

# Evaluation of simple pre-determined length insertion technique (SPLIT) with conventional method for oral fibreoptic intubation: A randomised cross-over study

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## ABSTRACT

**Background and Aims:** The difficulty during flexible fiber-optic bronchoscopy (FOB) guided tracheal intubation could be because of inability in visualising glottis, advancing and railroading of endotracheal tube. Several methods are available for visualising glottis, but none is ideal. Hence, this randomised controlled study was designed to evaluate the simple pre-determined length insertion technique (SPLIT) during oral FOB. **Methods:** Fifty-eight patients were randomised into Group C and Group P. General anaesthesia was maintained with sevoflurane and oxygen in spontaneous respiration. In Group C, conventional flexible fiberoptic laryngoscopy was done followed by SPLIT and vice versa in Group P. The time to visualise the glottis ( $T_1$ ), from glottic visualisation to pass beyond glottis ( $T_2$ ) and from incisors to pass beyond the glottis ( $T_3$ ) were noted from the recorded video. The time interval was analysed using Wilcoxon matched pairs test and Mann-Whitney U-test. **Results:** The  $T_1$  was significantly less in SPLIT as compared to conventional technique (13 [10, 20.25] vs. 33 [22, 48] s). The  $T_3$  was significantly less in SPLIT (24.5 [19.75, 30] vs. 44 [34, 61.25] s). The  $T_1$  by SPLIT was comparable between residents and consultants ( $P = 0.09$ ), whereas it was significantly more among residents than the conventional technique. The SPLIT was preferred by 91.3% anaesthesiologists. **Conclusion:** The SPLIT significantly lessened the time to visualise the glottis than conventional technique for FOB. The SPLIT was the preferred technique. Hence, we suggest using the SPLIT to secure the airway at the earliest and also as an alternative to conventional technique.

**Key words:** Fiberoptic intubation, intubation techniques, tracheal intubation

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## INTRODUCTION

The flexible fiber-optic bronchoscopy (FOB) guided tracheal intubation remains the gold standard in difficult airway management in spite of many newer airway gadgets. FOB-guided intubation can be performed through nasal or oral route either in awake or anaesthetised patients. The actual fiber-optic intubation procedure could be divided into three steps which include the visualisation of the glottis with fiberscope, passing the fiberscope through the glottis into trachea till carina and railroading the endotracheal tube over the fiberscope into the trachea. To expedite the successful visualisation of the glottis, different methods such as jaw thrust, lingual traction, fiber-optic

assisting airway devices and laryngoscopy assisted fiber-optic intubation have been employed.<sup>[1,2]</sup> None of them has been found to be individually effective to improve the glottic visualisation while the combination offers a better outcome on most occasion.

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Usually, FOB is performed by recognising the airway structures while keeping the airway in focus and proceeding with the FOB.<sup>[3]</sup> On the contrary, the FOB could also be advanced to a fixed distance to facilitate the glottic visualisation. This alternative technique had successfully reduced the time needed for glottic visualisation through the nasal route.<sup>[4]</sup> However, this technique has not been evaluated in the oral flexible fiber-optic intubation. The oral fiber-optic intubation is further demanding than the nasal route because of the perpendicular alignment of oral and pharyngeal axis. Hence, we planned to conduct this trial by inserting the fixed length of FOB during oral flexible fiber-optic intubation. The length of FOB to be introduced was designed from the technique of selecting an appropriate oral airway. This pre-determined length was calculated from the angle of mouth to tragus of the ear.<sup>[5]</sup> The primary aim of this randomised crossover trial was to compare the time to visualise the glottis and time to pass beyond the glottis in conventional versus the simple pre-determined length insertion technique (SPLIT). The secondary aim was to find out the preferred technique among the participants.

## METHODS

This randomised crossover trial was conducted in a tertiary care hospital and research institute after obtaining approval from the institutional research and ethics committee. Those patients with age between 18 and 65 years belonging to the American Society of Anesthesiologists physical status 1 and 2 scheduled for an elective surgical procedure requiring general anaesthesia with muscle relaxants were included in the trial. Patients with gastro-oesophageal reflux disease anticipated difficult airway, pregnancy, abdominal distension, maxillofacial trauma and known allergy to anaesthetic drugs were excluded from the study.

Written informed consent was obtained from all patients included in the study. The routine pre-anaesthetic evaluation was performed on the day before the surgery. They were premedicated with aspiration prophylaxis and anxiolytics as per departmental protocol. In the pre-anaesthetic room, an intravenous infusion was initiated, and glycopyrrolate (0.2 mg) was administered. The pre-determined length that was the vertical distance from the angle of mouth to the tragus was measured, and they were randomised into either Group C or Group P. The randomisation was done using the computer generated random number list, and the concealment allocation was done

using the serially numbered opaque sealed envelope technique.

In the operation room, standard monitors were established, and baseline parameters were noted. Subsequently, the haemodynamics were recorded for every 5 min until the end of the procedure. After adequate preoxygenation, all were administered fentanyl (2 µg/kg) and midazolam (1 mg) intravenously. Then the anaesthesia was induced with titrated dose of propofol. Successively they were allowed to breathe spontaneously with oxygen and sevoflurane. Video-assisted flexible fiberoptic laryngoscopy was performed by the residents and the consultants. Residents involved in this study had a prior experience with at least ten fiber-optic intubations.

In Group P, the SPLIT was attempted initially, and the video-assisted flexible fiber-optic laryngoscope was introduced orally, exactly in the midline, up to the pre-determined length in a single step. Then the visualisation of glottic structures was attempted by anti-flexion of the endoscope. If the glottis was not visualised, the fiberscope was advanced by another 1–2 cm and anti-flexed. Once the glottis was visualised, the fiberscope was introduced through the vocal cords till 1–2 cm beyond it. After this, fiberscope was removed, and oxygen with sevoflurane was administered through the face mask, and conventional technique was performed. In Group C, the video-assisted flexible fiber-optic laryngoscope was introduced through the oral cavity. After that, the flexible fiberscope was advanced in a conventional way while identifying the airway structures. After glottic visualisation and passing the fiberscope beyond the glottis, it was removed, and the oxygen with sevoflurane was administered. Thereafter the SPLIT was attempted.

The observed parameters include the time taken from the introduction of fiberscope from the incisors to the visualisation of glottis ( $T_1$ ), time taken from the visualisation of glottis to the passage of fiber-optic tip just beyond glottis ( $T_2$ ), time from the incisors to pass it beyond the glottis ( $T_3$ ), pre-determined length, vital parameters and preferred technique. The timings were noted by a single observer from the recorded video to avoid the observer bias in measuring the time. In SPLIT, the glottic view was scored using a four-point scoring system (3-only epiglottis, 2-epiglottis and vocal cords, 1-only vocal cords, 0-none).

During the study, the patient was in spontaneous respiration, and the head was maintained in neutral position with a jaw thrust. A gentle lingual traction was applied in both the groups by a second anaesthesiologist (who was not directly involved in the study). Sevoflurane with oxygen was administered through the breathing circuit at the angle of mouth throughout the fiber-optic procedure. Inadequate depth was managed with further doses of propofol. Desaturation or laryngospasm during the fiber-optic procedure was treated with 100% O<sub>2</sub> and positive pressure ventilation. After the study period, the anaesthesia plan was decided by the attending anaesthesiologist. Anaesthesia was deepened with propofol, opioid, inhalation agent and if needed muscle paralysis was administered. The airway was secured with endotracheal tube by direct laryngoscopy or with supraglottic airway devices as decided by the attending anaesthesiologist.

The sample size was calculated from the previous study using an alpha level of 0.05 and a power of 90% using two samples mean test in OpenEpi<sup>®</sup> software. The mean intubation time of 33.5 ± 20.8 and 18.75 ± 4.9 s was calculated from the median values from Stacey *et al.*<sup>[2]</sup> using the mathematical formula.<sup>[6]</sup> Assuming 25% drop outs, we calculated a final sample size of 58. The demographic parameters were expressed as mean and standard deviation. The observed parameters were tested for normality using Kolmogorov–Smirnov test. The time interval was analysed using Wilcoxon matched pairs test. The time taken by residents and consultants was analysed using Mann–Whitney U-test. Preferred technique by the participants and fiberoptic scoring of the larynx were expressed in a frequency distribution. The *P* < 0.05 was considered as statistically significant. SPSS version 16 (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis.

## RESULTS

Two hundred patients were screened for our study between November 2012 and June 2014 who were planned for elective surgery under general anaesthesia. One hundred and forty-two patients were not included as they did not meet the inclusion criteria and fifty-eight patients were recruited in the study. None of the patients were lost to follow-up from the study after recruitment. Data were obtained from all these 58 patients [Figure 1]. The demographic parameters were summarised in Table 1. The haemodynamic

parameters were recorded every 5 min from induction were stable throughout the study period.

The time (sec) to visualise the glottis (T<sub>1</sub>) was significantly shorter in the SPLIT in comparison to conventional technique (13 [10, 20.25] vs. 33 [22, 48] s, *P* < 0.001). In subgroup analysis, it was significantly shorter in SPLIT among the residents and also among the consultants. The time from glottic visualisation to pass beyond the glottis (T<sub>2</sub>) was comparable between the SPLIT and conventional techniques. In the subgroup analysis, T<sub>2</sub> was comparable in residents and consultants. The time from insertion of FOB to pass beyond the glottis (T<sub>3</sub>) was significantly shorter in the SPLIT in comparison to the conventional technique. In subgroup analysis, it was significantly less in the SPLIT among the residents and also among consultants [Table 2].

In the SPLIT, all the time intervals were comparable between the residents and the consultants. Whereas in the conventional technique, the T<sub>1</sub> and T<sub>3</sub> were significantly longer in the residents than the consultants and T<sub>2</sub> was comparable. In SPLIT, during fiber-optic scoring, only epiglottis was seen in 16 (27.5%) patients, vocal cords, and epiglottis were seen in 18 (31%) patients, only vocal cords were seen

**Table 1: Demographic parameters**

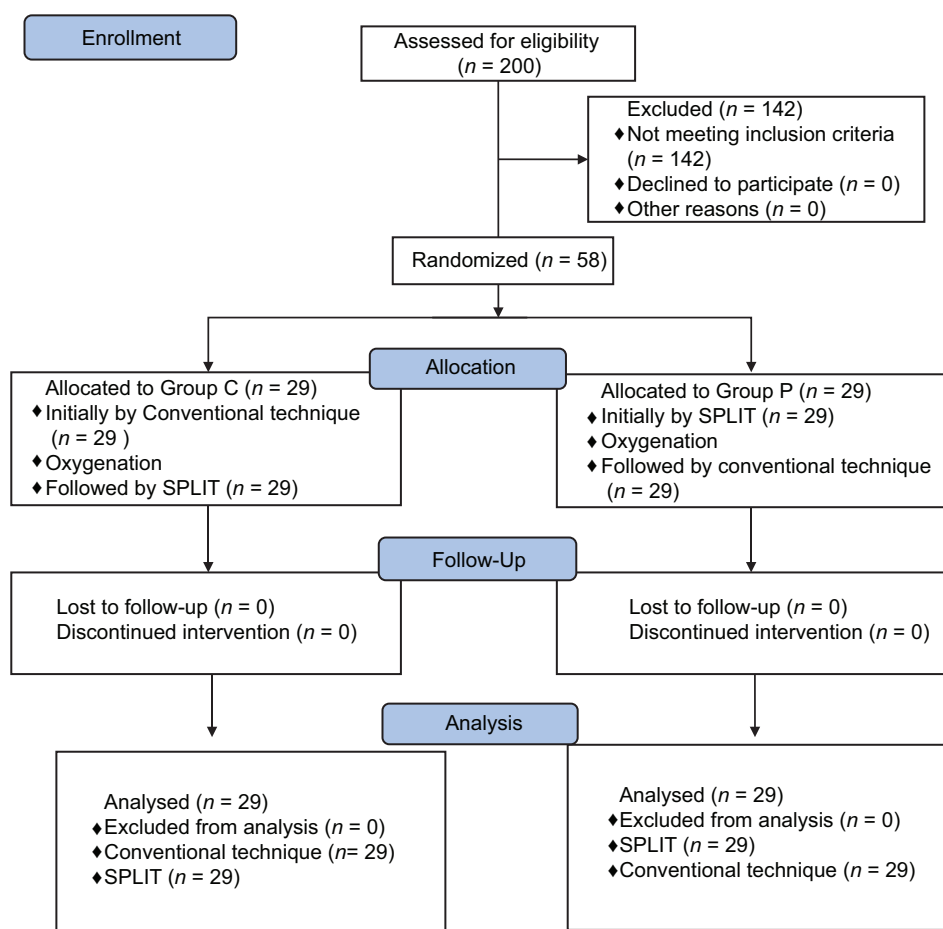
Parameters	Both groups (n=58)
Age (years)	38.9±12.7
Gender (n): Male/female	23/35
Height (cm)	161.3±5.5
Weight (kg)	58.5±7.6
BMI (kg/m <sup>2</sup> )	22.4±2.6
Pre-determined length (cm)	11.4±0.6
ASA physical status (n): 1/2	46/12
Mallampatti classification (n): Class I/II	27/31

Data are expressed as mean±SD. SD – Standard deviation; ASA – American Society of Anesthesiologists; BMI – Body mass index

**Table 2: Time duration in simple pre-determined length insertion technique and conventional techniques**

Time (s)	Both groups	SPLIT	Conventional technique	<i>P</i>
T <sub>1</sub>	Resident (n=29)	15 (11-22)	43 (37.5-52.5)	<0.001
	Consultant (n=29)	12 (10-14.5)	23 (16.75-31.5)	<0.001
	Overall (n=58)	13 (10-20.25)	33 (22-48)	<0.001
T <sub>2</sub>	Resident (n=29)	10 (8-15)	12 (9.5-16)	0.48
	Consultant (n=29)	9 (6-12)	10 (7.75-12.25)	0.064
	Overall (n=58)	9.5 (7-13)	11 (8-16.25)	0.062
T <sub>3</sub>	Resident (n=29)	27 (22-30.5)	56 (43-68.25)	<0.001
	Consultant (n=29)	22 (17-29.25)	36 (22.5-48.5)	<0.001
	Overall (n=58)	24.5 (19.75-30)	44 (34-61.25)	<0.001

Data are expressed as median (interquartile range). SPLIT – Simple pre-determined length insertion technique



**Figure 1:** The CONSORT 2010 flow chat diagram

in 23 (39.6%) patients. In one patient (1.9%) no glottic structures were seen after inserting the pre-determined length. The SPLIT was the most preferred technique (91.3%) among the anaesthesiologist in comparison to conventional technique (8.7%) which was statistically significant. Among the residents, 93.1% of the participants preferred the SPLIT, and among the consultants, 89.1% of the participants preferred the SPLIT.

Both groups were analysed further to study the influence of the SPLIT over the conventional technique while SPLIT was performed first and vice versa. The  $T_2$  was significantly shorter in the consultants with conventional technique when they performed the conventional technique first. All the other time intervals were comparable between the two groups among the consultants and within the residents irrespective of whether the SPLIT was performed as the first or second technique during the cross over [Table 3].

## DISCUSSION

We found that the time to visualise the glottis was significantly shorter in SPLIT with comparison to conventional technique. The decline in time with the SPLIT was due to the advancement of the fiberscope by pre-determined length in a single step. Similar results were obtained by alternative facilitatory methods in which there was 30%–54% reduction in time to visualise the larynx compared to conventional method.<sup>[3,4]</sup> Whereas in our study, we found 60% time reduction in visualising the glottis by the SPLIT in comparison to conventional technique. The time to pass the fiberscope beyond the glottis was also significantly shorter in the SPLIT in comparison to conventional technique. However, the time taken from glottic visualisation to pass the glottis was not statistically significant. Therefore, the reduction in the time to pass the fiberscope beyond the glottis was by the SPLIT *per se*.

In the subgroup analysis, we observed that the time to visualise the glottis by the SPLIT was comparable

Table 3: Time duration within consultant and resident group

Technique	Time (s)	Consultants			Residents		
		Group P	Group C	P	Group P	Group C	P
		SPLIT	T <sub>1</sub>	13 (11-15.5)	11.5 (10-13)	0.30	14 (11.25-24)
	T <sub>2</sub>	10 (7-13)	7.5 (5.75-9.25)	0.01	10 (8-19)	10 (8.5-11.5)	0.24
	T <sub>3</sub>	23 (20.5-30)	19.5 (16-23)	0.19	28 (22-42)	26.5 (22-30)	0.77
Conventional technique	T <sub>1</sub>	24 (21.25-32.5)	22 (16-31)	0.13	44 (36.75-51)	42.5 (35-54)	0.34
	T <sub>2</sub>	11 (7-19)	9 (7.75-13.5)	0.35	12 (7-17)	14 (10.15-25)	0.75
	T <sub>3</sub>	39 (32-51.5)	30.5 (24-41)	0.35	56 (44-68.25)	56.5 (42-68)	0.46

Data are expressed as median (interquartile range). Group P – SPLIT followed by conventional technique; Group C – Conventional technique followed by SPLIT. SPLIT – Simple pre-determined length insertion technique

between the residents and consultants. This could be certainly because it was simple method and easy to perform even with a limited experience. However, in the conventional technique, the consultants were able to visualise the glottis faster because of their experience. The time to visualise the glottis by conventional technique was also significantly less by consultants as compared to residents. This reflects the fact that the fiber-optic intubation by conventional technique needs more experience. In the SPLIT, the time required was significantly less even in hands of novice anaesthesiologists.

The SPLIT can be compared to Tele laryngoscopy, which is used to visualise the vocal cords by the Ear, Nose and Throat surgeon. The Tele laryngoscope, in which visualising camera is at an angle of 70° to its axis, will be advanced for visualising the vocal cords.<sup>[7,8]</sup> In a similar way, in the SPLIT also, after inserting the pre-determined length and then anti-flexing the fiber-optic tip to an appropriate angle, the glottis was visualised. This technique bypassed the possible difficulties in the upper airway so that the glottis was visualised more rapidly. We planned this study as crossover design to eliminate the influence of one technique over another. Hence, we analysed the participants who performed the conventional technique followed by the SPLIT and vice versa. Among the residents, the time to visualise the glottis was comparable when the SPLIT was done first or followed by the conventional method. This indicated that there was no influence of conventional technique while performing the SPLIT. Similar results were perceived among the consultants also.

Among the participants 91.3%, anaesthesiologist preferred the SPLIT when compared to conventional technique. Preference was slightly more among residents, as they found the SPLIT was more comfortable, easy to perform and relatively simple technique for the beginners. This could be because the early visualisation of glottis increased the confidence of

anaesthesiologists, which enabled them to choose that as the preferred technique. In a study, it was observed that the duration of intubation was more in first five fiber-optic intubations by residents in comparison with next five intubations.<sup>[9]</sup> Another study also observed similar results where the time reduction occurred with serial fiber-optic intubations in inexperienced hands.<sup>[3]</sup> In our study, visualising the glottis earlier would have increased the poise among residents leading to faster learning curve with shorter intubation time. Therefore, the SPLIT could be adapted as a learning tool for fiber-optic intubation for novice anaesthesia residents, which would help them to improve the learning curve and confidence in fiber-optic intubation.

In the SPLIT, the participants were able to visualise the vocal cords alone or along with epiglottis in 58.5% of the patients and rest of the patients we were able to visualise the epiglottis and with slight advancement (1–1.5 cm), glottis was also visualised. In one patient, no glottic structures were seen initially, but after advancing, the scope to a distance of 2 cm epiglottis and glottis was visualised. By the SPLIT glottis and/or epiglottis was visualised in 98.1% of the patients immediately after fiber-optic insertion.

The advantage of the SPLIT are, lesser risk of airway trauma and easy to perform even in hands of novice anaesthesiologists. Although there was a concern of trauma during the blind fiberscope insertion, practically there was no such trauma as fiberscope was introduced while the airway was kept wide open by lingual traction. Since the pre-determined length was measured from the patient itself and easy to perform, it can be done by anaesthesiologists with limited experience in FOB. The operator bias was eliminated as all the time measurements were noted from the recorded video by a single observer. The use of the SPLIT could also be extended to the pre-operative endoscopic airway examination.<sup>[10]</sup> Thus, the SPLIT can be an alternative to conventional technique.



Our study had several limitations as it was done in normal airway under general anaesthesia and the actual endotracheal intubation was not performed. In the presence of airway abnormalities and anticipated difficult airway the SPLIT may result in airway trauma. The usefulness of SPLIT in these subgroup of patients needs further randomised controlled trials. The shorter time to visualise the glottis may not always translate into shorter tracheal intubation. Because of the ethical concern, we did not compare the actual intubation timings. Further studies are needed to compare total time of flexible fiber-optic intubation by actual intubation of the patients with these two techniques. Since our study included only normal airway, further studies on patients with difficult airway are needed to evaluate the efficacy of this technique in difficult airway. Another limitation was that the possibility of operator bias in choosing the preferred technique could not be ruled out.

## CONCLUSION

SPLIT significantly lessened the time to visualise the glottis than the conventional technique. The SPLIT was the preferred technique by most of the anaesthesiologists. Hence, we suggest using the SPLIT to secure the airway at the earliest and also as an alternative to conventional technique.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Durga VK, Millns JP, Smith JE. Manoeuvres used to clear the airway during fiberoptic intubation. *Br J Anaesth* 2001;87:207-11.
2. Stacey MR, Rassam S, Sivasankar R, Hall JE, Latto IP. A comparison of direct laryngoscopy and jaw thrust to aid fiberoptic intubation. *Anaesthesia* 2005;60:445-8.
3. Wheeler M, Roth AG, Dsida RM, Rae B, Seshadri R, Sullivan CL, *et al.* Teaching residents pediatric fiberoptic intubation of the trachea: Traditional fiberoptic with an eyepiece versus a video-assisted technique using a fiberoptic with an integrated camera. *Anesthesiology* 2004;101:842-6.
4. Mohammadzadeh A, Haghghi M, Naderi B, Chaudhry A, Khan ZH, Rasouli MR, *et al.* Comparison of two different methods of fiber-optic nasal intubation: Conventional method versus facilitated method (NASAL-18). *Ups J Med Sci* 2011;116:138-41.
5. Greenberg RS. Facemask, nasal, and oral airway devices. *Anesthesiol Clin North America* 2002;20:833-61.
6. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol* 2005;5:13.
7. Mendes Neto JA, Pinna BR, Caporrino Neto J, Pedrosa JE. Comparison between telelaryngoscopy and suspension laryngoscopy in the diagnosis of benign vocal fold lesions. *Braz J Otorhinolaryngol* 2008;74:869-75.
8. Ponka D, Baddar F. Indirect laryngoscopy. *Can Fam Physician* 2013;59:1201.
9. Erb T, Hampl KF, Schürch M, Kern CG, Marsch SC. Teaching the use of fiberoptic intubation in anesthetized, spontaneously breathing patients. *Anesth Analg* 1999;89:1292-5.
10. Rosenblatt W, Ianus AI, Sukhupragarn W, Fickenscher A, Sasaki C. Preoperative endoscopic airway examination (PEAE) provides superior airway information and may reduce the use of unnecessary awake intubation. *Anesth Analg* 2011;112:602-7.

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