Original Article

A randomised controlled trial comparing video laryngoscopy versus conventional blind technique for transoesophageal echocardiography probe insertion in paediatric patients undergoing cardiac surgery: A pilot study

Address for correspondence:
Dr. Guriqbal Singh, Department of Cardiac Anesthesia, U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India.
E-mail: guriqbal6@gmail.com

Submitted: 24-Sep-2024
Revised: 24-Dec-2024
Accepted: 25-Dec-2024
Published: 17-Feb-2025

Access this article online
Website: https://journals.lww.com/ijaweb
DOI: 10.4103/ija.ija_975_24
Quick response code

Guriqbal Singh, Jigisha Pujara, Ankit Chauhan, Venuthurupalli S. P. Rajesh, Shrikant Sonune, Jamalpur Sravan Kumar, Himani Pandya[1]

Department of Cardiac Anaesthesia, U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, [1]Department of Research, U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India

ABSTRACT

Background and Aims: Inserting a transoesophageal echocardiography (TEE) probe can cause pharyngeal and oesophageal injuries in paediatric patients undergoing cardiac surgery. The study's primary objective was to assess the incidence of oropharyngeal injury on video laryngoscope (VL) examination at the end of surgery. **Methods:** This randomised controlled study was conducted on 100 patients, aged 2–10 years, undergoing elective cardiac surgery requiring TEE evaluation. Patients having a deranged coagulation profile, sore throat, difficult tracheal intubation, trauma during tracheal intubation and contraindications for TEE insertion were excluded from the study. Patients were randomised into the conventional group (Group C; $n = 50$), where the TEE probe was inserted using the conventional blind insertion technique, and the VL group (Group VL; $n = 50$). All patients were examined with VL for oropharyngeal injury after removal of the TEE probe at the completion of surgery, and the injury site was documented. **Results:** The incidence of pharyngeal mucosal injury was significantly lesser in Group VL ($n = 2$) than in the Group C ($n = 9$) ($P = 0.025$). The number of attempts for successful TEE probe insertion was significantly lower in Group VL ($P < 0.05$). The mean duration for successful TEE probe insertion at the first attempt was significantly longer in Group VL than in Group C ($P < 0.0001$). **Conclusion:** The use of VL for TEE probe insertion in paediatric patients significantly reduced the incidence of pharyngeal injury related to its insertion and provided direct visualisation of the oesophageal inlet.

Keywords: Cardiac surgery, laryngoscopy, oesophageal injury, orophrayngeal injury, paediatric, TEE, transoesophageal echocardiography, video laryngoscope

INTRODUCTION

Transoesophageal echocardiography (TEE) has become a standard perioperative diagnostic tool during paediatric cardiac surgeries. The insertion of the TEE probe may lead to pharyngeal and oesophageal injuries in paediatric patients undergoing cardiac surgery. In anaesthetised patients, the reported incidence of oropharyngeal injury related to the insertion of a TEE probe is 0.2%–1.2% and of orogastric tract perforation is 0.01%–0.09%.[1-6]

How to cite this article: Singh G, Pujara J, Chauhan A, Rajesh VS, Sonune S, Kumar JS, *et al.* A randomised controlled trial comparing video laryngoscopy versus conventional blind technique for transoesophageal echocardiography probe insertion in paediatric patients undergoing cardiac surgery: A pilot study. Indian J Anaesth 2025;69:268-74.

Conventionally, the TEE probe is inserted blindly in patients under general anaesthesia. However, difficulties may occur in directing the probe tip into the oesophageal orifice during insertion by conventional blind technique, which may result in oral and pharyngeal injuries. Video laryngoscopes (VLs) have been shown to improve the laryngeal view and rate of successful tracheal intubation.[7]

The primary objective of our study was to observe the incidence of oropharyngeal injury after TEE probe insertion using two different techniques (conventional blind technique versus VL guided) in paediatric patients undergoing elective cardiac surgery. The secondary objectives were to study the number of attempts required for successful TEE probe insertion, the duration of insertion and the relationship between laryngeal and oesophageal inlet. We hypothesised that a VL provides direct and better visualisation of the oesophageal inlet, and its use may reduce the incidence of injuries related to TEE probe insertion as compared to conventional blind insertion of TEE probe.

METHODS

This single-centre, randomised interventional study was conducted from March 2024 to September 2024 after obtaining approval from the Institute Ethics Committee (vide approval number EC/Approval/22/C. Anae/21/06/2023, dated 21/06/2023). Informed consent was obtained from the parents/guardians of the patients for participation in the study and the use of the patient data for research and educational purposes. The study was carried out using the principles of the Declaration of Helsinki, 2013 and Good Clinical Practice guidelines. This study was registered at the Clinical Trials Registry-India (vide registration number CTRI/2024/07/071383, accessible at www.ctri.nic.in). The study included 100 paediatric patients aged 2–10 years undergoing elective cardiac surgeries requiring TEE evaluation. Patients with a deranged coagulation profile, sore throat, difficult tracheal intubation, trauma during tracheal intubation and contraindications to TEE probe insertion were excluded from the study.

Using computer-generated table sequences (GraphPad Software, Boston, MA, USA), patients were randomised into either a conventional group (Group C) or the VL group (Group VL) [Figure 1]. Two cardiac anaesthesiologists with more than 3 years of experience in perioperative paediatric TEE participated and inserted the probe into the study population. General anaesthesia was administered under standard American Society of Anesthesiologists monitoring guidelines. Induction of anaesthesia was done according to institutional protocol. Induction of anaesthesia was done with midazolam 0.1 mg/kg, ketamine 1 mg/kg, fentanyl 5 μg/kg and vecuronium 0.1 mg/kg intravenously. After anaesthesia induction, a conventional Macintosh laryngoscope of appropriate size was used to secure the airway with an appropriate-sized cuffed endotracheal tube [Avanos Microcuff endotracheal tube (ETT); Avanos Medical Inc, Alpharetta, GA, USA]. The nasal temperature probe was inserted in all the patients. The anaesthesia was maintained with intermittent doses of intravenous fentanyl 1 μg/kg, vecuronium 0.02 mg/kg, and sevoflurane [1–1.2 minimum alveolar concentration (MAC)] on oxygen. In Group C, a paediatric TEE probe (9T-RS GE Vingmed Ultrasound AS, Horten, Norway) was inserted using the conventional blind technique. The TEE probe was inserted in the neutral head position with the right hand through the midline while gently lifting the mandible forward and putting the thumb of the left hand into the mouth. In Group VL, BPL VL (BPL Medical Technologies Private Limited, Palakkad, India), a Macintosh-type, non-channelled VL with a 66° viewing angle, was used to insert a paediatric TEE probe. The VL blade was inserted orally and advanced to the epiglottic vallecula. The oesophageal inlet was evaluated, and the TEE probe was advanced into the oesophagus under direct vision [Figure 2]. The TEE probe was removed after the surgery, and all the patients were examined with a VL for oropharyngeal injuries. The injury site(s) were documented and recorded with the help of the image capture button on the VL. Trauma during TEE probe insertion was defined as evidence of physical injury to the oropharynx or oesophagus causing abrasions, tears, bleeding or haematoma, visible on VL examination at the completion of surgery. The number of attempts to insert the TEE probe and the duration of probe insertion were documented. If more than three attempts were required to insert the TEE probe by either technique, those patients were excluded from the study. The duration of TEE probe insertion was defined as the time from opening the mouth to insertion of the TEE probe into the oesophagus and obtaining the mid-oesophageal four-chamber view in Group C, while in Group VL, it was defined as the

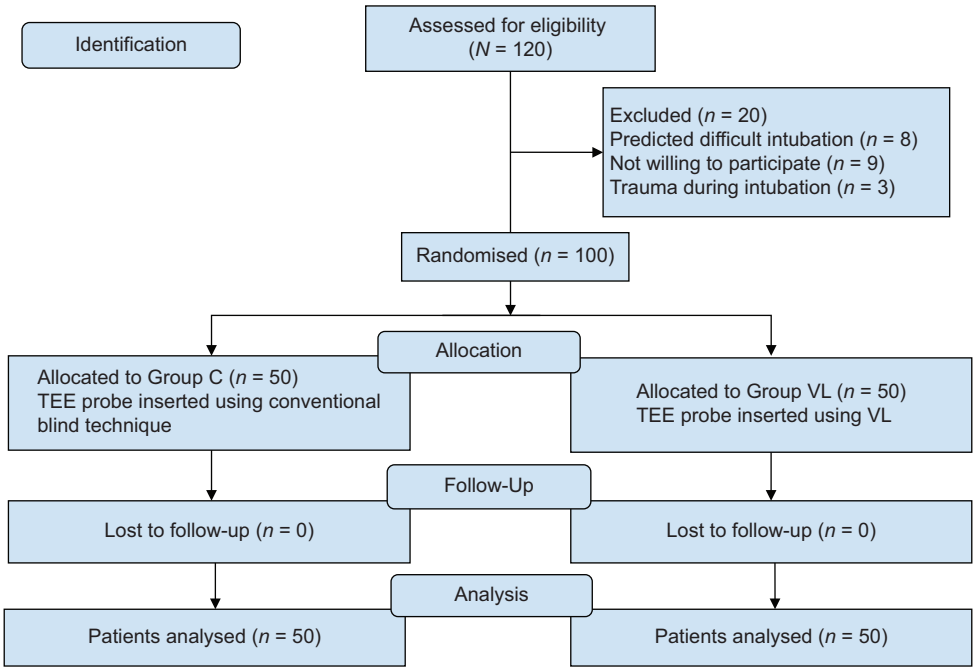

Figure 1: Consolidated standards of reporting trials (CONSORT) flow diagram. C = conventional, VL = video laryngoscope, TEE = transoesophageal echocardiography

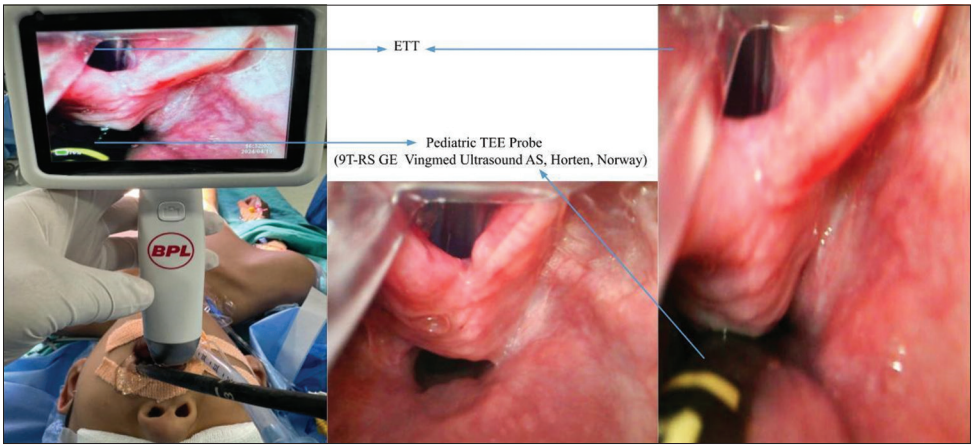

Figure 2: Insertion of paediatric TEE probe using a video laryngoscope. TEE = transoesophageal echocardiography

time from the opening of the mouth for insertion of VL to the time of obtaining mid-oesophageal four-chamber view after insertion of the probe into the oesophageal inlet. A blinded anaesthesiologist examined photographs of Group VL to determine the relationship between the oesophageal inlet and the larynx.

The primary outcome of our study was to observe the incidence of oropharyngeal injury after TEE probe insertion using two different techniques in paediatric patients undergoing elective cardiac surgery. The secondary outcomes were to study the number of attempts required for successful TEE probe insertion, the duration of insertion and the relationship between laryngeal and oesophageal inlet.

Few studies have been done in the adult population to analyse the incidence of injury caused by TEE probes. However, due to the unavailability of literature on the incidence of injury caused by TEE probes in the paediatric population of this particular age group, the present study was conducted as a pilot study with a minimum sample size of 50 in each group.

Statistical analysis was done using Statistical Package for the Social Sciences version 20.0 software (SPSS Inc, Chicago, Illinois, USA). Normally distributed continuous data was analysed using the Student's

t-test. The primary outcome, which is the incidence of oropharyngeal injury, was analysed using the Chi-squared test. The secondary outcome, such as the number of TEE probe insertions, was analysed using the Chi-squared test, and the mean duration for successful TEE probe insertion at the first attempt was analysed using the Student's *t*-test. The number of patients in two age subgroups and the incidence of injuries for both subgroups were analysed using the Chi-squared test. A *P* value less than 0.05 was considered statistically significant.

RESULTS

We assessed 120 patients for eligibility, and 100 were recruited into the study (Figure 1). This study included 100 patients, with 50 patients randomised into each group. There were no statistically significant differences between the two groups with respect to age, weight, body surface area, gender and Cormack–Lehane grading [Table 1]. The injuries in Group C (n = 9, 18%) were significantly more in comparison to Group VL (n = 2, 4%; P = 0.025) on VL examination after TEE probe removal [Table 2]. The probe was successfully inserted on the first attempt in 42 patients (84%) in Group C, while it was successfully inserted on the first attempt in 48 patients (96%) in Group VL (P = 0.004). The mean duration for successful TEE probe insertion at the first attempt was significantly higher in Group VL, that is, 28.75 s [standard deviation (SD): 7.65], compared to Group C, that is, 18.55 s (SD: 5.0) ($P < 0.0001$) [Table 2]. The common sites of injuries are shown in Table 2. The injuries were documented by VL examination in all the patients after TEE probe removal, and a few of these injuries have been shown in Figure 3. In Group VL, the relationship between the oesophageal inlet and the larynx was posterior in 43 patients (86%) and posterolateral in seven patients (14%). Table 2 also shows the subgroup analysis in two age groups (2–5 and 5–10 years). The number of patients with injury was higher in the subgroup of 2–5 years in the control group, while it was equal in both the subgroups in Group VL, though it was statistically insignificant.

Table 1: Demographic characteristics

Variable	Group C (n=50)	Group VL (n=50)
Age (months)	65.84 (32.9)	66.16 (28.76)
Weight (kg)	13.72 (4.37)	15.02 (4.22)
Body surface area (kg/m^2)	0.58 (0.15)	0.62 (0.12)
Gender		
Male, *n* (%)	30 (60%)	33 (66%)
Female, *n* (%)	20 (40%)	17 (34%)
Cormack–Lehane grading		
1, *n* (%)	25 (50%)	27 (54%)
2, *n* (%)	21 (42%)	22 (44%)
3, *n* (%)	4 (8%)	1 (2%)

Data presented as mean (standard deviation) or *n*. C=conventional, VL=video laryngoscope, *n*=number of patients

DISCUSSION

Our study showed that TEE probe insertion using a VL results in a higher success rate for probe insertion on the first attempt and causes significantly fewer oropharyngeal injuries.

In comparison to non-anaesthetised patients, patients under general anaesthesia with endotracheal intubation have a loss of swallowing reflex and pharyngeal space collapse, leading to difficulty in the insertion of TEE probe and are unable to respond to the injuries caused by TEE probe insertion.[8] The incidence of major complications related to intraoperative TEE probe insertion in adult cardiac surgical patients has been reported to be 0.4%, and the most common among them is oropharyngeal bleeding (60%).[9] VL provides direct visualisation of the oesophageal inlet, pyriform fossa and laryngeal inlet, and advancing the TEE probe by directly visualising the oesophageal inlet and insertion into it may avoid oropharyngeal injury.[10] VL provides a better view of the oesophageal inlet than a conventional laryngoscope.[11] In our institute, we routinely place the TEE probe using the conventional blind technique, so we compared the conventional blind insertion technique with insertion using VL.

Table 3 shows a comparison of our study with the different studies conducted on adult patients. The findings of our study are similar to the study conducted by Kavrut Ozturk and Kavakli[8] in adult patients undergoing cardiovascular surgery. They reported a higher success rate of insertion of the TEE probe at the first attempt and a longer duration of insertion

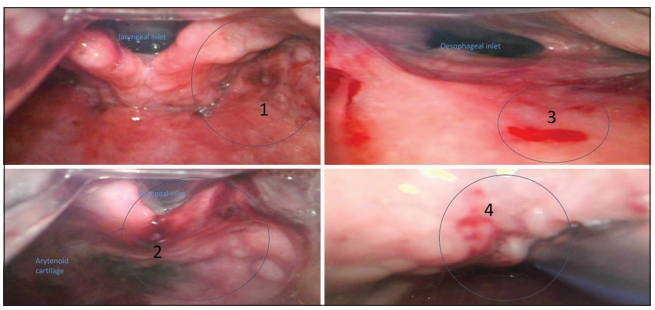

Figure 3: Injuries post-TEE probe removal (labelled as 1, 2, 3 and 4). TEE = transoesophageal echocardiography

Table 2: Comparison between the two groups regarding the incidence of injury, attempts and duration of probe insertion

	Group C (*n*=50)	Group VL (*n*=50)	P
Injury, *n* (%)	9 (18%)	2 (4%)	0.025
Attempts of probe insertion, *n* (%)			0.004
1	42 (84%)	48 (96%)	
2	6 (12%)	2 (4%)	
3	2 (4%)	0 (0%)	
Duration for successful TEE probe insertion at the first attempt (s) Mean (SD) (95% CI)	18.55 (5.0) (17.13, 19.97)	28.75 (7.65) (26.52, 30.92)	<0.0001
Sites of injury, *n*			
Posterior pharyngeal wall	2	1	
Piriform sinus	3	1	
Arytenoids	2	0	
Oesophageal inlet	1	0	
Oral cavity injuries	1	0	
Age (years), *n* (%)			
2–5	17 (34%)	11 (22%)	0.270
5–10	33 (66%)	39 (78%)	
Incidence of injury in two age subgroups *n*			
2–5 years	6	1	1
5–10 years	3	1	

Data expressed as mean (standard deviation) (95% CI) or *n* (percentage). *n*=number of patients. C=conventional, CI=confidence interval, SD=standard deviation, TEE=transoesophageal echocardiography, VL=video laryngoscope

Table 3: Comparison of our study with different studies conducted in adult patients

	Ozturk and Kavakli[10]	Borde *et al*.[8]	Taboada *et al*.[14]	Ishida *et al*.[13]	Our study
Study participants	86 adult patients undergoing cardiovascular surgeries	363 patients aged 18–70 years undergoing elective cardiac surgery	100 intubated, critically ill patients	100 patients undergoing elective surgery	100 patients aged 2–10 years undergoing elective cardiac surgery
Study groups	Conventional group (*n*=41) McGrath group (*n*=42)	Conventional group (*n*=177) Video laryngoscope group (*n*=186)	Conventional group (*n*=50) Video laryngoscope group (*n*=50)	MacIntosh group (*n*=50) McGrath group (*n*=50)	Conventional group (*n*=50) Video laryngoscope group (*n*=50)
Success rate of insertion at the first attempt, *n* (%)	Conventional group=18 (43.9%) McGrath group=38 (90.5%) (*P*=0.012)	Conventional group=154 (87%) Video laryngoscope group=176 (94.6%) (*P*=0.029)	Conventional group=29 (58%) Video laryngoscope group=45 (90%) (*P*<0.001)	MacIntosh group=38 (76%) McGrath group=46 (92%) (*P*=0.039)	Conventional group=42 (84%) Video laryngoscope group=48 (96%) (*P*=0.04)
Injury, *n* (%)	Blood presence at the tip of the probe Conventional group versus McGrath group (21.9% vs. 4.8%, *P*=0.02) Pharyngeal injury (17.1% vs. 2.4%, *P*=0.037)	Conventional group=26 (14.7%) Video laryngoscope group=14 (7.5%) (*P*<0.05)	Conventional group=26 (52%) Video laryngoscope group=7 (14%) (*P*<0.001)	MacIntosh group=8 (16%) McGrath group=2 (4%) (*P*=0.042)	Conventional group=9 (18%) Video laryngoscope group=2 (4%) (*P*=0.025)
Total duration of insertion (s)	Conventional group=11 (4) McGrath group=22 (8) (*P*=0.016)	–	–	MacIntosh group=36 (13) McGrath group=21 (7) (*P*<0.01)	Conventional group=18.55 (5.0) Video laryngoscope group=28.75 (7.65) (*P*<0.0001)

Data presented as mean (standard deviation) or *n* (percentage). *n*=number of patients

in the McGrath group compared to the conventional group. The incidence of injury was higher in the conventional group than in the McGrath group. Ishida *et al*.[11] reported a higher success rate of probe insertion and lower incidence of injury in the McGrath group compared to the McIntosh group for TEE insertion. Our study's findings are similar to those conducted in tracheally intubated, critically ill adult patients in an intensive care unit by Taboada *et al*.[12] [Table 3]. Similarly, Borde *et al*.[13] reported a higher incidence of injury in the conventional group compared to the Group VL and a higher success rate of insertion of the TEE probe at the first attempt in the Group VL compared to the conventional group in their study conducted in

adult patients undergoing elective cardiac surgery. In this study, the relationship between oesophageal and laryngeal inlet was also studied in the Group VL, and the authors found that the oesophageal inlet was posterolateral (47%) followed by posterior (41%) and lateral in 12% of the patients in relation to the laryngeal inlet. The relationship between the laryngeal inlet and oesophageal inlet may not always be anteroposterior, which may lead to difficulty in inserting the TEE probe and may result in injury. Data regarding the incidence of oropharyngeal injury related to intraoperative TEE insertion is scarce. However, Stevenson[14] studied the overall complications by the TEE probe in his case series of 1650 paediatric patients, ranging from 1 day to 21 years, and reported the incidence of overall complications related to the TEE probe in 3.2% of the patients, including failure to insert the probe in 0.8% of the patients. They did not find any significant bleeding or oesophageal injuries and observed one case of minor lip lacerations.

Murphy and McCheyne[15] conducted a prospective national audit of major gastrointestinal complications of TEE studies and found zero incidence of major complications, consistent with a worst-case incidence of five per 1000 TEE examinations. Verma *et al*.[16] observed an increase in endotracheal tube cuff pressure during the insertion of a TEE probe and a reduction in tracheal perfusion pressure in paediatric patients undergoing cardiac surgery, and recommended monitoring cuff pressure to avoid possible airway complications. However, in our study, cuff pressure was not monitored.

The limitations of this study are that we did not follow-up with the patients in the postoperative period to assess the occurrence of odynophagia or dysphagia after surgery. We assessed complications related to probe insertion and did not assess other injuries related to repeated manipulations or thermal injury. The sample size may be too small to study serious complications such as oesophageal or gastric perforation, which often necessitate evaluation and additional interventions. We did not examine the nasopharyngeal cavity before placing the TEE probe. We did not grade the trauma caused by TEE probe insertion or observe the haemodynamic response during insertion of the TEE probe. Another limitation is that it is a single-centre study. We examined the oropharyngeal cavity as well as the laryngeal and oesophageal inlet using the VL while progressively advancing the VL inside the oropharyngeal cavity and further ahead till we visualised laryngeal and oesophageal inlet. There was no fresh injury/bleed attributed to the VL. But chances of some occult injury cannot be ruled out. No visible fresh injury was documented, which could be attributed to the VL examination.

CONCLUSION

Using a VL for TEE probe insertion in paediatric patients significantly reduces the incidence of pharyngeal injury related to its insertion and the number of attempts to insert the probe successfully. VL provides direct visualisation of the oesophageal inlet. The current study suggests that using a VL to insert a TEE probe should be regularly practised.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared upon request.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

ORCID

Guriqbal Singh: https://orcid.org/0000-0001-6772-7632
Jigisha Pujara: https://orcid.org/0000-0003-0047-5797
Ankit Chauhan: https://orcid.org/0000-0003-2665-2050
Venuthurupalli S. P. Rajesh: https://orcid.org/0000-0002-0194-2353
Shrikant Sonune: https://orcid.org/0009-0006-2348-2075
Jamalpur Sravan Kumar: https://orcid.org/0009-0009-0477-9182
Himani Pandya: https://orcid.org/0009-0009-8070-1379

REFERENCES

1. Kallmeyer IJ, Collard CD, Fox JA, Body SC, Shernan SK. The safety of intraoperative transesophageal echocardiography: A case series of 7200 cardiac surgical patients. Anesth Analg 2001;92:1126–30.
2. Lenon MJ, Gibbs NM, Weightman WM, Leber J, Ee HC, Yusoff IF. Transesophageal echocardiography-related gastrointestinal complications in cardiac surgical patients. J Cardiothorac Vasc Anesth2005;19:141-5.
3. Piercy M, McNicol L, Dinh DT, Story DA, Smith JA. Major complications related to the use of transesophageal echocardiography in cardiac surgery. J Cardiothorac Vasc Anesth 2009; 23:62–5.
4. Min JK, Spencer KT, Furlong KT, DeCara JM, Sugeng L, Ward RP, *et al*. Clinical features of complications from transesophageal echocardiography: A single-centre case series

of 10,000 consecutive examinations. J Am Soc Echocardiogr 2005;18:925-9.
5. Bavalia N1, Anis A, Benz M, Maldjian P, Bolanowski PJ, Saric M. Esophageal perforation, the most feared complication of TEE: Early recognition by multimodality imaging. Echocardiography 2011;28:E56–9.
6. Hahn RT, Abraham T, Adams MS, Bruce CJ, Glas KE, Lang RM, *et al*. Guidelines for performing a comprehensive transesophageal echocardiographic examination: Recom- mendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. J Am Soc Echocardiogr 2013;26:921–64.
7. Lewis SR, Butler AR, Parker J, Cook TM, Robinson OJS, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation: A cochrane systematic review. Br J Anaesth 2017;119:369–83.
8. Kavrut Ozturk N, Kavakli AS. Use of McGrath MAC videolaryngoscope to assist transesophageal echocardiography probe insertion in intubated patients. J Cardiothorac Vasc Anesth 2017;31:191–6.
9. Huang CH, Lu CW, Lin TY, Cheng Y-J, Wang M-J. Complications of intraoperative transesophageal echocardiography in adult cardiac surgical patients—experience of two institutions in Taiwan. J Formos Med Assoc 2007;106:92–5.
10. Shippey B, Ray D, McKeown D. Use of McGrath videolaryngoscope in the management of difficult and failed tracheal intubation. Br J Anaesth 2008;100:116–9.
11. Ishida T, Kiuchi C, Sekiguchi T, Tsujimoto T, Kawamata M. McGRATH MAC video laryngoscope for insertion of a Transesophageal echocardiography probe: A randomised controlled trial. Eur J Anaesthesiol. 2016;33:263-8.
12. Taboada M, Cariñena A, Estany-Gestal A, Iglesias-Álvarez D, Veiras S, Martínez A, *et al*. Videolaryngoscope versus conventional technique for insertion of a transesophageal echocardiography probe in intubated ICU patients (VIDLARECO trial): A randomized clinical trial. Anaesth Crit Care Pain Med 2024;43:101346.
13. Borde D, C K, Jasapara A, Shetty V, Juvekar N, Desurkar V, *et al*. Use of a video laryngoscope to reduce complications of transesophageal echocardiography probe insertion: A multicenter randomized study. J Cardiothorac Vasc Anesth 2022;36:4289-95.
14. Stevenson JG. Incidence of complications in pediatric transesophageal echocardiography: Experience in 1650 cases. J Am Soc Echocardiogr 1999;12:527-32.
15. Murphy T, McCheyne A. Prospective national audit of major gastrointestinal complications of transesophageal echocardiography studies in children. Ann Card Anaesth 2022;25:178-81.
16. Verma A, Singh G, Trivedi V, Ramkiran KS, Babu MJ, Pandya H, *et al*. Effect of transesophageal echocardiography probe on tracheal perfusion pressure and ventilatory parameters in pediatric patients undergoing cardiac surgery using cardiopulmonary bypass: A prospective observational study. Ann Card Anaesth 2023;26:393-8.