



PHRENIC NERVE INJURY FROM ICE SLUSH PLACED DURING MULTI-CARDIAC VALVE REPAIR / REPLACEMENT

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ABSTRACT

OBJECTIVE: To find out the frequency of phrenic nerve injury in our patients undergoing heart valve surgeries (mitral, aortic & tricuspid, in any combination)

MATERIAL AND METHODS:

This study was performed at Cardiothoracic Department, Punjab Institute of Cardiology, Lahore, from 1st January 2009 to 31st December 2015. A total of 2087 patients underwent valve repair and replacements during the study period. AVR and mitral / aortic valve replacement with tricuspid valve repair was taken on 789 patients. Both men and women aged 20-55 years, undergoing elective AVR or MVR+TVr or AVR+TVr were included in the study. SPSS (Statistical Package for Social Sciences) for Windows version 21 was used for the analysis of data. A p-value of ≤ 0.05 was taken as significant.

RESULTS: A total of 789 patients underwent multiple valve replacement/repair. The mean age of patients was 33.21 years, median being 34 years. Male patients accounted for 337 (42.7%) patients and females being 452 (57.3%) in number. Total ICU stay remained ≤ 2 days in 88%, whereas hospital stay remained upto 7 days in 88.8%. Time on mechanical ventilation was ≤ 2 days in 98%. Pleural effusion was found in 25 patients (3.2%). Chest intubation was performed in 17 patients (2.2%). Seven patients (0.9%) developed nosocomial pneumonia. In 40 patients chest x ray showed atelectasis, whereas elevated left hemidiaphragm was found in 4 (0.5%) patients. There was decreased left sided abdominal movement in all of these 4 patients, found relieved at 6 months followup.

CONCLUSION: Phrenic nerve injury is a rare but reversible complication of valvular heart replacement / repair. Once occurred it increases morbidity.

KEY WORDS: ICE slush phrenic injury, Cardiac valve repair / replacement.

INTRODUCTION

There are four valves of heart, two on the right side (Tricuspid & Pulmonary) and two on the left side (Mitral & Aortic).¹ Mitral and Aortic valve are related to high pressure zone and continuous wear and tear. They may be congenitally deformed, injured with rheumatic aetiology or senility. Once the damage is severe, this may give rise to need of either repair or replacement of the valve either with open heart surgery or with minimal invasive procedures.²

In developing countries like ours, the open heart surgery is still most prevalent procedure. This involves sternotomy, cardiopulmonary bypass (CPB) with hypothermia, Aortic cross clamping with

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cardioplegia.^{3,4} Surgeon may apply local cooling inside the pericardium either with cold water or ice slush. This local application of cold solution has been shown to increase the chances of phrenic nerve injury, the later being the nerve supply to diaphragm, the main respiratory muscle. This injury results in multiple other morbid complications, and even mortality.⁵

A lot has been told about the phrenic nerve injury secondary to ice slush placement,⁶⁻⁹ but in our center the ice slush is regularly used by the cardiac surgeons. These surgeons were of the opinion that such injury is rare and even if occurs is so reversible that it goes unnoticed. They outweigh the chances of nerve injury and prefer to protect the heart with local application of cold ice packs or solutions. Working on this rationale this study aimed to find out the frequency of phrenic nerve injury in our patients undergoing heart valve surgeries (mitral, aortic & tricuspid, in any combination), in advanced cardiac center of this region.

MATERIALS & METHODS:

This study was performed at Cardiothoracic Department, Punjab Institute of Cardiology, Lahore,

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from 1st January 2009 to 31st December 2015. A total of 2087 patients underwent valve repair and replacements during the study period. MVR with or without Tricuspid valve repair accounted for 1105 cases, whereas AVR with or without Tricuspid valve for 527 cases. A total of 455 patients underwent MVR with AVR (Dual Valve Replacement). DVR and mitral / aortic valve replacement with tricuspid valve repair was taken on 789 patients. The surgeons operating these cases were not known of the fact that such prospective study was undertaken during this period.

Both men and women aged 20-55 years, undergoing elective DVR or MVR+TVr or AVR+TVr were included in the study. However, patients for emergency valve replacement, redo valve surgery, & those patients with associated additional cardiac pathologies (coronary artery disease, aortic aneurysm and congenital heart disease, detected preoperatively on echocardiogram and angiography), those patients with chronic obstructive pulmonary disease, diabetes mellitus, obesity (BMI (body mass index, >30) and neurological disorders, were excluded from the study.

All these cases were operated at the same Institute. We assessed all patients preoperatively as per institution routine. After all antiseptic measures were taken a midline sternotomy under cardiopulmonary bypass with double venous cannulation was performed. Hypothermia was maintained between 28-32°C, with cardiac diastolic arrest by antegrade cold blood cardioplegia with potassium. Ice slush either was applied all the time during repair / replacement of the valves, either directly into the pericardial well or Ice slush wrapped inside gauze and then applied directly over the left anterolateral surface of heart. Once the valve replacement / repair procedure was over, deairing was performed. Cross clamp removed from the ascending aorta, CPB disconnected along with its connections. Patient was normothermized (37°C). Hemostasis maintained and drains & pericardial pacing wires placed. After the procedure Stainless-steel no.5 wire were used for sternum closure. Presternal fascia, subcutaneous tissue and the skin closure was performed as standard.

A pre-designed proforma was used, recorded demographic profile of patients, type of valvular pathology & procedure performed, the size of valve prosthesis, cardiopulmonary bypass & cross clamp time, total operative time, time dependent on mechanical ventilation, delayed extubation if any, re-intubation, total ICU & Hospital stay, pleural

effusion, nosocomial pneumonia, reciprocal diaphragmatic / abdominal movement, Chest x-ray results (elevation of diaphragm, pleural effusion, no movement of diaphragm in expiration and inspiration) before operation during hospital stay and after 6 weeks of operation, need for chest intubation and mortality.

SPSS (Statistical Package for Social Sciences) for Windows version 21 was used for the analysis of data. All qualitative variables, like diaphragmatic paralysis and gender, were presented in the form of tables, percentages, graphs and pie charts. All quantitative variables were presented in the form of mean \pm standard deviation and bar charts. Frequency of phrenic nerve injury was checked using Pearson chi-square test, Fischer Exact Test. A p-value of ≤ 0.05 was taken as significant.

RESULTS:

A total of 789 patients underwent multiple valve replacement/repair. The mean age of patients was 33.21 years, median being 34 years. Male patients accounted for 337 (42.7%) patients and females being 452 (57.3%) in number. In 696 patients (88.2%) the LVESD was 40-45 mm, LVEDD was 56-60mm in 551 patients (69.8%), ejection fraction being 51-60% in 599 patients (75.9%).

The CPB time was less than 120min in 89.5%, Cross clamp time being less than 50 min in 82.6%. Hypothermia was kept below 30°C in 60.8% patients. Pericardial patch was applied for closure of ascending aortotomy in 8.1% patients. In 33.6% patients both the pleura remained intact.

Total ICU stay remained ≤ 2 days in 88%, whereas hospital stay remained upto 7 days in 88.8%. Time on mechanical ventilation was ≤ 2 days in 98%. Pleural effusion was found in 25 pa-

Table-1: Demographic and clinical characteristics of patients.

Variables		Frequency(%)
Gender	Male	337(42.7%)
	Female	452(57.3%)
Age		33.21
LVESD	40-45 mm	696(88.2%)
	56-60 mm	551(69.8%)
EF	51-60%	599(75.9%)
CPB	<120 min	706(89.5%)
Cross clamp time	<50 min	652(82.6%)
Hypothermia	<30° C	480(60.8%)
Pericardial patch	Closure of ascending aortotomy	64(8.1%)
	Pleura	265(33.6%)
ICU stay	≤ 2 days	695(88%)
Hospital stay	>7 days	695(88%)
Time on mechanical ventilation	≥ 2 days	774(98%)



Table-2: Post-op Complications of patients.

Variables	Frequency(%)
Pleural effusion	25(3.2%)
Chest intubation	17(2.2%)
Nosocomial pneumonia	7(0.9%)
Atelectasis	40
Left hemidiaphragm	4(0.5%)
Abdominal movement	4(0.506%)
Mortality	30(3.8%)

tients (3.2%). Chest intubation was performed in 17 patients (2.2%). Seven patients (0.9%) developed nosocomial pneumonia. In 40 patients chest x ray showed atelectasis, whereas elevated left hemidiaphragm was found in 4 (0.5%) patients. There was decreased left sided abdominal movement in all of these 4 patients, found relieved at 6 months followup. During study period 3.8% patients died.

DISCUSSION:

One of the major complication following cardiac surgery is the phrenic nerve injury¹⁰. It leads to disabling effects from diaphragmatic dysfunction, especially in children and patients with a history of chronic obstructive airway disease. Variety of mechanisms of injury have been proposed e.g. hypothermia, mechanical trauma and possibly ischaemia.⁵

If the phrenic nerve injury is severe and bilateral it has poor prognosis. Maccherini M et al¹¹ detected temporary diaphragmatic paralysis secondary to local application of ice slush. Similarly, Cassese M et al¹² found that this injury along with failure to extubate frequently occurs with the use of ice slush (p= 0.009 & p= 0.034 respectively). However in only 30 % of such patients these complications present upto 6 months postoperatively. Additionally, Efthimious J et al¹³ found ice slush injuries in 36% patients, being present at 1 year postoperatively in 9%. Moreover, Diehl J et al¹⁴ found 2.1% occurrence of Ice slush injury to phrenic nerve (p= <0.05). They have also shown some events like nosocomial pneumonia, prolonged mechanical ventilation and fatality in this group. Allen et al¹⁵ found that patients who received iced topical hypothermia had longer postoperative hospitalization, higher incidence of atelectasis and higher left diaphragms. Nikas et al¹⁸ studied CABG patients and found no significant differences regarding cardiac morbidity or mortality but greater incidence of diaphragmatic paralysis, which in turn increased pulmonary complications. In our study chest X-rays of 40 patients showed atelectasis, whereas elevated left hemidiaphragm was found in 4 (0.5%) patients. There

was decreased left sided abdominal movement in all of these 4 patients, found relieved at 6 months followup. This shows that temporary phrenic nerve injury had occurred in these patients.

Aimann et al¹⁶ found that Ice slush topical hypothermia during open heart surgery is associated with a high incidence of phrenic nerve cold injury. Moreover, long-term follow-up data showed often incomplete regression of the phrenic nerve paralysis. In their study Brodaty et al¹⁷ studied the long-term course of cold-induced phrenic nerve injury in a series of 750 patients undergoing open heart surgery with topical cooling. They observed fifty cases (6.6%) of phrenic nerve paralysis. Such patients had significantly increased incidence of respiratory complications including atelectasis, bronchial obstruction, pleural effusion, pneumonia and prolonged assisted ventilation and intensive care stay. Moreover, long-term follow-up of 42 patients (mean: 14 months; range: 3–42 months) showed often incomplete regression of the phrenic nerve paralysis. In our study we also found Pleural effusion and nosocomial pneumonia (3.2% & 0.9% respectively). Total ICU stay remained ≤2 days in 88%, whereas hospital stay remained upto 7 days in 88.8%. Time on mechanical ventilation was ≤2 days in 98% in our study.

Braathen B et al concluded that topical cooling is an unnecessary adjunct to myocardial protection in patients undergoing cardiac surgery.¹⁹ Similarly, Allen et al¹⁵ also found that Supplemental topical cooling does not improve postoperative haemodynamics neither does it reduce inotropic requirements, enzyme release or risk of myocardial infarction. However, few randomized studies exist on the value of topical cooling as an adjunct to myocardial protection

CONCLUSION:

Phrenic nerve injury is a rare but reversible complication of valvular heart replacement / repair. Once occurred it increases morbidity and mortality.

Author’s Contribution

SA: Conducted the study and wrote the article. AA: Helped in conducted the study. SA: Consultant Incharge. MI: Data rearrangement, table and statistics. WR: Patient supervision and consultant incharge. JSK: Supervision of data collection.



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