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Multiple Ligations in Patent Ductus Arteriosus

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Abstract

Background: Congenital heart disease encompasses a wide range of anomalies, that result from abnormal fetal development of heart and great vessels. Ductus arteriosus is a normal fetal vascular structure that allows blood from right ventricle to bypass the high resistance pulmonary vascular bed and pass directly to systemic circulation. Following birth the ductus closes, and in some patients if it does not close, left to right shunting occurs, causing volume overload of left heart, followed by its further sequel. *Material and Methods*: The study was conducted on all the patients, operated for patent ductus arteriosus in the Department of Cardio Vascular and Thoracic surgery. *Results:* A total of 79 patients mostly in 1st decade of life, irrespective of age, sex, presentation and surgical outcome were included in the study. 24 patients (30.37%) had history of preterm delivery. Systodiastolic murmur was audible in majority, and echocardiographic evidence of patent ductus arteriosus was present in all. Multiple ligation of the patent ductus was the surgical procedure of choice, long term results in survivors were excellent. *Conclusion:* Patent ductus arteriosus is a common congenital anomaly, presentation is suggestive, clinical examination is diagnostic, echocardiography is confirmative, multiple ligation is the operation of choice and long term results in survivors are excellent.

Keywords: Patent Ductus Arteriosus; Multiple Ligations.

Introduction

The ductus arteriosus is derived from the 6th aortic arch, and normally extends from main or the left pulmonary artery to descending aorta just distal to the origin of left subclavian artery. The length is variable from 5 to 20 mm, with larger aortic orifice, rarely ductus may be right sided, bilateral or absent. In normal full-term neonates, functional closure of the ductus occurs within first 10 to 15 hours of life. During fetal development low oxygen tension and high levels of circulating prostaglandins maintain ductal patency, but after birth the rise in oxygen tension and fall in prostaglandins levels lead to ductal closure. Delayed closure of the ductus is called prolonged patency, and failure of closure results in persistent patency, also called as Patent Ductus Arteriosus (PDA). Final closure may occur at any age but is uncommon after the age of six months. PDA results in left to right shunt of blood, with pulmonary congestion and left ventricular volume overload. Shunting occurs throughout the systole and diastole and results in diastolic hypotension, and possibly impaired perfusion of brain, lower extremities, and abdominal organs. Sub endocardial ischemia may be noted even in infants, ultimately myocardial dysfunction may occur and lead to left ventricular failure.

The incidence of PDA which accounts for 5 to 10% of congenital cardiac defects, is more common in females, and varies from one in 2500 to 5000 live births, and the incidence increases with prematurity and decreasing birth weight. Although prolonged

survival has been reported, mortality of infants with untreated PDA may be as high as 30%. Presentation, clinical examination and echocardiography help in establishing diagnosis in almost all the patients. Except in conditions where ductal circulation is the only means of perfusion notably in pulmonary atresia, severe coarctation of aorta, patency of ductus is not desirable. Pharmacotherapy for closure, device closure and or surgical obliteration gives excellent results.

Material and Methods

The study was conducted in Department of Cardiovascular and Thoracic Surgery (CVTS). All the patients with isolated PDA or PDA associated with other anomalies, irrespective of age, sex, presentation and surgical outcome were included in the study. Besides a detailed history a thorough general and systemic examination was done. Transthoracic echocardiography was the investigation of choice. After induction of anesthesia, the patients were positioned on the right side, preferably near the surgeon's side of the operating table, a small roll or pillow may be placed under the mid chest. Posterolateral, lateral or axillary incision was given, underlying muscles were incised and or retracted and the pleural cavity was entered through 4th intercostals space. Chest cavity was inspected, mediastinal pleura over the proximal descending thoracic aorta was incised, traction sutures were placed on the anterior and posterior pleural flaps, the anterior pleural traction sutures were pulled and anchored to retractors or the chest wall. Vein that traverses the aorta obliquely on its anterior surface is ligated and divided. The left recurrent laryngeal and vagus nerves are identified and protected, areolar tissue and the pericardial lappet anterior to the ductus are elevated and dissected free of ductus, anterior, superior and inferior surfaces of ductus are freed, and a right angled clamp is passed behind the ductus, any remaining areolar tissue is stretched, or cut away, till the tip of clamp is visible on other side, silk threads are passed, and multiple ligations (three ligatures, aortic end, central ductus and pulmonary end) of the PDA were done. Repair of Atrial Septal defect was done after three months of PDA ligation in three patients, one patient was managed with phosphodiesterase 5 inhibitor before surgery, and in one patch aortoplasty was also done. Morbidity and mortality was recorded and the patients were followed in outpatientdepartment.

Results

A total of 79 patients were included in the study, with majority in first decade of life, Table 1. There were more female patients 47 (59.49%), the youngest was a 3 months old child and the eldest a 36 years old female, 24 patients (30%) had history of preterm birth, at 30 to 35 weeks of gestation, most of the patients belonged to low socio-economic group, and were from rural areas. Recurrent chest infection was the most common presentation, Table-2, and systodiastolic murmur was audible in 68 patients (86.07%). Electrocardiography, skiagram chest, and echocardiography was performed in all. Cardiomegaly was present in 39 (49.36%), and biventricular enlargement in 16 patients, (20.25%). 65 patients (82.27%) were operated by posterolateral, and 14 (17.72%) by axillary thoracotomy approach. 2 patients (2.53%) developed chylothorax, which subsided over two weeks, 3 patients (3.79%) died in immediate post operative period in intensive care unit, one each because of refractory arrhythmia, massive bleeding, and aspiration respectively. Survivors had uneventful post operative period, with excellent long term results.

Table 1: Showing age distribution of patients, who underwent PDA ligation

Decade of Life	Number of Patients	Percentage
First decade	52	65.82
Second decade	20	25.31
Third decade	05	6.32
Fourth decade	02	2.53

Table 2: Showing symptomatology in patients with PDA at presentation

Symptom	Number of Patients	Percentage
Recurrent chest infections	30	37.97
Cardiac failure	09	11.39
Failure to thrive	07	8.86
Bronchopneumonia	06	7.59
Asymptomatic	27	34.17

*More than one symptom was present in a patient.

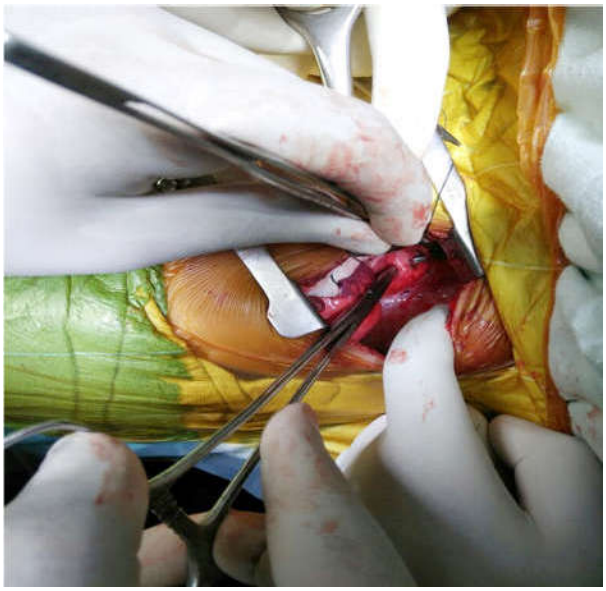

Fig. 1: Photograph showing, right-angle clamp has been placed behind the ductus to grasp the silk ligature

Fig. 2: Photograph showing Silk ligature has been placed around the patent ductus

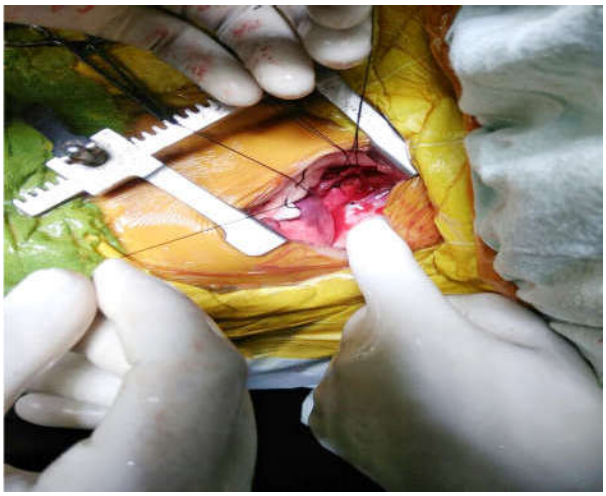

Fig. 3: Photograph showing Multiple ligations of the ductus have been done

Comments

A seemingly benign condition PDA can present with a grim phenomenon, especially in premature infants, or if the shunt is large. Isolated PDA in term infants occurs in approximately 1 in 2000 live births and accounts for 5% to 10% of all types of congenital heart diseases [1]. It may occur in siblings, suggesting a genetic factor, it is particularly common when the mother contracts rubella during the first trimester of pregnancy.Clinical presentation though diagnostic may be misleading at times, such as, in premature infants the murmur is usually systolic, with increasing size of the shunt, the murmur becomes louder and more prolonged, extending in to early diastole. Many children are asymptomatic, and the clinical features depend on the magnitude of the left to right shunt. The clinical diagnosis is based on increased or bounding peripheral pulses, and crescendo-decrescendo murmur in the 2nd and 3rd intercostals spaces. The murmur is truly continuous in patients with very large shunts. In a typical case, clinical diagnosis is sufficient, electrocardiogram / X-ray chest may be normal, or may show left ventricular hypertrophy / cardiomegaly and pulmonary plethora respectively. Echocardiography helps in establishing the diagnosis, not only in isolated PDA, but in patients with associated anomalies also. Except in patients with ductus dependent circulation, pharmacological closure, minimally invasive ligation / obliteration, or open ligation / division suturing is considered.

PDA being more common in females is well known [2]. None of our patients were operated immediately after birth, either the patients did not present early or were not sick enough to warrant such an intervention.The youngest being a three months old child, is at variance to other studies who had operated patients younger than that [2]. Symptomatology is in accordance to other studies [3], so is the presence of continuous murmur, which is best heard at the age of 2 to 3 months, but may be absent in some patients with congestive heart failure [4]. Two-dimensional echocardiography as the investigation of choice is well established, and is helpful even in silent ductus i.e. patients without auscultatory findings [5]. The role of ductus arteriosus in fetal circulation is well known [6], ligation or crushing of ductus had been proposed in 1907 [7], initial attempts of ligation failed [8], in the coming years ductus ligation succeeded [9], to the extent that division suturing was also done [10]. Less invasive methods for ductus closure are Avalon plug [11], pharmacotherapy [12], trans catheter device closure [13], and videothoracoscopic surgical interruption of PDA [14].

Ligation of PDA through posterolateral thoracotomy has been reported long back [8-9], so is the division suturing [10]. Ligation of ductus is indicated in patients with uncomplicated and pliable ductus, ligation as the procedure of choice has been reported by others also [15], but they used trans-axillary thoracotomy approach in all, except in one patient, who also needed posterolateral thoracotomy to control aortic bleeding.The study differs from procedures where, posterolateral thoracotomy has been used with good results [16], their thoracotomy was muscle sparing, patients were only neonates, and the obliteration of ductus was achieved using medium-sized surgical clip.The results of present study are similar to the studies, where elective admission for PDA ligation, with majority in first decade of life and greater than 3 months of age, has been reported [17, but differs in that we have not compared the results with other similar group with regard to hospital stay, and hospital charges. Multiple ligation done in present study is at variance to the ligation cum division-suture of PDA, and the observation that, ligation is associated with significant incidence of false aneurysm of the aorta [18]. The study also runs contrary to the observation that PDA should be closed under cardiopulmonary bypass and balloon occlusion [19], and also that PDA ligation is associated with increased chronic lung disease, retinopathy of prematurity, and neurodevelopmental impairment [20]. Post operatively patients developed hemorrhage, pneumothorax, chylothorax which resolved over a period of time, but none of the patients had left recurrent laryngeal nerve damage, which can occur after ductal closure [21]. Mortality of 3.79% is very high, when compared to other studies [22-23], but the patients died because of massive bleeding, refractory arrhythmia and aspiration. Long term results in survivors were excellent, and there was no prevalence of recurrent or persistent ductal patency.

Limitations

The study included only patients above 3 months of age, admitted electively for PDA ligation, ligation has neither been compared with division suturing nor with any other less invasive procedure.

Conclusion

Multiple ligation of PDA though abandoned and obsolete in advanced and higher cardiac centers, has lot of limitations, is invasive, may not be acceptable to all the patients, cannot be a substitute to pharmaco-therapy/minimally invasive interventions, but, should always be done in centers where advanced facilities are not available, pharmacotherapy has failed, minimally invasive procedures have failed, or, are not available/possible. The operative results are excellent and are comparable to that of division suturing.

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