Original Article

GlideScope versus D-blade for tracheal intubation in cervical spine patients: A randomised controlled trial

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ABSTRACT

Background and Aims: Airway management in patients with cervical spine pathology is challenging. The aim of the study was to evaluate GlideScope (GVL) and D blade of C-MAC (CMAC-D) using manual inline axial stabilisation (MIAS) for tracheal intubation in patients with cervical spine injury/pathology. **Methods:** This is a randomised, single-blind, hospital-based study. After obtaining informed consent, 54 patients with cervical spine pathology/injury were grouped into GVL group or CMAC-D group, ($n = 27$ each) based on computer-generated random number table. Preoperative airway difficulty score (ADS) was calculated. The primary outcome of the study was intubation difficulty score (IDS) and the secondary outcomes included total time taken to secure airway, failure to intubate, haemodynamic parameters and adverse events. Data was represented in the form of number (%) or mean and standard deviation and median and interquartile range as appropriate. Chi square test was used for analysing IDS. **Results:** The mean ± SD of IDS of the CMAC-D and GVL groups were 0.04 ± 0.2 (0.04–0.11) and 0.19 ± 0.40 (0.03–0.34), respectively, (P value = 0.096). The number (%) of patients with IDS > 0 was 1 (3.7) in CMAC-D and 5 (18.5) in GVL group, (P value = 0.192). Demographic data, ADS, Cormack–Lehane grading, success rate, time of tracheal intubation, type of surgeries, haemodynamic parameters and post-operative complications were similar in both the groups. **Conclusion:** Both GVL and CMAC-D with MIAS are equally efficacious in tracheal intubation in cervical spine injury/pathology patients without other difficult airway management criteria.

Key words: Cervical spine injury, tracheal intubation, video laryngoscope

INTRODUCTION

Airway management in patients with cervical spine pathology is of utmost importance to the anaesthesiologists because of the possibility of further aggravating any injury to the neural structures. To prevent this, cervical collar or manual inline axial stabilization (MIAS) is routinely applied.[1]

The available airway devices/techniques to secure airway in such a situation include awake fibreoptic intubation, intubating laryngeal mask airway (ILMA), conventional oral intubation with direct laryngoscopy with MIAS and recently the video laryngoscopes.[1,2] Awake fibreoptic intubation is gold standard but in urgent or emergent situations when a patient is too anxious or if there are blood/secretions in the airway, use of fibreoptic intubation

may be technically challenging and even may not be possible.[3] Lennarson *et al.* concluded that the greatest amount of movement, specifically extension, occurs during direct laryngoscopy with oral intubation. Maximal extension occurred at the occiput—first cervical vertebrae (Oc-C1) junction followed by movement at the first and second cervical vertebrae (C1-C2) junction. There tends to be a linear decrease in movement with the remaining

cervical segments.[4] In another study, the spine movement during orotracheal intubation was greater with a cervical collar immobilization device (13.7%) compared to just manual inline stabilization (7.5%). Cervical spine movement was also greatest with the Macintosh and Corzelli-London-McCoy blades than the Miller blade.[5] Recently, video laryngoscopes are used widely with MIAS as they only require alignment of the pharyngeal and laryngeal axes, which lie along much more similar angles when compared with the oral axis, possibly making tracheal intubation easier.[6]

In a recent study, GlideScope (GVL) was compared with CMAC-D for laryngoscopy and intubation during general anaesthesia in patients with suspected difficult airway in otorhinolaryngology patients.[6] Although both intubating devices look similar, they have different designs. While the GVL blade has a 60° curvature, the CMAC-D shows a pronounced angulation of 40° which is bent to another 20° near tip. Search of the published literature did not reveal any study comparing GVL with CMAC-D for tracheal intubation using MIAS in cervical spine injury/pathology patients. Therefore, we hypothesise that GVL and CMAC-D will have differences in ease of tracheal intubation in cervical spine injury/pathology patients scheduled for surgery under general anaesthesia.

METHODS

This randomised, single-blind clinical trial was conducted between March 2016 and June 2017. After approval of protocol by the Institutional Ethics Committee (no. 7953/G.M. dated 28-03-2016), the trial was registered with the Clinical Trial Registry of India (CTRI/2016/03/006743).

We enrolled 54 patients of both gender, aged 18 to 65 years, with ASA (American Society of Anesthesiologists) physical status I/II and scheduled for elective cervical spine surgery under general anaesthesia. Written informed consent was obtained from patients. Presence of risk factors for difficult intubation (Mallampatti class III or IV; thyromental distance <6 cm; and interincisor distance <3.5 cm), morbid obesity or at increased risk of gastric aspiration were excluded from the study.

The primary outcome of the study was intubation difficulty score (IDS).[7] The secondary outcomes included total time taken to secure airway, success rate, number of attempts, number of airway optimization maneuvers required, Cormack–Lehane (C–L) grade of laryngoscopic view, haemodynamics and any adverse events.

Patients were evaluated and enrolled preoperatively a day prior to surgery and airway difficulty score (ADS)[7] was recorded by a junior resident (D.K.). All patients were kept fasting overnight and pre-medicated with tablet alprazolam 0.25 mg and ranitidine 150 mg the night before surgery. On arrival of patient into the operating room, continuous monitoring of heart rate (HR), electrocardiogram (ECG), noninvasive blood pressure (NIBP), oxygen saturation (SpO$_2$) and end tidal carbon dioxide (Et-CO$_2$) [Aespire view GE Health Care, Helsinki, Finland] was done and an intravenous line was secured. Before induction, patients were randomised to either of the two groups using computer-generated random number table by an anaesthesiologist, not involved in the clinical trial. The group allocation was concealed in sealed, opaque envelopes, which was not to be opened until the patient's consent was obtained.

The standard general anaesthetic technique and drugs were used for all the patients. With MIAS in place, all 54 patients underwent indirect laryngoscopy and endotracheal intubation with 27 patients in each group as per group allocation to either the GlideScope GVL blade (Verathon Inc., Canada) or CMAC-D blade (Karl Storz Endoscopy, Tuttlingen, Germany) groups. The C–L score was recorded by an independent observer. Trachea was intubated with an appropriate sized cuffed tracheal tube (size 7.0–7.5mm in females and 8.0–8.5mm in males). Laryngoscopy in both the groups was performed by an experienced anaesthesiologist (S.G., V.A.) trained in use of both the devices. IDS score was calculated.[7] IDS is a quantitative 7-point scale incorporating multiple indices known to be associated with difficult intubation. IDS score may vary from zero to 1 depending on number of intubation attempts, number of operators, number of alternative intubation techniques used, glottis exposure, lifting force required during laryngoscopy, necessity for external laryngeal pressure and position of the vocal cords at intubation with a score >5 indicating moderate to major difficulty, [Annexure 1].[7] Observations were noted by an independent observer not aware of group allocation. MIAS was performed by an experienced anaesthesia technician by holding the sides of the neck and the mastoid processes, thus preventing

flexion/extension or rotational movement of the head and neck. After successful tracheal intubation (as confirmed by a square wave capnogram), in all the patients, the lungs were mechanically ventilated. Depth of anaesthesia was maintained with isoflurane (0.5–1%) in a mixture of nitrous oxide and oxygen in a 2:1 ratio. No other medications were administered, or procedures performed, during the 10 minutes data collection period after tracheal intubation. Subsequent management was left to the discretion of the attending anaesthesiologist providing care for the patient. The time duration of the tracheal intubation was defined as the time taken from insertion of the blade between the teeth until the ETT is placed through the vocal cords, as evidenced by visual confirmation by the anaesthetist and the presence of carbon dioxide in the exhaled breath as square capnography was the end point. The total time taken to secure the airway was the sum of all laryngoscopy and intubation times over the entire procedure. In case of failure with initial intubation, the patient was given bag and mask ventilation between the attempts ensuring adequate oxygenation ($SpO_2 > 90\%$). Failure to intubate after three attempts was considered as failed intubation. In such a situation, intention to treat was followed using devices as per difficult intubation guidelines; second-generation LMA, video laryngoscope, fibreoptic bronchoscope and, if required, front of neck access was employed to maintain airway. Haemodynamics and Et-CO_2 were recorded at baseline, before induction, before intubation and 1, 2, 3, 4, 5 and 10 minutes after intubation. Patients were observed in the postoperative care area for any adverse events.

Statistical analysis

Sample size estimation was based on primary outcome measure, namely the IDS score. Based on prior study,[8] we considered that a clinically important reduction in the number of patients (n) with an IDS score greater than 0 in these patients would be 40% or greater and using an $\alpha = 0.05$ and $\beta = 0.2$, for an experimental design incorporating two equal-sized groups, a priori power analysis revealed that 25 patients would be required per group. To compensate for the possible dropouts, we therefore aimed to enroll 54 patients (27 each). All analyses were performed on an intention-to-treat basis.

After compilation of data, statistical analysis was done using IBM SPSS STATISTICS (version 22.0).

Discrete categorical data is represented in the form of number or percentage (%), continuous normally distributed data as mean and standard deviation and skewed data as median and interquartile range. The normality of quantitative data was checked by measures of Kolmogorov-Smirnov tests of normality. Student t-test or Mann–Whitney U test was applied to compare two groups depending upon the normality of the data. Proportions were compared using Chi square for analysing IDS. For comparison of haemodynamic parameters (time related variables), repeated measure ANOVA was applied. For skewed data or for scores (time related variables) Friedman test followed by Wilcoxon Signed Rank test was used. All data was expressed as mean ± SD. All analyses were conducted with $P < 0.05$ considered as statistically significant score.

RESULTS

A total of 62 patients were screened during the trial, of which eight patients were excluded. Amongst 54 selected patients, 27 patients were allocated to CMAC-D group and another 27 patients were allocated to GVL group [Figure 1]. Both the groups were comparable regarding their demographics, ASA physical status, ADS score, and type of surgeries [Table 1]. Axial surgeries included any surgery at or above level of C-2 while subaxial surgeries included any surgery at or below level of C-3. Indications for which surgeries were performed included patients with neoplastic, degenerative or trauma to cervical spine. The number (%) of patients with IDS >0 was 1 (3.7) in CMAC-D and 5 (18.5) in GVL group, ($P = 0.192$). Mean ± SD of IDS was 0.04 ± 0.19 (0.04-0.11) in CMAC-D group and. 19 ± 0.40 (0.03–0.34) in GVL group, ($P = 0.096$). The mean ± SD of ADS in CMAC-D group was 8.59 ± 1.12 and that in GVL group was 8.37 ± 1.01, ($P = 0.333$). Mean ± SD of time for tracheal intubation was 28.3 ± 8.9 seconds in CMAC-D group and 30.5 ± 10.3 seconds in GVL group, ($P = 0.410$) [Table 2 and Figure 2]. The shortest intubation time with both devices was 16 seconds. None of the patients in either group required any airway optimization maneuvers. The difference between C–L grade in both the groups was also nonsignificant, ($P = 0.192$) [Table 2]. Although patients in CMAC-D group had slightly higher ADS score, they exhibited lower IDS and superior C–L grade on laryngoscopy [Table 2]. The rate of successful tracheal intubation was 100% in both the groups. The haemodynamic parameters were similar
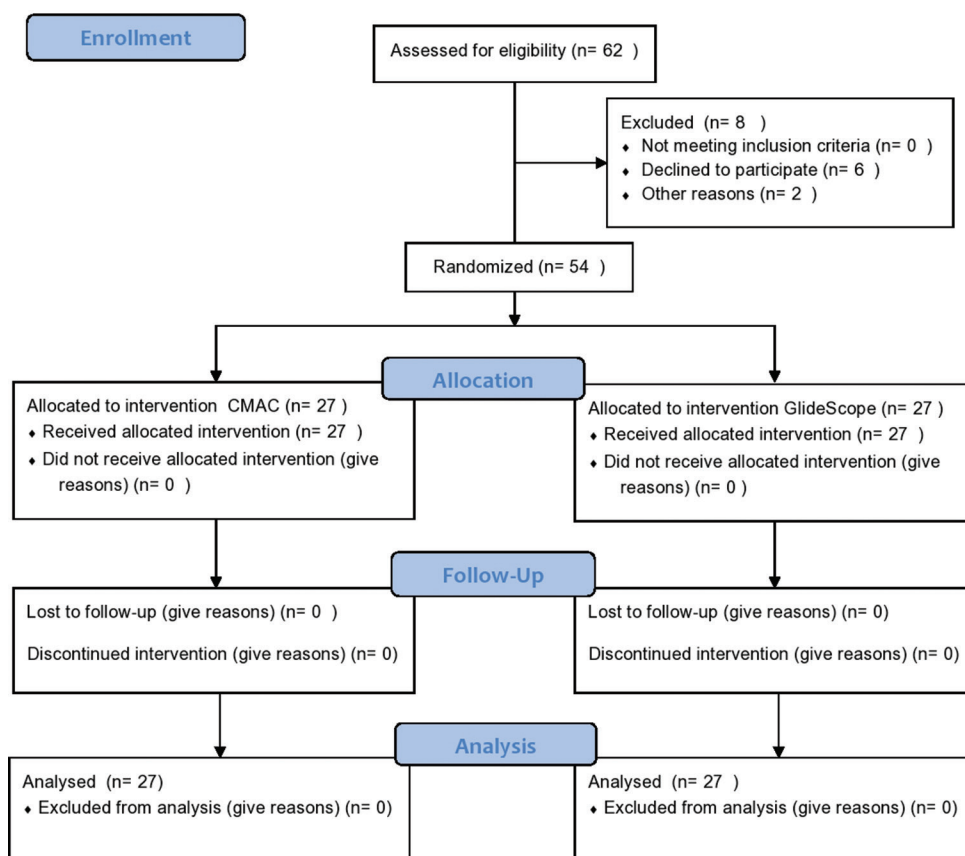
Enrollment

Assessed for eligibility (n= 62)

Excluded (n= 8)
• Not meeting inclusion criteria (n= 0)
• Declined to participate (n= 6)
• Other reasons (n= 2)

Randomized (n= 54)

Allocation

Allocated to intervention CMAC (n= 27)
• Received allocated intervention (n= 27)
• Did not receive allocated intervention (give reasons) (n= 0)

Allocated to intervention GlideScope (n= 27)
• Received allocated intervention (n= 27)
• Did not receive allocated intervention (give reasons) (n= 0)

Follow-Up

Lost to follow-up (give reasons) (n= 0)

Discontinued intervention (give reasons) (n= 0)

Lost to follow-up (give reasons) (n= 0)

Discontinued intervention (give reasons) (n= 0)

Analysis

Analysed (n= 27)
• Excluded from analysis (give reasons) (n= 0)

Analysed (n= 27)
• Excluded from analysis (give reasons) (n= 0)

Figure 1: CONSORT diagram of study recruitment

Table 1: Patient characteristics and airway assessment for CMAC-D group and GVL group		
	CMAC-D group (*n*=27)	**GVL group (*n*=27)**
Age; years	44.3±16.2 [37.9-50.7]	39.70±14.90 [33.81-45.60]
Male: Female	5 (18.5%):22 (81.5%)	1 (3.7%):26 (96.3%)
Body weight; Kg	62.7±12.0) [58.0-67.5]	64.5±11.6 [59.9-69.1]
Pulse rate; per min	77.1±12.0 [72.4-81.9]	74.9±13.6 [69.5-80.3]
SBP; mmHg	112.5±15.0 [106.6-118.5]	112.4±17.1 [105.6-119.2]
Cervical axial surgery	3 (11.1%)	2 (7.4%)
Cervical subaxial surgery	24 (88.9%)	25 (92.6%)

Values are mean±SD [95% confidence interval], number or number (proportion). SBP – Systolic Blood Pressure; DSP – Diastolic Blood Pressure; IDS – Intubation Difficulty Score; ADS – Airway Difficulty Score

Table 2: Data is represented as mean±SD (95% confidence interval for mean) or median (IQR) or *n* of patient (%)			
	CMAC-D (*n*=27)	**GVL (*n*=27)**	**P**
IDS	0.04±0.19 (0.04-0.11)	0.19±0.40 (0.03-0.34)	0.096
IDS	0.00 (0.00-0.00)	0.00 (0.00-0.00)	
IDS value 0	26 (96.3)	22 (81.5)	0.192
IDS value 1	1(3.7)	5 (18.5)	0.086
ADS	8.59±1.12 (8.15-9.03)	8.37±1.01 (7.97-8.77)	0.333
Time of intubation (seconds)	28.33±8.93 (24.80-31.87)	30.52±10.34 (26.43-34.61)	0.410
CL			
CL grade 1	26 (96.3%)	22 (81.5%)	0.192
CL grade 2	1 (3.7%)	5 (18.5%)	

IDS – Intubation diffi culty score, ADS – Airway diffi culty score, Time – Time of intubation, CL – Cormack-Lehane Grading, IQR – Interquartile range

in both the groups and none of the patients had any airway injury. All the patients were extubated at the end of surgery except two (7.4%) patients in CMAC-D group. The first patient was extubated next day and the second patient underwent surgical tracheostomy on post-operative day seven in view of prolonged
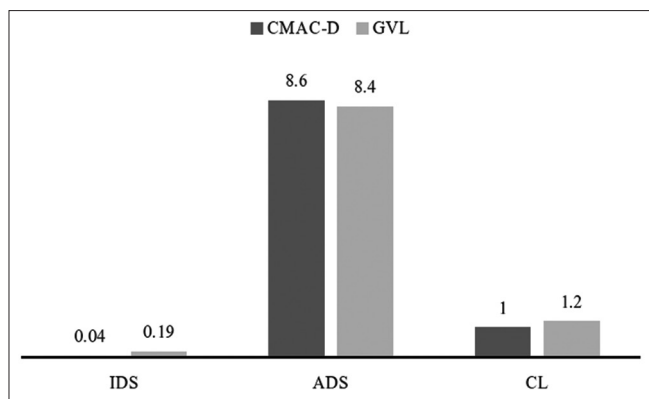
Figure 2: Bar diagram is represented as comparison of mean value of intubation difficulty score (IDS), airway difficulty score (ADS), and time of successful intubation in seconds between patient's tracheal intubation with CMAC- D (■) versus GVL GlideScope (■) video laryngoscope

mechanical ventilation. In rest of the patients, there was no sore throat, stridor or hoarseness of voice in either group. None of the patients had any worsening of neurological deficit.

DISCUSSION

In the present study, no significant mean difference for IDS grade >0 was found between the two groups. This was due to the fact that both the airway devices GVL and CMAC-D significantly improved the C–L view at laryngoscopy with *in situ* MIAS. The novelty of the present study was the comparison of GVL versus CMAC-D in patients with cervical spine pathology.

The GVL was designed with the advantage of being able to look around the corner allowing a view of the glottis via the high-resolution complementary metal oxide semiconductor (CMOS) cameras. GVL does not require alignment of oral, pharyngeal and tracheal axis in patient. The camera is placed 3 cm from the tip of blade and at the point of angulation of blade. The camera is recessed to protect it from blood secretion and has a wide viewing angle of 50°. It is similar in design to a conventional laryngoscope but GVL blade has an angulation of 60° and the location of camera is midway along the bottom of the blade which provides a wider field of view than the fibreoptic laryngoscope. The other features of GVL are its antifog technology due to rapid heating mechanism. The maximum width of blade for size 4, 5 is 14 mm. This feature allows GVL to be used in patients with limited mouth opening.[9] GlideScope (GVL) has a highly angulated blade which reduces the movements of the cervical spine and reduces the risk of secondary damage

during intubation in patients with cervical spine trauma/pathology.[10]

The CMAC system has developed the highly angulated D-Blade (CMAC-D). CMAC-D was essentially designed for management of the difficult airway. It extends the assortment of different blade forms adaptive for the CMAC system. CMAC-D shows a pronounced angulation of 40° (Karl Storz GmbH, Tuttlingen, Germany) and a further 20° at 40 mm from the tip of the blade.[6] Although both CMAC-D and GVL are comparable in shape and size of blade, both require rigid stylet for introduction of ET tube into trachea and have same steps for endotracheal intubation.

D blade of C-MAC (CMAC-D) is reported to cause less-dental pressure than the conventional C-MAC and Macintosh laryngoscope in patients with cervical spine immobilisation.[6,11] A study compared GlideScope with CMAC in patients with cervical spine immobilisation and reported both devices to be effective, although intubation was more often successful with GlideScope.[12] Although video laryngoscopes have been compared with other airway devices in manikin studies[10] or in simulated difficult airway scenario,[1,6,11-13] studies are scant in patients with real cervical spine injury/pathology.[12] Bruck *et al.*, reported that both CMAC and GlideScope provided an excellent glottic view in patients with cervical spine immobilisation, but tracheal intubation was more often successful with Glide Scope.[12] In contrast, we found CMAC-D was slightly better than GVL probably because we used D blade of CMAC while in their study conventional blade of C-MAC was used.

Shravanalakshmi D *et al.* compared conventional C-MAC, CMAC-D and Kings Vision video laryngoscopes and found comparable IDS scores in C-MAC group and Kings Vision group ($P = 0.340$).[13] However, the median score of IDS was "0" in all the three groups. In the present study, mean difference in ADS, C-L grade and IDS between the two groups was statistically not significant, and both the devices are equally efficacious for ease of intubation.

Serocki *et al.* reported insufficient laryngoscopic view (defined as CL ≥III) in 18 patients (19.2%) with direct laryngoscopy, two patients with GlideScope (2.1%) and none with CMAC-D. Hence, similar laryngoscopic view was reported with GlideScope and CMAC-D blade in suspected difficult airway.[6] The intubation time reported in their study[6] was shorter (CMAC-D:

17.7 ± 9.7, GVL: 18.7 ± 14.0 seconds) as compared to mean intubation time (CMAC-D: 28.3 ± 8.9, GVL: 30.5 ± 10.3 seconds) observed in our study. We had intubated trachea of patients with cervical spine injury/pathology with MIAS in place. It is well established that MIAS makes the laryngoscopy and intubation more difficult.[1,2] In contrast, Serocki *et al.* studied suspected difficult airway cases but did not comment on preoperative ADS scores while we studied patients with actual cervical spine pathology.[6]

Shravanalakshmi *et al.* reported that the mean tracheal intubation time was comparable in CMAC versus Kings Vision (23 vs. 24 s) and Kings Vision versus D blade (24 vs. 26 s), while it was significantly reduced with conventional CMAC as compared to CMAC-D (23 vs 26 s).[13] The increased time was taken for the insertion of CMAC-D blade through the mouth owing to increased curvature of the D blade.[13] It could be because they were not familiar/experienced with the D blade while in our study all the intubations were performed by anaesthetists with experience of more than 50 intubations with each device. The use of conventional C-MAC was not a fair comparison with patients who were being allocated to either GVL or CMAC-D for tracheal intubation.

In the present study, ADS was not significantly different between the two groups ($P = 0.333$). Reed *et al.* reported that high ADS in patients resulted in a poor laryngoscopic view compared with those patients with a low ADS ($P = 0.050$) and ADS of more than six is a predictor of difficult intubation.[14] In contrast, in the present study, although ADS was more than 6 in both the groups (8.59 ± 1.1 in CMAC-D group and 8.31L group), we did not encounter any difficulty in intubation; rather it was easier in both the groups. This is because with use of video laryngoscopes, alignment of airway axis is not required. While comparing GVL and CMAC-D, we found that ADS was slightly lower in GVL group but IDS was higher.

In our study, tracheal intubations in both the groups were performed in the first attempt. A study by Serocki *et al.* also showed similar results with GVL and CMAC-D, but with direct laryngoscopy four failed tracheal intubations were reported (out of 32 patients).[6] Direct laryngoscopy significantly reduces the intubation time but is associated with high failure rates in patients with simulated difficult airway or in patients with cervical spine injury with MIAS.[11] Following first traumatic tracheal intubation attempt,

subsequent laryngoscopy may become difficult. Therefore, the first intubation attempt must be the best attempt, advocating the use of video laryngoscopes as the first modality in such scenarios.

None of the patients in our study required external laryngeal manipulation. The literature reports that two patients in CMAC group, three patients in Kings Vision group, and five patients in CMAC-D group required external laryngeal maneuver for aiding the passage of the ET tube through glottic opening ($P = 0.620$). In one patient of the King Vision group, bougie-assisted endotracheal tube insertion was done.[13]

The present study has few limitations. First, we did not include patients with very high preoperative ADS score or patients with morbid obesity. Second, the time interval between insertion of either blade between the teeth to visualization of larynx, and from visualization of larynx to insertion of endotracheal tube into trachea was not recorded separately. Third, we did not perform fluoroscopy to record cervical spine movements during face mask ventilation and laryngoscopy under general anaesthesia. Future studies can be planned for obese patients with cervical spine injuries.

CONCLUSION

The present study established that GVL as well as CMAC-D blade with MIAS were equally efficacious for tracheal intubation in patients without difficult airway management criteria scheduled for cervical spine injury/pathology surgery under general anaesthesia.

Conflicts of interest
There are no conflicts of interest.

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ANNEXURE 1

Intubation difficulty scale (IDS)[7]

Intubation difficulty scale (IDS) is a blend of subjective and objective criteria that permits a qualitative and quantitative approach to the progressive nature of the difficulty of intubation. It can easily be calculated by the operator or an independent observer. It requires recording of seven parameters:

N1 – number of intubation >1 attempts [1st attempt is taken as 0]
N2 – the number of >1 operators [1st operator is 0, 2nd is 1 and so on]
N3 – the number of alternative intubation techniques used
N4 – glottis exposure (C/L grade minus 1)
N5 – lifting force required during laryngoscopy (0 normal, 1 increased)
N6 – necessity for external laryngeal pressure (0 not applied, 1 applied)
N7 – position of the vocal cords at intubation (0 abduction, 1 adduction)

The final score is calculated by adding all the seven parameters. The grading of difficulty based on IDS is:

IDS score	Degree of difficulty
0	Easy
0 < IDS ≤5	Slight difficulty
5 < IDS	Moderate to major difficulty
IDS = ∞	Impossible intubation