

Comparison of glottic visualisation through supraglottic airway device (SAD) using bronchoscope in the ramped versus supine 'sniffing air' position: A pilot feasibility study

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ABSTRACT

Background and Aims: Airway management in obese patients is associated with increased risk of difficult airway and intubation. After failed intubation, supraglottic airway-guided flexible bronchoscopic intubation (SAGFBI) may be required. It is uncertain whether SAGFBI is best performed in the ramped versus conventional supine "sniffing air" position. We conducted a feasibility study to evaluate the logistics of positioning, compared glottic views, and evaluated SAGFBI success rates. **Methods:** We conducted a prospective, pilot study in patients with a body mass index (BMI) 30–40 kg/m² undergoing elective operations requiring tracheal intubation. All patients were placed in a ramped position. After induction, a supraglottic airway device (SAD) was inserted. A flexible bronchoscope was inserted into the SAD and a photograph of the glottic view taken. The patient was repositioned to the supine position. A second photograph was taken. SAGFBI was performed. Images were randomised and assessed by two independent anaesthetists. **Results:** Of 17 patients recruited, 15 patients were repositioned successfully. There were no differences in glottic views observed in the two positions. SAGFBI was successful in 92.9% of patients (median time 91.5 s). Haemodynamic changes were noted in 42.7% of patients which resolved spontaneously. **Conclusion:** Our pilot study was completed within 5 months, achieved low dropout rate and protocol feasibility was established. SAGFBI was successfully and safely performed in obese patients, with a median time of 91.5 s. The time taken for SAGFBI was similar to awake intubation using FBI and videolaryngoscopy. Our study provided preliminary data supporting future, larger-scale studies to evaluate glottic views in the ramped versus supine positions.

Key words: Airway management, feasibility studies, intratracheal, intubation, obesity, patient positioning

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INTRODUCTION

Obesity is a multisystemic disease with increasing prevalence worldwide.^[1] Airway management in obese patients may be challenging, and is associated with a greater risk of difficult airways.^[1] Obesity-related pulmonary changes include impaired lung mechanics, increased oxygen consumption, and rapid desaturation.^[1] Adopting the ramped position in obese patients during induction of general anaesthesia improves preoxygenation and ventilation, prolongs safe apnoea time, and facilitates tracheal intubation.^[2,3] The Difficult Airway Society (DAS) guidelines recommend supraglottic airway device (SAD) insertion after failed

intubation for rescue ventilation,^[4] which is successful in 65–94% of cases.^[5]

Flexible bronchoscopic intubation via the SAD (supraglottic airway guided flexible bronchoscopic intubation, SAGFBI) has high

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Table 1: Characteristics of patients

Patients' characteristics	Median (IQR)
Age (years)	47 (43-56)
Body mass index (BMI) (kg/m ²)	35.4 (32.1-37.2)
Body weight (kg)	96.8 (84.1-102.8)
Neck circumference (cm)	43 (43-44.75)
Interdental distance (cm)	4.3 (4-4.5)
Thyro-mental distance (cm)	7 (7-7.5)
Number of patients, n (%)	
STOPBANG score	
Low	7 (50%)
Moderate	3 (21.4%)
High	4 (28.6%)
Presence of obstructive sleep apnoea	
Yes	2 (14.3%)
No	12 (85.7%)
Mallampati score	
1	4 (28.6%)
2	7 (50%)
3	3 (21.4%)
4	0 (0)

success rates in difficult airways (96–100%),^[6] and obese patients (100%).^[7] However, we are unaware of studies evaluating the effect of positioning (supine versus ramped) on bronchoscopic glottic view in obese patients. This would help determine whether to maintain the ramped position or to change into the supine position. The latter maneuver requires extra personnel to achieve safely (e.g., lowering an obese patient, ensuring intravenous lines and breathing circuits are not dislodged), and care to ensure airway control is not lost (e.g., laryngospasm during maneuvering).

We conducted a pilot feasibility study evaluating glottic views during SAGFBI in obese patients in the ramped versus supine “sniffing air” positions. The primary outcome was to determine study protocol feasibility including patient recruitment, dropout rate, and practical implementation. Secondary outcomes included: (i) comparison of bronchoscopic glottic views in both positions, (ii) time taken for SAGFBI, (iii) success rate of SAGFBI, (iv) airway maneuvers (e.g., slight SAD withdrawal, jaw thrust) undertaken to facilitate SAGFBI, and (v) associated adverse events.

METHODS

The study was approved by the Singhealth Institutional Research Board (CIRB reference 2017/2135) prior to commencement and registered with the Clinical Trials Registry (<https://clinicaltrials.gov>, NCT 03678246).

A single-center, prospective pilot feasibility study was conducted from July to November 2018. All adult patients (aged 21 years and above) with obesity [body mass index (BMI) 30–40 kg/m²] scheduled for elective operations requiring oral intubation were screened in the pre-anesthetic clinic. Exclusion criteria were known or anticipated difficult airway, morbid obesity (BMI >40 kg/m²), at risk of aspiration and American Society of Anesthesiologists (ASA) status 3 and above. Eligible patients were recruited and written informed consent obtained. Patients’ characteristics including age, gender, BMI, Mallampati score, neck circumference, thyromental distance, and interdental distance were recorded [Table 1].

After patient recruitment, the dates and theatre listings were identified and we liaised with the roster manager regarding list allocation. On the day of operation, a team brief with all theatre personnel was implemented including instructions on patient repositioning after induction of anaesthesia.

SAGFBI was performed by one of the two study anesthetists who had experience with the technique (described below) and completed more than five attempts prior to the study. A maximum of two intubation attempts were allowed. If intubation was unsuccessful or oxygen saturation (SpO₂) ≤95%, the study would be terminated and subsequent airway management was at the anaesthetist's discretion.

All patients were placed in a ramped position using a Troop Elevation Pillow™ (Mercury Medical, Clearwater, FL, USA) with horizontal alignment of the sternal notch and the external auditory meatus. Additional adjuncts, for example, pillow were used if necessary. Preoxygenation for 3 min was performed to achieve an end-tidal oxygen concentration of 85%. General anaesthesia was induced with propofol (2 mg/kg based on lean body weight, LBW), fentanyl (1 mcg/kg LBW), and rocuronium (1 mg/kg based on ideal body weight, IBW). Haemodynamic parameters were measured at one minute intervals. Bag-and-mask ventilation with 100% oxygen and sevoflurane (end-tidal concentration 1.5-2%) for 3 min was performed. After full muscle paralysis, a fully deflated Ambu Auragain™ SAD (size 3 for females, size 4 for males) was inserted, and then connected to the anaesthetic circuit to confirm ventilation and satisfactory placement.

A 3.8 mm Ambu® aScope™ (Ambu A/S, Baltorpbakken, Ballerup) bronchoscope (herein

referred to as “bronchoscope”) was preloaded with an endotracheal tube (ETT) and connected to its monitor. Sizes 6.0 and 7.0 mm ETT were used with sizes 3 and 4 Auragain™ respectively. The bronchoscope was inserted through the Auragain™. Upon reaching the exit of the bowl of the SAD (“glottic view”), a photograph was taken from the monitor. After removal of the bronchoscope, the patient was positioned supine after removing the pillow. SAGFBI was then commenced. The bronchoscope was re-inserted into the SAD and a second glottic view photograph taken. The bronchoscope was passed into the trachea and the ETT railroaded. The bronchoscope was removed and the ETT position was confirmed via capnography. The ETT was held in place using a Magill’s forceps while the SAD was carefully removed. After securing the ETT, surgery proceeded.

Images of the glottic view in the ramped and supine positions were kept paired but the sequence was randomised, and reviewed by two independent assessors. Glottic view assessment was based on the Cormack and Lehane laryngeal view classification.^[8] [Table 2]. The number of intubation attempts and oesophageal intubations were recorded. The time taken for various components of SAGFBI were recorded: [Table 3]

1. “SAD ventilation time” = time from picking up SAD to obtaining a normal capnograph after ventilation of the lungs.
2. “SAGFBI time” = time from picking up bronchoscope (patient in supine position) to obtaining a normal capnograph after intubation and ventilation of the lungs.
3. “Total study time” = time from picking up SAD to obtaining a normal capnograph after intubation and ventilation of the lungs; this included time for SAD insertion, supine positioning of patient, photographing the glottic views, and performing SAGFBI.

Failed SAGFBI attempt was defined as requiring more than two attempts or oesophageal intubation. Subjective scores of the degree of “bronchoscope tip manipulation” to enter the glottis and “resistance to railroadings” the ETT were recorded [Table 4]. “Airway maneuvers” performed to facilitate SAGFBI were documented. Adverse events including >20% variation in heart rate and blood pressure from baseline values, SpO₂ ≤95%, dental or oral trauma, and bronchospasm were also recorded.

Descriptive statistics of median and interquartile range were reported for continuous data and percentage count for categorical data. Glottic views were compared in the ramped and supine positions using Wilcoxon-Signed-Rank test. Agreement of Cormack–Lehane grade between the two assessors was measured separately for the two positions, via the kappa statistics. As this was a pilot feasibility study, formal sample size calculation was not performed. Based on the recommended sample size of 12 for pilot studies,^[9] we recruited 17 patients anticipating a potential 20–30% dropout rate.^[10] A modified intention-to-treat analysis was performed. A sensitivity analysis was also performed and detected no change in result.

RESULTS

Our study achieved the targeted recruitment number with a low dropout rate and was successfully completed after 5 months. 17 patients were eligible and 15 participated in the study (dropout rate of 11.8%). One patient declined participation 1 day after enrolment. The other developed a respiratory tract infection. One further patient was excluded due to inadvertent enrolment error (BMI of 47 kg/m²).

We included 14 patients (6 males, 8 females) in our analysis. There were no missing data. Patients’ characteristics are listed in Table 1. Median age of our patients was 47 years and the median BMI was

Table 2: Comparison of glottic views in the ramped vs supine position

Glottic views	Assessor 1			Assessor 2		
	Ramped (n=14)	Supine (n=14)	P	Ramped (n=14)	Supine (n=14)	P
Cormack-Lehane grade						
1	1 (7.1%)	2 (14.3%)	0.48	2 (14.3%)	2 (14.3%)	0.317
2a	8 (57.1%)	4 (28.6%)		7 (50.0%)	4 (28.6%)	
2b	2 (14.3%)	5 (35.7%)		2 (14.3%)	5 (35.7%)	
3	3 (21.4%)	3 (21.4%)		3 (21.4%)	3 (21.4%)	
4	0 (0%)	0 (0%)		0 (0%)	0 (0%)	

Cormack-Lehane grade: 1 - vocal cords fully visualised, 2a - vocal cords partially visualised, 2b - only arytenoids are visible, 3 - epiglottis visible, 4 - epiglottis not visible

Table 3: Time taken for various components of SAGFBI

Components of SAGFBI	Time taken in seconds/median (IQR)
SAD ventilation time (in ramped position)	29 (22-35)
SAFBI time (in supine position)	91.5 (70-107)
Total study time	225 (194-277)

'SAD ventilation time' = time from picking up the SAD to obtaining a normal capnograph after ventilation of the lungs. 'SAGFBI time' = time from picking up the bronchoscope with the patient in supine position to obtaining a normal capnograph after intubation and ventilation of the lungs. 'Total study time' = time from picking up the SAD to obtaining a normal capnograph after intubation and ventilation of the lungs; this included time for SAD insertion, supine positioning of the patient, photographing the glottic view in both ramped and supine positions, and performing SAGFBI

Table 4: Performance of SAGFBI in 14 patients in the supine position

Outcomes	Number of patients, n (%)
Intubation attempts	
1	12 (85.7%)
2	2 (14.3%)
Time to intubation (SAGFBI) in seconds/Median (IQR)	91.5 (70-107)
Bronchoscope tip manipulation score*	
1	9 (64.3%)
2	4 (28.6%)
3	1 (7.1%)
4	0 (0%)
Resistance to railroading score**	
1	8 (57.1%)
2	5 (35.7%)
3	1 (7.1%)
4	0 (0%)
Successful SAGFBI attempt	
Yes	13 (92.9%)
No	1 (7.1%)
Airway manoeuvres performed to facilitate SAGFBI	
Yes	3 (21.4%)
No	11 (78.6%)

*Bronchoscope tip manipulation score: 1 - easy, none or minimal, 2 - moderate, 3 - severe, 4 - failed, **Resistance to railroading score: 1 - easy, no resistance, 2 - minor resistance, 3 - marked resistance, 4 - impossible

35.4 kg/m². On routine airway assessment, 78.6% of patients had Mallampati score of 1 or 2. 50% of the patients had moderate to high STOPBANG scores. Two patients had severe obstructive sleep apnoea.

During anaesthesia induction, difficulties in bag mask ventilation were encountered in four patients. Oral airways were inserted in two patients, while two-handed technique was required in two patients to achieve satisfactory manual ventilation.

The median (IQR) times taken for bronchoscopic glottic visualisation in the ramped and supine positions were 20 (12.25, 28.25) and 13.5 (10.5, 19.75) s, respectively. Using the Wilcoxon-Signed-Rank test, this difference

was not statistically significant ($P = 0.142$). 78.6% of the glottic views were Cormack–Lehane Grade 1 or 2 in both positions. Both assessors identified more grade 2a and less grade 2b glottic views in the ramped position compared with the supine positions, although this was not statistically significant [Table 2]. We did not detect any correlation between glottic views, FOB manipulation scores, and resistance to railroading scores. There was good agreement of Cormack–Lehane grade between both assessors for the ramped and supine positions (Kappa = 0.888 and 0.803, respectively).

SAGFBI was performed in the supine position, and was successful in 13 out of 14 patients (92.9%). 12 of the 13 intubations (92.3%) were successful on first attempt. In the remaining patients, intubation was successful on the second attempt due to resistance during ETT railroading on the first attempt [Table 4]. The single failed intubation was due to inadvertent oesophageal intubation despite a grade 2A glottic view. The procedure was terminated due to SpO₂ ≤ 95% and subsequent conventional intubation was successful.

The median SAGFBI and total study times were 91.5 and 225 s, respectively. In 92.9% of cases, minimal to moderate manipulation of the bronchoscope was required. None or little resistance to railroading was encountered.

Airway maneuvers were required in three patients (21.4%) without difficult airway predictors. Six patients (42.9%) developed transient tachycardia or hypertension [Table 5]. All patients maintained oxygen saturation ≥ 99% except for three patients [Table 5]. In one patient, intubation was successfully completed in 6 min. Desaturation from 96% to lowest 86% occurred 1 minute later, resolving with manual lung recruitment maneuvers. In another patient, signs of anaphylaxis developed soon after successful SAGFBI with lowest SpO₂ of 95%. Intravenous antihistamine and hydrocortisone were administered. Although she remained stable thereafter, surgery was postponed. Following allergist referral, a diagnosis of allergy to either ceftriaxone or rocuronium was made. In the third patient, SAGFBI was unsuccessful at 7 min (SpO₂ 98%). Direct laryngoscopic intubation was performed successfully, with a transient SpO₂ of 88%. There were no postoperative sequelae associated with any of these adverse events.

DISCUSSION

In our study, the primary outcome on study feasibility (patient recruitment and safe positioning

Table 5: Type of adverse events encountered during SAGFBI

Type of adverse events	Number of patients, n (%)	
Tachycardia (>20% variation from baseline)	Yes	5 (35.7%)
	No	9 (64.3%)
Hypertension (>20% variation from baseline)	Yes	6 (42.9%)
	No	8 (57.1%)
Respiratory compromise (SpO ₂ ≤95%)	Yes	3 (21.4%)
	No	11 (78.6%)

of the anaesthetised obese patients from the ramped to supine position) was successfully achieved. This was due to early liaison with the roster manager, and effective coordination of theatre personnel to facilitate repositioning of the patient.

Feasibility and pilot studies are preliminary research activities undertaken to determine the practicality of future research, by examining areas of methodological uncertainty before commencing large studies.^[11] In our study, we were uncertain about trial recruitment and logistical issues, hence, we did a pilot feasibility study with small sample size.

Patient recruitment took 5 months, exceeding the expected 3 months duration. One possible reason is our exclusion criteria of ASA 3 or above patients; our institution is a tertiary hospital, receiving a higher number of such patients. By incorporating safeguards to minimise patient risk in the methodology (maximum two SAGFBI attempts and study termination if SpO₂ ≤95%), patient acceptance to recruitment was good.

Although earlier studies reported better laryngoscopic views in the ramped position,^[2,3] a more recent study reported poorer views requiring more intubation attempts.^[12] In our study, partial or full glottic views were observed in 78.6% of patients in both positions, similar to other studies.^[13] Although the ramped position is recommended in obese patients to facilitate direct laryngoscopy and tracheal intubation, we did not detect any difference in bronchoscopic glottic views in the ramped versus supine positions. Hence, after failed intubation and SAD insertion for rescue ventilation, we recommend maintaining the ramped position due to: prolonged safe apnoea time; increased functional residual capacity; no available evidence of glottic view differences during SAGFBI; and avoiding patient repositioning.

We reported high intubation success rates using SAGFBI, in line with other studies on normal

airways (95–100%).^[14] In a recent study in obese patients, first attempt and second attempt success rates in SAGFBI were 91% and 100%, respectively.^[7] This reinforces the DAS's recommendation that if rescue SAD ventilation is successful, then SAGFBI to secure the airway should be considered.

In our study, the authors performing SAGFBI were specialist anaesthetists, which may account for the high success rate. However, manikin studies showed no difference in SAGFBI times and success rates regardless of operator experience.^[15] This supports junior anaesthetists performing SAGFBI following failed intubation.

Our SAGFBI times are comparable to others using Auragain™ with duration ranging from 40 to 127 s.^[7] Safe apnoea time of 247 s was reported in obese patients.^[16] In anticipated difficult airways, SAGFBI confers additional advantages: SAD placement helps maintain a patent airway, allowing oxygenation; and rescue ventilation can be provided in between intubation attempts. Appropriate SAD placement is essential as malpositioning may lead to difficulties in SAGFBI. Selection of appropriately-sized SAD, based on patient's IBW is important.^[17] Despite adequate glottic visualisation, intubation may still fail due to ETT impingement during railroading over the bronchoscope, hence adequate size matching is important to minimise the gap.^[18] To minimize ETT tip impingement onto peri-glottic structures, use a tapered ETT (e.g., LMA® Fastrach™)^[18] with the bevel facing posteriorly.^[19] Another cause is resistance during ETT advancement, hence lubrication is essential.^[18]

After successful intubation, the SAD can be left *in situ* (cuff deflated), or removed. Caution is required during SAD removal, preferably performed using either a Fastrach™ stabiliser rod or a Magills forceps to avoid inadvertent extubation.^[20]

Significant proportion of our patients developed haemodynamic changes during SAGFBI, but were transient and resolved spontaneously. This may be due to hypercarbia secondary to longer intubation times, resulting in sympathetic stimulation.^[18]

Two patients developed transient hypoxia despite successful SAGFBI. The time to intubation was 84 s and 179 s, longer in the latter due to interim bag-and-mask ventilation. Hypoxia may be due to

a shorter safe apnoea time^[1] and supine positioning. One patient developed an anaphylactic reaction, a rare event with an estimated incidence of 1 in 10,000, with antibiotics and muscle relaxants being the most common drugs.^[21]

Our study has some limitations. First, although no difference in glottic views in the ramped versus supine positions was detected, this is a pilot study and therefore inadequately powered. Second, the bronchoscope tip may not be positioned at the identical location in the SAD bowl during photography. Third, our patients were ASA 1 or 2, without anticipated difficult airways. Therefore in obese patients with potential difficult airways, further studies with a larger sample size and expanded patient recruitment criteria are needed to determine the optimal positioning for, and the success rates of SAGFBI.

In our study, the proportion of Cormack–Lehane grades 1 and 2A in the ramped versus supine positions is 60% and 30%, respectively. Using Chi-square test with a power of 80%, a 2-sided type I error of 5% and incidence of glottis view as stated above, a post-hoc sample size of 41 patients is required for a full-scale study.

CONCLUSION

Our pilot study was completed and protocol feasibility was established. SAGFBI was successfully and safely performed in 92.9% of patients. There were no observed differences in glottic views between the supine and ramped positions. Our study provides preliminary data on optimal positioning for SAGFBI. This will help guide management after failed intubation in the obese population, whether to maintain the ramped position for subsequent airway attempts, including SAGFBI.

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Conflicts of interest

PW has received airway equipment for evaluation and research from numerous companies, and has lectured

at conferences and symposiums sponsored by Ambu. He has no financial interest in any airway company.

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