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*Original Article*

# Effectiveness of supraglottic ventilation by transtracheal catheter for painless ERCP

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**Abstract:** Purpose: This study aimed to investigate the effect of supraglottic ventilation via transtracheal catheter in painless endoscopic retrograde cholangiopancreatography (ERCP). Methods: Sixty patients with painless ERCP who were treated in our hospital were enrolled as the study subjects and divided into a study group (n=30) and a control group (n=30) according to the method of ventilation during the operation. The control group received ventilation via modified laryngeal mask, while the study group received supraglottic ventilation through a transtracheal tube. The mean arterial pressure (MAP), heart rate (HR), oxygen saturation ($SpO_2$), and End-tidal $CO_2$ ($EtCO_2$) at multiple time points after admission (T0), after induction of anesthesia (T1), immediately after catheter placement (T2), immediately after operation (T3), and at the time of resuscitation (T4) were compared between the two groups. The incidence of various adverse events in the perioperative period was also compared. Results: The two groups showed significant fluctuations in intraoperative hemodynamic parameters. However, the changes in MAP, $SpO_2$ and $ETCO_2$ of the study group were more stable, and better than those of the control group at the T2 and T3 ($P<0.05$). The intubation time, operation time and recovery time of patients in the study group were significantly lower than those in the control group ($P<0.05$). The total incidence of adverse events in the study group was significantly lower than that in the control group ($P<0.05$). Conclusion: It is highly feasible to apply supraglottic ventilation with transvalvular catheter in painless ERCP, which can significantly stabilize the perioperative hemodynamic parameters, accelerate recovery and also help decrease the rate of postoperative complications.

**Keywords:** Transtracheal catheter, supraglottic ventilation, painless ERCP, effectiveness

## Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is a procedure that allows the physician to see the pancreatic and bile ducts in the body, and displaying the pancreaticobiliary duct by injecting contrast agent [1]. Compared to traditional screening techniques, ERCP has the advantages of little trauma, short operative time, few complications, and short hospital stays [2, 3]. In recent years, ERCP has achieved good results in the treatment of many diseases (such as bile duct stones, cholangiocarcinoma, malignant bile duct obstruction, *etc*.), and it has become the main surgical method for pancreaticobiliary diseases [4, 5].

ERCP usually needs to be completed under propofol anesthesia. However, clinical practice has shown that ERCP can cause respiratory depression, which may affect the operation and the patient's safety. Therefore, adequate ventilation is important to ensure a smooth operation of ERCP [6, 7]. Supraglottic ventilation via transtracheal catheter is an emerging type of ventilation, and it is mostly used in laryngeal surgery or the treatment of unclear airways. A clinical study of 90 patients with laryngeal cancer indicated that this technique could ensure adequate intraoperative ventilation and oxygen saturation, and there was no significant difference in the postoperative resuscitation time compared with routine ventilation, suggesting the high feasibility of the technique [8, 9].

The purpose of this study was to establish a controlled analysis to explore the feasibility of supraglottic ventilation by transtracheal catheter for painless ERCP, so as to provide a clinical reference for improving the prognosis of patients undergoing painless ERCP.

## Materials and methods

### *General information*

Sixty patients who received painless ERCP from January 2018 to August 2020 were enrolled and divided into a study group (n=30) and a control group (n=30) according to the method of intraoperative ventilation. The control group received ventilation via a modified laryngeal mask, and the study group received supraglottic ventilation with a transtracheal catheter.

Inclusion criteria: (1) subjects between 18 and 80 years of age; (2) cardiac function: I-II; (3) American Society of Anesthesiologists (ASA): I-III; (4) patients with complete medical records; (5) patients with clear consciousness and who were able to cooperate with the research. The study was approved by the ethics committee of Yichun People's Hospital. All enrolled subjects signed the informed consent.

Exclusion criteria: (1) patients combined with psychiatric disorders; (2) patients with contraindications to nasal cannulation; (3) patients with $CO_2$ accumulation before operation; (4) patients with coagulation disorders; (5) patients with poor compliance with the procedures.

### *Intervention methods*

Patients in the study group fasted for 8 h and abstained from water for 2 h prior to the operation. After entering the operating room, venous access was established, and an electrocardiogram, blood pressure, blood oxygen, heart rate (HR), electroencephalography dual frequency index (BIS) and other indicators were monitored. The study group received supraglottic ventilation via a tracheal catheter. After induction of anesthesia, the catheter was placed in the patient's nostril. The cuff was used until the balloon was fully inflated. The ventilation was first manually controlled. When the patient's chest moved up and down, mechanical ventilation was given. After induction of anesthesia in the control group, a modified laryngeal mask was inserted and the anesthesia machine was connected to perform ventilation. The tidal volume in both groups was set at 8-10 ml/kg, the respiratory rate was set at 12-18 breaths/min, and the respiratory ratio was set at 1:2. Anesthesia was maintained with propofol and remifentanil during the operation in both groups, and the BIS was set at about 55±5 by the anesthesiologist according to the actual conditions.

### *Outcome measurement*

The mean arterial pressure (MAP), HR, oxygen saturation ($SpO_2$) and End-tidal $CO_2$ ($ETCO_2$) of the two groups were recorded at five time points: after admission (T0), after induction of anesthesia (T1), immediately after tube placement (T2), immediately after operation (T3) and at the time of resuscitation (T4), and inter- and intra-group comparisons were performed. The clinical indicators of the two groups, including intubation time (time from intubation/placement of mask to satisfactory ventilation), operation time (time from endoscope insertion to withdrawal), extubation time (time from resumption of spontaneous breathing to opening eyes in response to sound), awakening time (time from awakening time to being able to follow the physician's instructions to perform actions for >10 s), and $PaCO_2$. The differences between the two groups were compared. The incidence of perioperative adverse events (cardiac arrhythmias, blood pressure abnormalities, choking, reflux & misaspiration, and somatic reactions, *etc*.) was recorded in both groups.

### *Statistical analysis*

The collected data were entered into EXCEL and SPSS 22.0 statistical software was used for data analysis. A normal distribution test was carried out on the collected data, if the data conformed to a normal distribution, the count data were expressed as [n (%)], the Chi-square test was chosen for the analysis of the differences between groups, the measurement data were expressed as (mean ± standard deviation), the t-test was used for the analysis of the differences between groups, and the mean comparison test was used for the analysis of the differences between continuous variables. All figures were illustrated with GraphPad Prism 8. $P<0.05$ indicated a statistically significant difference [10].

## Results

### *Comparison of baseline data between the two groups*

The study group included 34 males and 26 females, with an average age of (40.19±2.22)

**Table 1.** Comparison of baseline data between the two groups ($\chi \pm SD$)/[n (%)]

| Baseline data | | Study group (n=30) | Control group (n=30) | $t/X^2$ | *P* |
|---|---|---|---|---|---|
| Gender | Male | 34 | 37 | 0.31 | 0.577 |
| | Female | 26 | 23 | | |
| Average age (years) | | 40.19±2.22 | 39.98±2.61 | 0.475 | 0.636 |
| Average body weight (kg) | | 65.19±3.41 | 65.23±3.39 | 0.064 | 0.949 |
| Average height (m) | | 1.69±0.43 | 1.71±0.39 | 0.267 | 0.79 |
| Surgical method | Endobronchial ultrasound-guided biopsy | 9 | 10 | 0.671 | 0.234 |
| | Bronchial thermoplasty | 11 | 11 | | |
| | Bronchial stent placement | 10 | 9 | | |
| ASA Classification | I | 14 | 20 | 0.711 | 0.187 |
| | II | 26 | 22 | | |
| | III | 20 | 18 | | |
| Hypertension | Yes | 9 | 10 | 0.063 | 0.803 |
| | No | 51 | 50 | | |
| Diabetes | Yes | 15 | 16 | 0.043 | 0.835 |
| | No | 45 | 44 | | |

**Table 2.** Analysis of perioperative MAP changes in both groups ($X \pm SD$) (mmHg)

| Group | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Study group (n=30) | 100.28±12.21 | 90.34±11.21 | 93.89±14.32 | 85.98±12.31 | 97.28±16.58 |
| Control group (n=30) | 98.98±13.29 | 89.98±12.01 | 86.19±13.21 | 78.29±11.29 | 98.18±15.98 |
| *t* | 0.558 | 0.17 | 3.061 | 3.566 | 0.303 |
| *P* | 0.578 | 0.865 | 0.003 | 0.001 | 0.762 |

**Table 3.** Analysis of perioperative HR changes in both groups ($X \pm SD$) (times/min)

| Group | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Study group (n=30) | 79.18±14.33 | 73.29±13.22 | 74.18±10.29 | 84.39±9.98 | 88.28±10.29 |
| Control group (n=30) | 78.98±15.10 | 74.10±12.89 | 70.18±11.29 | 76.18±10.29 | 90.21±9.87 |
| *t* | 0.074 | 0.34 | 2.028 | 4.436 | 1.048 |
| *P* | 0.941 | 0.734 | 0.045 | <0.001 | 0.297 |

years, average body weight of (65.19±3.41) kg, and average height of (1.69±0.43) m, while the control group included 37 males and 23 females, with an average age of (39.98±2.61) years, average body weight of (65.23±3.39) kg, and average height of (1.71±0.39) m. The two groups were comparable in clinical data such as gender, age, body mass, height, ASA classification, and education level ($P>0.05$) (**Table 1**).

*Analysis of changes in perioperative hemodynamic parameters*

In terms of MAP and HR, both groups showed a trend of decrease and then increase, and intergroup comparisons showed that at T2 and T3, the MAP and HR of the study group were significantly higher than those of the control group ($P<0.05$) (**Tables 2** and **3**). The changes of MAP and HR in the study group were significantly smaller than those of the control group (**Figure 1A**, **1B**). For $SpO_2$ and $ETCO_2$, both groups showed a trend of increase and then decrease, and at T2 and T3, both $SpO_2$ and $ETCO_2$ of the study group were higher than those of the control group ($P<0.05$) (**Tables 4** and **5**), and the change of $SpO_2$ in the study group was smaller than that in the control group, and the change of $ETCO_2$ was larger than that in the control group (**Figure 1C**, **1D**).

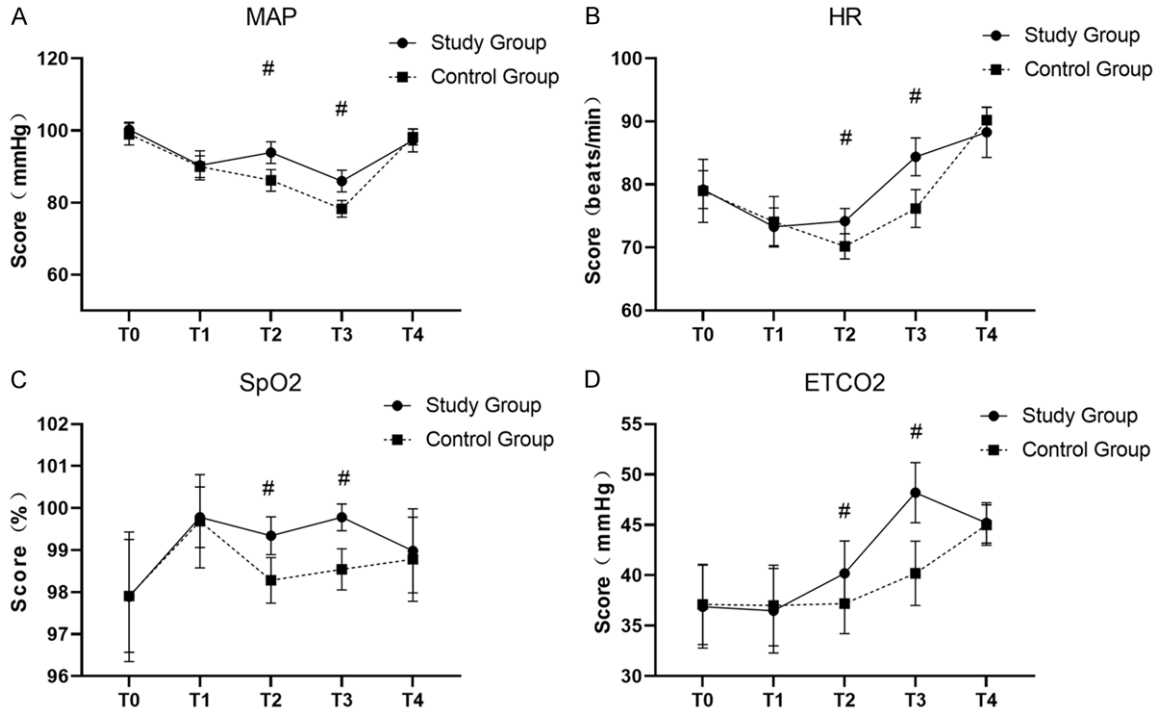


**Figure 1.** Changes in perioperative hemodynamic parameters in the two groups. At both T2 and T3, MAP (A), HR (B), $SpO_2$ (C) and $ETCO_2$ (D) in the study group were higher than those in the control group ($P<0.05$). #$P<0.05$.

**Table 4.** Analysis of perioperative $SpO_2$ changes in both groups ($X \pm SD$) (%)

| Group | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Study group (n=30) | 97.89±1.54 | 99.78±0.72 | 99.34±0.45 | 99.78±0.32 | 98.98±1.98 |
| Control group (n=30) | 97.91±1.34 | 99.69±1.11 | 98.28±0.54 | 98.54±0.49 | 98.78±1.27 |
| *t* | 0.076 | 0.527 | 11.681 | 16.412 | 0.659 |
| *P* | 0.94 | 0.599 | <0.001 | <0.001 | 0.511 |

**Table 5.** Analysis of perioperative $ETCO_2$ changes in both groups ($X \pm SD$) (mmHg)

| Grouping | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Study group (n=30) | 36.89±4.11 | 36.49±4.19 | 40.19±3.21 | 48.19±2.98 | 45.19±5.87 |
| Control group (n=30) | 37.12±3.98 | 37.01±4.01 | 37.19±2.98 | 40.19±3.19 | 44.98±5.98 |
| *t* | 0.311 | 0.695 | 5.305 | 14.195 | 0.194 |
| *P* | 0.756 | 0.488 | <0.001 | <0.001 | 0.847 |

*Comparison of the differences in general medical indicators and incidence of adverse events*

The intubation time, operation time and resuscitation time of patients in the study group were significantly lower than those of patients in the control group ($P<0.05$), and the other indicators showed no significant difference between the two groups ($P>0.05$) (**Figure 2**). There was 1 case of reflux and misaspiration in the study group, with an incidence rate of 1.67%, while there was 2 cases of cardiac arrhythmia, 3 cases of bucking, 2 cases of reflux and misaspiration, and 2 cases of somatic response, with an incidence rate of 15.00%. The difference in the incidence of adverse events was significant between the two groups ($P<0.05$) (**Table 6**).

## Discussion

ERCP is a comprehensive diagnosis and treatment technique guided by X-ray, which has a good therapeutic effect on a variety of pancre-

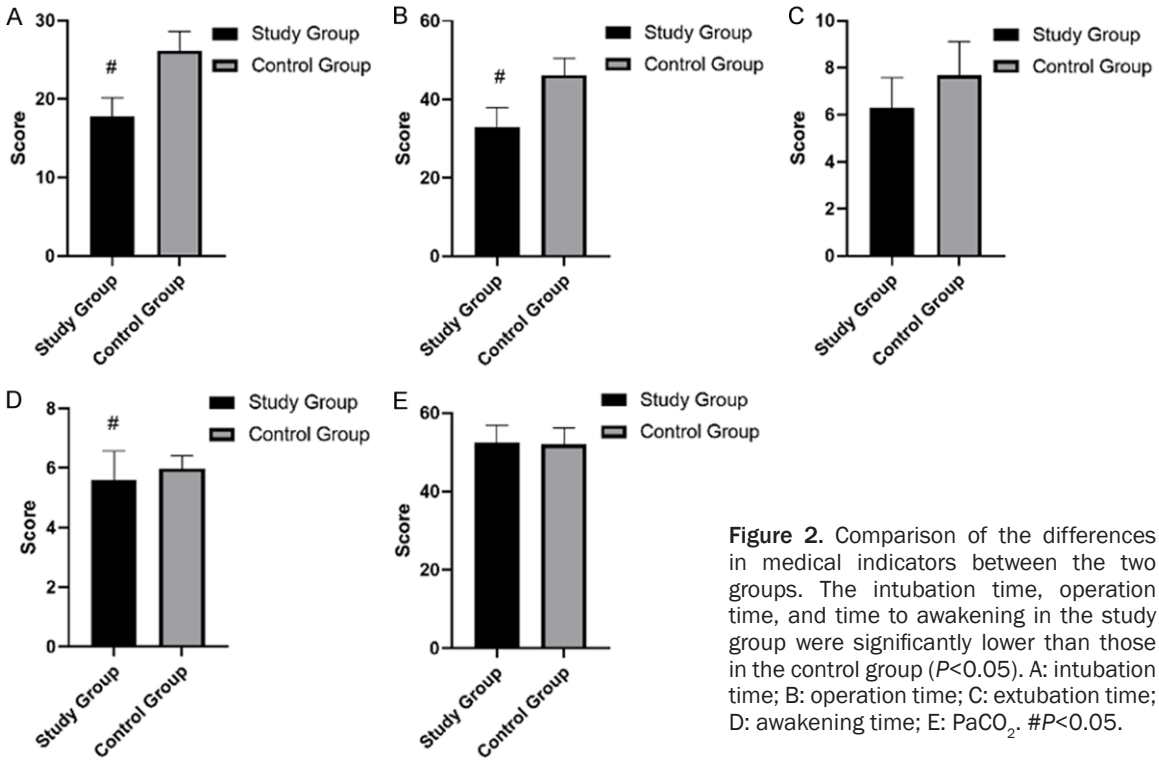


**Figure 2.** Comparison of the differences in medical indicators between the two groups. The intubation time, operation time, and time to awakening in the study group were significantly lower than those in the control group ($P$<0.05). A: intubation time; B: operation time; C: extubation time; D: awakening time; E: $PaCO_2$. #$P$<0.05.

**Table 6.** Comparison of the difference in the incidence of adverse events between the two groups [n (%)]

| Group | Cardiac arrhythmia | Bucking | Reflux and misaspiration | Somatic response | Total incidence rate |
|---|---|---|---|---|---|
| Study group (n=30) | 0 (0.00) | 0 (0.00) | 1 (1.67) | 0 (0.00) | 1 (1.67) |
| Control group (n=30) | 2 (3.33) | 3 (5.00) | 2 (3.33) | 2 (3.33) | 9 (15.00) |
| *t* | - | - | - | - | 6.982 |
| *P* | - | - | - | - | 0.008 |

atic and biliary conditions, and is currently widely used in clinical practice [11]. Evidence has shown that ERCP requires the insertion of duodenoscope under local anesthesia or intravenous anesthesia. During the operation, patients often have foreign body sensation, and at present, propofol combined with sufentanil is commonly used to alleviate or inhibit the adverse reactions [12, 13]. However, some scholars have found that propofol has significant effects of blood vessel dilation, inhibiting the vasomotor center and respiratory center, and the endoscope will occupy the patient's mouth, making it more difficult for anesthesiologists to control breathing. Therefore, it is necessary to find a safe and effective ventilation method to alleviate the patient's respiratory depression and improve the surgical effect [14-16].

In this study, we investigated the effect of supraglottic ventilation in painless ERCP by setting up different subgroups, and the results showed that perioperative hemodynamic parameters of patients in the study group with supraglottic ventilation were significantly better than those in the control group with modified mask ventilation. During the period from induction of anesthesia to patient awakening, the MAP and HR of the patients in the study group were more stable, with small changes in amplitude, while the $SpO_2$ increased more rapidly and remained basically unchanged intraoperatively. A study of 80 patients undergoing painless bronchoscopy revealed that intraoperative MAP and HR of patients in the observation group with supraglottic ventilation were significantly lower than those of patients in the control group undergoing spontaneous breathing

during surgery, and scholars conclud that MAP and HR can reflect the hemodynamic stability, indicating that supraglottic ventilation would not cause significant irritation to the patient [17]. We used MAP, HR, $SpO_2$ and other indicators as perioperative vital signs. MAP, HR, $SpO_2$ and $ETCO_2$ in the study group were higher than those in the control group at T2 and T3. Higher levels of $SpO_2$ indicated that patients in the study group had higher intraoperative oxygen saturation, suggesting a lower risk of ischemia [18]. However, the MAP and HR levels in the study group were higher than those in the control group, which was not consistent with other studies. In fact, the MAP and HR of the study group have been maintained at a high level during the T0-T4, with no significant changes during the observation period. However, the changes of MAP and HR were significantly greater in the control group [19]. Studies have pointed out that large changes in hemodynamic indicators should be minimized in patients during the perioperative period, because drastic changes may induce cardiovascular and cerebrovascular accidents and other severe complications, especially in elderly patients combined with cardiovascular diseases that have low cardiopulmonary function reserve, and high intensity stimulation is likely to induce adverse events [20-22].

It was also found that the intubation time, operative time, and time to resuscitation in the study group were significantly shorter than those in the control group, suggesting that the overall perioperative period was shorter in the study group. A controlled study of painless fiberoptic bronchoscopy has indicated that supraglottic ventilation via a tracheal catheter can facilitate lung gas exchange, which is similar to tracheal intubation but the operation is simpler and can achieve better ventilation [23]. It was revealed that although the mask ventilation produced a positive effect on ventilation, the characteristics of the mask itself as well as the patient's own factors could affect mask placement, reduce the success rate of primary intubation, and may even affect endoscopic placement intraoperatively [24]. Clinically, relevant studies have pointed out that supraglottic ventilation via a tracheal tube has the advantages of low ventilation resistance, low incidence of lung barotrauma, easy treatment of emergencies, etc., and the depth and position of insertion can be adjusted before placement of ERCP endoscope, so that the intubation time and operation time are shorter [25, 26]. The incidence of adverse events in the two groups reflected the differences in $SpO_2$ levels between the two groups, suggesting that supraglottic ventilation could reduce the incidence of complications during intubation, with high safety.

In conclusion, it is highly feasible to apply supraglottic ventilation via a transtracheal catheter to painless ERCP, which can significantly stabilize the hemodynamic parameters, accelerate the perioperative process of patients, and help reduce the incidence of postoperative complications. There are some shortcomings in this study. The sample size of patients enrolled is small. Besides, we did not analyze whether the underlying disease would affect the results of the study, and the reasons for the higher postoperative $PaCO_2$ levels in the two groups were not explored in detail, which will be revised and improved in the next study.

## Disclosure of conflict of interest

None.

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