The midline approach for endotracheal intubation with GlideScope video laryngoscopy could provide a better glottis exposure in adults:A randomised controlled trial

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Abstract

Background: Previous studies demonstrated that the common laryngoscopic approach (right-sided) and midline approach are both used for endotracheal intubation by direct laryngoscopy. Although a midline approach is commonly recommended for video laryngoscopy (VL) in clinical, lacking of published evidences to support it. The study aimed to evaluate the effects of different video laryngoscopic approach on intubation. Methods: Two hundred and sixty-two patients aged 18 years who underwent elective surgery in general anesthesia, requiring endotracheal intubation, were included in the prospective, randomized, controlled study. Participants were randomly and equally allocated to right approach (Group R) or midline approach (Group M). All intubations were conducted with GlideScope video laryngoscopy by experienced anaesthetists. The primary outcomes were Cormack-Lehane laryngoscopic views (CLV) and first-pass success (FPS) rate. The secondary outcomes were time to glottis exposure, time to tracheal intubation, hemodynamic response and other adverse events. Comparative analysis was performed between the both groups. Results: All patients ultimately were successfully intubated. No significant differences were observed in patient characteristics and airway assessments (P>0.05). Compared with Group R, Group M had a better CLV (χ2=14.706, P=0.001) and shorter time to glottis exposure (8.82±2.04 vs 12.38±1.81, t=14.94, P<0.001) and tracheal intubation (37.19±5.01 vs 45.23±4.81, t=13.25, P<0.001), but no difference in FPS rate (70.2% vs 71.8%, χ2=0.074, P=0.446). Between groups, the rates of hoarseness or sore throat, minor injury, hypoxemiaand changes of SBP and HR were noted no significant difference (P>0.05). Conclusion: Although FPS rate did not differ based upon laryngoscopic approach type; however, the midline approach could provide a better glottis exposure, shorter time to glottis exposure and intubation. The midline approach should be recommended for teaching in VL-assisted endotracheal intubation. Trial registration: The study was registered in Chinese Clinical Trial Registry (ChiCTR-RNC-13003898). Keywords: endotracheal intubation; video laryngoscopic; laryngoscopic approach

Background

In the past decade, video-laryngoscopy assisted tracheal intubation has extensively been applied in airway management because of better visualization of the laryngeal structures on a high-resolution video screen[1-3]. Common teaching in direct laryngoscopy advocates that the device is inserted into the right side of the mouth, the tongue is moved to the left by the blade flange, the blade tip is advanced into the epiglottic valecula, and then the device is raised to obtain the laryngeal view (right-sided approach) [4]. Up to now, this method has been considered the gold standard in tracheal intubation, and even in teaching for undergraduates. However, we found that right-sided approach may not be appropriate for intubation by using video laryngoscopy (VL) in clinical. The midline approach without sweep of the tongue is commonly recommended to achieve an unobstructed view of the larynx by VL, but lacking of published evidences to support this. Israel and colleagues conducted a retrospective cohort study of children who underwent endotracheal intubation by using the VL, and found that no diffenence in successful intubation on the first attempt based upon laryngoscopic approach type[5]. But many factors including the glottis visualization, pre-shaped angulation of tube, level of trainee and presence of difficult airway predictors, are all correlated with first-pass success (FPS) [6-8]. Other studies also demonstrated that VL help to decrease intubation failure but did not improve the FPS in intensive care unit patients requiring intubation or in anesthesiology practice.[9-11] Therefore, FPS rate may not be adequate to evaluate performance of different laryngoscopic approach on intubation. It needs an urgent evidence to support which approach makes a greater contribution to glottic opening.

In this study, we aimed to compare the right-sided versus midline laryngoscopic blade approach in adult patients who underwent video laryngoscopy-assisted tracheal intubation for the following outcomes: 1) Cormack-Lehane laryngoscopic views (CLV); 2) first-pass success (FPS) rate; 3) time to glottis exposure and intubation; 4) adverse events and hemodynamic changes during intubation.

Methods

Study design

Ethical approval for this study (Ethical Committee NO.9-2013) was provided by the Ethical Issues Committee, Yiji Shan Hospital of Wannan Medical College, Anhui, China (Chairperson Prof Cao H) on 6 November 2013. Written informed consent was obtained from all patients prior to participation. This study is an interventional, randomized controlled trial. Participates were randomly and equally allocated to two groups: right-sided approach group (Group R) and midline approach group (Group M). The Randomized sequence was generated by computer and all allocations were included in sealed opaque envelopes. For randomization, the envelopes will be opened only after transporting the patient to the operating room, and only one envelope can be opened per patient. Patients were blinded to interventions.

Patients above 18 years of age, American Society of Anesthesiology (ASA) physical status I-III, undergoing elective surgical procedure under general endotracheal anesthesia in our hospital from August 2018 to March 2019, were all enrolled. Patients were excluded as followed criteria:1) patients with predicable difficult airway: mallampati score ≥IV, interincisor gap less than 3.5 cm, thyromental distance less than 6.5 cm, sternomental distance less than 12.5 cm; 2) patients with reduced neck extension and flexion, airway obstruction (infectious, traumatic, foreign body, anaphylaxis), recent airway surgery, or history of a difficult airway; 3) exclusion criteria included the need for a rapid sequence induction, an alternative intubation method or known or suspected oral, pharyngeal or laryngeal masses; 4) patients with poor dentition, symptomatic gastrooesophageal reflux, cervical spine instability, unstable hypertension, coronary artery disease, cerebral disease or if the resources were not available to conduct the procedure on the scheduled date of surgery.

After transferred into the operative room, patients were monitored for non-invasive blood pressure (BP), heart rate (HR), pulse oximetry (SpO_2) and end-tidal carbon dioxide partial pressure ($P_{ET}CO_2$). The demographic and clinical characteristics of patients were collected. Then patients underwent a uniform induction technique with midazolam 0.05mg/kg, propofol 2.0 to 2.5 mg/kg and adequately relaxed with cisatracurium 0.15 mg/kg as evident by loss of all train of four responses using a peripheral nerve stimulator. With the induction of anesthesia, patients could also be administered 0.5μg/kg of sulfentanyl. All the patients were intubated by the oral route and used by Glidescope video laryngoscope. For patients in group R, the blade flange was inserted from the right side of mouth to obtain glottic opening. While a midline approach was conducted in group M. In both groups, video laryngoscopy-assisted tracheal intubations were done by an experienced anesthesiologist. Intraoperative anesthesia was intravenous maintained with propofol 4-8mg/kg/h and remifentanil 0.1-0.2μg/kg /min. Bispectral index (BIS) was used to monitor the depth of anesthesia and keep the BIS value between 45 and 60.

Outcomes

Our primary outcome was CLV and FPS rate. The CLV was determined by modified Cormack-Lehane view of the glottis based on the view obtained at video laryngoscopy: grade I, the glottis is completely visible; grade IIa, glottis opening is partially visible; grade IIb, only arytenoid cartilages is visible; grade III, only the tip of the epiglottis is visible; and grade IV, no glottis structures are visible.[12] Our secondary outcomes were time to glottis exposure and tracheal intubation. We defined time to glottis exposure as time from insertion of blade into the mouth until exposure of the glottis, time to tracheal intubation as time from starting at blade insertion and ending at blade removal from the mouth. Other outcomes including hypoxemia (SpO_2<90%), hemodynamic changes [Systolic blood pressure (SBP) and Heart rate were recorded before intubation, 1 minute, 2 minute and 5 minutes post-intubation], minor injury (Oropharyngeal mucosal injury), hoarseness or sore throat on the first postoperative day assessed by a blinded anaesthetist, were also recorded.

Sample size

We conducted a pilot study of 60 patients for sample size assessment. In this pilot study, the number of CVL grade I-II was 30(100%) in Group M and 28(93.3%) in Group R. A sample size of 218 (109 in each group) allowed the detection of a 20% difference between the two group, with an α of 0.05 (two tailed) and a β of 0.20, power of 0.8. To account for 20% attrition, a total sample size of 262 (131 in each group) was selected.

Statistical analysis

Continuous variables, such as the height, weight, Body Mass Index (BMI) of the patients and metrics of airway assessments are presented as the mean±SD. Categorical data are presented as percent. The primary efficacy variable of laryngoscopic views, FPS rate and adverse events in different groups were analyzed using the chi square test (χ2) or or Fisher’s exact test. Mann-Whitney U test or Student’s t test was used to compare the both groups with respect to basic characteristics and other outcomes included time to glottis exposure, SBP and HR. All statistical tests were two-sided tests (test level α=0.05), P values<0.05 was considered statistically significant.

Results

Two hundred and ninety-five patients were approached, 14 not met inclusion criterion, 8 declined to participate and 11 excluded for other reasons. Finally, a total of 262 patients completed the study, with 131 in each group (**Fig. 1**). Of which, 133 (50.8%) patients were male and 129 (49.2%) female. The basic characteristics and metrics of airway assessment in both groups were shown in **Table**. **1**. No significant differences were observed in age, gender, weight, height, Body mass index, Mallampati score, Sternomental distance, Interincisor distance, Thyromental distance and ASA physical status (P>0.05).

In Group M, 122 (93.1%) patients were grade I, 9 (6.9%) were grade IIa and no patients above grade IIb. In Group R, 100 (76.3%) patients were grade I, 29 (22.2%) were grade IIa, 2 (1.5%) were grade IIb and no patients above grade III. Compared with Group R, Group M had a better CLV ($\chi 2$=14.706, P=0.001). All patients ultimately were successfully intubated and the total success rate was comparable in two groups (P=1.00). Ninty-two (70.2%) patients were successful on the first attempt in Group M and 94 (71.8%) in Group R, the FPS rate existed no difference between them ($\chi 2$=0.074, P=0.446). In addition, compared with Group R, Group M had a shorter time to glottis exposure (8.82±2.04 vs 12.38±1.81, t=14.94, P< 0.001) and tracheal intubation (37.19±5.01 vs 45.23±4.81, t=13.25, P< 0.001). (**Table. 2**)

During intubation, hoarseness or sore throat has been the most common adverse events, although rate for these was not different between groups (74.8% in Group M vs 77.9% in Group R, $\chi 2$=0.338, P=0.331). Seven (5.3%) patient had hypoxemia and 8 (6.1%) had minor injury in Group M, 6(4.6%) patient had hypoxemia and 9 (6.9%) had minor injury in Group R, the rates were also no difference between groups (hypoxemia: 5.3% vs 4.6%, $\chi 2$=0.081, P=0.500; minor injury: 6.1% vs 6.9%, $\chi 2$=0.063, P=0.500) (**Table. 2**).

For hemodynamic response to intubation stress, the baseline, SBP and HR before intubation, 1 minute, 2 minute and 5 minutes post-intubation in two groups were recorded respectively. There is no significant difference in changes of SBP and HR between both groups (P>0.05) (**Fig. 2** and **Fig. 3**).

Discussion

As an available tool for difficult airway management, Video laryngoscopy has been demonstrated to improve success rate and decrease iatrogenic airway trauma.[2,3,6] However, the better method of video laryngoscopy-assisted tracheal intubation has not been verified. The performance of intubation used by the right-sided approach versus midline approach was compared. We found midline approach had a better Cormack-Lehane laryngoscopic views and shorter time to glottis exposure and tracheal intubation. The differences in FPS rate, hypoxemia, hemodynamic response and other adverse events between both groups were not observed.

To get an adequate direct visualization during intubation, the tongue is commonly swept to the left according to guidance[4,13]. Although the midline approach has been proposed for intubation by some experts in the early 20th century, they point to direct laryngoscopy not for video laryngoscopy.[5,13-15] And it has no clear evidences exist to support the clinical experience until now. In 2015, Israel and colleagues firstly explored effects of both approach in a pediatric emergency department with the C-MAC video laryngoscope on FPS rate[5]. They found PFS did not differ based upon laryngoscopic approach type. But this did not illustrate that the both approaches were identical, because many factors mentioned above contributes to first-pass success. Similar to their result, The FPS rate was also comparable between both groups in our study. Thus, the success rate of endotracheal intubation was not recognized as our only main outcome. Instead, we think it more persuasive to add laryngoscopic views as an indicator for comparing the effect of different approach on intubation. Finally, we demonstrated that the glottis exposure in midline approach was better than right approach. In addition, different from the both approach, left-molar approach requires that the tongue be displaced to the right. It has been reported that the left molar approach can also provided a better laryngeal view in cases of unexpected difficult intubation and make difficult intubation easier when performed by direct laryngoscopy[16,17]. Nevertheless, whether it has a better laryngeal view than conventional approach when performed by VL remains advanced research.

Because it is difficult to recognize key anatomic landmarks by a right-sided approach, it may need a longer time to reach an optimal view[5,6]. Our finding further support this statement: midline approach need a shorter time to glottis exposure compared with right-sided approach during tracheal intubation by using VL. In the right-sided approach, the tongue was moved to the left and deviated from the median line of the mouth, resulting in angulation between tongue and blade. It must increase much more force to exposure the glottis due to dispersion of forces. In contrast, laryngoscope blade is straight to exposure glottis in a midline approach, avoiding more forces. Adverse events such as oedema, tooth, and soft tissue lesion can be caused by excessive forces transmitted through laryngoscope during an intubation[18]. So the rate of the minor injury in midline approach was lower than in right approach in theory. Increasing evidence indicates that the video laryngoscope has an established role in tracheal intubation, decreasing the forces applied to the soft tissues of the upper airway and the incidence of complications, when compared with the Macintosh laryngoscope[18-20]. However, we found no difference in rates of adverse events between two approaches on contrary to these studies and Israel’s result. There are two potential explanations for this. Firstly, patients with predicable difficult airways were not included in our study. All performances of endotracheal intubation in both groups were conducted by VL with a lower applied force. Secondly, participates were children in Israel’s study while they were adult in present study. Compared with adults, children may be more likely to suffer from tissue damage. For hemodynamic response to intubation, patients did not significantly differ in SBP and HR after stress between two groups.

Of course, our study had some limitations. Firstly, video laryngoscopy is originally designed as a device to manage difficult intubation with direct laryngoscopy, but the patients with predicable difficult airways were all excluded in our trial. Whether the midline approach would be effective in this population needs a further study. Secondly, investigators were not blinded to the outcome measures. Thirdly, several video laryngoscopes with different designs are commercially available and have been investigated in a wide variety of settings[21,22]. All intubation procedures were performed by Glidescope video laryngoscope in present study. Whether the results were applied to other video laryngoscopes may be worth discussing.

Conclusions

We observed that the midline approach was associated with a better glottis exposure and shorter time to intubation compared to the right-sided approach. The midline approach should be recommended for teaching in video laryngoscopy-assisted endotracheal intubation.

Abbreviations

VL: video laryngoscopy; CLV: Cormack-Lehane laryngoscopic views; FPS: first-pass success; ASA: American Society of Anesthesiology; BMI: Body Mass Index; BP: non-invasive blood pressure; HR: heart rate; SpO_2: pulse oximetry; $P_{ET}CO_2$: end-tidal carbon dioxide partial pressure; BIS: Bispectral index; SBP: Systolic blood pressure.

Declarations

Acknowledgements

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

QSL and ZP conducted the study and collected the data. CY and JLX supervised the research and analyzed the data. JLX and DZP wrote and revised the manuscript. YWD and DZP designed and conducted the study. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was approved by the Ethical Issues Committee, Yiji Shan Hospital of Wannan Medical College, Anhui, China (Chairperson Prof Cao H) on 6 November 2013. Written informed consent was obtained from all patients.

Consent for publication

Not applicable.

Competing interests

All authors have no interests to declare.

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Tables

Table 1. Patient characteristics and airway assessments

	Group R (n=131)	Group M (n=131)
Age;year	54.60±11.16	56.87±12.60
Gender		
male	70(53.4)	63(48.1)
female	61(46.6)	68(51.9)
Height;cm	165.67±7.11	166.27±8.52
Weight;kg	61.46±7.81	60±8.22
ASA physical status		
1	28(21.4)	32(24.4)
2	97(74.0)	95(72.5)
3	6(4.6)	4(3.1)
Body mass index; $kg.m^{-2}$	22.57±3.81	21.77±4.01
Sternomental distance;cm	16.52±0.91	16.41±1.05
Interincisor distance;cm	3.95±0.56	4.05±0.60
Thyromental distance;cm	7.58±0.61	7.62±0.58
Mallampati score		
1	73(55.7)	75(57.3)
2	50(38.2)	49(37.4)
3	8(6.1)	7(5.3)

Values are Number (proportion) or Mean ± SD. No differences were observed between the two groups.

Group R, right-sided approach group; Group M, midline approach group.

Table 2. Details of intubation

	Group R (n=131)	Group M (n=131)	p value
Glottic view			0.001
1	100(76.3)	122(93.1)	
2a	29(22.2)	9(6.9)	
2b	2(1.5)	0	
3	0	0	
FPS rate	94(71.8)	92(70.2)	0.446
Total success rate	131(100)	131(100)	1.0
Exposure time;s	12.38±1.81	8.82±2.04	< 0.001
Intubation time,s	45.23±4.81	37.19±5.01	< 0.001
Adverse events			
Hypoxemia	6(4.6)	7(5.3)	0.500
Minor injury	9(6.9)	8(6.1)	0.500
Hoarseness or Sore throat	102(77.9)	98(74.8)	0.331

Values are Number (proportion) or Mean ± SD. Group R, right-sided approach group; Group M ,midline approach group.

Figures

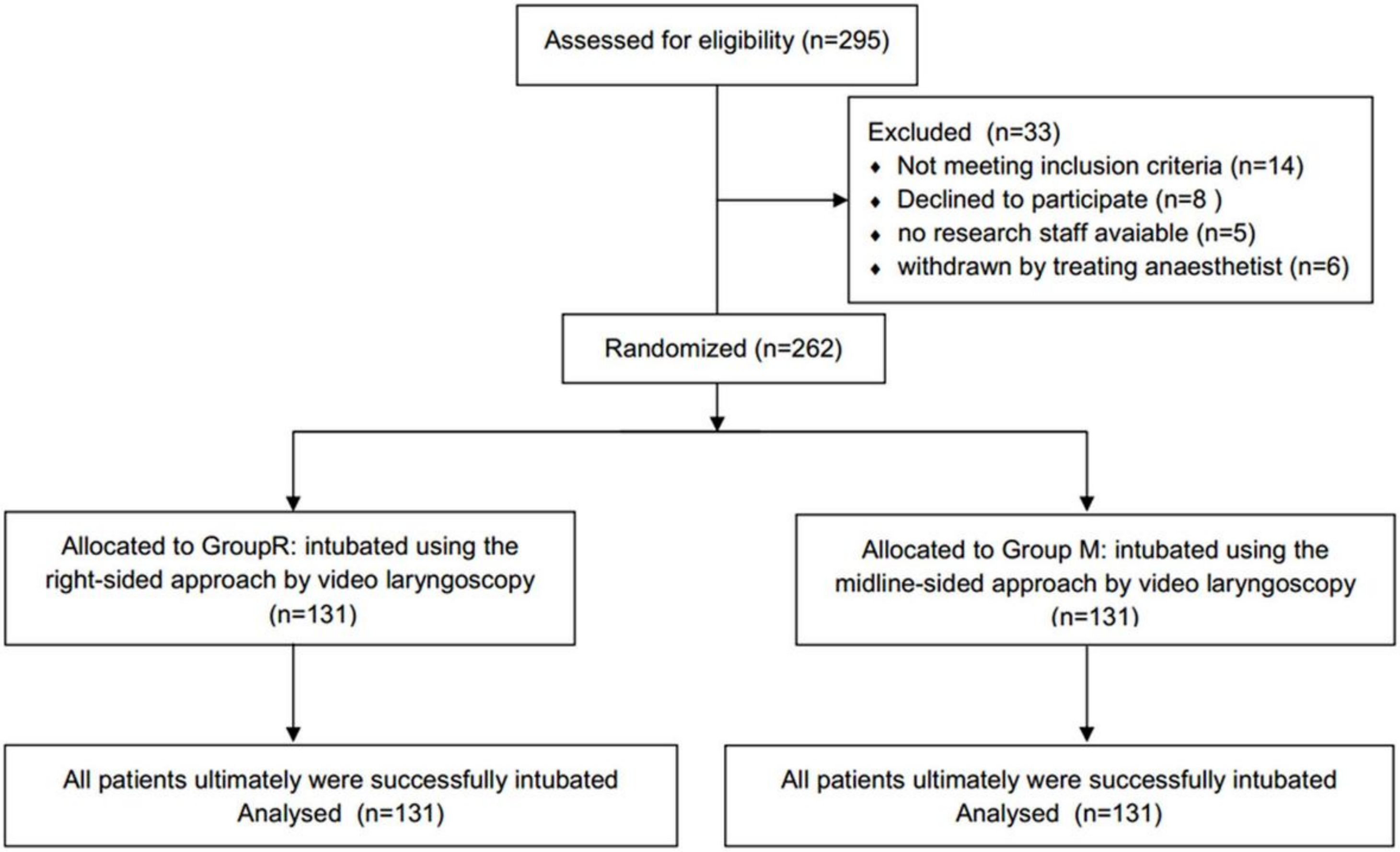

Figure 1

CONSORT flow chart for patient recruitment and randomization.

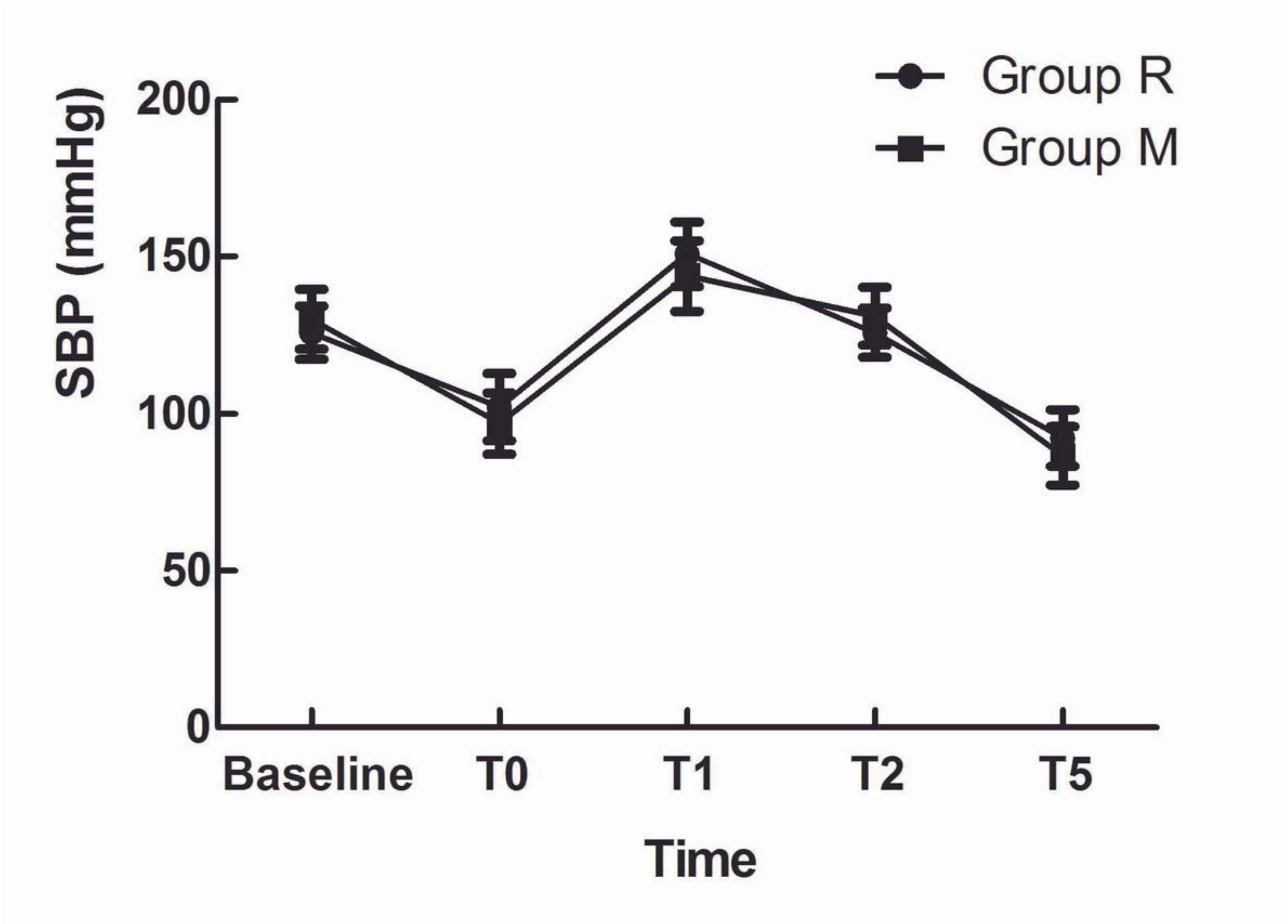

Figure 2

The effect of different laryngoscopic approach on Systolic blood pressure (SBP).

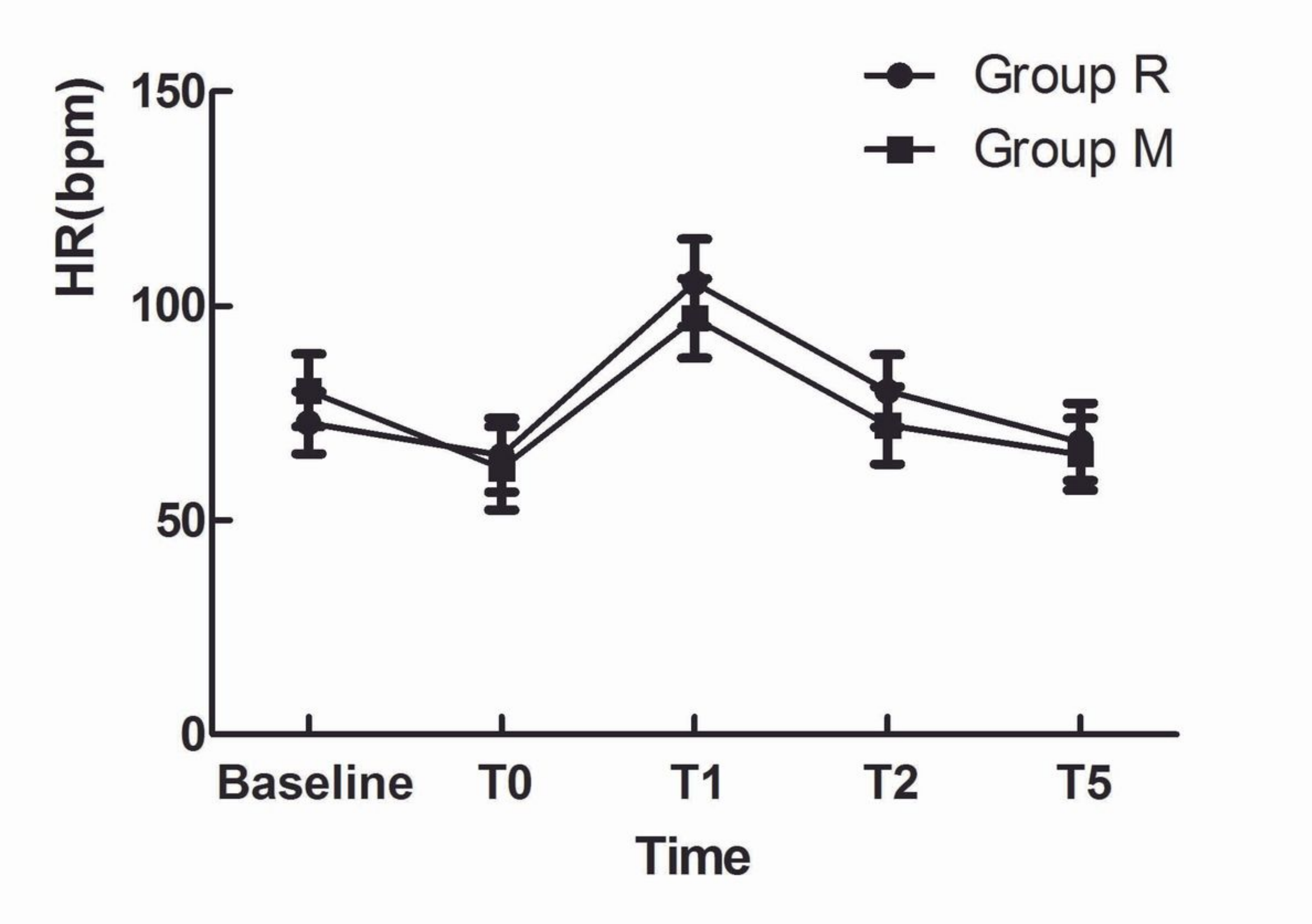

Figure 3

The effect of different laryngoscopic approach on Heart rate (HR).