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Original Article

Differential lung ventilation versus continuous positive airway pressure to improve oxygenation during one lung ventilation in thoracoscopic sympathectomy

Anesthesia

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ABSTRACT

Background: One lung ventilation (OLV) offers the optimal surgical field exposure in thoracoscopic sympathectomy. Nevertheless, insufficient gas exchange and hypoxemia are frequent issues during OLV.

Objective: To investigate the impact of employing differential lung ventilation (DLV) or continuous positive airway pressure (CPAP) on peripheral oxygen saturation during OLV in thoracoscopic sympathectomy.

Methodology: This prospective, randomized controlled clinical study enrolled 60 patients scheduled for elective thoracoscopic sympathectomy. Patients were randomly assigned to one of three groups; Group A (OLV) (control group) the lung in the operated side will remain opened to atmosphere, Group B (OLV + CPAP group) the lung in the operated side will be connected to CPAP will be set to 5 cmH_2O. and Group C (OLV + DLV group) the lung in the operated side will be connected to a small portable ventilator that will be set at a rate of 8breaths per minute, inspired gas 100%oxygen, peak pressure and tidal volume will be set to the lowest available values to result in a peak pressure of 10 cmH_2O and a tidal volume around 100ml.

Results: Oxygen saturation showed a significant difference among the groups after 10min from establishing OLV with the highest peripheral arterial oxygen saturation (SpO_2) in group C followed by group B then group A but no significant difference among groups in SpO_2 at initiation of OLV and after reestablishing two lung ventilation. Also, highest grades of surgeon satisfaction were noticed in group B followed by group C then group A (p= 0.008). No significant difference was noted among the groups, with respect to airway pressures, hemodynamic parameters, and postoperative complications**.**

Conclusion: Differential lung ventilation showed superior efficacy on maintaining peripheral oxygen saturation during OLV in thoracoscopic sympathectomy compared to CPAP, but CPAP showed better surgeon preference over DLV. Both DLV and CPAP can be used safely and effectively without significant hemodynamic alterations.

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INTRODUCTION

Thoracoscopic sympathectomy is a globally recognized procedure for primary palmar hyperhidrosis. General anesthesia with one lung ventilation (OLV) is considered the most suitable method for thoracoscopic sympathectomy. This technique typically offers the optimal surgical operating field exposure, particularly in cases where a bilateral treatment is required [1] [2]. Gas exchange deficiency is a frequent issue during OLV, which has a detrimental impact on morbidity and mortality. When one lung is ventilated, a trans-pulmonary shunt is emerged by bypass the non-ventilated lung, leading to hypoxemia [3] [4]. Oxygen administration to the non-ventilated lung is mostly utilized for the treatment of hypoxemia during OLV, but it can also be employed as a preventive measure [5] [6]. Various methods are employed to improve hypoxemia, including the utilization of continuous positive airway pressure (CPAP) on the non-ventilated lung. CPAP was determined to be highly successful in enhancing oxygenation during OLV [7] [8]. A further method involves using a minimal ventilation parameter to ventilate the lung of the operated side, resulting in differential lung ventilation (DLV). DLV is a method used to manage lung illnesses that affect only one side or are unevenly distributed [9] [10]. DLV enables the ventilation of both lungs with different ventilator configurations in order to enhance oxygenation [11]. The aim of this study was to investigate the impact of employing DLV or CPAP on peripheral oxygen saturation during OLV in thoracoscopic sympathectomy.

PATIENT AND METHODS

This prospective, randomized, controlled study was carried out at Al-Zahraa University Hospital from October 2021 till November 2023. The study was done after approval of Research ethics committee in Al-Azhar University. Every participant received a detailed explanation of the study's objectives, procedures, and potential risks. Prior to any procedures, explicit written agreement was obtained from the patients themselves after being fully informed or from their parents in the case of patients under the age of 21.

This study enrolled 60 patients, aged between 16 and 45 years, with American Society of Anesthesiologists (ASA) physical status I, II of both sexes, and scheduled for elective thoracoscopic sympathectomy. The exclusion criteria included patient refusal, a medical history of respiratory disease such as chronic obstructive pulmonary disease (COPD), patients with known cardiac, renal, or hepatic disease, pregnancy, probable difficulty in intubation, and intraoperative hypoxemia if the SpO_2 level dropped below 85%.

On arrival to operating room and after standard monitoring, all patients received a premedication of midazolam intravenously at a dosage of 0.02 mg/kg. Anesthesia was administered using fentanyl at a dose of 1 μg/kg, propofol at a dose of 2 mg/kg, and rocuronium at a dose of 0.5 mg/kg intravenously. A rigid laryngoscope equipped with a curved Macintosh blade was employed to obtain a clear view of the larynx. Subsequently, a left-sided double lumen tube (DLT) (Shiley. Covidien limited IDA Business & Technology Park Tullamore, Irland), was used to intubate the trachea. The appropriate tube size for females was 35-39 F, while for males it was 39-41 F. Then the tracheal cuff was inflated with 5-10mL of air, and bilateral breath sounds were confirmed using auscultation. Next, the bronchial cuff was inflated with 3-5 ml of air. Additionally, the tracheal lumen was clamped. Subsequently, it was verified that only unilateral left-sided breath sounds were detected during auscultation, indicating that the bronchial opening is correctly positioned in the left bronchus. If breath sounds are still audible on the right side, it suggests that the bronchial aperture is still located in the trachea and the tube should be further inserted. Next, the tracheal lumen was unclamped and the bronchial lumen was clamped. Confirmation was obtained with auscultation of breath sounds exclusively on the right side. Subsequently, the positioning of the DLT was verified by fiberoptic bronchoscopy.

Volume-controlled ventilation was the favored method of ventilation, with a tidal volume was set to be 6- 8 ml/kg during two-lung ventilation (TLV), and 4-6 ml/kg during OLV. The ventilating rate was modified to ensure that $PaCO_2$ levels remained within 35-45 mmHg. The initial respiratory rate within TLV was regulated at 10-12 breaths per minute, and subsequently escalated to 12-15 breaths per minute during OLV. In addition, the level of oxygen concentration was consistently maintained at 100% during the entire treatment. All patients were situated in a supine position for the surgical procedure.

During the start of OLV, patients were assigned randomly to one of three groups using a closed opaque envelope method. The lung of the operated side was treated based on the group assignment. Group A (control group) (OLV group) where the lung on the operated side was exposed to the atmosphere. Group B (OLV+ CPAP group) involved connecting the lung on the operated side to a CPAP system set at 5 cm H_2O.

Group C, consisting of patients in the OLV+ DLV group, had their operated lung connected to a portable ventilator. The ventilator was programmed to deliver a tidal volume around 100 ml, and peak pressure not exceeding10 cm H_2O, FiO2 100%, with respiratory rate 8 bpm.

Following the surgical procedure, the collapsed lung was reinflated using direct visualization. Once the patient's respiratory function improved sufficiently, the remaining effects of the muscle relaxant were counteracted by administering neostigmine (0.05mg/kg) intravenously, along with atropine (0.01mg/kg) intravenously. The patient's endotracheal tube was removed after complete restoration of upper airway reflexes and satisfactory muscle strength.

The primary outcome was assessment of incidence of hypoxia by measuring peripheral arterial oxygen saturation between three groups. Secondary outcomes included hemodynamics (HR, MAP), airway pressures, postoperative complications, and surgeon satisfaction.

Sample size calculation was based on mean difference increased oxygenation between differential lung ventilation versus CPAP in one lung ventilation retrieved from previous research (Kremer et al., 2019). Using G*power version 3.0.10 to calculate sample size based t test, 2-tailed , α error =0.05 and power = 80.0% , effect size 0.915, the total calculated sample size was 20 in each group (total 60) (20 in each group).

Statistical analysis

The recorded outcomes were analyzed utilizing SPSS version 23.0, a statistical software designed for social sciences by SPSS Inc. in Chicago, Illinois, USA. The quantitative data was revealed employing the mean ±standard deviation, and ranges for variables that exhibited a parametric (normal) distribution. Variables that deviated from a normal distribution were identified using the median and inter-quartile range (IQR). Furthermore, qualitative features are expressed quantitatively by numerical values and percentages. The Independent-samples t-test is used to contrast the means of two parametric variables, whereas One Way ANOVA test is appropriate for comparing more than two variables. The Chi-square test was employed to contrast groups with categorical data. A 95% confidence interval was established with a corresponding margin of error of 5%. P-value < 0.05 deemed significant.

RESULTS

There was no significant disparity in age, sex, American Society of Anesthesiologists (ASA) physical status, weight, height, BMI, and duration of surgery, as shown in table (1).

Changes in the airway pressures

No significant difference was noted among the groups, with respect to peak airway pressure, plateau pressure, and mean airway pressure at (T1) baseline, at (T2) after 10 min from establishing OLV, and (T3) after establishment of TLV, as shown in table (2).

Hemodynamic parameters

There was no significant distinction in HR among the three groups when assessed during TLV using before initiation of OLV as a baseline (T1), after 10 min from establishing OLV (T2), and after reestablishing TLV (T3) as shown in table (3). Similarly, no significant distinction was obtained in MAP between the three groups when recorded during TLV before initiation of OLV as a baseline (T1), after 10 min from establishing OLV (T2), and after reestablishing TLV (T3), as shown in table (4).

Table (1): Comparison between groups regarding demographic data

Demographic data	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value
Age (years)	20.85 ± 6.35	20.25± 6.15	21.80 ± 5.94	F=.323	0.725
Sex:					
- Male	17(85)	16(80)	18(90)	X^2= 0.784	0.676
- Female	3(15)	4(20)	2(10)		
ASA physical status:					
- I	12 (60%)	10 (50%)	8 (40%)	X^2= 0.1.6	0.449
- II	8 (40%)	10 (50%)	12 (60%)		
Weight (kg)	79.10 ± 7.24	78.50 ±5.52	78.65 ±6.05	F=0.049	0.952
Height (cm)	179.65 ±4.49	179.35 ±3.86	178.80 ± 4.69	F=0.195	0.823
BMI (Kg/m²)	23.63 ± 2.12	23.44 ± 1.31	23.95 ± 1.32	F=0.502	0.608
Duration (min)	51.0±6.89	51.70±4.57	55.35±9.87	F=1.97	0.148

ASA: American Society of Anesthesiologists, BMI: Body mass index, F: One Way ANOVA, X: Chi Square test

Table (2): Comparison between groups regarding airway pressures cmH$_2$O

Airway pressures		Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value
Peak inspiratory pressure (PIP)	**T1**	14.95±2.65	14.35±2.39	13.50±2.72	F=1.58	0.214
	T2	21.70±3.59	20.10±3.65	20.45±2.76	F=1.25	0.294
	T3	15.9±2.26	15.0±1.97	14.50±2.65	F=1.88	0.162
Mean airway pressure	**T1**	5.25±1.45	5.80±1.58	5.90±0.91	F=1.36	0.265
	T2	6.85±1.38	7.0±1.49	7.35±1.04	F=0.757	0.474
	T3	5.85±0.88	6.35±1.66	6.20±0.95	F=0.96	0.508
Plateau pressure	**T1**	6.30±2.75	7.40±2.92	8.0±2.32	F=1.47	0.135
	T2	17.45±2.31	18.65±2.58	19.25±2.59	F=1.93	0.076
	T3	8.40±2.50	9.55±2.78	9.80±2.35	F=1.48	0.189

F: One Way ANOVA, T1: During two-lung ventilation using VCV before initiation of OLV (baseline), T2: After 10 min from establishing OLV, T3: After reestablishing two-lung ventilation.

Table (3): Comparison between the groups regarding heart rate

Heart Rate (HR) (beat/min)	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value
T1	88.20±7.76	90.05±4.40	87.40±7.68	F=0.202	0.455
T2	89.15±7.90	90.25±4.93	89.65±7.30	F=11.11	0.878
T3	85.95±7.78	88.75±4.20	85.35±6.71	F=2.14	0.26

F: One Way ANOVA, T1: During two-lung ventilation using VCV before initiation of OLV (baseline), T2: After 10 min from establishing OLV, T3: After reestablishing two-lung ventilation.

Peripheral arterial oxygen saturation (SpO_2)

Regarding measurement of SpO_2 there was no significant distinction between the three groups at (T1) baseline, and (T3) after reestablishing TLV, but significant disparity appeared at (T2) after 10 min from establishing OLV with the highest SpO_2 values in group C followed by group B then group A, as shown figure (1), and table (5).

Surgeon satisfaction

Surgeon satisfaction was evaluated by surgeon postoperatively, and statistical data showed significant distinction among the groups with highest grades of satisfaction in group B followed by group C then group A (p= 0.008) as shown in table (6).

Postoperative complications

No significant distinction was found among the groups as regard postoperative complications (hemothorax, pneumothorax, surgical emphysema, postoperative hypoxemia) as shown in table (7).

Table (4): Comparison between the groups regarding mean arterial blood pressure

Mean arterial blood pressure (MAP) (mmHg)	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value
T1	69.30±4.31	69.50±4.81	69.80±4.21	F=0.064	0.938
T2	74.05±4.09	74.90±5.56	75.10±3.71	F=0.303	0.740
T3	71.30±3.89	71.9±4.62	71.60±3.93	F=0.104	0.901

F: One Way ANOVA, T1: During two-lung ventilation using VCV before initiation of OLV (baseline), T2: After 10 min from establishing OLV, T3: After reestablishing two-lung ventilation.

Table (5): Comparison between the groups regarding SpO_2 measurement

Peripheral arterial oxygen saturation (SpO_2)	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value	
T1	98.5±0.61	98.50±0.51	98.40±0.59	F=0.202	0.818	P1=1.0 P2=0.584 P3=0.584
T2	91.20±2.15	92.96±2.79	95.95±2.04	F=11.11	<0.001*	P1=0.03* P2=0.001* P3=0.001*
T3	96.80±2.19	97.30±2.11	98.25±0.79	F=2.14	0.16	P1=0.387 P2=0.103 P3=0.103

F: One Way ANOVA, T1: During two-lung ventilation using VCV before initiation of OLV (baseline), T2: After 10 min from establishing OLV, T3: After reestablishing two-lung ventilation, P1: group A vs. Group B, P2: group A vs. Group C. P3: group B vs. group C, *: Significant p-value (<0.05).

Table (6): Comparison between groups regarding surgeon satisfaction

Grade of surgeon satisfaction N (%)	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value	
Excellent	8(40.0%)	19(95.0%)	13(65.0%)	X^2= 18.8	0.008*	P1=0.008* P2=0.05* P3=0.05*
Good	5(25.0%)	1 (5.0%)	6(30.0%)			
Fair	7(35.0%)	0 (0.0%)	1(5.0%)			

T1: During two-lung ventilation using VCV before initiation of OLV (baseline), T2: After 10 min from establishing OLV, T3: After reestablishing two-lung ventilation, X^2: Chi Square test, *: Significant p-value (<0.05).

Table (7): Comparison between the groups regarding postoperative complications

Postoperative complications	Group A n=20	Group B n=20	Group C n=20	Stat. test	p-value
Hemothorax	0(0.0%)	1(5.0)	1(5.0)	X^{2MC}=1.03	0.596
Pneumothorax	0(0.0%)	0(0.0%)	1(5.0)	X^{2MC}=2.03	0.362
Surgical emphysema	1(10.0)	1(5.0)	2(10.0)	X^{2MC}=0.436	0.804
Postoperative hypoxemia	3(15.0)	2(10.0)	0(0.0%)	X^{2MC}=3.06	0.217

X^2: Chi Square test

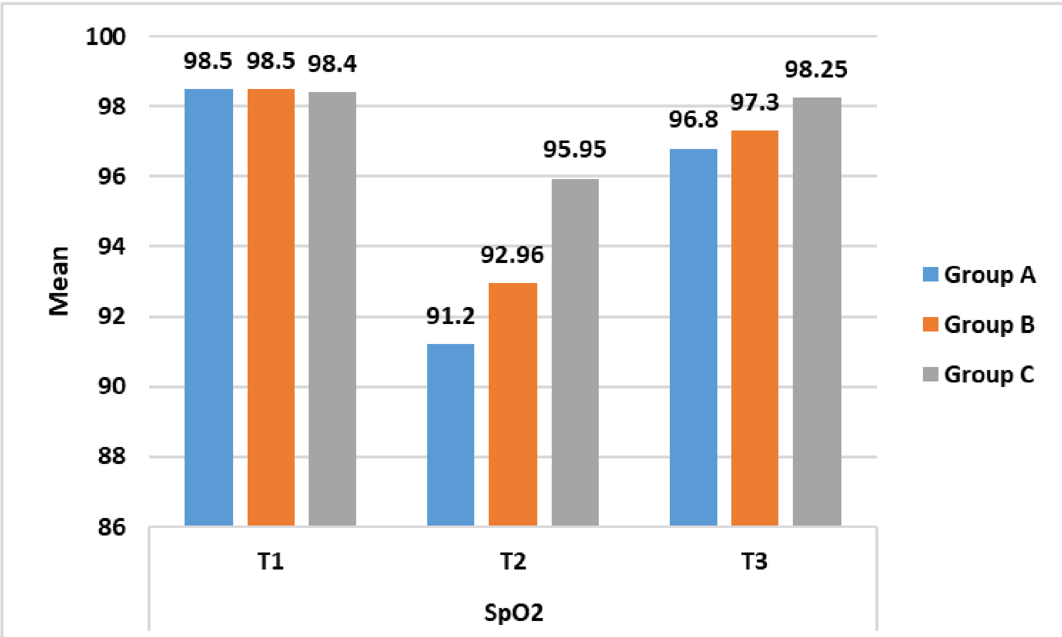

Figure (1): Comparison between the groups regarding SpO_2

DISCUSSION

The current study revealed a statistically significant disparity in SpO_2 levels during OLV at (T2), with group C exhibiting the highest SpO_2 values, followed by group B then group A. Nevertheless, no significant disparity was observed between the three groups at the baseline (T1) or after reestablishing TLV (T3). The data was inconsistent with Kremer et al. [4], who conducted a prospective research involving 30 patients, undergoing elective video-assisted thoracoscopic lobectomy. They contrasted the administration of the non-dependent lung with CPAP (5 cmH_2O) versus DLV (RR=8 bpm, and TV=50 ml). The study concluded that DLV is more effective than CPAP in enhancing patient's oxygenation during OLV and can be utilized in cases where CPAP was unsuccessful.

Consistent with our findings, Shechtman et al. [12] contrasted the administration of DLV with CPAP to the non-dependent lung, and revealed a considerable boost in arterial oxygen partial pressure during DLV rather than CPAP. Furthermore, our findings go in line with Chigurupati et al. [13], who studied effectiveness of applying mini-ventilation (DLV) to NDL by a separate ventilator give tidal volume 70 ml with FiO2 of 1 ,I:E ratio1:10 and respiratory rate 6/min on 30 patient undergoing elective open thoracotomy aiming to improve oxygenation and determined that intermittent positive pressure ventilation with a limited tidal volume is an efficient method for enhancing arterial oxygenation during OLV without hindering surgical access during elective open thoracotomy.

Tojo et al. [14] proposed a theoretical explanation for the superior performance of DLV. They suggested that by ventilating both lungs with equal pressure, similar to using CPAP, the fresh gas flow advances towards the parts of the lung with lower impedance. Nevertheless, regions characterized by elevated impedance, such as atelectatic regions, are not adequately ventilated. This further worsens gas exchange. Nevertheless, individually ventilating different sections of the lung with varying pressures is more in line with the body's natural processes, compared to employing CPAP. This approach assists in pushing air into collapsed areas of the lung, reducing V/Q mismatch and enhancing oxygenation.

This study found no significant variation in airway pressures, including peak airway pressure, plateau pressure, and mean airway pressure, among the groups at baseline (T1), during OLV (T2), and after the establishment of TLV (T3). These observations are in accordance with the research conducted by Kremer et al.[4], which concluded that there was no significant difference observed in peak and plateau pressures during OLV, OLV + CPAP, or OLV + DLV. In consistent with our research, Shechtman et al., [12] contrasted the administration of DLV with CPAP to the non-dependent lung, and revealed non-significant changes in neither dynamic compliance nor peak inspiratory pressure among the groups.

Regarding hemodynamic data, no significant distinction was detected in HR and MAP among the three groups at baseline (T1), during OLV (T2), and after reestablishing TLV (T3). These findings comply with the study conducted by Abe et al. [15], which examined twenty-five patients undergoing excision of a descending aortic aneurysm. This study focused on the assessment of the impact of high-frequency jet ventilation (HFJV) as a method of (DLV) and compare it to continuous positive airway pressure (CPAP). They proved that there were no alterations in the average HR and MAP among the two groups under investigation.

This study illustrated that surgeon satisfaction about surgical field showed significant difference between the three groups with highest grades of satisfaction in group B followed by group C then group A. These observations are in parallel to study conducted by Shechtman et al. [12], which compared the use of CPAP at a pressure of 5 cmH_2O to mini-ventilation (DLV) using a portable ventilator with a respiratory rate of 8 breaths per minute and a tidal volume of 100 to 150 ml.

The study reported that surgeons showed a greater preference for CPAP over DLV, which can be attributed to the better visibility of the surgical field attained with CPAP over DLV. Indeed, researchers demonstrated that mini-ventilation of the non-dependent lung is more efficient than CPAP in improving oxygenation during lung resection. Even though it can minimize clarity in the surgical area. Consequently, DLV is best utilized when CPAP fails to alleviate hypoxemia. In agreement with our study, Chigurupati et al. [13], revealed that the effectiveness of using mini-ventilation (DLV) on non-dependent lungs was examined. This was done by providing a separate ventilator that delivered a tidal volume of 70 ml with a FiO2 of 1, and I: E ratio of 1:10, and a respiratory rate of 6/min. The study included 30 patients who were undergoing elective open thoracotomy, with the goal of enhancing oxygenation. The researchers determined that surgeons reported high levels of satisfaction while using DLV over conventional method of OLV, as this technique did not impede surgical access and can be used as an option to address hypoxemia during OLV. In harmony with our findings, Kremer et al. [4] discovered a significant level of satisfaction in using both CPAP and DLV

The current study highlighted non-significant disparity among the three groups in terms of postoperative complications, including hemothorax, pneumothorax, surgical emphysema, and postoperative hypoxemia. This finding was consistent with the study conducted by El-Tahan et al. [16], which examined 75 patients who were scheduled for elective thoracotomy and evaluated the effects of administering CPAP versus HFJV. The study revealed the absence of any respiratory or cardiovascular complications, postoperative oxygen deficiency, pneumonia, or the necessity for further surgery or thoracotomy. Supporting, Tojo et al. [14], indicated diminished extravascular fluid shift and limited cytokine response with the utilization of CPAP to the non-dependent lung during OLV. Consequently, lung injury subsequent to OLV can be avoided with CPAP utilization.

There is paucity of data, investigating the role of DLV in thoracoscopic surgeries. Consequently, further high quality, well-organized randomized controlled trials should be conducted to boost our evidence.

CONCLUSION

Differential lung ventilation showed superior efficacy on maintaining peripheral oxygen saturation during OLV in thoracoscopic sympathectomy compared to CPAP, but CPAP showed better surgeon preference over DLV. Both DLV and CPAP can be used safely and effectively without significant hemodynamic alterations or complication.

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الملخص العربي

التهوية التباينية للرئتين مقابل الضغط الايجابي المستمر بمجرى الهواء لتحسين نسبة الأوكسجين بالدم أثناء تقنية تهوية رئة واحدة لعملية قطع العصب السمباثاوي الصدري بالمنظار

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ملخص البحث:

الخلفية: ان استخدام تقنية تهوية رئه واحده في عملية قطع العصب السمباثاوي الصدري بالمنظار ، يوفر مجالا جراحيا افضل للعميلة . ومع ذلك يحدث عجز في عملية تبادل الغازات و نقص الاوكسجين بالدم .

الهدف: التحرى عن تاثير استخدام التهويه التباينية للرئتين مقابل استخدام الضغط الايجابي المستمر للاوكسجين بمجري الهواء علي نسبة تشبع الاوكسجين في الشراين الطرفية للدم اثناء اجراء عملية قطع العصب السيمباثاوي الصدري بالمنظار باستخدام تقنية تهوية رئه

الطرق: اشتملت هذه الدراسة الاكلينكيه المنضبطه المستقبليه علي 60 مريض خضعوا للتخدير بتقنية تهوية رئه واحدة لاجراء عملية قطع العصب السمباثاوي الصدري بالمنظار لعلاج تعرق اليدين, وتم تقسيم المرضى عشوائيا على ثلاثة مجوعات:

- المجموعة الاولى : تم فيها تعريض الرئه الموجودة بالناحية التي يجري فيها العملية الي هواء الغرفة .
- المجموعة الثانية: تم فيها توصيل الرئه الموجودة بالناحية التي يجري فيها العملية الي نظام الضغط الايجابي المستمر للاوكسجين بمجري الهواء بمعدل ضغط يعادل 5 سم ماء .
- المجموعة الثالثة: تم فيها توصيل الرئه الموجودة بالناحية التي يجري فيها العملية الي جهاز تنفس صناعي صغير محمول وتم اعدادة علي ما يلي معدل تنفس: 8 انفاس /دقيقة نسبة الاوكسجين بهواء الشهيق 100% وحجم الهواء بالشهيق والزفيرحوالى 100مل لتر علي ان لا يتعدي اقصي ضغط بمجري الهواء عن 10 سم ماء .

النتائج: اظهرت الدراسة اختلافا احصائيا معتبرا بين المجموعات في تحسين نسبة تشبع الاكسجين بالدم بعد مرور 10 دقائق من البدء في تهوية رئه واحده مع وجود اعلى درجات تحسن لنسبة تشبع الاكسجين بالدم اثناء استخدام تقنية التهويه التباينيه للرئتين يتبعها في الأفضلية استخدام نظام الضغط الايجابي المستمر للأكسجين بمجري الهواء وكذلك وجدت الدراسة ان اعلى نسبة رضا للجراحين عن المجال الجراحى اثناء العملية مع استخدام نظام الضغط الايجابي المستمر للأكسجين بمجري الهواء ثم يليه نظام استخدام بتقنية التهويه التباينيه للرئتين كما وتبين عدم وجود اختلاف احصائى يذكر بين مجموعات الدراسة على كلا من قياس العلامات الحيوية (ضغط الدم – عدد ضربات القلب) وضغوطات مجرى الهواء ومضاعفات ما بعد الجراحة.

الاستنتاجات: اثبتت الدراسة افضليه اثناء استخدام كلا من تقنية التهويه التباينيه للرئتين وكذلك استخدام نظام الضغط الايجابي المستمر للأكسجين بمجري الهواء في تحسين نسبة تشبع الاكسجين بالدم اثناء عملية قطع العصب السيمباثاوى مع ظهور افضليه اعلي اثناء تقنية التهويه التباينيه بينما كانت هناك افضلية من قبل الجراحين بالنسبة للمجال الجراحى اثناء العملية مع استخدام نظام الضغط الايجابي المستمر للأكسجين بمجري الهواء ولهذا يمكن استخدام كلا من النظامين بامان و فاعلية دون اضرار بالعلامات الحيوية للمريض او زيادة مضاعفات ما بعد الجراحة.

الكلمات المفتاحية: تقنية تهوية رئه واحده، تقنية التهويه التباينيه للرئتين، نظام الضغط الايجابي المستمر بمجري الهواء، عملية قطع العصب السيمباثاوى

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