA) physical status II or III who underwent elective or emergency C-sections at SGT Medical College, Hospital, and Research Institute, Gurugram. Participants were divided into two equal cohorts (n = 30 each) receiving either General Anaesthesia (Group A) or Spinal Anaesthesia (Group B). Physiological parameters (Systolic Blood Pressure [SBP], Diastolic Blood Pressure [DBP], Pulse Rate [PR]), demographic data, and intraoperative/postoperative complications were documented and analysed using independent t-tests and Chi-square tests.

Results: Parturients in the SA cohort experienced a significantly higher incidence of maternal hypotension (60.0%, n = 18; $p < 0.001$) and intraoperative shivering (60.0%, n = 18) than in the GA cohort. The SA group demonstrated significantly lower post-induction SBP (112.80 ± 11.08 mmHg vs. 126.72 ± 6.14 mmHg, $t = 5.94$, $p = 0.001$) and PR (71.93 ± 7.30 bpm vs. 77.17 ± 7.95 bpm, $t = 2.64$, $p = 0.011$). Conversely, the GA cohort exhibited major airway-related challenges, with difficult intubation reported in 40.0% (n = 12) and failed intubation in 30.0% (n = 9) of cases. Postoperative hypothermia occurred in 23.0% of GA cases, whereas post-procedural pain (23.0%) and nausea/vomiting (20.0%) were predominantly observed in SA cases.

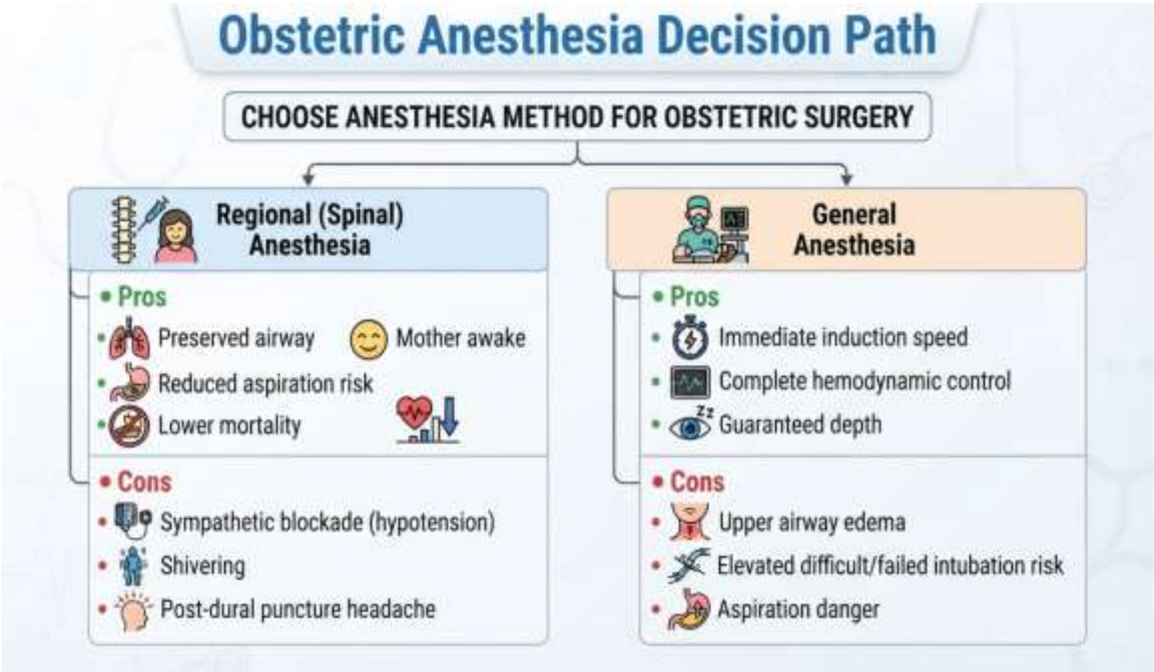
Conclusion: Both anaesthetic modalities possess distinct risk profiles. Spinal Anaesthesia provides superior airway safety and post-procedural comfort but carries a high burden of sympathetically mediated hypotension and hypothermic shivering. General Anaesthesia avoids sympatholysis-induced hemodynamic drops but introduces substantial risks of airway failure. Meticulous preoperative planning, rigorous airway screening, and proactive vasopressor/thermal management are vital to optimising maternal outcomes.

Introduction

Medication-induced general Anaesthesia represents a reversible state characterised by immobility, profound analgesia, amnesia, and unconsciousness while maintaining thermoregulatory, cardiorespiratory, and autonomic equilibrium. In contrast, regional techniques such as spinal Anaesthesia involve the targeted deposition of local anaesthetic agents into the subarachnoid space, bathed directly by cerebrospinal fluid (CSF). This temporary blockade disrupts nerve signal transmission from the lower abdomen, pelvic region, and lower extremities, blocking nociceptive signalling while leaving central consciousness intact.

Historically, general Anaesthesia served as the primary technique for both routine vaginal deliveries and emergency lower-segment C-sections. However, over recent decades, neuraxial interventions—specifically single-shot spinal Anaesthesia using hyperbaric bupivacaine—have supplanted GA as the primary modality for both elective and emergency C-sections. This paradigm shift is driven by the rapid onset, technical simplicity, and robust sensory block provided by subarachnoid administration. Crucially, epidemiological studies indicate that neuraxial Anaesthesia is associated with a substantially lower maternal mortality rate than GA, with neuraxial techniques estimated to be roughly 16.7 times safer in obstetric populations.

The primary clinical driver for favouring neuraxial blocks over GA is the avoidance of two high-fatality obstetric hazards: failed or difficult endotracheal intubation and pulmonary aspiration of gastric contents (Mendelson's syndrome). Gravid physiological adaptations—such as elevated intra-abdominal pressure from the enlarged uterus, reduced lower oesophageal sphincter tone mediated by elevated progesterone, delayed gastric emptying during labour, and tissue edema of the upper airway—markedly amplify these risks during general Anaesthesia induction.
Despite the clear benefits of regional techniques, general Anaesthesia remains an irreplaceable tool in modern obstetric care. GA is essential during acute regional failure, systemic maternal coagulopathies, severe hypovolemic shock, infection at the neuraxial injection site, or acute fetal compromise requiring immediate delivery (e.g., severe bradycardia or cord prolapse).



Physiological Considerations in Obstetric Anaesthesia
Subarachnoid administration of local anaesthetics induces acute preganglionic sympathetic blockade. This sympatholysis causes peripheral vasodilation, venous pooling, reduced venous return to the heart, decreased cardiac output, and subsequent maternal hypotension. If unmanaged, post-spinal hypotension severely reduces uteroplacental perfusion, compromising fetal oxygenation. Additionally, intraoperative shivering remains a distressing complication of neuraxial blocks, disrupting patient comfort and increasing oxygen consumption.
On the other hand, general Anaesthesia exposes the parturient to the risks of awareness under Anaesthesia, rapid desaturation due to decreased functional residual capacity (FRC), and difficult airway management due to pregnancy-induced tissue friability and hypervascularity.
Study Objectives
• To investigate the incidence and clinical pattern of anaesthetic complications associated with General Anaesthesia and Spinal Anaesthesia in parturients undergoing C-section.
• To evaluate and compare the physiological stability, safety, and operational efficacy of General versus Spinal Anaesthesia in modern clinical practice.

2. Review of Literature

Anaesthetic management during C-section has evolved through clinical research focused on maternal and fetal safety. Bloom et al. [6] conducted a large-scale observational analysis involving 37,142 women undergoing C-section across major academic centres. Regional Anaesthesia was selected in 93% of cases, with a low procedural failure rate of 3%. The authors concluded that regional techniques had established clear clinical dominance due to their superior safety profile, while identifying specific risk factors associated with failure.

Mancuso et al. [25] evaluated neonatal outcomes in 179 women undergoing elective C-section under SA (n = 90), GA (n = 89), or converted GA (n = 63). Neonatal depression at 1 minute was significantly lower in the spinal cohort (1.1%) compared to the general (25.9%) and conversion (12.7%) groups. At 5 minutes, Apgar parameters aligned across groups, confirming that while both approaches are clinically viable, SA offers clear advantages in immediate neonatal vigour.

Etezadi et al. [26] analysed the incidence of Post-Dural Puncture Headache (PDPH) in 361 parturients receiving spinal Anaesthesia with a 25-gauge Quincke needle, reporting a 10.8% incidence rate. To address intraoperative shivering, Giovani et al. [27] conducted a randomised double-blind trial demonstrating that adding sufentanil (2.5 mcg) to hyperbaric bupivacaine (10 mg) and morphine (80 mcg) significantly suppressed post-spinal shivering in the immediate recovery phase.

Saygi et al. [28] evaluated 100 elective C-section cases split evenly between GA and SA, establishing that SA provided superior postoperative comfort, lower analgesic requirements, and improved initial Apgar scores. Ghaffari et al. [29] further demonstrated that among ASA II parturients, SA led to significantly higher EuroQol Visual Analogue Scale (EQ-VAS) scores at 24 hours post-delivery, along with fewer limitations in mobility and routine activity compared to GA. Vijaya et al. [30] evaluated 100 singleton pregnancies and observed an overall anaesthetic complication rate below 10%, supporting guidelines favoring neuraxial intervention.

Regarding hemodynamic instability, Algarni et al. [32] identified mild (31.4%), moderate (23.9%), and severe (30.1%) post-spinal hypotension in a Saudi Arabian cohort, noting that elevated BMI and higher local anaesthetic doses significantly increased hypotension risk. Similarly, Iqbal et al. [33] observed post-spinal hypotension in 26.8% of 272 patients. Munyanziza et al. [34] demonstrated that a 40% incidence of severe hypotension could be mitigated through crystalloid co-loading, left lateral uterine displacement, and ephedrine administration.

Comparing side effect profiles, Afroz et al. [35] observed that post-procedural pain (47%), hypotension (37%), and headache (27%) dominated the spinal group, whereas pain (27%), headache (40%), and vomiting (50%) were frequent following general Anaesthesia. Furthermore, studies in developing healthcare settings documented a 6.0% failed spinal rate, attributing conversions to operator experience [36]. Chau-in et al. [37] reported an overall obstetric complication rate of 35.9 per 10,000 cases in Thailand, identifying provider inexperience, inadequate preoperative evaluation, and acute maternal systemic disease as major contributing factors.

3. Methodology

3.1 Study Design and Setting

This prospective observational cohort study was conducted in the Department of Anesthesiology and Critical Care, SGT Medical College, Hospital, and Research Institute, Gurugram, Haryana, India.

3.2 Ethical Considerations

Ethical clearance was granted by the Institutional Ethics Committee (IEC) of SGT University (Ref. No.: FAHS/IEC/2023-24/77, dated April 15, 2024). Informed consent was obtained from all participating patients in both English and Hindi before surgical intervention.

3.3 Study Population and Sample Size

The study enrolled N = 60 obstetric patients scheduled for elective or emergency C-sections between December 2023 and April 2024. Sample size was calculated using G*Power statistical software. Patients were divided into two equal groups (n = 30 per group):

• Group A (General Anaesthesia): Patients receiving standard endotracheal general Anaesthesia.
• Group B (Spinal Anaesthesia): Patients receiving subarachnoid block regional Anaesthesia.

Participant allocation followed a convenience sampling method using a randomised sealed-envelope technique.

3.4 Selection Criteria

Inclusion Criteria:

• Female patients aged 25 to 40 years.
• ASA Physical Status classification II or III.
• Scheduled for elective or emergency C-section under SA or GA.
• Voluntarily signed informed consent.

Exclusion Criteria:
• Refusal to provide informed consent.
• Maternal age < 25 years or > 40 years.
• ASA Physical Status classification IV or higher.
• Absolute contraindications to neuraxial blockade (e.g., severe coagulopathy, local infection, uncorrected hypovolemia).

3.5 Anaesthetic Procedures and Data Collection

Preoperative evaluations included airway grading (Mallampati score), baseline vital signs, body weight, ASA classification, and relevant blood investigations (haemoglobin, coagulation profile).

Group A (GA): Pre-oxygenation was followed by rapid sequence induction using standard intravenous agents and muscle relaxants. Endotracheal intubation was performed using direct laryngoscopy. Complications including difficult intubation, failed intubation, hypothermia, hypotension, and pulmonary aspiration were recorded.

Group B (SA): Performed in the sitting or lateral position at L3-L4 or L2-L3 interspaces using standard subarachnoid administration of hyperbaric bupivacaine 0.5% (10-12.5 mg). Complications including hypotension (defined as SBP drop > 20% from baseline or SBP < 90 mmHg), intraoperative shivering, nausea/vomiting, post-procedural pain, high spinal block, and block failure were systematically monitored.

3.6 Statistical Analysis

Data were tabulated using MS Excel and analysed using SPSS and GraphPad Prism. Continuous variables (e.g., age, weight, blood pressure, heart rate) are presented as Mean ± Standard Deviation (SD) and compared using independent sample t-tests. Categorical variables (e.g., ASA grade, surgical urgency, complication rates) are expressed as frequencies and percentages and compared using Chi-square tests. Statistical significance was defined as $p < 0.05$.

4. Observations and Results

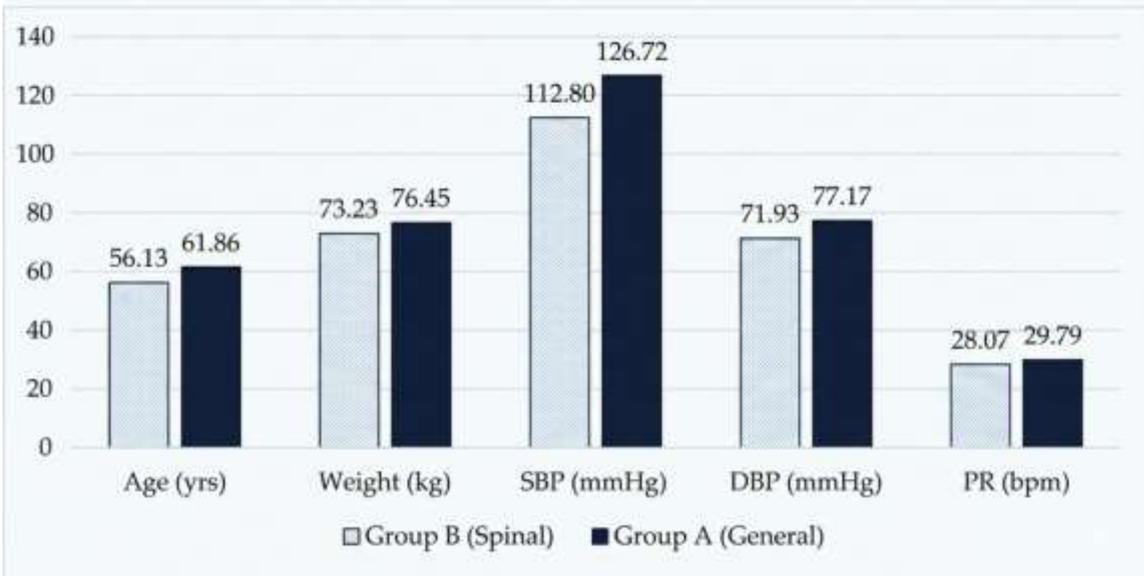
A total of 60 female patients were analysed (30 in Group A, 30 in Group B).

4.1 Demographic and Baseline Vital Statistics

Parameter	**Group B: Spinal (n=30)**	**Group A: General (n=30)**	**t-value**	**p-value**	**Significance**
Age (years)	28.07 ± 2.82	29.79 ± 4.14	1.88	0.065	Non-Significant (NS)
Weight (kg)	56.13 ± 5.62	61.86 ± 9.20	2.90	0.005	Statistically Significant ($p < 0.01$)
Systolic BP (mmHg)	112.80 ± 11.08	126.72 ± 6.14	5.94	0.001	Statistically Significant ($p < 0.01$)
Diastolic BP (mmHg)	73.23 ± 12.62	76.45 ± 5.55	1.26	0.213	Non-Significant (NS)
Pulse Rate (bpm)	71.93 ± 7.30	77.17 ± 7.95	2.64	0.011	Statistically Significant ($p < 0.05$)

There was no statistically significant difference in mean maternal age between the spinal (28.07 ± 2.82 years) and general Anaesthesia (29.79 ± 4.14 years) groups ($p = 0.065$). Similarly, baseline Diastolic Blood Pressure (DBP) showed no significant difference (73.23 ± 12.62 mmHg vs. 76.45 ± 5.55 mmHg, $p = 0.213$). However, statistically significant differences were observed in Weight, SBP, and Pulse Rate.

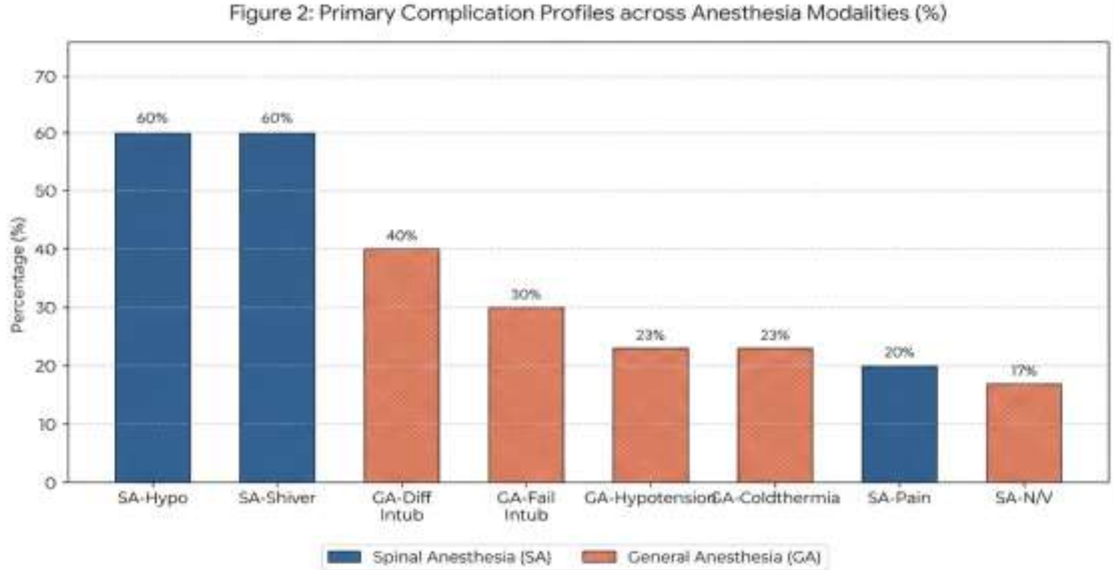
Figure 1: Mean Vital Parameters and Weight Comparison (Spinal vs. General Anesthesia)



4.2 Complication Profile in Spinal Anaesthesia

Complication Type	Present (n, %)	Absent (n, %)
Hypotension	18 (60.0%)	12 (40.0%)
Shivering	18 (60.0%)	12 (40.0%)
Postoperative Pain	7 (23.0%)	23 (77.0%)
Nausea & Vomiting	6 (20.0%)	24 (80.0%)
High Spinal Block	1 (3.0%)	29 (97.0%)
Failed Regional Anaesthesia	0 (0.0%)	30 (100.0%)

Figure 2: Primary Complication Profiles across Anesthesia Modalities (%)



4.3 Complication Profile in General Anaesthesia

Complication Type	Present (n, %)	Absent (n, %)
Difficult Intubation	12 (40.0%)	18 (60.0%)
Failed Intubation	9 (30.0%)	21 (70.0%)

Hypothermia	7 (23.0%)	23 (77.0%)
Hypotension	5 (17.0%)	25 (83.0%)
Pulmonary Aspiration	0 (0.0%)	30 (100.0%)

4.4 American Society of Anesthesiologists (ASA) Physical Status Distribution

ASA Status Grade	Group B: Spinal (n=30)	Group A: General (n=30)	Chi-square	p-value	Significance
ASA Grade II	25 (83.0%)	23 (77.0%)	0.157	0.692	Non-Significant (NS)
ASA Grade III	5 (17.0%)	7 (23.0%)	—	—	—

4.5 Surgical Urgency Classification

Case Urgency Type	Group B: Spinal (n=30)	Group A: General (n=30)	Chi-square	p-value	Significance
Elective C-Section	10 (33.0%)	9 (30.0%)	0.080	0.777	Non-Significant (NS)
Emergency C-Section	20 (67.0%)	21 (70.0%)	—	—	—

5. Discussion

Obstetric Anaesthesia requires balancing maternal safety with fetal well-being. Selecting an appropriate technique demands clear understanding of the physiological stresses imposed by both modalities.

5.1 Patient Demographics and Baseline Dynamics

The mean maternal age in our cohort (28.07 years in SA vs. 29.79 years in GA) reflects standard childbearing demographics in regional tertiary clinical centres. Baseline ASA distribution and surgical urgency (predominantly emergency procedures, 67-70%) were statistically balanced across both study arms, validating comparative analyses between cohorts.

5.2 Hemodynamic Instability and Neuraxial Sympatholysis

Post-spinal hypotension occurred in 60.0% of parturients in Group B. Subarachnoid local anaesthetic administration blocks preganglionic sympathetic fibres, causing acute arterial and venous vasodilation. In contrast, Group A (GA) exhibited a significantly lower incidence of hypotension (17.0%), as controlled intravenous induction and vasopressor administration maintain higher systemic vascular resistance.

5.3 Thermoregulation and Post-Spinal Shivering

Intraoperative shivering affected 60.0% of patients in the SA cohort, matching the rate of post-spinal hypotension. Neuraxial Anaesthesia impairs central thermoregulatory control, lowers the shivering threshold, and induces peripheral heat redistribution via vasodilation. In contrast, general Anaesthesia disrupts thermoregulation through systemic metabolic suppression, leading primarily to core hypothermia (23.0%) rather than active muscular shivering.

5.4 Airway Management Challenges in General Anaesthesia

Airway complications represented the most critical hazard in the General Anaesthesia cohort, with difficult intubation observed in 40.0% of cases and failed intubation in 30.0%. Pregnancy induces marked physiological changes in the upper respiratory tract, including mucosal edema, hypervascularity, weight gain, and breast enlargement, which impede laryngoscope positioning and vocal cord visualisation. Reassuringly, zero cases of pulmonary aspiration were recorded in our study.

5.5 Postoperative Symptoms and Regional Block Efficacy

Minor post-procedural complications differed markedly between techniques. In Spinal Anaesthesia, 23.0% of patients experienced incisional pain as the block wore off, and 20.0% reported nausea and vomiting. In General Anaesthesia, emergence agitation, sore throat, and narcotic-induced emesis were primary postoperative issues. High spinal block occurred in 1 case (3.0%) in Group B and was successfully managed. Complete regional block failure was 0.0%, demonstrating high reliability.

6. Overall Conclusion

This prospective evaluation highlights the distinct safety profiles and clinical trade-offs of Spinal Anaesthesia versus General Anaesthesia for C-section delivery:

• Spinal Anaesthesia remains the preferred, safer first-line modality for obstetric delivery, providing superior initial postoperative analgesia and avoiding airway risks. However, it carries a high burden of sympathetically mediated hypotension (60.0%) and intraoperative shivering (60.0%).

• General Anaesthesia remains essential for high-urgency emergency scenarios where neuraxial block is contraindicated. However, it presents major airway management challenges, including high rates of difficult (40.0%) and failed (30.0%) intubation in emergency settings.

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