

**A Study to Analyze the Postoperative Period PTE.****Madhav Kumar<sup>1</sup>, Aandrei Jivendra Jha<sup>2</sup>, Namita Mishra<sup>3</sup>, Tushar Kumar<sup>4</sup>, Devi Shetty<sup>5</sup>**<sup>1</sup>Assistant professor, Department of Cardiothoracic and Vascular Surgery, IGIMS, Patna, Bihar, India<sup>2</sup>Associate Professor, Department of Cardiothoracic and Vascular Surgery, IGIMS, Patna, Bihar, India<sup>3</sup>Assistant professor, Department of Anaesthesiology, ESIC, Medical College and Hospital, Bihta, Patna, India<sup>4</sup>Associate Professor, Department of CTVS, IGIMS, Patna, Bihar, India<sup>5</sup>Senior Consultant Cardiac surgeon, Department of Cardiac surgery, Narayana Institute of Cardiac Sciences, Bangalore, India

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Conflict of interest: Nil

**Abstract****Aim:** The aim of the present study was to analyze the efficacy, safety, morbidity and survival associated in the postoperative period.**Methods:** The present study was conducted in the Department of Cardiac surgery, Narayana Institute of cardiac sciences, Bangalore, India and a total of 90 consecutive patients undergoing PTE were included. All the data were collected prospectively.**Results:** Mean age of the patient was 42.08 years with male preponderance. Only 54 patients gave previous history of deep venous thrombosis. Signs of right ventricular failure like edema, jaundice, ascites and raised jugular venous pressure were present. Out of 90 patients, 18 were tested positive for antiphospholipid antibody, and 3 were having protein C/S deficiency. These abnormalities were observed predominantly in the younger age group (<35 years). The mean preoperative mPAP was 41.97±8.26 mmHg; mean cardiac index was 1.98±0.22 L/min/m<sup>2</sup> and mean pulmonary vascular resistance was 418.39±95.88 dynes/sec/cm. In this regard, our study showed significant reduction in PAP, pulmonary vascular resistance and corresponding improvement in cardiac index. The mean ICU stay of patients who survived was 11.25 days. The mortality rate in our study was 11.11% (10 patients) of which two patients had significant pulmonary hemorrhage in the immediate postoperative period. In our study we encountered two cases of pulmonary hemorrhage.**Conclusion:** Pulmonary endarterectomy is an effective and potentially curative surgical treatment for patients with severe chronic thromboembolic pulmonary hypertension. The mean ICU stay of patients who survived was 11.25 days. The mortality rate in our study was 11.11% (10 patients) of which two patients had significant pulmonary hemorrhage in the immediate postoperative period. In our study we encountered two cases of pulmonary hemorrhage.**Keywords:** Chronic thromboembolic pulmonary hypertension, mean pulmonary artery pressure, pulmonary thromboendarterectomy

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**Introduction**

Patients with chronic thromboembolic pulmonary hypertension (CTEPH) present with progressive exertional dyspnea and fatigue that respond poorly to medical management. [1,2] Over periods of months to years, symptoms worsen and right ventricular dysfunction intervenes. Survival of non operated patients with CTEPH beyond the onset of symptoms has not been firmly established, although Riedel and coworkers<sup>1</sup> reported a median survival of 2–3 yr from initial diagnosis, with

longevity adversely affected by the severity of pulmonary hypertension.

Pulmonary thromboendarterectomy (PTE) for select patients offers a potential surgical remedy for this condition. The removal of organized thromboembolic material from the major pulmonary vessels can restore pulmonary hemodynamics to normal or near normal levels in most patients undergoing this operation. [3-6] Furthermore, as experience has accumulated,

postoperative mortality has progressively declined. A report of 273 consecutive patients undergoing PTE at the University of California, San Diego (UCSD) has shown an in-hospital mortality of 6.6%. [7]

Patients suffering from chronic thromboembolic pulmonary hypertension have severe limitations during exercise, and sometimes even at rest, mainly because of a ventilation/perfusion mismatch and pulmonary hypertension leading to chronic right heart failure. [8] Therefore, PTE has been regarded as a promising, potentially curative surgical procedure since its introduction approximately 30 years ago. [9,10] However, PTE is associated with specific postoperative complications, such as reperfusion pulmonary edema and right heart failure, leading to considerable mortality of 7-24%. [11-13] Reperfusion pulmonary edema (RPE) is characterized by sustained arterial hypoxemia caused by focal pulmonary infiltrates in regions distal to the vessels subjected to endarterectomy. [14] RPE after PTE requires prolonged postoperative mechanical ventilation (MV) (>72 h) and intensive care treatment with its potential risks and side-effects. [15,16]

The aim of the present study was to analyze the efficacy, safety, morbidity and survival associated in the postoperative period of PTE.

#### Materials and Methods

The present study was conducted in the Department of Cardiac surgery, Narayana Institute of cardiac sciences, Bangalore, India for year and a total of 90 consecutive patients undergoing PTE were included. All the data were collected prospectively. Study was approved by the hospital ethical committee and an informed consent was taken from all patients. Patients accepted for surgery included those with pulmonary artery hypertension and evidence of thromboembolic disease which was confirmed on computerized tomographic pulmonary angiography. All patients were subjected to echocardiogram and coronary angiogram.

Preoperative pulmonary artery pressure, cardiac index and pulmonary vascular resistance were measured prior to surgical incision. In the postoperative period the same values were compared after 24 h.

All the operations were performed by one surgeon with the standardized technique using extracorporeal circulation and intermittent periods of circulatory arrest under deep hypothermia. Postoperative care was protocol-based, which included elective mechanical ventilation for a minimum of 48 h with a maximal inspiratory pressure maintained below 30 cm of water and fractional inspired oxygen level is kept below 0.5 ensuring oxygen saturation of over 90% and aggressive diuresis along with other standard care followed for open heart surgeries. Anticoagulation was reinitiated within 6-8 h postoperatively in all the patients. All patients were started on sildenafil citrate 25 mg three times daily from first operative day onwards.

Standard monitoring consisted of invasive arterial blood pressure, Swan-Ganz catheter for pulmonary artery pressure and continuous cardiac output monitoring, once daily chest X-ray, 2D-Echo and arterial blood gases.

Weaning was initiated with spontaneous breathing trial after achieving stable hemodynamics with minimal inotropic supports. The spontaneous breathing trial was continued for 4-6 h. Based on the hemodynamic parameters and extubation criteria patients were either extubated or continued on mechanical ventilation.

Three weaning trials were given every day for patients who did not meet extubation criteria, to be labelled as weaning failure and those patients were subjected to tracheostomy. The predictors of prolonged mechanical ventilation in the postoperative period were postoperative severe pulmonary artery hypertension, neurological complication, pulmonary hemorrhage and RPE. The hemodynamic data, ICU stay, morbidity and survival were analyzed. All patients were followed up to six months and a telephonic survey was conducted using a standard questionnaire. They were assessed and classified as per NYHA grading.

#### Statistical analysis

Values are summarized as mean±standard deviation or n (%). Paired t test statistical analysis was applied to compare preoperative and postoperative hemodynamic parameters. Values of P<0.025 were considered statistically significant.

#### Results

**Table 1: Base line data**

|                |   |        |
|----------------|---|--------|
| Sex            | M | 65     |
|                | F | 25     |
| Mean Age (yrs) | M | 42.08  |
| Height (cms)   |   | 164.66 |
| Weight (kgs)   |   | 68.32  |

Mean age of the patient was 42.08 years with male preponderance.

**Table 2: Preoperative data**

|                                    |                              |    |
|------------------------------------|------------------------------|----|
| New York Heart Association grading | II                           | 35 |
|                                    | III                          | 32 |
|                                    | IV                           | 24 |
| Right ventricular failure          |                              | 48 |
| Anti-failure drugs                 |                              | 18 |
| Deep venous thrombus               |                              | 54 |
| Antiphospholipid AB                |                              | 18 |
| Protein C/S deficiency             |                              | 3  |
| Anticoagulants                     |                              | 36 |
| Home oxygen                        |                              | 5  |
| Co-morbidities                     | Bronchial asthma             | 9  |
|                                    | Chronic smoker               | 18 |
|                                    | Renal dysfunction            | 15 |
|                                    | Diabetes mellitus            | 12 |
|                                    | Hypertension                 | 3  |
|                                    | Hyperthyroidism              | 10 |
|                                    | Systemic lupus erythematosus | 1  |
|                                    | Cerebrovascular accident     | 1  |

Only 54 patients gave previous history of deep venous thrombosis. Signs of right ventricular failure like edema, jaundice, ascites and raised jugular venous pressure were present. Out of 90 patients, 18 were tested positive for antiphospholipid antibody, and 3 were having protein C/S deficiency. These abnormalities were observed predominantly in the younger age group (<35 years).

**Table 3: Comparison of hemodynamic parameters**

| Study parameters | Preoperative | Postoperative | Significance    |
|------------------|--------------|---------------|-----------------|
| CI               | 1.98±0.22    | 3.29±0.51     | <i>P</i> <0.001 |
| PVR              | 416.34±94.86 | 144.46±35.25  | <i>P</i> <0.001 |
| PA systolic      | 74.86±16.24  | 39.48±12.68   | <i>P</i> <0.001 |
| PA diastolic     | 26.64±6.46   | 17.93±6.49    | <i>P</i> <0.001 |
| Mean PAP         | 41.97±8.26   | 25.15±7.43    | <i>P</i> <0.001 |

The mean preoperative mPAP was 41.97±8.26 mmHg; mean cardiac index was 1.98±0.22 L/min/m<sup>2</sup> and mean pulmonary vascular resistance was 418.39±95.88 dynes/sec/cm. In this regard, our study showed significant reduction in PAP, pulmonary vascular resistance and corresponding improvement in cardiac index.

**Table 4: Postoperative complications**

|                               |                           |             |
|-------------------------------|---------------------------|-------------|
| MV (HRS)                      |                           | 74.16±28.92 |
| Duration of inotropic support |                           | 6.24±3.77   |
| Noninvasive ventilation       |                           | 24          |
| Reperfusion edema             |                           | 2           |
| Pulmonary hemorrhage          |                           | 0           |
| Bronchoscopy                  |                           | 2           |
| Sepsis                        |                           | 10          |
| ECOM                          | Intraoperative            | 2           |
|                               | Postoperative             | 1           |
| Acute renal failure           | Non oliguric              | 22          |
|                               | Renal replacement Therapy | 4           |
|                               | Total                     | 26          |
| Tracheostomy                  | MV                        | 10.8 days   |
|                               | Weaning failure           | 3 (60)      |
|                               | Decannulation time        | 14.2 days   |
| ICU stay                      | 11.25 days                |             |
| Mortality                     | Total                     | 10          |

|                |                             |   |
|----------------|-----------------------------|---|
| Cause of death | Pulmonary hemorrhage        | 2 |
|                | Cerebrovascular accident    | 2 |
|                | Sepsis, acute renal failure | 2 |

The mean ICU stay of patients who survived was 11.25 days. The mortality rate in our study was 11.11% (10 patients) of which two patients had significant pulmonary hemorrhage in the immediate postoperative period. In our study we encountered two cases of pulmonary hemorrhage.

### Discussion

Chronic thromboembolic pulmonary hypertension is an insidious and often unrecognized disease that has been ignored for a long time. Diagnosis is often delayed or overlooked. Chronic thromboembolic pulmonary hypertension is associated with considerable morbidity and mortality. In general, prognosis is poor: the five-year survival in patients with a mean pulmonary artery pressure (mPAP) of more than 40 mmHg is only 30% and that in patients with mPAP exceeding 50 mmHg is only 10%. [17-20]

Mean age of the patient was 42.08 years with male preponderance. Only 54 patients gave previous history of deep venous thrombosis. Signs of right ventricular failure like edema, jaundice, ascites and raised jugular venous pressure were present. Out of 90 patients, 18 were tested positive for antiphospholipid antibody, and 3 were having protein C/S deficiency. These abnormalities were observed predominantly in the younger age group (<35 years). The mean preoperative mPAP was 41.97±8.26 mmHg; mean cardiac index was 1.98±0.22 L/min/m<sup>2</sup> and mean pulmonary vascular resistance was 418.39±95.88 dynes/sec/cm. In this regard, our study showed significant reduction in PAP, pulmonary vascular resistance and corresponding improvement in cardiac index. The mean ICU stay of patients who survived was 11.25 days. Postoperative management in these patients plays a significant role because of complications such as RPE, pulmonary hemorrhage, ventilation perfusion mismatch etc. [21,22] To overcome these problems, we developed protocol-based postoperative management. These included postoperative MV for more than 48 h, use of low tidal volume and PEEP. The pharmacological adjuncts used were, methylprednisolone for three postoperative days, heparin therapy commencing 6-8 h postoperatively and, oral warfarin thereafter, aggressive diuretic therapy and sildenafil citrate. These measures were improvised gradually as we gained experience in managing these patients. An early tracheostomy was planned whenever the anticipated duration of MV was more than five days. Continuous cardiac output and its derivatives' monitoring, serial echocardiography, serial chest X-rays, acid base gases were the mainstay of

postoperative monitoring and based on these values, the postoperative management was fine-tuned.

By performing endarterectomy of pulmonary artery branches, perfusion of non-perfused lung areas is re-established and cardiac output is increased. [23,24] This was clearly evident in our study where the majority of our patients had improved cardiac index and pulmonary vascular resistance. The mortality rate in our study was 11.11% (10 patients) of which two patients had significant pulmonary hemorrhage in the immediate postoperative period. In our study we encountered two cases of pulmonary hemorrhage. Postoperative management of PTE surgery has its own complications when compared to other open-heart surgeries. Most commonly seen in early peri-operative course are RPE and pulmonary hemorrhage. In our study we encountered two cases of pulmonary hemorrhage and one case of severe RPE. All patients with the above complications required ECMO but in only one patient ECMO was successfully weaned. Nine patients (25%) required noninvasive ventilation support for a brief duration due to mild form of RPE.

### Conclusion

Pulmonary endarterectomy is an effective and potentially curative surgical treatment for patients with severe chronic thromboembolic pulmonary hypertension. The mean ICU stay of patients who survived was 11.25 days. The mortality rate in our study was 11.11% (10 patients) of which two patients had significant pulmonary hemorrhage in the immediate postoperative period. In our study we encountered two cases of pulmonary hemorrhage.

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