Prevention of post operative phrenic nerve palsy in patients undergoing cardiac surgery

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Abstract

Introduction. Close proximity of phrenic nerves to pericardium and internal mammary arteries (IMA) makes them liable to injury during cardiac surgery which occurs due to its transection, compromised vascularity or hypothermia.

Methods. Between July, 1999 to August, 2000 fifty fresh cadavers were examined and the intrathoracic course of phrenic nerves was studied. This information was utilised while performing 200 open heart operations. Intermittent cooled saline (4°C) was used instead of ice slush for topical cooling and pericardiophrenic branch of IMA was preserved while harvesting it.

Results. Variations were observed in the anatomical relationship between the phrenic nerves and proximal internal mammary arteries. Incidence of unilateral phrenic nerve injury among patients who had open heart surgery was 1.5% and was 4% among patients in whom internal mammary artery was harvested.

Conclusion. A thorough knowledge of anatomical variations in the course of phrenic nerves, preservation of pericardiophrenic branch of IMA while harvesting it for CABG and use of cooled saline instead of ice slush for topical cooling helps in avoiding phrenic nerve injury during cardiac surgery. (Ind J Thorac Cardiovasc Surg, 2001; 17: 225-229)

Key words: Phrenic nerve, anatomy; Phrenic nerve, palsy; Phrenic nerve, frost bitten; Hemidiaphragm elevation.

Introduction

Phrenic nerve palsy can occur in 10 to 40 percent of patients undergoing cardiac surgery. Close proximity of phrenic nerves to the pericardium makes them liable to injury during cardiac surgery. Apart from complete transection, the phrenic nerves can get stretched or compressed during mobilisation of the heart and this occurs more often while dissecting internal mammary artery (IMA) for its use as an arterial conduit during coronary artery bypass graft surgery (CABG) and during redo cardiac surgery when the pericardium is adherent. Injury to the phrenic nerves can also occur secondary to its compromised vascular supply or hypothermia, induced by the use of topical ice slush for myocardial protection.

The anatomical relationships of phrenic nerves to various structures in the thorax, especially to the internal mammary arteries are variable and have not been described in detail. A precise knowledge of these variations is extremely important for the cardiac surgeon in order to prevent phrenic nerve injury during surgical manipulations. There is also no definite evidence to suggest that topical ice slush provides better myocardial protection than cooled saline.

We therefore studied the anatomical relationships of phrenic nerves in detail in cadavers, in order to attain a thorough knowledge of its variations to avoid direct injury to these nerves during surgery and also used cooled saline solution instead of ice slush for topical cooling to avoid hypothermic phrenic nerve palsy in patients undergoing open heart surgery.

Material and Methods

Between July, 1999 and August, 2000, fifty fresh adult cadavers were examined with the informed consent of relatives and approval of the ethical committee in the
Department of Anatomy at IG Medical College. Their age ranged between 20 to 65 years and 38 were male while 12 were female. The anterior sternocostal wall of thorax was removed with a portion of the subclavian and axillary arteries along with the phrenic nerves sectioned above the subclavian artery. The specimen were fixed in 10% formaldehyde solution. Dissections were performed to study the intrathoracic course of phrenic nerve in detail, especially the variations in its relationship to the internal mammary artery (IMA), as it passed medially. The anatomy of the pericardiophrenic artery, which is a major source of blood supply to the phrenic nerve was also studied and the vessel from which it took origin and its distance from the origin of IMA were also noted.

This information was utilized by the cardiac surgeons in the Department of Cardiovascular and Thoracic surgery, PGIMER which is the nearest referral institution where open heart surgery is performed. The surgeons having acquired a thorough knowledge of the anatomical variations in the relations of the phrenic nerve and its blood supply, took special precautions to avoid injury to the phrenic nerves while performing 200 consecutive open heart operations and preserved the pericardiophrenic branch of internal mammary artery (IMA) while dissecting IMA for use as an arterial conduit. Intermittent antegrade, with or without retrograde cold blood cardioplegia and moderate systemic hypothermia were used for myocardial protection. The use of topical ice slush was altogether avoided and instead, cooled saline solution (4°C) was instilled intermittently in the pericardial cavity during delivery of cardioplegia after every 20 minutes.

Chest roentgenograms of these patients were reviewed in the post operative period after one week and in follow up after one month and subsequently every six months. The following criteria for screening the patients for radiologic evidence of phrenic nerve injury were used: (i) right hemidiaphragm elevation more than two rib spaces higher than left hemidiaphragm (right phrenic nerve injury), (ii) left hemidiaphragm more than one rib space higher than right hemidiaphragm (left phrenic nerve injury), and (iii) bilateral hemidiaphragm elevation more than one rib space higher than the preoperative levels (bilateral phrenic nerve injury).

The presence of phrenic nerve palsy was further confirmed by the presence of paradoxical movements of the diaphragm on fluoroscopy. Pulmonary function tests were also conducted in those patients who had evidence of phrenic nerve palsy during follow up after surgery at every six monthly intervals.

**Results**

In 26 cadavers (52%) both phrenic nerves crossed anterior to the internal mammary arteries and entered the thorax medial to it (Figure 1). In 7 cases (14%) both the phrenic nerves crossed the IMA posterior to it (Fig. 2). In 10 cases (20%) left phrenic nerve crossed posterior to IMA while right phrenic nerve crossed anterior to it. In 6 cases (12%) the left phrenic nerve crossed anterior to the IMA while the right phrenic nerve crossed posterior to it (Figure 3). In one case an anomaly not yet reported in literature was seen where an accessory phrenic nerve crossed posterior to the IMA and the left phrenic nerve crossed anterior to it forming a loop around the artery (Fig. 4). The distance between the origin of the left internal mammary artery (LIMA) and the point where it was crossed by left phrenic nerve ranged from 0.6 to 4.1 cm (mean 1.8±0.6 cm). The distance between origin of right internal mammary artery (RIMA) and the point where it was crossed by the right phrenic nerve varied from 0.4 to 4.2 cm (mean 1.6 ± 0.7 cm).

The origin of pericardiophrenic arteries was from the IMA in 92% cases (Figure 1), and from its thymic branches in 8%. The distance between the origin of IMA and the origin of pericardiophrenic artery varied from 1.8 to 6.8 cm (mean 3.9 ± 0.8 cm).

On post operative evaluation of the 200 patients who had undergone open heart surgery which included fifty patients in whom IMA was harvested (Table 1), left phrenic nerve palsy was seen in two patients. Both of