

Original Research Article

Association of patent ductus arteriosus (PDA) with prematurity and low birth weight neonates

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ABSTRACT

Background: Patent ductus arteriosus (PDA) is a major morbidity encountered in preterm neonates, especially in babies less than 28 weeks gestation or 1000g. It may close spontaneously in preterm neonates; however, failure to close spontaneously in preterm neonates results in significant mortality and morbidity in them.

Methods: This prospective study was conducted in a tertiary care hospital in north India over a period of one year. The study cohort consisted of preterm, newborn babies admitted in the hospital with gestational age less than 37 weeks and birth weight <2500g.

Results: In this study total number of patients admitted during the study were 2930. Out of these preterm low birth weight neonates were 432. Among preterm low birth weight neonates admitted, 132 neonates were excluded as per exclusion criteria. Patent ductus arteriosus was detected in 56 among the 300 neonates giving an overall incidence of patent ductus arteriosus 18.6%, the incidence of patent ductus arteriosus was 56.2% for neonates weighing less than 1000gm, 24.7% for neonates weighing between 1000-1499g, 11.6% for neonates weighing between 1500-1999g and 5.6% for the neonates weighing between 2000-2499g.

Conclusions: Thus, incidence of patent ductus arteriosus was inversely proportional to gestational age and birth. Data also suggest that immaturity is the major determinant of the persistent patency of ductus arteriosus.

Keywords: Patent ductus arteriosus, Preterm neonates, Screening

INTRODUCTION

The ductus arteriosus is a vascular structure that serves to divert ventricular output away from the lungs towards the placenta in utero by connecting main pulmonary artery to the descending aorta. This essential fetal structure normally closes spontaneously after birth. After the first few weeks of life, persistence of ductal patency is abnormal. The physiological impact and clinical significance of the patent ductus arteriosus [PDA] depend

largely on its size and the underlying cardiovascular status of the patient.¹

Fetal patency of the ductus arteriosus is controlled by many factors, the most important of which are relatively low fetal oxygen tension and cyclo-oxygenase mediated products of arachadonic acid metabolism (primarily prostaglandin [PGE2] and prostacyclin [PGI2]).^{2,3} After birth the abrupt increase in the oxygen tension inhibits ductal smooth muscle voltage-dependent potassium channels, which results in an influx of calcium and ductal

constriction.⁴ PGE2 and PGI2 levels fall because of metabolism in the now functioning lungs and elimination of the placental source. Functional complete closure usually occurs within 24-48 hours of birth in term neonates. Within the next 2-3 weeks, infolding of the endothelium along with subintimal disruption and proliferation result in fibrosis and a permanent seal.⁵ Spontaneous closure of the ductus has been noticed by various researchers in upto two-third of the preterm neonates.⁶⁻⁷ The resulting fibrous band with no lumen persists as the ligamentum arteriosum. The various factors contributing to an increased incidence of PDA in preterm neonates includes:⁸⁻¹⁰

- (a) Increased sensitivity of ductus to prostaglandins as compared to term neonates.
- (b) Sensitivity to prostaglandins is sustained for longer period.
- (c) Higher incidence of hypoxia and acidosis.
- (d) Defective smooth muscle migration resulting in compromised anatomic closure.

PDA presents with clinical features of wide pulse pressure (>25mmhg), prominent pericardial pulsation, bounding pulses, an ejection systolic murmur and occasionally pan systolic murmur heard best at the 2nd left parasternal area on auscultation.^{11,12}

METHODS

This prospective study was conducted in a tertiary care hospital in north India over a period of one year. Informed consent was obtained from the parents/guardians.

Diagnosis of PDA was made on the basis of following criteria:

- a) Clinical diagnosis
- b) Chest X-ray: radiographic findings are non-specific which include cardiomegaly, upturned left bronchus due to left arterial enlargement and pulmonary plethora.¹³
- c) Echocardiography: Echocardiographic criteria include:¹⁴⁻¹⁶
 - Left arterial dilatation (left arterial: aortic root>1.6).
 - Diastolic turbulence (back flow) on Doppler in the pulmonary artery.
 - Direct imaging to measure the diameter of PDA.
 - A haemodynamically significant PDA is diagnosed in the presence of ductus diameter >1.5mm and absent/retrograde diastolic flow in post-ductal aorta.

Inclusion criteria

- The study population consisted of preterm, new born babies admitted in the hospital with gestational age less than 37 weeks and birth weight <2500g.

Exclusion criteria

- Neonates more than 37 weeks of gestational age
- Neonates weighing more than 2500gms.
- Neonates inappropriate for gestational age (IUGR).
- Neonates with severe birth asphyxia (A.S. <5 at 5 min of age).
- Terminally ill patients having hypoxia, acidosis, shock etc.
- Neonates with multiple congenital cardiac anomalies.
- Infant of diabetic mother.

After admission to hospital, detailed relevant history, clinical examination and investigations were on a predesigned proforma. The definite gestational age for each preterm neonate was based on the data of last menstrual period or by New Ballard Score. The preterm low birth weight neonates not falling under the exclusion criteria were subjected to echocardiographic assessment.

RESULTS

In this study total number of patients admitted during the study was 2930. Out of these 2930, the total number of preterm low birth weight neonates was 432. Among the total preterm low birth weight neonates admitted, 300 neonates who were not falling under exclusion criteria were monitored for patent ductus arteriosus. Among the 300 neonates monitored 10.6%(32) had weight of less than 1000g, 31%(93) had weight between 1000-1499g, 28.6%(86) had weight between 1500-1999g and 29.6%(89) had weight between 2000-2499g. As per the gestational age 18.6% (56) were between 27-29 weeks, 47.4% (142) were between 30-32weeks and 34% (102) were between 33-39 weeks (Figure 1).

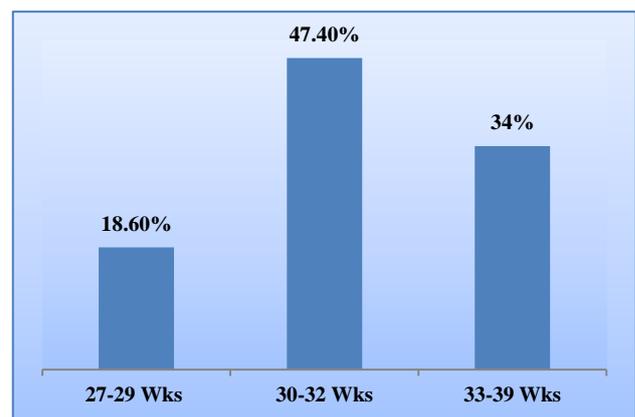


Figure 1: Percentage of PDA as per gestational age.

The number of female neonates were 46.7%(140) and male neonates were 53.3%(160). Common clinical findings observed among the preterm low birth weight neonates monitored for patent ductus arteriosus were tachypnoea (43.3%), tachycardia (40.0%), murmur (23.3%) followed by hepatomegaly (15%), bounding pulse (13.3%) and hyperactive precordium (10%). Chest

X-ray findings were positive in 10.0% of neonates (Table 1).

Table 1: Clinical findings observed and their percentage.

Clinical findings	No. of neonates	Percentage
Tachypnea	130	43.3
Tachycardia	120	40.0
Murmur	70	23.3
Hepatomegaly	45	15.0
Bounding pulse	40	13.3
Hyperactive precordium	30	10.0
Positive chest X-ray	30	10.0

The preterm low birth neonates after detailed clinical examination were subjected to echocardiographic assessment. Patent ductus arteriosus was detected in 56 among the 300 neonates monitored giving an incidence of patent ductus arteriosus 18.6%. When the subset of patients was taken in relation to birth weight, the incidence of patent ductus arteriosus was 56.2% for neonates weighing less than 1000g, 24.7% for neonates weighing between 1000-1499g, 11.6% for neonates weighing between 1500-1999g and 5.6% for the neonates weighing between 2000-2499g. Taking subset of neonates in relation to birth weight, PDA was observed in 56.2% of neonates weighing below 1000gms as compared to 14.1% only in those weighing greater than 1000gms making it statistically significant with p value of <0.0001 (Table 2).

Table 2: Incidence of PDA as per birth weight.

Birth weight (g)	No. of neonates	PDA detected	Incidence %
<1000	32	18	56.2
1000-1499	93	23	24.7
1500-1999	86	10	11.6
2000-2499	89	5	5.6
Total	300	56	18.6

There was no significant difference in the incidence of neonates on the basis of gender as 18.7% in male and 18.5% in female neonates. However, no relation was seen in relation to birth order and mode of delivery (Table 3).

The clinical findings were plotted with echocardiographic findings, authors found 44 out of 70 (62.8%) of those who had murmur were having PDA, followed by positive chest X-ray findings 17 out of 30(56.6%), hyperactive precordium with 12 out of 30(40%) and bounding pulse with 15 out of 40(37.5%) had echocardiographic findings consistent with PDA. The other clinical findings included in clinical diagnosis of PDA i.e. tachypnoea, tachycardia and hepatomegaly were present in 14.6%, 9.1% and 6.6% respectively. Thus, showing that presence of clinical findings of murmur, cardiomegaly on chest X-ray, hyperactive precordium and bounding pulses were more

consistent with presence of PDA in low birth weight neonates.

Table 3: Percentage of PDA as per Birth order, mode of delivery and consanguinity.

		No. of neonates	Percentage
Birth order	1 st	112	37.4
	>1 st	188	62.6
Mode of delivery	Caesarian section	103	34.4
	Normal vaginal	197	65.6
Consanguinity	Yes	85	28.3
	No	215	71.7

DISCUSSION

New born babies maintain some degree of patency of their ductus arteriosus for 24-48 hours after birth; in premature infants the ductus often remain patent for several days or even weeks.^{22,23} However, the degree of left to right shunting through patent ductus varies, as does the clinical impact of the shunting on a neonate. Consequently, at the onset of present study authors elected to utilize findings that suggest not only patency of ductus (e.g. a murmur) but findings indicating a significant degree of shunting on echocardiography.

The wide variability in the incidence of patent ductus arteriosus (PDA) has been reported previously, this is probably due to the differences in criteria for diagnosis or in the management of small premature neonates.^{17-20,24}

In present study authors observed that the overall incidence of patent ductus arteriosus was 18.6%. Almost similar results have been reported by R.Curtis Ellison George et al, they monitored 1689 infants out of which 342 (20.2%) had PDA.¹² Present results were almost similar to the results that have been reported by Bijan Siassi MD et al who conducted their study on the incidence and clinical feature of preterm LBW neonates.¹⁸ Overall incidence in their study was 21%. The incidence of PDA reported by Afiune JY, Julio M. Singer et al as 34.4% is higher as compared to present study. But they have calculated incidence on third day of life only, which can give higher incidence of patent ductusarteriosus. Hammoud MS, Elson HA et al in their study had reported 53.4% incidence of PDA in preterm LBW neonates.¹⁹ The higher incidence in their study could have been due to the study population comprising of preterm neonates less than 1580g, whereas present study included preterm neonates less than 2500g.

The incidence of PDA was significantly higher among the infants with birth weight below 1000g (56.2%) and also among those with gestational age less than 30 weeks (50.0%), while incidence was lower in those with birth weight above 1000g (14.1%), and those with gestational

age more than 30 weeks (11.4%). These results are almost similar to the results observed by Curtis Ellison R et al, Afiune JY et al, Yeh TF, Can I et al.^{6,25,27}

In this study the incidence of PDA was (18.7%) among male and (18.5%) among female neonates. Incidence was almost equal for each group. Similar results have also been reported by Curtis Ellison R et al, this study revealed that the incidence of PDA decreases with increase in the postnatal age.¹² Among the neonates in present study who were taken for echocardiography before 7th day of life, PDA was detected 24.7 % (26/105) neonates. Whereas among the neonates who were taken between 8-14th day of life 17.6% (20/113) had PDA and 12.1% (10/82) among those taken after 5th day of life. Decrease in incidence of PDA in preterm neonates with increasing postnatal age in this study is consistent with the results obtained by Arun Sasi, Ashok Deorarietal, Nemerofsky SL, Parravicini E et al, Jorge Yussef Afiune, Singer JM et al and Silverman et al.^{5,7,20,21}

Various demographic factors were studied in relation to incidence of patent ductus arteriosus. These included birth order, consanguinity, place of delivery and mode of delivery. None of these factors were found to have a statistically significant relation to the incidence of PDA.

In this study authors observed 62.8% incidence of patent ductus arteriosus among the neonates who had murmur, 40% among the neonates who had hyperactive pericardium, and 37.5% among the neonates who had bounding pulse, 14.6% among the neonates who had tachypnea, 9.1% among the neonates who had tachycardia and 6.6% among neonates who had hepatomegaly. Patent ductus arteriosus was detected in 56.6% of neonates who chest X-ray findings positive. These results were consistent with the study by R.Curtis Ellison et al, Jorge Yussef Afiune, Singer JM et al.^{12,20}

CONCLUSION

This study was aimed to determine the incidence of patent ductus arteriosus in preterm low birth weight neonates admitted in the hospital during the study period. Two thousand nine hundred and thirty neonates were admitted during the study period. Out of these 432 neonates were preterm low birth weights. Three hundred preterm low birth weight neonates were studied, out of which 56(18.6%) had PDA detected on echocardiography. In present study overall incidence of patent ductus arteriosus in preterm low birth weight neonates was 18.6%. The incidence of patent ductus arteriosus was 56.2% for infants weighing less than 1000g, 24.7% for infants weighing between 1000-1499g, 11.6% for infants weighing between 1500-1999 and 5.6% for the infants weighing between 2000-2499g. If the subset of neonates with weights below 1000g was taken alone, incidence of patent ductus arteriosus was 56.2%, while among those weighing more than 1000g had incidence of 14% which was statistically significant

($p < 0.0001$). The patent ductus arteriosus was observed in 50% of those neonates with gestational age of less than 30 weeks, while its incidence was 11.4% in those having gestational age of more than 30 weeks which is also statistically significant with p value of < 0.0001 . The incidence of PDA was almost identical for male and female neonates. Incidence of patent ductus arteriosus was 62.8% among those who had murmur, 40% among those having hyperactive precordium and 37.5% among neonates who had bounding pulses.

Thus, incidence of patent ductus arteriosus was inversely proportional to gestational age and birth weight. Data also suggest that immaturity is the major determinant of the persistent patency of ductus arteriosus.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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