Original Article

Tracheal intubation with King Vision video laryngoscope in patients with cervical spine instability–Comparison of straight versus curved reinforced endotracheal tubes

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ABSTRACT

Background and Aims: King Vision video laryngoscope is commonly used to facilitate intubation in corrective surgery for cervical spine instability patients due to less manipulation. Curved and straight reinforced tracheal tubes are regularly used in this surgery as neck of the patient is likely to be flexed. We aimed to compare intubation characteristics between the curved and straight reinforced tubes through King Vision video laryngoscope in patients to be operated for cervical spine instability with the primary objective being intubation time. **Methods:** Sixty patients undergoing cervical spine surgery were enroled in this prospective randomised comparative clinical study. All were intubated after applying manual in-line stabilisation of the neck, using either curved (group C) or straight (group S) reinforced endotracheal tubes through King Vision video laryngoscope. The intubation time, number of attempts, incidence of tube impingement with arytenoids/aryepiglottic folds, optimisation manoeuvres required and complications were observed. Unpaired 't' test and Chi-square test were used to analyse the data using MedCalc software, version 12.5. **Results:** Time taken for intubation was shorter with curved compared to straight reinforced tube (16.24 ± 3.09 vs. 29.08 ± 5.48 seconds, $P < 0.0001$) The first attempt success rate was higher using curved than straight reinforced tube (93.3% vs. 70%, $P = 0.02$). Incidences of impingement with arytenoids/aryepiglottic folds and optimisation manoeuvres required more with the straight reinforced tube. **Conclusion:** The intubation was fast and with higher first attempt success rate with curved than with straight reinforced tube through King Vision videolaryngoscope when used in patients with cervical spine instability.

Key words: Cervical spine instability, endotracheal tubes, videolaryngoscope

INTRODUCTION

Patients with cervical spine instability require less manipulation of the neck during endotracheal intubation to lessen the chance of iatrogenic injury. Manual in-line stabilisation is commonly applied to minimise the neck movement during tracheal intubation. This could render intubation more difficult.[1] In recent decades, clear benefits of various videolaryngoscopes over direct laryngoscopy in terms of higher success rate in normal as well as difficult airway cases became evident.[2] King Vision video laryngoscope (KVVL) (King Systems, Noblesville, Indiana, USA) is being widely used among anaesthesiologists.[3] Avoidance of morning sniffing position as well as the application of force in vallecula to view the glottis makes its use more advantageous in patients with cervical spine instability with less chances of spine injury and haemodynamic disturbances.[4] The exaggerated curvature of the blade and the use of digital technology provide a

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perfect view of the larynx on the light emitting diode monitor attached with it.

The "wire reinforced" or armoured endotracheal tubes are cuffed; silicone rubber tubes are quite flexible yet difficult to get compressed or kinked. They become more useful in the circumstances where the trachea is anticipated to remain intubated for a prolonged duration, or if the neck is to remain flexed in prone position during the procedure like cervical spine operated by posterior approach. They are also useful while using the anterior surgical approach on the cervical spine to avoid airway compromise due to pressure on the endotracheal tube, which might be caused by the instruments being used. These tubes are of two types, curved reinforced (CRT) and straight reinforced (SRT) tubes.

Previously published studies comparing standard polyvinyl chloride (PVC), CRT and SRT tubes for tracheal intubation using different channelled videolaryngoscopes like Airtraq or Airway scope in normal adults have demonstrated that PVC is superior to CRT/SRT and CRT is superior to SRT.[5,6] A study comparing reinforced tube for intubation using KVVL and direct laryngoscopy suggesting faster intubation with KVVL is also available.[7] As patients with cervical spine instability are regularly managed using videolaryngoscope and reinforced tubes during surgery, we undertook this study to compare the intubation characteristics with the primary objective being intubation time using CRT and SRT through KVVL in adults to be operated for cervical spine surgery. We hypothesised that less time would be required to intubate using CRT with KVVL. The secondary objectives were attempts of intubation, incidences of tube impingement on arytenoids/aryepiglottic fold, optimisation manoeuvres required and complications.

METHODS

This prospective, randomised study was conducted at a tertiary care hospital during the period from October 2018 to October 2019, after taking permission from Institutional Ethical Committee for Human Research and registering in the Clinical Trials Registry- India (CTRI/2018/10/015947). Sixty patients of either sex between 18 and 60 years of age of American Society of Anesthesiologists (ASA) physical status I and II undergoing cervical spine surgery were recruited. Patients having anticipated airway difficulties like patients with morbid obesity, having mouth opening <3 cm, thyromental distance <6 cm, micrognathia or history of difficult intubation and with increased risk of pulmonary aspiration were excluded.

All patients were randomly divided into two groups using computer-generated random numbers and allotted to one of the groups, namely Group C, in which patients were intubated with CRT (Rusch, Teleflex Medical Sdn, Kamunting, Malaysia) and Group S, in which patients were intubated with SRT (Romsons Scientific and Surgical Industries Pvt. Ltd, Agra, India). On the day before the scheduled surgery, pre-anaesthetic check-up with thorough airway assessment including neck circumference, sternomental distance, thyromental distance and Mallampati scoring was done. Jaw movement was checked by the ability of anterior subluxation of mandible. Written informed consent was taken and a standard protocol for nil per oral status was followed. After taking the patient inside the operation theatre, an intravenous (IV) line was secured and baseline vitals were noted. All patients were premedicated with IV glycopyrrolate 0.2 mg and fentanyl 2 μg/kg.

After mounting the KVVL blade, performance of the device was checked once by pushing the 'ON' button and checking the image on the monitor. Straight or curved reinforced endotracheal tubes of appropriate size were lubricated with lignocaine jelly and preloaded on a KVVL channelled blade.

After pre-oxygenation for 3 minutes, induction of general anaesthesia was done with IV propofol 2 mg/kg and adequate relaxation was achieved with IV succinylcholine. After the disappearance of fasciculation from toes, just before laryngoscopy, anterior part of the hard cervical collar was removed, and the spine immobilisation was maintained using manual in-line- stabilisation (MILS) by an assistant anaesthesiologist. The KVVL was preloaded with either of the two tubes (CRT or SRT), advanced from the centre of the tongue towards the glottis by viewing on the screen of the monitor. Intubation was attempted only if an optimal glottis view, with a POGO score of ≥75% was obtained. The tube was advanced into the trachea under direct observation on the video screen. After the disappearance of the cuff, the device was removed from the mouth, the tube was attached to the closed-circuit and tracheal intubation was confirmed by the continuous waves of the capnograph. All the intubation procedures were conducted by an anaesthesiologist having an experience of at least 25 intubations using KVVL.

Time for intubation was noted as time in seconds taken from obtaining an optimal glottis view (75%) to the first wave of capnograph. Incidence of impingement of tube with the arytenoids/aryepiglottic fold was noted. Optimisation manoeuvres required for intubation like external laryngeal pressure or manipulation of the KVVL blade (rotation towards the right or left)/manipulation of the tube (rotation towards the right or left) or use of bougie to assist intubation were noted and scored accordingly as 0–no manoeuvres required, 1–use of external laryngeal pressure/manipulation of KVVL blade/tube and 2–use of bougie required. Maximum two attempts at intubation were allowed, after which it was declared as failed attempt; these cases were then managed according to "Difficult Airway Society" guidelines and excluded from the study.

Intraoperatively, anaesthesia was maintained according to standard protocol. At the end of the procedure, patients were extubated after fulfilling the criteria for extubation. Post-operative complications like minor tongue/lip/dental trauma, sore throat, or nausea/vomiting were noted.

Data generated from a pilot study done in the same institute 6 months before in 20 patients having cervical spine injury was used to calculate the sample size. With this pilot study, the difference observed in "intubation time" between CRT and SRT was 14.3 ± 8 seconds versus 25.2 ± 6.4 seconds with a mean difference of 10.2 seconds, standardised effect size derived was 1.7. Assuming a two-sided alpha error of 0.05 and a power of 95%, the sample size required was 27/group. To make it round-off, we enroled 30 patients/group. Observed data were entered into Microsoft Excel 2010 and statistical analyses were performed using MedCalc, version 12.5 (MedCalc software, Ostend, Belgium). For all continuous variables, results are presented as mean ± standard deviation (SD) and categorical variables as percentage. Unpaired 't' test was applied to see the statistical significance of continuous data like airway parameters and intubation time between the two groups. Chi-square test was used to obtain the association between categorical variables like ASA grading, gender, attempts of intubation, incidences of tube impingement and optimisation manoeuvres. Ninety-five percent confidence interval (CI) was also calculated to observe the significance level in continuous and categorical parameters between the two groups. The significance of statistical analysis was judged by P value and $P < 0.05$ was considered as significant.

RESULTS

All 60 patients included in the study were analysed [Figure 1]. The demographic data and airway parameters were comparable in both groups [Table 1]. Time required to intubate using CRT was less compared to SRT (16.24 ± 3.09 vs. 29.08 ± 5.48, 95% CI 11 to 15, degree of freedom 58, $P < 0.0001$) [Table 2]. Statistically, a significant difference was observed between the two groups while comparing attempts at intubation, incidences of tube impingement with arytenoids/aryepiglottic fold and optimisation manoeuvres required [Table 2]. The first-attempt success rate was higher with CRT compared to SRT through KVVL (93% vs. 70%, 95% CI 6 to 42, degree of freedom 1, $P = 0.02$). Incidences of tube impingement with arytenoids/aryepiglottic fold were higher with SRT (95% CI 29 to 70, degree of freedom 1, $P < 0.0001$). Optimisation manoeuvres like external laryngeal pressure/tube rotation/KVVL blade manipulation were required in five (6.67%) patients in whom CRT was used compared to 23 (76.67%) patients in the SRT group (95% CI 47 to 83, degree of freedom 1, $P < 0.0001$). External laryngeal pressure was required in zero versus three, KVVL blade rotation on right side was required in two versus eight and tube rotation on left side was required in three versus nine patients while comparing CRT with SRT. None of the patients in group C required bougie whereas two patients in group S required the use of bougie during intubation [Table 3].

Minor lip/dental trauma was found in two patients in group C and four patients in group S [Table 2]. There was not a single case of failure to intubate, or oesophageal intubation noted in both groups.

Table 1: Demographic data and airway parameters

Parameters	Group C Mean±*SD	Group S Mean±SD	*P*
Age (years)	37.92±14.46	41±14.72	*P*=0.42
Sex (M:F)	21:9	20:10	*P*=0.78
*ASA Grading (I:II)	13:17	15:15	*P*=0.60
Mouth opening (millimetre)	49.1±2.26	48.84±2.39	*P*=0.67
Mallampati Grading	1.83±0.65	1.74±0.60	*P*=0.58
Jaw movement	Normal	Normal	
Thyromental distance (cm)	6.92±1.12	6.62±0.45	*P*=0.18
Neck circumference (cm)	34.3±2.68	35.16±2.43	*P*=0.20
Sternomental distance (cm)	12.37±1.39	12.84±0.82	*P*=0.12

*ASA: American Society of Anesthesiologists, SD: Standard Deviation

Table 2: Intubation characteristics

Parameter	Group C [Number (proportion)]	Group S [Number (proportion)]	*P*
Time required for intubation (seconds) (Mean±SD*)	16.24±3.09	29.08±5.48	*P*<0.0001
First	28 (93.33%)	21 (70%)	*P*=0.0206
Second	2 (6.67%)	9 (30%)	*P*=0.0206
Incidence of impingement of tube with arytenoids	4 (13.3%)	20 (67%)	*P*<0.0001
Optimisation manoeuvres score			
0	25 (83.33%)	5 (6.67%)	*P*<0.0001
1	5 (6.67%)	23 (76.67%)	*P*<0.0001
2	0 (0%)	2 (6.66%)	
Total patients requiring manoeuvres	5 (6.67%)	25 (83.33%)	*P*<0.0001
Complications			
Lip/dental trauma	2 (6.6%)	4 (13.3%)	*P*=0.390

SD: Standard Deviation

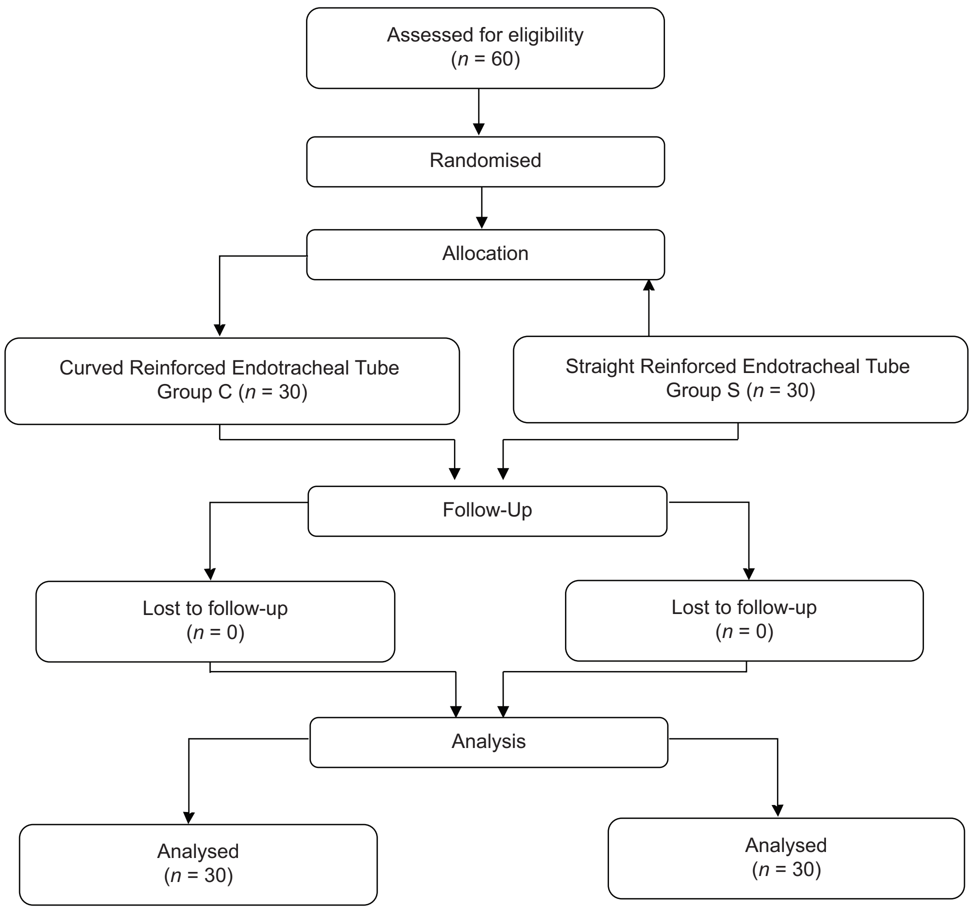

Figure 1: CONSORT flow diagram

DISCUSSION

Video-laryngoscopy assisted intubation using PVC or reinforced tubes can be helpful in encountering the difficulties in airway management and the risk of hypoxia due to prolonged apnoea time leading to devastating neurological injury in patients with cervical spine instability.[7-11] To the best of our knowledge, this is the first study comparing CRT and SRT using KVVL in patients with cervical spine instability. The present study revealed that the average time required for intubation was less with CRT (16.24 ± 3.09 seconds) than SRT (29.08 ± 5.48 seconds) when used through KVVL. We have calculated the intubation time from obtaining optimal glottis view to the first wave of capnograph. Kush Goyal *et al*.[5] also considered the same while using Airtraq. In a study done by Dimitriou *et al*.,[12] the time elapsed from inserting the blade between the teeth to the endotracheal tube crossing the vocal cords as evidenced by visual confirmation by

Table 3: Number of patients required optimisation manoeuvres during intubation		
Manoeuvrers used	Group C	Group S
External Laryngeal Pressure	0	3
Tube rotated to left	3	9
Tube rotated to right	0	1
*KVVL blade rotated to left	0	2
KVVL blade rotated to right	2	8
Use of bougie	0	2

*KVVL - King Vision videolaryngoscope blade

the anaesthesiologist was considered as the duration of intubation. In our study, we excluded the time from insertion of KVVL in the mouth till obtaining the optimal view of glottis contemplating it to be similar in the two groups as it does not depend on the type of endotracheal tube used for intubation through KVVL.

We also found a higher first-attempt success rate, fewer incidences of impingement with arytenoids/ aryepiglottic fold and less requirement of optimisation manoeuvres using CRT for intubation compared to SRT through KVVL.

Our study results demonstrated that a primary determinant for intubation through the KVVL is the angle created by the endotracheal tube emerging from its guiding channel. The blade of the KVVL must be adequately positioned and aligned in front of the glottis entrance for successful intubation because the direction of the endotracheal tube cannot be manipulated except to direct in either right or left lateral direction by the operator. This study highlighted the dependence of intubation angle on the type of the reinforced endotracheal tube passed through the KVVL. The CRT has a curvature and emerges from the KVVL with its distal end pointing anteriorly at a lesser angle towards the plane of the glottis compared to SRT [Figure 2]. Therefore, the chances of impingement of tube with arytenoids/aryepiglottic folds would be lesser, and chances of successful intubation would be higher. Our findings showed the superiority of the curved over straight reinforced tube for intubation through KVVL in patients with cervical injuries. Due to absence of steep curvature, SRT exits the KVVL with a higher angle and was found directed posteriorly towards either the arytenoid cartilage or the oesophagus. In most cases, this resulted in increased duration of the intubation procedure, a requirement of additional optimisation manoeuvres and/or multiple attempts of intubation.

Incidences of impingement of tube with arytenoids/ aryepiglottic fold were more with straight (67%) than curved (13%) reinforced tube. Similarly, Toshiyuki Minonishi *et al.*[6] also reported a higher number of cases with impingement of tubes on the arytenoid cartilages with the use of SRT passed through an Airwayscope. Our study demonstrated successful intubation with the first attempt in 93.33% and 70% cases with curved and straight reinforced endotracheal tubes, respectively. The intubation success rate for different types of endotracheal tubes emerging from the Airtraq laryngoscope in anaesthetised patients was 100% for PVC tracheal tubes and 78.5% for SRT in a previously published study and it was 92.5% and 85% while comparing CRT and SRT in another study.[5,12] Similarly, Toshiyuki Minonishi *et al.*[6] described a higher number of insertion attempts with the use of SRT than with CRT (2.4 ± 1.4 vs. 1.2 ± 0.5) through Airway scope. They reported that failure of tracheal intubation in the straight group was due to the arytenoid cartilages hindering the tube advancement and not due to limited view of the larynx.

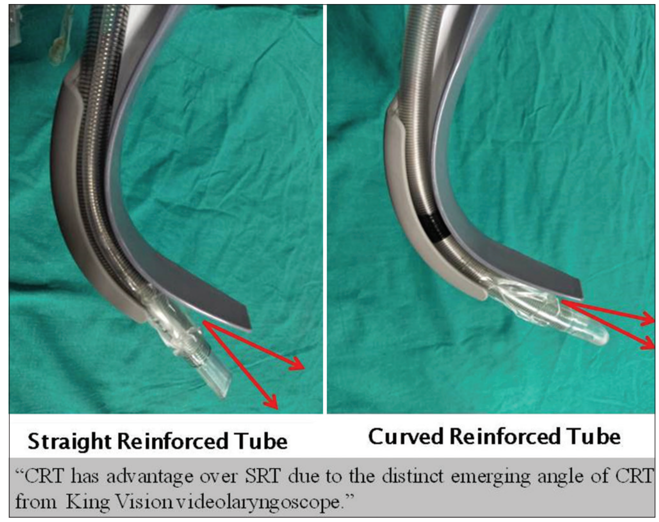

Figure 2: Distinct emerging angle of SRT and CRT from KVVL blade (Original)(SRT – Straight reinforced tube, CRT – Curved reinforced tube, KVVL – King Vision videolaryngoscope blade)

Majority of patients (93%) in group S required optimisation manoeuvres for successful intubation in our study. Out of them, a higher number of cases required the use of either rotation of KVVL blade on the right side or rotation of tube on the left side. To overcome the impingement on arytenoids/ aryepiglottic fold observed with channelled KVVL blade, anticlockwise rotation of tube as it slides off the dedicated slot is the most useful manoeuvre described.[13] Ali *et al.*[14] used a rigid stylet introduced into the reinforced endotracheal tube to give a preformed curved shape and rigidity to the tube while using Airtraq. We had to use a bougie in two patients in the SRT group in whom all other manoeuvres failed to assist the intubation.

The incidences of lip/dental trauma were similar in both the groups. Previous studies demonstrated the same using CRT and SRT with Airtraq and Airwayscope.[5,6] However, higher incidences of airway trauma were observed by Dimitriou *et al*.[12] with both the types of reinforced tubes compared to PVC tubes.

The limitations of our study include the inclusion of only Mallampati grade I and II patients, and hence, the results may not be reflected in grade III and IV patients. As the investigator was not blinded to the type of endotracheal tube used, all intubation procedures were performed by an experienced anaesthesiologist to reduce the bias. Also, our results may not apply to other channelled video laryngoscopes. Research work in the future requires the comparison of various channelled video laryngoscopes using different types of reinforced and PVC endotracheal tubes.

CONCLUSION

We conclude that in patients with cervical spine instability, intubation with a curved reinforced tube through KVVL was fast, with a higher first-attempt success rate, and required fewer optimisation manoeuvres than the straight reinforced tube. To effectively use the KVVL in clinical practice, anaesthesiologists should be aware of the different angles associated with reinforced endotracheal tubes.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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