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Original Article

Anesthesia Management in Pulmonary Thromboendarterectomy and Our Single Center Experience

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ABSTRACT

Objective: In this study, the results of 26 patients who underwent pulmonary endarterectomy in our center between November 2015 and December 2019 are presented by evaluating together with anesthesia management in pulmonary thromboendarterectomy performed only in certain centers in our country.

Methods: All the patients routinely monitored using advanced monitoring methods (5-lead ECG, pulse oximetry, radial artery catheterization, ETCO2, central venous catheter, rSO2 to monitor cerebral oxygenation, femoral artery catheterization, and [cardiac output (CO), cardiac index (CI), Pulmonary vascular resistance (PVR), SVR] thermodilution catheter for hemodynamic evaluation). Routinely, all patients were evaluated with perioperative transesophageal echocardiography. All operations were performed under cardiopulmonary bypass with deep hypothermic circulatory arrest. Pulmonary artery pressure (PAP), mPAP, CI, CO, PVR, and SVR values were measured before and after the operation. The length of stay in the intensive care unit, the duration of mechanical ventilator, the length of stay in the hospital, the extracorporeal life support needs, and mortality rates were recorded.

Results: Post-operative CI, CO, oxygen saturation in room air, and 6-min walking distance increased significantly. On the other hand, significant reductions in PAP and PVR were detected. Mean duration of stay on mechanical ventilator was 2 (1–4) days and average hospital stay was 14 (10–18) days. Five patients (19.2%) needed extracorporeal life support. Within the 1st year, 5 mortalities (19.23%) were recorded.

Conclusion: Pulmonary thromboendarterectomy is a very complicated procedure in terms of both surgery and anesthesia management. Therefore, the success of the operation can be achieved with a good perioperative anesthesia management as well as surgical success.

INTRODUCTION

Chronic thromboembolic pulmonary hypertension (CTEPH) is a chronic disease that occurs due to obstruction of the pulmonary arterial circulation which causes an increase in pulmonary arterial pressure. This pressure increase can lead to an eventual right-sided heart failure. According to the definitions of the World Health Organization, CTEPH is accepted as one of the five categories of pulmonary hypertension (Table 1).[1] Thromboembolism can often cause this phenomenon, which occurs as a result of a permanent mechanical obstruction in the pulmonary arterial bed.[2] Although the pathogenesis of CTEPH has not been fully elucidated, some of the associated risk factors have been described. Common points among risk factors are that they tend to cause chronic inflammation and thrombosis (Table 2).[3]

Suspicion of CTEPH is the key to diagnosis. Diagnostic tools to confirm the diagnosis in the presence of clinical suspicion include echocardiography, ventilation-perfusion scintigraphy, and right heart catheterization. Pulmonary Computed tomography angiography, conventional pulmonary angiography, or pulmonary MR angiography should be preferred to determine the treatment strategy after diagnosis and to evaluate surgical resection.[4] A pulmonary arterial pressure at rest above 25 mmHg and a pulmonary capillary wedge pressure below 15 mmHg are the primary conditions for the diagnosis of CTEPH.[4,5]

Table 1. Pulmonary hypertension classification (WHO)

Group 1	Pulmonary arterial hypertension
Group 2	Pulmonary hypertension due to left heart disease
Group 3	Pulmonary hypertension due to chronic lung disease and hypoxia
Group 4	Chronic thromboembolic pulmonary hypertension
Group 5	Pulmonary hypertension with unclear multifactorial mechanisms

Table 2. Risk factors

Previous venous thromboembolism
Infected intracardiac pace-maker implants
Malignity
Splenectomy
Ventriculoatrial shunts
Antiphospholipid antibodies
Lupus anticoagulant positivity
Having non-O blood group

Surgical pulmonary endarterectomy (PEA) stands out as the most potent and curative treatment modality that can be recommended for CTEPH. According to the results of an international, multicenter and prospective study, the 3-year life expectancy of the patients with the surgical treatment was 89%, while this rate decreased to 70% in the patients that received non-surgical treatments.[6,7] With the appropriate patient selection, correct surgical technique and good perioperative management, mortality rates have decreased from 20% to 5–10%. Case series with mortality rates even lower than 5% have been reported in centers with advanced experience.[8,9]

Effective treatment of CTEPH requires a multidisciplinary teamwork. Coordination of the pulmonologist, cardiologist, cardiovascular surgeon, and anesthesiologist maximizes the benefit of the patient from PEA by providing good management of the perioperative period. As one of the most important members of this team, the management of an anesthesiologist specialized in cardiac surgeries during the perioperative process is extremely important. As a center specialized in cardiac surgery, we aimed to present our anesthesia management during PEA in this study.

MATERIALS AND METHODS

In our center, 26 patients who underwent PEA between November 2015 and December 2019 were evaluated retrospectively. Demographic data obtained from hospital records were evaluated. The presence of hypertension, diabetes, and coronary artery disease recorded in the interrogation of the histories of the patients was investigated. Pre-operative and post-operative cardiac index (CI), cardiac output (CO), Left ventricular ejection fraction, Pulmonary vascular resistance (PVR), Right ventricular diameter, Right ventricular systolic, Tricuspid annular plane systolic excursion, Pulmonary artery pressure (PAP), and 6-min walking test results were recorded, and the measurements were evaluated. Cardiopulmonary bypass times and Total circulatory arrest (TCA) times were determined as operative data. In the post-operative period, the presence of pathological findings in the neurological examination, mortality, duration of mechanical ventilation, and length of hospital stay was recorded and evaluated.

Anesthesia management

Anesthesia management of the PEA process concerns a special patient group. It should not be forgotten that there are two main determinants in the management of this process. First of all, care should be taken in this patient group due to borderline right ventricular functions, and the whole process should be designed to prevent right ventricular failure and sudden collapse. Second, for the operation to be considered fully successful, complete surgical resection must be achieved and the PVR must be reduced as much as possible. This is only possible with a bloodless surgical site. Therefore, deep hypothermic circulatory arrest (DHCA) is considered the second most important point of this operation in terms of anesthesia management. Procedure-specific complications (reperfusion injury, bronchial hemorrhage, pulmonary steal syndrome, residual pulmonary hypertension, and right ventricular failure) should always be kept in mind during the operative and post-operative period and should be prepared for Extra Corporeal Membrane Oxygenator (ECMO) when necessary. Anesthesia management is important for these patients in every period, including pre-operative, perioperative, and post-operative. Anesthetic management of the perioperative and post-operative periods can be examined in three time intervals. These are pre-cardiopulmonary bypass period, cardiopulmonary by-pass and DHCA period, and post-operative care and management of possible complications period.

Pre-cardiopulmonary bypass period

After the patients are taken to the operating room, a wide peripheral intravenous catheter and a radial artery catheter are inserted for arterial monitoring. 5-lead ECG and peripheral oxygen saturation (sPO_2), end-tidal CO_2, pulmonary arterial catheterization, pulmonary arterial pressure, and central venous pressure are routinely monitored. Near infrared spectroscopy is used for cerebral monitoring. It is recommended to perform advanced invasive procedures in the post-intubation period, which may cause the patient to be stressed, thus increasing PVR and collapse of the right ventricle with borderline functions. Anesthesia induction was achieved with midazolam (0.1 mg/kg), fentanyl (5 mcg/kg), and rocuronium (1 mg/kg). Maintenance anesthesia was provided using propofol, fentanyl and sevoflurane. Vancomycin (1 g) is administered to all patients as prophylactic antibiotherapy with induction. Tranexamic acid is administered as a 1000 mg loading dose followed by an infusion of 7.5 mg/kg/h. After the patients are intubated with a single lumen endotracheal tube, a femoral artery catheter is inserted. While radial artery follow-up is performed before anesthesia induction, femoral artery catheterization is important because radial artery monitoring does not provide accurate data, especially during DHCA due to peripheral vasospasm. Subsequently, a central venous catheter and a pulmonary artery thermodilution catheter are inserted and PAP, PVR, CI, and CO are calculated and recorded. Rectal and esophageal temperature probes are placed for body temperature monitoring. Transesophageal echocardiography should be used for cardiac evaluation before proceeding to the cardiopulmonary bypass stage. Right and left ventricular functions and presence of intracardiac thrombus are the main issues to be evaluated. During cardiopulmonary bypass, hematocrit value should be targeted in the range of 18–24 g/dL. CTEPH patients have polycythemic hematocrit values due to relative hypoxia unless they have any additional hemoglobinopathies. It is important to keep the hematocrit values at the targeted levels against the possible disorders that may occur in the microvascular bed due to hypothermia. For this purpose, 1 to 3 units of blood are taken from the patients for autotransfusion while the cardiopulmonary by-pass is terminated.[10,11] Before proceeding to the cardiopulmonary bypass, 300 IU/kg heparin is administered to the patient, and when the ACT value is above 400 seconds, the cardiopulmonary bypass is initiated.[12]

Cardiopulmonary bypass and DHCA period

CPB management is different from routine bypass management in the PEA patient group. The volume overload and associated excess fluid extravasation caused by pulmonary edema will be detrimental to borderline right ventricular functions. To prevent this, crystalloid liquids should be avoided, and the prime solution of CPB circuit should be prepared with 5% albumin or colloid liquids.[13,14] In addition, 20% mannitol is added to provoke diuresis, remove free oxygen radicals, and prevent cerebral edema.[15,16] After initiating the cardiopulmonary bypass, the patient is cooled to 20°C in 45–60 min. During the cooling process, there should be no more than 10°C difference between the arterial blood temperature and the rectal/esophageal temperature. It is important to perform the PEA operation fully effectively in terms of the treatment of the disease. Therefore, working in a bloodless pulmonary vascular bed is very important for the success of the surgery. This makes the use of DHCA essential. No cognitive superiority was found in the postoperative period in patients who underwent PEA with or without antegrade cerebral perfusion. Therefore, the optimal method for PEA operation is under DHCA.[17] Myocardial protection is provided by 10 mL/kg antegrade cold blood cardioplegia by placing an aortic cross-clamp. Before TCA, sodium thiopental (6 mg/kg), methylprednisolone (30 mg/kg, max 3 g), and mannitol (12.5 g) are administered to all patients for cerebral protection. TCA duration should not exceed 20 min. If the endarterectomy of the relevant segment has not been completed after 20 min or if the rSO_2 value has decreased below 40% without the expiration of 20 min, the circulation is allowed for 10 min by switching to the circulation by cardiopulmonary bypass. SpO_2 is expected to rise above 95% during this period. After the endarterectomy of each side is completed, the lungs are ventilated, and possible bronchial hemorrhages are controlled by aspiration. When the bilateral endarterectomy is completed, patients are then warmed up to a maximum of 36.5°C degrees for 90–120 min. During the warming phase, the perfusate temperature should not exceed 37.5°, the difference between arterial blood and the rectal/esophageal probe should be less than 10 degrees. Rapid warming should be avoided to prevent cerebral hyperthermia and its neurological complications.[18] If an additional cardiac procedure is to be performed, the warm-up phase may be considered for this purpose. Ultrafiltration can be applied in necessary patients to adjust the fluid balance and prevent the use of extra blood products at the termination of the CPB.

During cardiopulmonary bypass, ventilator settings (FiO_2 30%, PEEP 5 cmH_2O, tidal volume 3 mL/kg, and respiratory rate 10–12/min) are preferred so as to cause the least possible damage to the lung parenchyma. Airway peak pressure is monitored at every stage; sudden rises are considered as the first sign of possible pulmonary hemorrhage. Before terminating the cardiopulmonary bypass, ventilator settings are updated as 60% FiO_2, 6–8 mL/kg tidal volume, 12 respiratory rates and a PEEP of 5 cmH_2O. In patients who have reached the target temperature, a moderate dose of dopamine (5–6 mcg/kg/min) infusion is administered. By evaluating the hemodynamic status, adrenaline (0.05–0.15 mcg/kg/min), noradrenaline (0.05–0.15 mcg/kg/min), and milrinone (0.2–0.7 mcg/kg/min) may be added in necessary conditions. If clinical findings or CO evaluations predict vasoplegia after CPB, noradrenaline or vasopressin should be preferred. Adrenaline is our prominent support agent, especially in patients with weak right ventricular function. If surgery was only partially successful due to small vessel disease, then the use of pulmonary vasodilators such as milrinone, inhaled prostacyclin, and nitric oxide may be considered. The most important determinant in the termination stage from CPB is the right ventricular condition of the patient in the preoperative period. Although the right ventricular afterload is significantly reduced after a complete PEA operation, it should be noted that the right ventricle will be sensitive to volume overload. Avoiding right ventricular failure should be one of our main goals.[19] For this reason, we apply volume-limiting fluid balance in our patients. At the termination of the CPB, the volume in the reservoir is given to the patient very slowly, and the reservoir volume is reduced to the lowest possible level by applying ultrafiltration. To reduce fluid flow to the patient, inotropic and vasopressor agents are used to increase CO and provide perfusion pressure. Heparin is neutralized by protamine infusion in patients successfully weaning from

CPB. Thrombocytopenia can be seen in patients due to long DHCA and CPB times. As part of volume-limiting fluid balance practice, blood transfusion should be avoided in patients without active bleeding.

Post-operative care and management of possible complications

In PEA patients, the post-operative period is as critical as the management of the operative process. During the transfer of the patient from the operating room to the intensive care unit, a mobile ventilator should be used if possible, and PEEP application should not be interrupted.

If we summarize the weaning algorithm from the ventilator that we follow in our center; at the time of admission to the intensive care unit, ventilator settings are adjusted as 60–80% FiO_2, PEEP at least 5 and maximum 10 cmH_2O, pressure support 12 cmH_2O, tidal volume 6–8 mL/kg, respiratory frequency 12–16/min. We can follow that the targeted gas exchange is achieved by obtaining pH in 7.35–7.45 range, $paCO_2$ 4.5–6 kPa, paO_2 over 12 kPa, and SaO_2 over 93% in arterial blood gas. While weaning the patient from the ventilator, we decrease the FiO_2 value by 10% every 1–2 h down to 40%. After reaching the FiO_2 target, we reduce the PEEP value by 1 every hour, up to a maximum of 3 cmH_2O. After the patient begins to breathe spontaneously, we switch from SIMV mode to spontaneous-support mode. If all steps progress successfully and arterial blood gas values do not deteriorate, we proceed to extubation.

Reperfusion injury and associated pulmonary edema are one of the most important complications of the post-operative period. This complication, which is very difficult to treat after it occurs and will initiate a cycle that can progress to the need for ECMO, can be prevented with a good post-operative management. It is important to maintain absolute negative fluid balance in the first 24 h. Maintenance fluid therapy with crystalloid fluids should never be administered. If fluid replacement has become mandatory, autologous blood transfusion or replacement with colloid fluids should be preferred. The goal of negative fluid balance should be achieved with diuretic infusion or intermittent doses of diuretics. Any intervention that may lead to right ventricular failure should be avoided; therefore, pain that may cause PVR, insufficient sedation, hypoxia, hypercarbia, and any factor that may increase intrathoracic pressure should be minimized.[20]

Complications specific to PEA are pulmonary edema, pulmonary arterial steal, pulmonary hemorrhage, and persistent pulmonary hypertension. Pulmonary edema due to reperfusion occurs as a result of extravasation of the vascular bed, which has become highly permeable after surgery. It usually occurs within the first 72 h with hypoxia and accompanying increase in opacity in the relevant segment.[21] Negative fluid balance, application of diuresis, increasing the PEEP value up to 10 cmH_2O and returning to the reverse inspiration-expiration ratio in the ventilator constitute the basis of the treatment. Hemofiltration and even ECMO should be considered in advanced cases that do not respond to treatment. In pulmonary steal syndrome, transient periods of hypoxia occur due to increased blood flow to the newly perfused areas. This complication regresses after a while with remodelling of the pulmonary vascular bed.

Pulmonary bleeding is one of the rare but most frightening complications. Bleeding complications increase due to surgical difficulty, especially in subsegmental diseases with high preoperative PVR. Minor bleeding regresses with conservative treatments such as increasing PEEP, topical vasoconstrictors, and correction of coagulopathies. In life-threatening hemorrhages involving larger areas, it is necessary to block the bleeding lung and remove the blood from the healthy lung. ECMO support should be considered to allow time for the vascular trauma to heal. Persistent pulmonary hypertension may occur as a result of these complications or may result from surgically inadequate endarterectomy. It is known that there is an increase in mortality in the case of persistent pulmonary hypertension.[4,6] Although conservative treatments are applied for these patients, ECMO support may be needed. The need for ECMO in the post-operative period is a factor that significantly increases mortality.[22]

Statistical analysis

Statistical analysis was performed using the STATA for Macintosh version 12.0 software (STATA Corp., College Station, TX, USA). Descriptive data were expressed in mean±standard deviation (SD), median (min-max), or number and frequency. The Fisher's exact test was used to compare categorical data, while the Student's t-test was used to compare continuous variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

Between November 2015 and December 2019, 26 patients underwent PEA in our hospital. Eighteen of the patients were female (69.23%), eight were male (30.76%), mean patient age was 58 (34–67 years) (Table 3). In the pre-operative and post-operative hemodynamic evaluation of the patients, CO, CI, peripheral O2 saturation (sPO_2) in room air, 6-minute walking distance increased significantly in post-operative measurements, while PAP and PVR decreased significantly (Table 4). The mean duration of stay on mechanical ventilator was 2 (1–4) days, and the mean duration of stay in the hospital was 14 (10–18) days. No pathological findings were detected in the neurological examinations of the patients. Total cardiopulmonary bypass time was 290±50 min, cross-clamp time was 142±20 min, and TCA time was 24±6 min. No pathological findings were detected in the neurological examinations of the patients. Total cardiopulmonary bypass time was 290±50 min, cross-clamp time was 142±20 min, and TCA time was 24±6 min.

Table 3. Demographic data of patients

	Number of patients (n)	Ratio (%)
Female	18	69.23
Male	8	30.76
Hypertension	2	0.52
Diabetes mellitus	1	0.26
Coronary artery disease	1	0.26
COPD	2	0.52
ASD	2	0.52
Severe TR	1	0.26
Malignity	2	0.52
Hydatic cyst	2	0.52

ASD: Atrial septal defect; COPD: Chronic obstructive pulmonary disease; TR: Tricuspid regurgitation.

Table 4. Hemodynamic and echocardiographic findings

	Preoperative	Postoperative	p-value
CO (L/min)	4.1±1.4	5.4±1.3	0.001
CI (L/min/m^2)	2.2±0.8	2.5±0.3	0.004
LVEF (%)	55.5 ±7	57.5 ±5	0.000
PVR (dyn.s.cm^{-5})	698±10	235±10	0.000
RVD (mm)	5.5±1.2	5.2±0.8	0.005
RSV velocity (cm/s)	8±1.5	9.5±1.2	0.002
TAPSE (mm)	15.2±3	16.5±3	0.000
PAP (mmHg)	78±22	41±20	0.000
6 min walking test (m)	345±10	460±10	0.001

CI: Cardiac index; CO: Cardiac output; LVEF: Left ventricular ejection fraction; min: Minutes; PAP: Pulmonary artery pressure; PVR: Pulmonary vascular resistance; RSV: Right ventricular systolic; RVD: Right ventricular diameter; TAPSE: Tricuspid annular plane systolic excursion.

Operative characteristics are detailed in table 5

We lost our pulmonary hydatid cyst patient due to anaphylactic shock. One of our patients died on the post-operative 4th day due to pulmonary hemorrhage. In preoperative echocardiography, five patients had poor right ventricular function. Only three needed extracorporeal life support (ECLS). Overall, 19.2% (5/26) of patients required ECLS. Two of these patients needed ECLS due to reperfusion injury and the other three needed it due to right heart failure. One of the patients supplemented with extracorporeal membrane oxygenation (ECMO) died of multi-organ failure. Four patients with ECLS successfully weaned from ECMO and were discharged. Mortality was seen in one patient at 1st month postoperatively, and in another patient, mortality was seen at 3rd month postoperatively. These patients were patients with angiosarcoma and pulmonary adenocarcinoma, respectively. Mortality was observed in five patients (19.23%) in the 1st year. No mortality was seen in the 3-year follow-up of the remaining patients.

Table 5. Operative characteristics of patients

Operative characteristics		
Cardiopulmonary bypass time (min)	290±50 min	NS
Cross clamp time (min)	142±20 min	NS
TCA (min)	24±6 min	NS
Postoperative complications	**n**	**(%)**
Persistent pulmonary hypertension	5	19.2
Reperfusion edema	2	7.6
Pulmonary hemorrhage	1	3.8
Bleeding revision	2	7.6
Delayed sternal closure	2	7.6
Multiorgan failure	1	3.8
Hemofiltration	3	11.5
Right ventricular failure	3	11.5
ECLS need	5	19.2
Operative mortality	5	19.2

ECLS: Extracorporeal life support; NS: Non-significant; TCA: Total circulatory arrest; min: Minutes.

DISCUSSION

In the study of Madani et al.,[23] in which they compared initial and end-stage patients, old and new patient groups of 1000 and 500 patients were evaluated. While preoperative values in the operation series of end-stage patients were PVR:719.0±19.1 dyn.s.cm-5, PAP:75.5±19.1 mmHg, mPAP:45.5±11.6 mmHg, CO:4.3±1.4 L/min; after the endarterectomy the values were PVR:253.4±148.6 dyn.s.cm-5, PAP:41.7±14.1 mmHg, mPAP:26.0±8.4 mmHg, CO:5.6±1, 4 L/min. In the study of Sugiyama et al.,[24] which included 35 patients; While preoperative PVR was: 622 dyn.s.cm-5, mPAP: 43.0 mmHg, CO: 4.0 L/min, it was recorded as PVR: 202.5 dyn.s.cm-5, mPAP: 18.0 mmHg, CO: 4.2 L/min after endarterectomy. In our series of 26 cases, the pre-operative values were; PVR: 698±10 dyn.s.cm-5, PAP: 78±22 mmHg, CO:4.1±1.4 L/min; in post-operative measurements they were PVR: 235±10 dyn.s.cm-5, PAP:41±20 mmHg, and CO:5.4±1.3 L/min. As a result of the comparison of pre-operative values with post-operative measurements, our results are similar with the results reported in the literature.

Luo et al.[25] reported the length of stay in the intensive care unit and hospital stay in ten patients who underwent PTE as 9.7±5.7 days and 18.7±7.4 days, respectively. In our case series, the average hospital stay was 14 (10–18) days.

The gold standard treatment of CTEPH is surgery, which provides hemodynamic and functional improvement and improved life expectancy. Our highly experienced CTEPH team, consisting of cardiologists, cardiac and thoracic surgeons, anesthesia, and intensive care team, performs these operations successfully and safely. Post-operative care, hemodynamic, and ventilation management can be difficult for PEA patients.[26–28] Management of extracorporeal circulation, ischemia, hypothermia, and TCA are critical and very vital issues in intraoperative management.

Residual thrombotic material is the most important problem. Residual thrombotic material causes right ventricular dysfunction after cross-clamping and ischemia. The biggest problem of post-operative care is reperfusion edema of the lung seen in endarterectomized segments. Maintaining adequate right ventricular function, organ perfusion, kidney function, adequate oxygenation, and prevention of pulmonary artery reocclusion are the mainstays of post-operative care.[29] Thromboendarterectomy under circulatory arrest is the only effective treatment method in patients with severe pulmonary artery involvement with prominent respiratory and heart failure symptoms. Myocardial protection, right heart failure management, and management of TCA are the cornerstones of a successful surgical outcome.[30] Measuring CO, mixed venous oxygen saturation, and arterial blood gas samples are useful for monitoring adequate ventilation and perfusion.

This patient population with CTEPH usually has some degree of the right ventricular failure, and the goal of surgery is to improve RV function as much as possible. However, this implies a certain degree of hemodynamic deterioration during anesthesia, as well as possible cardiopulmonary collapse. Cardiopulmonary bypass and DHCA have special requirements regarding cooling and cerebral protection/oxygen monitoring. Post-bypass, anesthetists should also carefully manage the pre-operative and perioperative process, knowing that they will face potential complications such as residual pulmonary hypertension, RV failure, reperfusion pulmonary edema, and pulmonary hemorrhage.

In our patient group, pre-operative, perioperative, and post-operative management strategies yielded successful results. Especially the management of our patients with low and borderline right ventricular function values has resulted in satisfactory results.

CONCLUSION

Anesthesia management of patients undergoing PEA is continuously evaluated and improved. The success of a PEA program depends on the efforts of a multidisciplinary medical team experienced in preoperative evaluation, intraoperative management, and post-operative care. In this article, the experiences of our newly established CTEPH clinic are presented. As a team, we are aware that experience is an important parameter in this regard and we continue to work as a team.

Ethics Committee Approval

This study approved by the Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital-Clinical Research Ethics Committee (Date: 25.02.2021, Decision No: E-28001928-604.01.01).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: M.Ş.,T.K.; Design: M.Ş., T.K., H.K.; Supervision: T.K., G.O.; Materials: M.Ş., H.K.; Data: M.Ş., H.K., N.S.; Analysis: M.Ş., B.T.; Literature search: M.Ş.; Writing: M.Ş., B.T.; Critical revision: M.Ş., H.K., N.S., B.T., T.K., G.O.

Conflict of Interest

None declared.

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Pulmoner Tromboendarterektomide Anestezi Yönetimi ve Tek Merkez Deneyimlerimiz

Amaç: Bu çalışmada Kasım 2015 ile Aralık 2019 tarihleri arasında merkezimizde pulmoner endarterektomi operasyonu yapılan 26 hastanın sonuçları, ülkemizde sadece belirli merkezlerde yapılan pulmoner tromboendarterektomide anestezi yönetimi ile birlikte değerlendirilerek sunulmuştur.

Gereç ve Yöntem: Bütün hastalar rutin olarak ileri monitorizasyon yöntemleriyle (5-lead EKG, pulse oksimetre, radial arter kateterizasyonu, $ETCO_2$, santral venöz kateter, serebral oksijenasyon takibi yapmak için rSO_2 ve femoral arteryel kateter ve hastaların hemodinamik değerlendirmesini yapmak için (CO, CI, PVR, SVR) termodilüsyon kateteri) monitorize edildi. Rutin olarak bütün hastalar perioperatif TEE ile değerlendirildi. Bütün operasyonlar CPB altında DHCA eşliğinde gerçekleştirildi. Operasyon öncesi ve sonrası PAP, mPAP, CI, CO, PVR, SVR değerleri ölçüldü. Hastaların yoğun bakım kalış süreleri,mekanik ventilatöre bağlanma süreleri, hastanede kalış süreleri, ECLS ihtiyaçları ve mortalite oranları kaydedildi.

Bulgular: Hastaların operasyon sonrası kardiyak index (CI), kardiyak output (CO), oda havasındaki oksijen satürasyonu ve 6 dakikalık yürüyüş mesafesi önemli ölçüde artmıştır. Buna karşılık pulmoner arter basıncında ve pulmoner vasküler rezistansta anlamlı azalmalar tespit edilmiştir. Hastaların mekanik ventilatöre bağlı kalma süresi ortalama 2 (1–4) gün ve hastanede kalma süreleri ise ortalama 14 (10–18) gün olarak tespit edilmiştir. Beş hasta (%19.2) ECLS ye ihtiyaç duymuştur. İlk bir yıl içinde beş hastada (%19.23) mortalite kaydedilmiştir.

Sonuç: Pulmoner tromboendarterektomi hem cerrahi hem de anestezi yönetimi açısından oldukça komplike bir işlemdir. Bu nedenle ameliyatın başarısı, cerrahi başarının yanı sıra iyi bir perioperatif anestezi yönetimi ile sağlanabilir.

Anahtar Sözcükler: Anestezi; pulmoner; tromboendarterektomi.