Clinical Investigation

Effect of rigid cervical collar on tracheal intubation using Airtraq®

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ABSTRACT

Background and Aims: Cervical spine immobilisation with rigid cervical collar imposes difficulty in intubation. Removal of the anterior part of the collar may jeopardize the safety of the cervical spine. The effect of restricted mouth opening and cervical spine immobilisation that result from the application of rigid cervical collar on intubation using Airtraq® was evaluated. **Methods:** Seventy healthy adults with normal airways included in the study were intubated Using Airtraq® with (group C) and without rigid cervical collar (group NC). The ease of insertion of Airtraq® into the oral cavity, intubation time, intubation difficulty score (IDS) were compared using Wilcoxon sign ranked test and McNemar test, using SPSS version 13. **Results:** Intubation using Airtraq® was successful in the presence of the cervical collar in 96% which was comparable to group without collar ($P = 0.24$). The restriction of mouth opening resulted in mild difficulty in insertion of Airtraq®. The median Likert scale for insertion was - 1 in the group C and + 1 in group NC ($P < 0.001$). The intubation time was longer in group C (30 ± 14.3 s vs. 26.9 ± 14.8 s) compared to group NC. The need for adjusting manoeuvres was 18.5% in group C versus 6.2% in group NC ($P = 0.003$) and bougie was required in 12 (18.5%) and 4 (6.2%) patients in group C and NC, respectively, to facilitate intubation ($P = 0.02$). The modified IDS score was higher in group C but there was no difference in the number of patients with IDS < 2. **Conclusion:** Tracheal intubation using Airtraq® in the presence of rigid cervical collar has equivalent success rate, acceptable difficulty in insertion and mild increase in IDS.

Key words: Airtraq®, intubation, intubation difficulty score, rigid cervical collar

INTRODUCTION

Rigid cervical collar is universally used for immobilisation of cervical spine in trauma patients. Application of cervical collars may reduce cervical spine movements but render tracheal intubation with a standard laryngoscope difficult.[1] Removing the anterior portion of the collar before attempts at tracheal intubation has been suggested. Devices that facilitate intubation even in the presence of the cervical collar can prevent the unnecessary jeopardy of the safety of the cervical spine caused by its removal. Although awake fibreoptic intubation is the most reliable method in patients with cervical trauma, it has some limitations[2] such as lack of availability, need for expertise in the use, difficulty with non cooperative patient or presence of blood or secretions in the airway. There is growing evidence of data on improved success rate of intubation with use of video laryngoscopy in patients with cervical collar.[3-5]

The unique curving blade of the Airtraq®(Prodol Meditec, Spain), designed to fit the oropharyngeal anatomy, enables intubation without alignment of line-of-sight of the oral, pharyngeal and tracheal axis. Studies have shown that Airtraq® provides good glottic view and successful intubation in patients with simulated cervical spine immobilisation which was comparable to other video devices such as C Trach®,[6] Truview®[5] and superior to Macintosh[7] and McCoy[8] laryngoscopes. Cervical collar in combination with forehead strapping and manual

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in-line stabilization (MILS) virtually obliterates neck movement, including small movements that normally facilitate intubation. Several devices that facilitated intubation in neutral neck position were found to perform poorly in the presence of the cervical collar when compared to its removal.[9-12] The effect of restricted mouth opening and cervical spine immobilisation that result from the application of rigid cervical collar on intubation using Airtraq® has not been evaluated. We, therefore, tested the hypothesis that the Airtraq® allows tracheal intubation in the presence rigid cervical collar with similar ease as intubation in its absence.

METHODS

We based our sample size estimation on the intubation difficulty score (IDS) score. An IDS score of 0-1 represents ideal intubating conditions. Based on initial pilot studies, we projected an IDS score of 2 or lower in 90% patients with the regular Airtraq® intubation. Intubation in the presence of the cervical collar was considered to be equivalent to intubation without collar when IDS was 2 or less in at least 85% of patients. Based on these figures, using $\alpha = 0.05$ and $\beta = 0.2$, we estimated that 58 patients would be required. We, therefore, aimed to enrol 70 patients.

A randomized open labelled cross over study was undertaken to evaluate the effect of cervical immobilisation using rigid cervical collar and MILS on Airtraq®-aided intubation by comparing intubation characteristics with and without immobilisation. After obtaining approval from institutional ethics committee and informed consent, 70 adult ASA I and II patients of either gender of age between 19 and 50 years and weight between 40 and 70 kg scheduled to undergo elective surgical procedures under general anaesthesia with oral endotracheal intubation were included in the study. Patients with anticipated difficult airway (restricted mouth opening, Mallampati IV, thyromental distance < 5 cm neck circumference > 42 cm, body mass index > 30%), pregnant patients, patients with risk of pulmonary aspiration of gastric contents and patients with cervical spine pathology, reactive airway disease, cardiac disorders were excluded from the study. All patients underwent intubation with Airtraq® in a cross over fashion with and without cervical immobilization. Patients were randomized for the order of intubation either with (group C) or without cervical collar (group NC) to eliminate the bias of first observation influencing the latter.

Age, weight, and airway parameters (mento-hyoid distance, thyro-mental distance, sternomental distance, neck circumference) and mouth opening with and without cervical collar were noted. The patient was placed supine on the operating table with the occiput resting on a 5 cm thick foam pad. The head and neck were maintained in neutral position as confirmed by direct visualisation. Anaesthetic management was standardised for all patents. Monitors applied included electrocardiograph, pulse oximetry, capnograph and non-invasive blood pressure monitor. Patients were pre-oxygenated and anaesthetised using fentanyl 2 mcg/kg, thiopentone sodium 4-6 mg/kg intravenously. Muscle relaxation was provided with vecuronium 0.1 mg/kg and patients were intubated after 5 min so that adequate neuromuscular blockade is achieved. Patients were intubated using Airtraq® as per manufacturer's instructions by including the epiglottis at the tip. All intubations were performed by a single experienced operator with head in neutral position. The order of intubation, with or without cervical immobilisation was as per randomisation. When the patient had to be intubated with cervical spine immobilisation, a well-fitting hard cervical collar (Ambulance Collar, MGRM medicare Limited, India) was adjusted to the correct size and applied according to the manufacturer's instructions. MILS would be applied by the assistant, to stabilize the patient's head in a neutral position. Patients who were difficult to mask ventilate with the cervical collar were excluded from the study. The intubating anaesthesiologist was asked to assess the ease of insertion of Airtraq® into the oral cavity on a Likert scale from - 2 to + 2 (very difficult to very easy). If it was not possible to insert the Airtraq® or if the insertion took > 45 seconds (s) it was considered as failure. The IDS score as described by Adnet[13] using the seven parameters (number of operators, number of attempts, number of additional techniques, Cormack–Lehane view, lifting force, laryngeal pressure and vocal cord position) modified for intubation with Airtraq[8] [Appendix 1] was noted. The intubating anaesthesiologist noted the IDS during both the intubations. The intubating anaesthesiologist was asked to assess the ease of intubation on a visual analogue scale (VAS) of 0-10, 0 being the easiest intubation and 10 being most difficult intubation equivalent to failed intubation. Intubation time was noted as time from removal of face mask for intubation to removal of the Airtraq® and connection of anaesthesia circuit to the endotracheal tube. Intubations requiring more than one attempt were excluded from analysis for intubation time.

If intubation required more than 90 s or more than two attempts it was considered as failure. The rigid collar would be removed and intubation attempted with Airtraq®. If there was failure to intubate with Airtraq®, patients were intubated with conventional technique using Macintosh blade without cervical collar. Number of attempts required and failure to intubate were noted. Desaturation during the procedure was noted and abandoned if arterial saturation reduced to less than 90% and patient was ventilated with face mask until SpO_2 improved to 100% when the next attempt was made. Airway-related complications such as airway trauma in the form of injury to lips, teeth, mucosal injury laryngeal oedema, laryngospasm, bronchospasm, postoperative stridor and sore throat were noted.

Statistical analysis was performed using SPSS software version 13 (SPSS Inc Chicago) Continuous data are presented as mean ± standard deviation, ordinal data are presented as median with an interquartile range, and categorical data are presented as number and percentage. The paired categorical data with a dichotomous response were compared between the groups using McNemar test and those with multinominal responses were compared using marginal homogeneity test. IDS score was compared using Wilcoxon signed ranked test and continuous data distributed normally were compared using paired sample *t*-test. The exact two-tailed significance < 0.05 was considered significant for all tests.

RESULTS

Seventy patients were enrolled for the study. Two patients were excluded due to difficulty in mask ventilation. Three patients refused to participate. The demographic data and airway characteristics of 65 patients included in the study are shown in Table 1. The mouth opening was significantly lesser in the presence of the collar [Table 1]. Table 2 shows the comparison of intubation characteristics during Airtraq intubation with and without the presence of rigid cervical collar. The insertion of Airtraq® was rated as difficult (Likert scale - 2) in 1.5% in group NC whereas 11.1% were reported as difficult in group C ($P < 0.001$). The modified IDS score was significantly higher in the group C compared to group NC (75 quartile was 2 in group C and 0 in group NC) [Table 2]. There was no difference in the number of patients with IDS < 2 (93.8% in group C vs. 87.7% in group NC, P = 0.18) The IDS was 5 in one patient in group C. The individual parameters of the IDS score are reported in Table 3. There was no significant difference in the number of attempts and the glottis view. The need for additional manoeuvres like adjustment of Airtraq® and use of the bougie was 6.2% in group NC and 18.5% in group C ($P = 0.02$) and the need for lifting force was also significantly higher during intubation in group C (6.2% in group NC vs. 21.5% in group C ($P = 0.02$). Intubation was considered failure in two patients in the presence of the cervical collar. Though the Cormack–Lehane grade was 2 in both these patients, the endotracheal tube was advancing posteriorly, and intubation could not be accomplished within 90 s. They could be successfully intubated

Table 1: Airway characteristics

Parameter	Value
Age-mean(SD) (in years)	43.3 (10.9)
Gender	
Male	34 (52.3%)
Female	31 (47.7%)
Weight-mean(SD) (in kg)	58 (11.2)
Thyromental distance mean (SD) (in cm)	5.5 (0.9)
Sternomental distance mean (SD) (in cm)	10.8 (2.17)
Buckteeth present	6 (9.3%)
Not present	59 (90.7%)
Neck circumference mean (SD) (in cm)	36.6 (4.31)
Mouth opening mean (SD) (in cm)	
No collar	4.0 (0.65)
Collar	2.9 (0.59)*

*Statistically significant difference between mouth opening with and without application of cervical collar (*P*=0.000). SD – Standard deviation

Table 2: Comparison of Airtraq aided intubation with and without cervical collar

Parameter	*n* (%)		*P*
	Group NC	Group C	
Likert scale for insertion of Airtraq			
−2	1 (1.5)	7 (10.8)	<0.001
−1	15 (23.1)	29 (44.6)	
0	15 (23.1)	25 (38.5)	
1	28 (43.1)	2 (3.1)	
2	6 (9.2)	0 (0)	
Airway trauma			
No trauma	64 (98.4)	60 (92.3)	0.08
Trauma	1 (1.5)	5 (7.6)	
Airway complications			
No complications	65 (100)	65 (100)	1
Failed to intubate			
No failure	65 (100)	63 (96.9)	0.24
Failure	0 (0)	2 (3)	
Intubation time	26.9 (14.8)	30.0 (14.3)	0.002
Intubation difficulty score (median [IQR])	0 [0–0]	1 [0–2]	<0.001
Visual analogue scale for ease of intubation (median [IQR])	2 [2–4]	3 [2–4]	0.00

IQR – Interquartile range

Table 3: Comparison of IDS for intubation using Airtraq with and without cervical collar

IDS component	Parameter	*n* (%)		*P*
		Group NC	Group C	
N1	Number of attempts			
	Single attempt	61 (93.8)	59 (90.8)	0.25
	Two attempts	4 (6.2)	5 (7.7)	
	Three attempts	0	1 (1.5)	
N2	Number of operators			
	Single operator	65 (100)	65 (100)	1
N3	Number of alternative intubation techniques used			
	Not required	61 (93.8)	53 (81.5)	0.02
	Bougie	4 (6.2)	12 (18.5)	
N4	Glottis view Cormac lehane grade			
	1	55 (84.6)	52 (80)	0.51
	2	10 (15.4)	13 (20)	
N5	Lifting force/adjustment of Airtraq			
	Not used	61 (93.8)	51 (78.5)	0.02
	Used	4 (6.2)	14 (21.5)	
N6	External laryngeal pressure			
	Not applied	65 (100)	62 (95.4)	0.16
	Applied	0 (0)	3 (4.6)	
N7	Laryngeal position			
	Adducted	65 (100)	65 (100)	1

IDS – Intubation difficulty score

with the same Cormak–Lehane grade after removal of the collar. VAS was reported to be significantly higher, and the intubation times were significantly longer in group C when compared to group NC. Airway trauma was noted in 1 (1.5%) in group NC and 5 (7.6%) patients in group C ($P = 0.08$) [Table 2].

DISCUSSION

Cervical orthoses are universally used for extrication, transportation and immobilisation for cervical trauma patients. Application of cervical collars may reduce cervical spine movements but render tracheal intubation with a standard laryngoscope difficult.[2] Reduced mouth opening is a major contributing factor to the deterioration in the view obtained at laryngoscopy when a semi-rigid cervical collar is in place.[14] Other problems probably caused by the neck collar include strap under the chin lifting up and tipping the larynx anteriorly.[9] MILS that is recommended for cervical spine immobilisation further impairs glottic visualisation.[15,16]

Mouth opening was significantly reduced when patients were wearing cervical collars and this was the main factor contributing to the increased difficulty of laryngoscopy in this particular form of cervical spine immobilization.[2] There was a wide and unpredictable variation between subjects in the reduction in mouth opening and a significant proportion were reported to have inter-incisor distance of 20 mm or less in the presence of rigid cervical collar.[8,12,14] In a report by Aoi *et al*., 7 of 9 failed cases in the study had Inter Incisor distance < 10 mm which was insufficient to insert the 18 mm blade of airway scope.[12] In the present study, insertion of Airtraq® was possible in all patients despite restriction of mouth opening. The recommended mouth opening for no. 3 Airtraq® was 1.6 cm. The mean mouth opening following application of cervical spine immobilization was 2.9 cm. The intubating anaesthesiologist graded the insertion to be more difficult in the presence of the collar. The injuries, though minor mucosal abrasions, occurred during insertion of Airtraq®. The longer intubation time with a collar could have resulted from the difficulty in insertion.

Manual in-line stabilization that is recommended for cervical spine immobilisation further impairs glottic visualisation.[2] In patients with otherwise normal airways, MILS increases the tracheal intubation failure rate and worsens laryngeal visualisation during direct laryngoscopy.[16] MILS increases pressures applied by the laryngoscope blade during direct laryngoscopy and orotracheal intubation.[15] The incidence of poor view on laryngoscopy (grade 3 or 4) is reported as 64% in patients immobilised in a collar, tape and sandbags and significantly higher patients undergoing in-line manual immobilisation alone (22%).[2] Pressures applied to airway tissues by the laryngoscope blade are secondarily transmitted to the cervical spine and result in cranio-cervical motion. Other problems probably caused by the neck collar include strap under the chin lifting up and tipping the larynx anteriorly.[9] It has been suggested to remove the anterior portion of the collar before attempts at tracheal intubation. However, this may jeopardize the safety of the cervical spine. Fibreoptic laryngoscope technique enables rapid and easy orotracheal intubation in trauma patients with an immobilised cervical spine, but training is necessary.[17]

In the recent past new equipments were designed to facilitate intubation in neutral neck position without causing movement of the cervical spine. Many of them have been efficient in the presence of cervical immobilisation with rigid neck collar in simulated conditions.[15-18,21,24] They also produce less cervical movement than intubation using Macintosh

laryngoscope.[14] The procurement cost of most of these equipments is high and may be unaffordable to most institutions in India.

Though the performance of many airway devices was better than Macintosh or McCoy laryngoscope for intubation in the presence of the cervical collar, it was found that their efficacy was not equivalent to that observed in the absence of collar. Intubating laryngeal mask airway (ILMA) insertion took longer time (30 s vs. 22 s), and more patients required two insertion attempts (15 vs. 3), and ventilation adequacy with ILMA was worse in collared patients.[10] ILMA was difficult to insert and ventilation proved difficult in 10 patients wearing a neck collar and with cricoid pressure applied in a simulated trauma scenario.[9] These problems were probably caused by the neck collar strap under the chin lifting up and tipping the larynx anteriorly. In a study by Aoi *et al*.,[12] using the airway scope, intubation failure is reported in 30% of the cases in collar group whereas only 3.3% of the cases with MILS. The difficulty resulted from limitation of mouth opening. Using a C-MAC® (Karl Storz, Germany) video laryngoscope, endotracheal tube placement was successful in 88% of patients with a cervical immobilisation with a rigid collar. Glottic visualisation with C-MAC® was also poorer with immobilisation using rigid cervical collar endotracheal tube placement failed in 5/43 patients despite a mostly good laryngeal view.[18]

The Airtraq® disposable laryngoscope was designed to provide a clear view of the glottis without altering the normal alignment of the oropharyngeal axes.[19] As a result of an exaggerated blade curvature, an internal arrangement of optical lenses and a mechanism to prevent fogging of the distal lens, high quality view of the glottis is provided. It is recently made available at an affordable price in the Indian market. The Airtraq® facilitates tracheal intubation with the neck in a neutral position, which is similar to the neck position maintained by a rigid cervical collar. Intubation using Airtraq® in patients with simulated cervical spine immobilisation was found to be superior to Macintosh[20,21] McCoy[8] and comparable to CTrach,[6] other video laryngoscopes[22] such as airwayscope,[23] C-MAC®,[1] Glidescope®.[4] Airtraq® causes lesser cervical movement during intubation.[7,24-26]

A cervical collar in combination with forehead strapping and MILS virtually obliterates neck movement, even small movements that normally facilitate airway insertion. The effect of cervical spine immobilisation on intubation using Airtraq® has been evaluated in the present study. The success rate (96% vs. 100%) was not different in the presence of the collar. The mean difference in the intubation time was 5 s which was statistically significant but not clinically. This could have resulted from the difficulty in insertion of the Airtraq® and need for additional manoeuvres in the presence of the collar. The IDS score was statistically significantly higher with the application of immobilisation. The Cormak-Lehane grade was 1 in 80% of patients and 2 in 20% and this was comparable to glottic view in the absence of collar. However, the success of intubation or time required for intubation was not related to the glottic view with intubation. Ten patients required multiple attempts at intubation despite a good glotic view. This is frequent problem with other video laryngoscopes also.[18] Intubation was facilitated by use of gum elastic bougie as described by Donat *et al*.[27] when the glottic view was good but tube could not be aligned to the laryngeal inlet. The significant difference in the IDS was mainly because of the greater need for the adjusting manoeuvres and use of the bougie in the presence of the collar. This could have been necessitated because of the anterior tipping of larynx due to the cervical collar. Most patients in both groups were easy to intubate. There was no difference in the number of patients with IDS 2 or less (93.8% vs. 87.7%). Only one patient had an IDS of 5 considered as moderately difficult in the presence of the collar. There were two failures to intubate in the presence of the collar, with grade 2 view, but the endotracheal tube could not be advanced into the trachea. These two intubations were considered as failure as the time for intubation exceeded 90 s. The VAS for ease of intubation was higher in the presence of the collar only by one scale though it was statistically significant. The ease and success of intubation with Aitraq® in the presence of immobilisation with a cervical collar was equivalent to that without immobilisation.

There were certain limitations in the study design. The problem of bias was difficult to eliminate as an open labelled design as the presence of the collar was difficult to conceal. The crossover design helped to eliminate the inter-individual variation, but it was associated with additional airway interventions. Though the airway complications, major trauma or sore throat were absent in this study, presence

of trauma or airway complications during the first intubation made it difficult to comment on the second intubation. The intubation time of 10 patients was excluded from the analysis of intubation time. This could have influenced the mean intubation times in this study.

CONCLUSION

Tracheal intubation using Airtraq® in the presence of rigid cervical collar has equivalent success rate, acceptable difficulty in insertion and mild increase in IDS when compared to regular Airtraq® intubation. Airtraq® can be useful for tracheal intubation when it is not desirable to remove the hard cervical collar in patients with cervical trauma who require cervical immobilisation.

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Appendix 1: Modified intubation difficulty score[8]

IDS component	Laryngoscope	Airtraq
N1	Number of intubation attempts>1	Number of intubation attempts>1
N2	The number of operators>1	The number of operators>1
N3	Number of alternative intubation techniques used	Number of alternative intubation techniques used Bougie used: 1
N4	Glottic exposure (Cormack and Lehane grade−1)	Glottic exposure (Cormack and Lehane grade−1)
N5	Lifting force required during laryngoscopy Normal: 0 Increased: 1	Lifting force required during procedure Normal: 0 Increased or change in position of Airtraq required: 1
N6	Necessity for external laryngeal pressure	Necessity for external laryngeal pressure
N7	Position of the vocal cords at intubation Abduction/not visualized: 0 Adduction: 1	Position of the vocal cords at intubation Abduction/not visualized: 0 Adduction: 1

IDS is calculated from the sum of all the scores. IDS - Intubation difficulty score