Brief report

Comparison of endotracheal intubation with the Shikani Optical Stylet using the left molar approach and direct laryngoscopy

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The Shikani Optical StyletTM or SOS (Clarus Medical, USA) was developed as an aid to intubation for difficult airways.[1] The SOS is composed of a J-shaped malleable body and a lens and light source at the tip and an eyepiece at the proximal end. It combines the features of a fiberoptic bronchoscope and a lightwand. It can be used alone or combined with a camera or monitor and both adult and pediatric versions are available.[2,3]

Although approved by the FDA in 1996, the SOS is still unknown to many anesthesiologists and has only a few user reports. In 2005, JIA Nan-guang developed the left molar approach to use the SOS. We have used the SOS with the left molar approach in over 15 000 cases without any major complications. This study was undertaken to compare hemodynamic changes after intubation using our technique and direct laryngoscopy in patients without difficult airway.

METHODS

Patient selection

After obtaining Institutional approval and informed consent from each patient, 40 normotensive (ASA physical status Ⅰ) and 40 hypertensive patients (ASA physical status Ⅱ) scheduled for elective surgery under general anesthesia were enrolled in this study; as normotensive group (group N) and hypertensive group (group H). Hypertensive patients were those who had a history of hypertension and had been on antihypertensive medicines, and those whose systolic blood pressure were higher than 140 mmHg and/or diastolic pressure higher than 90 mmHg on three occasions after admission. Normotensive patients were those who had no hypertensive history and admission blood pressures on three occasions were lower than 140 mmHg systolic and 90 mmHg diastolic. Patients in both group N and group H were further randomly allocated into two subgroups by different intubation techniques (the direct laryngoscopy as group L and the SOS as group S) according to a computer-generated randomization table. Exclusion criteria were as follows: ear, nose, throat (ENT) surgery, Mallampati airway classification III-IV, upper airway abnormalities (such as oropharyngeal abscess, vocal cord polyp, etc), and respiratory illness (such as asthma, infection, tobacco addiction, etc). Neck surgery patients were also excluded because surgical maneuvers in the neck might lead to dislocation of the cuff of endotracheal tubes (ETTs) during operation and result in postoperative soar throat and/or hoarseness.

Anesthesia

Premedications before anesthesia was spared. Patients on regular antihypertensive medicines continued their drugs till the morning of surgery and all hypertensive patients took nifedipine 5 mg orally 1 hour prior to admission to the operating theater. Noninvasive systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and saturation of pulse oxygenation (SpO_2) were monitored by a multifunction monitor (Datex-Ohmed S5, Finland). Intravenous access was established by insertion of a 20-gauge cannula into the dorsal vein of the hand opposite to the side of the BP cuff application. Midazolam 2–5mg and fentanyl 50–100 μg were administered by titration till the patients were moderately sedated (Modified Observer's Assessment of Alertness/Sedation Scale[4] score of 2–3 points), and patient's SBP, DBP and HR at that time were recorded by another anesthesiologist (RA) as baseline values (BV). Then after 5 minutes of preoxygenation and denitrogenation, anesthesia was induced with additional fentanyl to attain a total dose of 2 μg/kg, followed by propofol 2 mg/kg. Rocuronium 0.6 mg/kg was given after loss of consciousness and the lungs were manually ventilated via a facemask with pure oxygen. Endotracheal intubation was performed 1min after the administration of rocuronium. Cuffed ETTs with internal diameter of 7.0 mm and 7.5 mm were used for female and male patients respectively, and all ETTs were lubricated with 2% lidocaine gel before use.

Intubation techniques

Patints in group L were intubated by direct laryngoscopy using a size 3 Macintosh laryngoscope (Timesco, UK). Patients in group S were intubated by the SOS using the left molar approach: the operator (right-handed) stood by the left shoulder of the patient and lifted his or her

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mandible upwards with the left hand, then inserted the SOS preloaded with an ETT by the right hand at the left corner of the patient's mouth above the left molar (Figure). The SOS was advanced medially and caudally until a "light spot" (indication of the ETT tip) was visualized beneath the thyroid cartilage. Its depth was fixed at the left mouth corner and the handle was rotated gently to allow the light spot to appear midline. After the glottis and vocal cords were visualized via the eyepiece, the SOS was advanced until tracheal rings were visible. The ETT was threaded over the SOS into the trachea and the SOS was retrieved. After inflation of the ETT cuff and confirmation of tube position by bilateral breath sounds and capnography, the ETT was secured and connected to the anesthesia ventilator for intermittent positive pressure ventilation with mixed fresh gas of oxygen and air at the ratio of 1:1. End tidal CO_2 ($ETCO_2$) was maintain within the normal range of 35—40 mmHg. All intubations were performed by one anesthesiologist experienced in both intubation techniques. Inserting instruments into the mouth and withdrawing out of it was regarded as "one attempt". Only one attempt of intubation was allowed for either technique and cases of initial tracheal intubation failure were excluded from the study. The duration of intubation[5] (time from the insertion of the laryngoscope or SOS into the mouth until its removal) was recorded by the RA. When vocal cords were not seen by direct laryngoscopy, external laryngeal pressure was applied to facilitate intubation. Cormack-Lehane score[6] without laryngeal pressure was recorded. BP and HR immediately before (BI) and after intubation (AI), and at one minute, two, three, four and five minutes following intubation (1 minute, 2, 3, 4 and 5 minutes) were also recorded before surgical procedure.

Figure. The operator (assumed to be right-handed) stands by the left shoulder of the patient and lifts patient's mandible upwards with the left hand. The SOS is then advanced medially and caudally until the lighted spot is visualized beneath the thyroid cartilage.

After intubation, anesthesia was maintain with continuous infusion of propofol 3 $mg \cdot kg^{-1} \cdot min^{-1}$ and remifentanil 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$. All patients were asked about sore throat and hoarseness before their discharge from the post anesthesia care unit (PACU) to general wards.

For severe hypertension (SBP>200 mmHg or increase of >30% above BVs for >60 seconds) or severe tachycardia (HR >120 beats/min >60 seconds) associated with intubation, nicardipine 0.25 mg or esmolol 10mg was administered incrementally.

Statistical analysis

SPSS 11.5 software was used for statistical analysis. Numerical variables were illustrated as mean±standard deviation (SD). Hemodynamic changes were analyzed by one-way analysis of variance (ANOVA) for repeated measurements with Fisher's test or unpaired two-tailed *t* test. The male/female ratio, airway classifications and intubation complication were analyzed using chi-square test. Significance was set as P <0.05.

RESULTS

All the four groups were comparable with respect to gender, age, weight, height and airway classification, regular preoperative antihypertensive medicines are reported (Table 1). All intubations were completed at first attempt and there was no difference in intubation duration among the four groups. There was no difference in Cormack- Lehane grading between the two laryngscopy groups and no patient needed external laryngeal pressure to facilitate intubation. Neither nicardipine nor esmolol was needed to treat severe hypertension or tachycardia. The number of patients who complained of sore throat was lower in group S than L (P <0.001, two-sided Fisher's exact test in two intubation techniques both within normotensive groups and hypertensive groups). One case of hoarseness was recorded postoperatively in group NL and the symptoms resolved spontaneously after 2 days (Table 2). The baseline values of blood pressure in the hypertensive groups (group HL and HS) were significantly higher than those in the normotensive groups (group NL and NS). Both the SBP and DBP decreased remarkably after anesthesia induction in all four groups. The HR didn't change following induction, but increased after intubation, and peaked at 1 minute after intubation. The SBP and DBP showed a significant increase over baseline values at 1 minute after intubation in both groups NL and HL. While in groups NS and HS, there was no BP increase within the five minutes after intubation when compared with their baseline values (Table 3).

DISCUSSION

We initially used the SOS according to the manufacturer's instructions, i.e., the operator stands above the patient's head and the SOS is introduced midline over the surface of the tongue. By adopting such an approach, operators tend to be over-dependent on the eyepiece during intubation and easily insert the SOS too deeply into the mouth or into the esophagus. We found the midline approach was time-consuming and prone to esophageal intubation for inexperienced users, which might partially explain why the SOS has not been widely used till now.

Table 1. Demographic characteristics and Mallampati airway classification

Variables	NL group (n=20)	NS group (n=20)	HL group (n=20)	HS group (n=20)
Sex (Male/Female)	11/9	10/10	10/10	12/8
Age (yr)	54.8±7.5	56.1±6.7	57.5±6.3	56.7±7.1
Weight (kg)	61.2±9.5	57.9±10.8	59.3±9.2	64.1±10.1
Height (cm)	158.6±11.3	161.2±10.6	159.7±9.9	162.3±10.9
Antihypertensive medicines				
Calcium blocker (n)	-	-	15	13
ACE inhibitor (n)	-	-	3	4
Alpha blocker (n)	-	-	2	0
Beta blocker (n)	-	-	6	7
Mallampati airway scale (n;1/2*)	12/8	13/7	12/8	12/8

*Mallampati airway classification(airway evaluation by open mouth inspection). 1: Faucial pillars, soft palate and uvula could be visualized; 2: Soft palate, fauces, uvula could be visualized.

Table 2. Intubation data and complications

Items	NL group (n=20)	NS group (n=20)	HL group (n=20)	HS group (n=20)
Intubation duration (s)	16.3±4.4	16.5±3.5	16.4±4.0	16.7±4.3
Cormack-Lehane (n;1/2/3/4#)	17/3/0/0	-	18/2/0/0	-
Esophageal intubation (n)	0	0	0	0
Complications				
Sore throat n (%)	13 (65.0)	2*(1.0)	15 (75.0)	1*(5.0)
Hoarseness n (%)	1 (5.0)	0 (0)	0 (0)	0 (0)

NL: normotensive+larygoscopy; NS: normotensive+Shikani optical stlyet; HL: hypertensive+larygoscopy; HS: hypertensive+Shikani optical stlyet. *P <0.05, compared with group L. #Cormack-Lehane grade(intubation difficulty assessed by larygoscopy). 1:Glottis (including anterior and posterior commissures) could be fully exposed; 2:Glottis could be partly exposed (anterior commissure not visualized); 3:Glottis could not be exposed (corniculate cartilages only could be visualized); 4:Glottis including corniculate cartilages could not be exposed.

Table 3. Hemodynamic changes during endotracheal intubation (n=20, mean±SD)

Items	Group	BL	BI	AI	1-min	2-min	3-min	4-min	5-min
SBP	NL	130±12	89±14*	133±11	140±18*	133±17	128±10	126±8	128±18
(mmHg)	NS	128±10	86±9*	125±11	127±13‡	125±14	125±11	126±7	128±15
	HL	158±18†	98±15*	153±12	165±11*	159±9	157±10	155±13	153±11
	HS	156±19†	95±15*	154±20	158±18‡	156±12	150±11	149±9	150±9
DBP	NL	67±9	41±7*	68±11	75±8*	69±8	68±11	67±9	69±8
(mmHg)	NS	71±7	39±5*	70±8	71±9‡	73±11	70±6	69±7	70±6
	HL	88±11†	49±6*	87±8	105±10*	98±11*	90±10	89±9	88±5
	HS	86±9†	47±9*	85±10	86±6‡	88±11	87±7	88±7	89±6
HR	NL	76±13	77±12	87±10*	95±20*	87±13*	79±9	77±10	72±9
(beats/min)	NS	79±11	81±13	86±15*	93±12*	78±14	75±13	76±13	77±10
	HL	78±10	79±12	86±12*	97±10*	93±11*	89±12*	77±13	76±10
	HS	77±11	78±8	86±11*	94±9*	89±11*	84±9*	78±10	80±12

SBP:systolic blood pressure, DBP:diastolic blood pressure, HR: heart rate. NL: normotensive+larygoscopy, NS: normotensive+Shikani optical stlyet, HL:hypertensive+larygoscopy, HS: hypertensive+Shikani optical stlyet. BL: baseline value, BI: immediately before endotracheal intubation, AI: immediately after endotracheal intubation. 1-, 2-, 3-, 4-, 5-min:1, 2, 3, 4, 5 minutes following intubation. *P <0.05, compared with baseline values. ‡P <0.05, compared with group L. †P <0.05, compared with group N.

Then, we developed a unique method, “the left molar approach”, to use the SOS, dealing with normal airway and difficult airway (e.g. patients with a limited mouth opening and neck motion due to ankylosing spondylitis). Such technique can be accomplished by one anesthesiologist and doesn’t need laryngeal pressure to optimize the view of the epiglottis or vocal cords.

Although fiberoptic intubation remains one of the gold standards for difficult airway management, it requires intensive training in manipulation of the endoscope. And it has been reported that the most common cause of failure of fiberoptic intubation is due to a lack of experience. When compared with fiberoptic broncho-scopy, the SOS is less expensive in cost, less time-consuming in maintenance, and the left molar approach is easier to learn; according to our observation during our residency training program. The left molar approach to use the SOS has become an integral part of the resident curriculum in our institution. Similar positive feedback has been obtained from outside institutions where we offered seminars and workshops.

Previously, Kimura et al[5] reported the use of the fiberoptic stylet scope (Styletscope™), facilitated by direct laryngoscopy, can attenuate intubation-induced hemodynamic response in normotensive and hypertensive patients when compared to direct laryngoscopy. In this study, we first reported the utilization of the left molar approach to use the SOS in patients with normal airway and tried to explore its hemodynamic influence with a larger sample size than the above-mentioned study.

One of the major findings in this study is that the hemodynamic response of using the SOS by means of the left molar approach was less significant than those by direct laryngoscopy in both normotensive and hypertensive patients. This can be explained by the fact

that the SOS, unlike other fiberoptic devices (e.g. Bullard, Wu, Upsher), has no integrated blade and, by avoiding elevation of the epiglottis to expose the glottis, the SOS induces less cardiovascular response.[5] Additionally, the left molar approach reduces the distance from the patient's teeth to the larynx and minimizes stimulation to the perilaryngeal area.[5,7] Evans et al[8] reported that the time taken to intubate a manikin with the SOS was shorter than with the gum elastic bougie (20.8±9.3 seconds vs 30±19.8 seconds). We, using the left molar approach, can intubate the patient more quickly (less than 20 seconds). Shorter intubation time might be another reason for less hyperhemodynamic response.[9] Another finding in this study is that the number of patients complaining of a sore throat was smaller when using the SOS by means of the left molar approach when compared with the direct laryngoscopy. One of the reasons for the reduced frequency of sore throat in the SOS group might be due to less direct stimuli to the mouth and larynx.[5]

Unfortunately, our study has several limitations. First, the relatively small sample size and flaws in the study design both decreased the convincing power of the study. Additionally, the results were based on the fact that all intubations were performed by a single anesthesiologist experienced in both techniques. Second, different preanesthetic management (e.g. antihypertensive and premedication) and different anesthesia regime may have different degrees of influence on the intubation-induced hemodynamic response.[9] Third, vencuronium is the preferred muscle relaxant of choice when studying endotracheal intubation due to its minimal effects on hemodynamics.[9-13] Rocurounium is another commonly used muscle relaxant in clinical practice due to its rapid onset of effects, but also has a vagolytic profile which may influence the results.[14,15] In the current study, we chose rocuronium, according to our local protocol, as the muscle relaxant to facilitate intubation. But, since rocurounium was administered to all patients at the same dosage, its effect on hemodynamics among different groups were comparable. Finally, we only compared the difference between the left molar approach to use the SOS and direct laryngoscopy, but didn't incorporate the midline approach to use the SOS which might stand as another useful control method. So, future studies comparing midline and left molar approaches for using the SOS are needed to further verify that our technique is more advantageous.

In summary, the SOS is a portable intubation tool that appears to be effective, easy to use and maintain. While it is primarily designed for difficult intubations, it has replaced the direct laryngoscopy in routine practice in our setting. The advantages of our technique to use the SOS may include quick endotracheal intubation, less cardiovascular stimulation, less oropharyngeal and dental trauma, and familiarization with skills necessary for managing difficult airways.

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