

A comparison of extraluminal and intraluminal use of the Uniblocker in left thoracic surgery

A CONSORT-compliant article

Zhuo Liu, MD^a, WenSheng He, MD^b, QianQian Jia, MD^b, XiaoChun Yang, MD^b,
ShuJuan Liang, MD^b, XiuLi Wang, MD, PhD^{a,*}

Abstract

Background: The aim of this study was to assess the feasibility and safety issues concerning extraluminal use of the Uniblocker for one-lung ventilation (OLV) in the left thoracic surgery.

Methods: Forty patients undergoing elective left thoracic surgery were included in this study, and all patients were randomly allocated to extraluminal use of Uniblocker group (E group, n=20) or intraluminal use of Uniblocker group (I group, n=20). Time for intubation, time for verification of the correct position of Uniblocker, incidence of Uniblocker displacement, index of pulmonary collapse, mean arterial pressure, heart rate, peak airway pressure, oxygen saturation in two-lung ventilation, and 30 minutes after OLV, bronchial damage after OLV, sore throat, and hoarseness postoperative were recorded.

Results: The time for positioning Uniblocker was 112.6 ± 31.2 seconds in intraluminal use group, whereas the time for positioning Uniblocker was significantly shorter in extraluminal use group (63.4 ± 15.8 seconds). The incidence of main bronchial injury, the time of intubation, the incidence of Uniblocker malposition after initial placement, the time of OLV, the degree of pulmonary collapse, mean arterial pressure, heart rate, peak airway pressure, oxygen saturation in two-lung ventilation, and 30 minutes after OLV, the incidence of sore throat and hoarseness postoperative have no statistical significance ($P > .05$).

Conclusion: Extraluminal use of the Uniblocker was proved to be a more rapid and more accurate method than conventional intraluminal use of the Uniblocker for OLV in left thoracic surgery.

Abbreviations: BBs = bronchial blockers, FOB = fiberoptic bronchoscope, OLV = one-lung ventilation, TLV = two-lung ventilation.

Keywords: extraluminal use, intraluminal use, left thoracic surgery, one-lung ventilation, Uniblocker

1. Introduction

One-lung ventilation (OLV) is desirable to facilitate surgical visualization during thoracic surgical procedures, especially those minimally invasive surgical procedures such as video-

assisted thoracoscopic surgery (VATS), minimally invasive cardiac surgery, and transthoracic spine surgery.^[1-3] Double-lumen tube (DLT) is the most commonly used device for OLV.^[4,5] However, compared with single-lumen tube (SLT), DLT is associated with some limitations, such as difficulty with intubation in patients with difficult airway and increasing the risk for potential traumatic injury,^[6,7] leading to sore throat and hoarseness postoperative.^[8] Furthermore, if patients require ventilation support after surgery, DLT need to be replaced by SLT postoperative. Bronchial blockers (BBs), such as Univent blocker, Arndt blocker,^[9] Cohen blocker, Uniblocker, EZ blocker, and Coopdech blocker, have more advantages than the DLT: easier insertion, especially in patients with difficult airway,^[10] and no need to exchange the tube when mechanical ventilation is required after surgery. However, in many studies, the BBs required more time for correct placement when compared with the left-sided DLT.^[11,12]

Recently, 2 studies show us that extraluminal use of the Arndt pediatric endobronchial blocker is an easier and more reliable method of attaining OLV in infants and small children.^[13,14] However, to our knowledge, there has been no prospective study comparing the effectiveness and safety issues of extraluminal use of the Uniblocker in adult patients. Thus, we designed this study to evaluate the feasibility and safety issues of extraluminal use of the Uniblocker for OLV in adult patients undergoing left thoracic surgery.

Editor: Bernhard Schaller.

Authors' contributions: Z.L. and X.L.W. contributed to the conception and design. W.S.H. and Q.Q.J. did the data collection. X.C.Y. and S.J.L. did the analysis and interpretation. Z.L., X.L.W., and Q.Q.J. did the writing, critical revision of the article. All authors reviewed and approved the final manuscript.

The authors have no conflicts of interests to declare.

This study was registered at <http://www.clinicaltrials.gov> (identifier: NCT02816918).

^a Department of Anesthesiology, The Third Hospital of Hebei Medical University, Shijiazhuang, ^b Department of Anesthesiology, The First Hospital of Qinhuangdao, Qinhuangdao, Hebei, China.

* Correspondence: XiuLi Wang, Department of Anesthesiology, The Third Hospital of Hebei Medical University, No. 139 Ziqiang Road, Shijiazhuang, 0500511 Hebei, China (e-mail: wangxiuli1234566@sina.com).

Copyright © 2017 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the Creative Commons Attribution-NoDerivatives License 4.0, which allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to the author.

Medicine (2017) 96:21(e6966)

Received: 26 December 2016 / Received in final form: 27 April 2017 / Accepted: 30 April 2017

<http://dx.doi.org/10.1097/MD.0000000000006966>

2. Patients and methods

2.1. Study population

This study was approved by the local medical ethics committee of the first hospital of Qinhuangdao (Approval Number: 20160521), and written informed consent was obtained from all patients. Forty American Society of Anesthesiologists (ASA) physical status I to III adult patients undergoing elective left thoracic surgery requiring OLV were enrolled in this study. Exclusion criteria were as follows: age >70 or <18 years, BMI >35, ASA classifications >III, modified Mallampati classification >2, thoracic surgery within the past 1 month, suspected tuberculosis or systemic infection.

2.2. Intubation

All patients in our study were screened by a senior anesthesiologist preoperatively and randomly allocated to extraluminal use of Uniblocker group (E group) or intraluminal use of Uniblocker group (I) group.

Randomization (1:1) was based on codes generated using the SAS 9.2 software (SAS Institute, Cary, NC) by a statistician who was blinded to the study. These codes were kept in sequentially numbered opaque envelopes and stored at the site of investigation until the end of the study.

All patients in 2 groups without premedication were received standard monitoring systems in the operating room, including invasive arterial blood pressure, heart rate (HR), electrocardiogram, and peripheral oxygen saturation (SpO₂).

Patients were placed in a supine position and preoxygenated for 3 minutes. For induction, all patients in 2 groups were intravenously injected with midazolam 0.03 mg/kg, fentanyl 3 μg/kg, propofol 1.5 to 2 mg/kg, and vecuronium 0.1 mg/kg. All patients were intubated exactly 2 minutes after receiving vecuronium by an experienced anesthesiologist.

Patients assigned to E group were first inserted Uniblocker (Fuji Systems, Tokyo, Japan) into the glottis via video laryngoscope (Fig. 1A). After passing the glottis, the Uniblocker was advanced toward the left mainstem bronchus until slight resistance was encountered, then a SLT with appropriate size (male: 8.0 mm, female: 7.5 mm) was intubated via video laryngoscope into the appropriate depth. After determine of the tube within the trachea, the cuff of SLT was inflated and the tube was fixed firmly at the patient's mouth with cloth tape. Before correct the position of Uniblocker, the cuff of SLT was deflated for pushing and twisting Uniblocker more freely. When correct the position of Uniblocker, the FOB (external diameter 3.8 mm; MDHAO Medical Technology Co, Ltd, Zhuhai, China) was inserted into the tracheal tube and the Uniblocker was guided to the correct position under direct vision of FOB (Fig. 1B and C). After these procedures, the cuffs of Uniblocker and SLT were inflated.

Patients assigned to I group were intubated with the SLT (male: 8.0 mm, female: 7.5 mm) via video laryngoscope and fixed the SLT firmly at the patient's mouth with cloth tape. The Uniblocker was advanced through the SLT and directed to the left mainstem bronchus at sufficient depth, and then FOB was inserted into the SLT. After further pushing and twisting, the Uniblocker moved into the left mainstem bronchus at optimal position under direct visualization of FOB, and then the Uniblocker was fixed firmly at the end of SLT.

The cuff-of Uniblocker in both groups were inflated with 4 to 5 mL of air under direct vision and located appropriately 10 to 15 mm below the carina in the left mainstem bronchus. After the

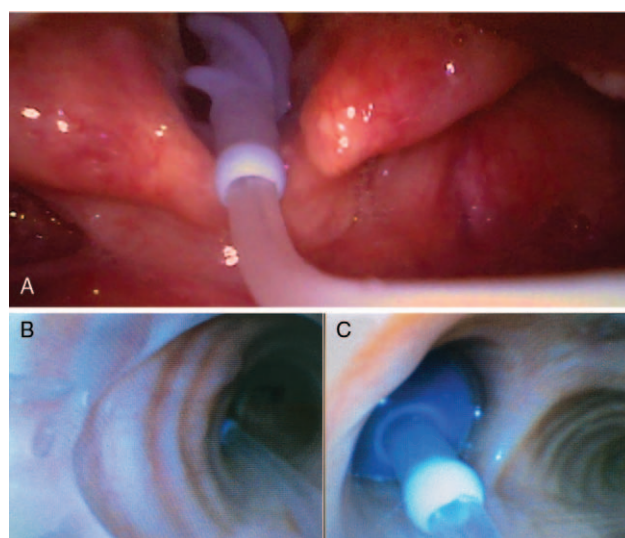


Figure 1. (A) The Uniblocker passed through the glottis. (B) The Uniblocker extraluminally of single-lumen tube. (C) The cuff of Uniblocker under the carina.

patients were placed in the lateral position, the position of the Uniblocker was reconfirmed by the operator using FOB.

The primary endpoints were the intubation time (IT) and the correct positioning time (PT). The IT is defined as the time from inserting the video laryngoscope into the patient's mouth until successful intubation of the SLT and Uniblocker within the trachea. The PT is defined as the time from inserting FOB into SLT until correct placement of the Uniblocker. IT and PT were assessed by an independent observer with a stopwatch. The secondary outcomes were the failure of intubation, the incidence of Uniblocker displacement, rank of pulmonary collapse, HR, mean arterial pressure (MAP), peak airway pressure (P_{aw}), SpO₂ in two-lung ventilation (TLV), and 30 minutes after OLV, signs of bronchial injuries and the occurrence of sore throat and hoarseness after surgery. Failure of intubation was defined as the inability to insert the Uniblocker into the target bronchus after 5 attempts. Pulmonary collapse was ranked as excellent, fair, or poor by thoracic surgeons who were independent of study.

The definitions of pulmonary collapse degree are listed below:

- (1) Excellent: complete collapse with perfect surgical exposure
- (2) Fair: total collapse, but still had residual air
- (3) Poor: no collapse was achieved or there was partial collapse with interference of surgical exposure

An independent anesthesiologist, who was blinded to the assignment of groups, recorded the signs of bronchial injuries using FOB after OLV and asked the patients about the occurrence of sore throat and hoarseness 24 hours after surgery.

2.3. Statistical analysis

In our study, sample size was based on a pilot study during which we measured the correct positioning time of extraluminal use of the Uniblocker, and also a previous study. With significance set at 0.05 and power set at 80%, the sample size required to detect the differences of correct positioning time was 36 patients. Taking into account the potential risk of failure to intubate, we planned to enroll 40 patients (20 per group) into the trial.

The SPSS 21 statistical software was used for data analysis. Continuous variables were presented as means \pm standard deviations (SDs). The differences between groups were compared using the independent-samples *t* test, and the differences within each group were compared using the paired-samples *t* test. The differences of proportions were analyzed using chi-square test. Differences in the incidence of malpositioning and sore throat, and hoarseness after surgery were analyzed using Fisher exact test. Mann-Whitney rank-sum test was used to analyze ratings of pulmonary collapse and main bronchial injury. $P < .05$ was considered statistically significant.

3. Results

All patients completed the surgical procedures. There were no significant differences in patient demographics, surgery time, and OLV time between the 2 groups ($P > .05$) (Table 1).

The time of correct positioning of Uniblocker was significantly less in E group (63.4 \pm 15.8 seconds) than that in I group (112.6 \pm 31.2 seconds) ($P < .05$). The incidence of main bronchial injury was lower in E group (occurred in 2 of 20 cases) than that in I group (occurred in 5 of 20 cases) ($P > .05$) (Table 2).

The time of intubation, the incidence of Uniblocker displacement, HR, MAP, SpO₂, P_{aw} in TLV and 30 minutes after OLV, the degree of pulmonary collapse, and the incidence of sore throat and hoarseness postoperative showed no statistical differences between the 2 groups ($P > .05$) (Tables 2 and 3).

4. Discussion

The most important finding of our study is that the novel technique of extraluminal use of the Uniblocker may provide an easier and less bronchial injury method of achieving OLV in adult patients compared with conventional intraluminal use of the Uniblocker.

Since 1982, Inoue et al had introduced the Univent tube for OLV,^[15,16] and the use of bronchial blockers (BBs) for OLV has been increased. However, in the study by Campos and Kernstine,^[11] the time of initial tube placement for Univent bronchial blocker (UBB) took 158 seconds (from the tube past the vocal cords until satisfactory placement of the UBB). Narayanaswamy et al^[12] found that the intubation time (from beginning of laryngoscopy to lung isolation) for the Uniblocker was 213 seconds, which required an average of 110 seconds longer than that for the left-sided DLT. This may be due to the anatomical reason that the left mainstem bronchus continues at a bigger angle and slender than right one. The data of Patel et al's^[17] study suggested that the trachea does not merely branch in the horizontal plane, but branches posteriorly as well.

Table 1

Demographic characteristics of the patients in two groups.

| | Extraluminal (n=20) | Intraluminal (n=20) |
|---|------------------------|------------------------|
| Age (mean \pm SD, y) | 52.8 \pm 12.5 | 55.3 \pm 13.6 |
| ASA (n, I/II/III) | 10/8/2 | 8/11/1 |
| Sex (n, M/F) | 12/ 8 | 10/10 |
| Height (mean \pm SD, cm) | 166.1 \pm 5.9 | 163.8 \pm 7.2 |
| Weight (mean \pm SD, kg) | 61.3 \pm 13.5 | 57.9 \pm 15.3 |
| BMI (mean \pm SD, kg/m ²) | 24.8 \pm 2.0 | 23.7 \pm 1.7 |
| Surgery time (mean \pm SD, min) | 128.5 \pm 26.3 | 140.8 \pm 20.4 |
| OLV time (mean \pm SD, min) | 112.5 \pm 25.3 | 113.4 \pm 27.2 |

ASA=American Society of Anesthesiologists, BMI=body mass index, OLV=one-lung ventilation, SD=standard deviation.

Table 2

Comparison of the time to intubation of Uniblocker, time to correct positioning of Uniblocker, dislodgement of Uniblocker, sore throat, hoarseness, and degree of main bronchial injury.

| | Extraluminal (n=20) | Intraluminal (n=20) | P |
|---|------------------------|------------------------|------|
| Intubation time (mean \pm SD, s) | 45.3 \pm 18.4 | 40.8 \pm 14.3 | .39 |
| Correct positioning time (mean \pm SD, s) | 63.4 \pm 15.8 | 112.6 \pm 31.2 | <.01 |
| Uniblocker dislodgement (n, %) | 1 (5) | 2 (10) | 1.00 |
| Sore throat, % | 6 (30) | 5 (25) | 1.00 |
| Hoarseness, % | 4 (20) | 3 (15) | 1.00 |
| Degree of main bronchial injury | 2 (10) | 5 (25) | .41 |
| 1 | 1 (5) | 2 (10) | 1.00 |
| 2 | 1 (5) | 2 (10) | 1.00 |
| 3 | 0 (0) | 1 (5) | 1.00 |
| 4 | 0 (0) | 0 (0) | |

Degree of left main bronchial injury: 1=clear; 2=a few petechiae; 3=coalesced petechiae, hemorrhage, or ecchymosis; 4=erosion.

In our study, the time for the placement of Uniblocker in intraluminal use of group was 153 seconds (intubation time add correct positioning time), which was similar to previous study,^[11,12] whereas in extraluminal use of group, the time of placement of Uniblocker was 109 seconds (intubation time add correct positioning time), which was obviously shorter than that in I group. The reasons may be that the internal diameter of SLT commonly used is 8.0 to 8.5 mm for male and 7.0 to 7.5 mm for female, the outer diameter of Uniblocker for adult patients is 3 mm, and the outer diameter of FOB commonly used is 3 to 5 mm. In I group, both Uniblocker and FOB were needed to be inserted into the tracheal tube lumen, so there was not enough space for Uniblocker to push and twist, and when Uniblocker or FOB was pushed forward, they were influenced by each other. Furthermore, the direction of the SLT is forward, which also limited the rotation of the Uniblocker to the left mainstem bronchus. Whereas in E group, without the constraints of SLT and the influence of FOB, the Uniblocker can be pushed and twisted more freely. In addition, there are more sizes of endotracheal tube and FOB for anesthesiologists to choose for extraluminal use of the Uniblocker.

Table 3

Hemodynamic and respiratory data of the patients in 2 groups.

| | Extraluminal (n=20) | Intraluminal (n=20) | P |
|---------------------------------------|------------------------|------------------------|------|
| HR, beats/min | | | |
| TLV | 84.4 \pm 9.2 | 85.3 \pm 6.9 | .74 |
| OLV (30 min) | 86.1 \pm 7.4 | 87.4 \pm 8.7 | .61 |
| MAP, mm Hg | | | |
| TLV | 71.4 \pm 8.6 | 73.1 \pm 9.7 | .24 |
| OLV (30 min) | 68.9 \pm 8.5 | 71.2 \pm 8.7 | .12 |
| SpO ₂ (mean \pm SD, %) | | | |
| TLV | 99.6 \pm 1.0 | 99.2 \pm 1.6 | .16 |
| OLV (30 min) | 96.5 \pm 3.6 | 95.9 \pm 2.7 | .45 |
| P _{aw} , cm H ₂ O | | | |
| TLV | 17.8 \pm 2.2 | 18.2 \pm 2.9 | .62 |
| OLV (30 min) | 23.5 \pm 3.2 | 24.2 \pm 3.5 | .48 |
| Degree of pulmonary collapse (n, %) | | | |
| Excellent | 14 (70) | 12 (60) | .74 |
| Fair | 4 (20) | 5 (25) | 1.00 |
| Poor | 2 (10) | 3 (15) | 1.00 |

HR=heart rate, MAP=mean arterial pressure, OLV=one-lung ventilation, P_{aw}=peak airway pressure, SpO₂=oxygen saturation, TLV=two-lung ventilation.

Displacement of BBs is a familiar problem, which may result in failure of sufficiently collapse the lung and increases the risk of hypoxia during OLV.^[12] In the study by Campos and Kernstine,^[11] malposition after turning patients to a lateral position occurred in 1 of 16 cases using Univent bronchial blocker. In this study, malposition of Uniblocker after turning patients to a lateral position occurred in 1 of 20 cases in E group, and 2 of 20 cases in I group. There was no significant difference between the 2 groups. However, once displacement of Uniblocker occurs, it is harder to reposition in I group than in E group, especially in lateral positions. The main reason for this was also that the SLT and FOB limited the rotation of Uniblocker.

Sore throat and hoarseness postoperative are common complaints, especially after tracheal intubation.^[18] In E group, the Uniblocker outside the lumen of SLT may cause compression effect on the vocal cord. However, the result of our study demonstrated that the incidence of sore throat and hoarseness between the 2 groups had no significant differences. This may be related that the Uniblocker is very thin and the glottis is a narrow crack, so the compression caused by the Uniblocker may be very slightly. A study reported that the incidence of sore throat of patients in Univent bronchial blocker group was 30%,^[19] which similar to our findings (25%–30%). Indeed, regardless of which device is chosen, it is most important that the operators are familiar with the device.^[20] In this study, to reduce the bias by operators with different levels of experience, all intubations were performed by the same experienced anesthesiologist in thoracic anesthesia.

The grades of bronchial damage of patients in I group were more serious than that in E group. Although this result has no statistical significance, which may be due to the small sample size, we believe that there is a clinical significance. An explanation for this may be that in I group, the Uniblocker needed to be inserted more to correct the position or reposition than that in E group.

Shaolin et al^[21] reported that the combined use of a Proseal laryngeal mask and Coopdech bronchial blocker for OLV in adults can achieve OLV for thoracoscopic procedures. However, perilyngeal leakage and malposition of Proseal laryngeal mask often occur, especially when the patients are placed in the lateral position, so this method need more experienced anesthesiologists and may not be conducive to popularization and promotion.

There are several limitations in this study. First, the overall sample size was small. Second, it was not possible to blind investigator to the technique. So, we could not completely rule out the possibility of biases in investigator in the comparisons between the 2 groups. Third, we only recruited the left-side thoracic surgery. Therefore, our results may not apply to the right-side thoracic surgery.

5. Conclusions

Extraluminal use of the Uniblocker is an efficient, successful, and easy to use method to provide OLV for left thoracic surgery. It may be substituted for conventional intraluminal use of the Uniblocker under emergency situations.

References

- [1] Drevet G, Ugalde FP. Uniportal video-assisted thoracoscopic surgery: safety, efficacy and learning curve during the first 250 cases in Quebec, Canada. *Ann Cardiothorac Surg* 2016;5:100–6.
- [2] Malik V, Jha AK, Kapoor PM. Anesthetic challenges in minimally invasive cardiac surgery: are we moving in a right direction? *Ann Cardiac Anaesth* 2016;19:489–97.
- [3] Dieberg G, Smart NA, King N. Minimally invasive cardiac surgery: a systematic review and meta-analysis. *Int J Cardiol* 2016;223:554–60.
- [4] Brodsky JB, Lemmens HJM. Left double-lumen tubes: clinical experience with 170 patients. *J Cardiothorac Vasc Anesth* 2003;17:289–98.
- [5] Shelley B, Macfie A, Kinsella J. Anesthesia for thoracic surgery: a survey of UK practice. *J Cardiothorac Vasc Anesth* 2011;25:1014–7.
- [6] Benumof JL. Difficult tubes and difficult airways. *J Cardiothorac Vasc Anesth* 1998;12:131–2.
- [7] Mourisse J, Liesveld J, Verhagen A, et al. Efficiency, efficacy and safety of EZ-blocker compared to left-sided double-lumen tube for one-lung ventilation. *Anesthesiology* 2013;118:550–61.
- [8] Knoll H, Ziegeler S, Schreiber JU, et al. Airway injuries after one lung ventilation: a comparison between double-lumen tube and endobronchial blocker: a randomized, prospective, controlled trial. *Anesthesiology* 2006;105:471–7.
- [9] Arndt GA, Kranner PW, Rusy DA, et al. Single-lung ventilation in a critically ill patient using a fiberoptically directed wire-guided endobronchial blocker. *Anesthesiology* 1999;90:1484–6.
- [10] Garcia-Aguado R, Mateo EM, Onrubia VJ, et al. Use of the Univent system tube for difficult intubation and for achieving one-lung anaesthesia. *Acta Anaesthesiol Scand* 1996;40:765–7.
- [11] Campos JH, Kernstine KH. A comparison of a left-sided bronchocath with the torque control blocker Univent and the Wire-Guided Blocker. *Anesth Analg* 2003;96:283–9.
- [12] Narayanaswamy M, McRae K, Slinger P, et al. Choosing a lung isolation device for thoracic surgery: a randomized trial of three bronchial blockers versus double-lumen tubes. *Anesth Analg* 2009;108:1097–101.
- [13] Bastien JL, O'Brien JG, Frantz FW. Extraluminal use of the Arndt pediatric endobronchial blocker in an infant: a case report. *Can J Anesth* 2006;2:159–61.
- [14] Templeton TW, Downard MG, Simpson CR, et al. Bending the rules: a novel approach to placement and retrospective experience with the 5 French Arndt endobronchial blocker in children <2 years. *Paediatr Anaesth* 2016;26:512–20.
- [15] Inoue H, Shohtsu A, Ogawa J, et al. New device for one-lung anesthesia: endotracheal tube with movable blocker. *J Thorac Cardiovasc Surg* 1982;83:940–1.
- [16] Campos JH. An update on bronchial blockers during lung separation techniques in adults. *Anesthesiology* 2003;97:1266–74.
- [17] Patel RV, Van Noord BA, Patel D, et al. Determination of the true inclination angle of the main bronchi relative to the median sagittal plane for placement of a left-sided double-lumen tube. *J Cardiothorac Vasc Anesth* 2016.
- [18] Lehmann M, Monte K, Barach P, et al. Postoperative patient complaints: a prospective interview study of 12,276 patients. *J Clin Anesth* 2010;22:13–21.
- [19] Zhong T, Wang W, Chen J, et al. Sore throat or hoarse voice with bronchial blockers or double-lumen tubes for lung isolation: a randomised, prospective trial. *Anaesth Intensive Care* 2009;37:441–6.
- [20] Campos JH, Hallam EA, Van NT, et al. Devices for lung isolation used by anesthesiologists with limited thoracic experience: comparison of double-lumen endotracheal tube, Univent torque control blocker, and Arndt wire-guided endobronchial blocker. *Anesthesiology* 2006;104:261–6.
- [21] Shaolin W, Jin Z, Hao C, et al. A clinical evaluation of the proseal laryngeal mask airway with a Coopdech bronchial blocker for one-lung ventilation in adults. *J Cardiothorac Vasc Anesth* 2014;28:912–5.