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Ligation of Patent Ductus Arteriosus for Premature Infants in Intensive Care Unit

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Abstract

Purpose: To review the results of ligation of patent ductus arteriosus in premature babies in an intensive care unit. ***Method:*** Retrospective review of premature babies who underwent ligation of patent ductus arteriosus in the intensive care unit, Grantham Hospital, during the period from January, 1999 to December, 2002. Results are compared with those who underwent ligation of patent ductus arteriosus in the operating theatre during the same period. ***Results:*** A total of 33 premature babies were recruited. Eighteen babies, including 11 male and 7 female babies with a mean gestation of 25.7 weeks (ranged from 24 to 30 weeks) and a mean birth weight of 835 grams (ranged from 625 to 1439 gram) underwent ligation of patent ductus arteriosus via a left thoracotomy in the intensive care unit. The mean body weight at the time of operation was 1132 grams with a range of 700 to 2700 grams. The indications were respiratory failure and congestive heart failure. The babies were referred from 4 different hospitals. All except 2 babies had a trial of indomethacin induction for closure of patent ductus arteriosus. All except 1 baby received surfactant treatment. The mean ductal size was 3 mm with a range of 2 to 5 mm. There were no statistical difference between the babies operated in the intensive care unit and the operating theatre in terms of the presence of bronchopulmonary dysplasia, necrotizing enterocolitis, pre-operative use of indomethacin, the size of the duct, the mean duration of anaesthesia, the mean change in oxygen requirement, ventilatory support and inotropic support. Babies undergoing ligation of the patent ductus arteriosus in the intensive care unit are significantly smaller in terms of their birth weight and their weight at surgery ($p<0.001$). They tend to be more premature ($p<0.001$) and sick as compared with those who have their surgery done in the operating theatre, with more babies having respiratory distress syndrome and intraventricular haemorrhage ($p<0.05$ and $p<0.001$, respectively). There is a significant decrease in body temperature ($p<0.05$) after operation in those babies who have ligation of patent ductus arteriosus performed in the operating theatre, and such a

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change is not observed in those with ligation of patent ductus arteriosus done in the intensive care unit. There was one hospital-mortality due to torrential bleeding from the posterior wall of the duct in the intensive care unit group. Blood loss was minimal in other infants and there was no empyema or wound dehiscence. Most of the patients were transferred back to the referring neonatal intensive care units the next day after surgery to manage other problems arising from prematurity (16 intraventricular haemorrhage, 3 bronchopulmonary dysplasia, 6 necrotizing enterocolitis, 18 respiratory distress syndrome). None of the patients required readmission for management of late surgical complications. ***Conclusion:*** Ligation of patent ductus arteriosus in the intensive care unit is safe and effective and outcomes are comparable to that performed in the operating theatre. Risks, including hypothermia, encountered during transfer of preterm infants to the operating theatre can be avoided and continuity of care can be provided when patent ductus arteriosus is ligated in the intensive care unit. The availability of an experienced multidisciplinary cardiac team to handle preterm babies during operation in the intensive care unit is essential for the success of such a practice.

Key words Intensive care unit; Patent ductus arteriosus; Premature infants; Surgery

Introduction

Patent ductus arteriosus (PDA) is common in preterm babies and persists in 15% to 80% of infants, depending on the gestational age, birth weight and the index of suspicion.[1] Premature infants with PDA are associated with more severe respiratory distress syndrome (RDS). Significant left to right shunting may cause heart failure in the preterm infant. This may complicate the clinical course of RDS and result in prolonged dependency on mechanical ventilation. Therefore significant PDA requires closure by surgical method if medical therapy with indomethacin to close the PDA fails.

This study is a retrospective review of our local experience comparing PDA ligation in our neonatal cardiac intensive care unit (ICU) and operating theatre (OT).

Methods

Medical records of preterm infants who underwent PDA ligation in the period from January, 1999 to December, 2002 were reviewed. All preterm infants were evaluated by our paediatric cardiologists. The presence of PDA and absence of other associated cardiac lesions was confirmed by transthoracic echocardiogram before operation. The following variables were extracted from the records: gestational age, birth weight, body weight at surgery, associated morbidities, previous medical treatment, intra-operative PDA size, duration of operation, pre-operative and post-operative body temperature and the inotropic and mechanical ventilatory requirements. Patients underwent PDA ligation in the OT before December, 1999. Subsequently, all PDA ligations are performed in the ICU unless there are multiple cardiac lesions such as associated coarctation of aorta or complex congenital heart disease. A total of 33 premature babies underwent PDA ligation during the study period. Eighteen and 15 patients received the operation in ICU and OT, respectively. The two groups of patients were compared with respect to the aforementioned variables. Readmissions for management of late surgical complications were noted.

Statistical Analysis

Data were expressed as mean±SD. Ranges were given where appropriate. Student's t test was used for comparison of continuum variable whereas Fisher Exact test was used for comparison of categorical data. A value of $p<0.05$ was considered statistically significant.

Results

The clinical data of patients was shown in Table 1. When compared with infants operated in the OT, infants operated on in the ICU had significantly lower gestational age at birth (25.7±1.78 vs 29.5±3.52 weeks, $p<0.001$), lower birth weight (835±222 vs 1326±585 grams, $p<0.001$), and lower body weight at operation (1132±463 vs 1628±495 grams, $p<0.001$). More babies in the ICU group have associated comorbidities, such as intraventricular hemorrhage ($p<0.025$) and respiratory distress syndrome ($p<0.001$). There was no difference in the intra-operative sizes of PDA between the two groups. The mean PDA size in the ICU

Table 1 Clinical data of patients

	ICU	OT	p value
No. of patients	18	15	NS
Gestation (weeks, mean±SD)	25.7±1.78	29.5±3.52	<0.001
Birth weight (grams)	835±222	1326±585	<0.001
Weight at surgery (grams)	1132±463	1628±495	<0.001
Size of PDA (mm)	3	3.6	NS
Indomethacin	16	10	NS
IVH	16	8	<0.05
RDS	18	6	<0.001
BPD	3	5	NS
NEC	6	2	NS

ICU, intensive care unit; OT, operating theatre; SD, standard deviation; PDA, patent ductus arteriosus; IVH, intraventricular haemorrhage; RDS, respiratory distress syndrome; BPD, bronchopulmonary disease; NEC, necrotizing enterocolitis

group was 3.0 mm (ranging from 2.0 to 5.0 mm) and that in the OT group was 3.6 mm (ranging from 2.8 to 5.0 mm). There was also no difference between the two groups in the number of patients treated pre-operatively with indomethacin.

The surgical and post-operative data was shown in Table 2. There was no significant difference in the duration of anaesthesia, inotropic support, oxygen requirement and requirement of ventilatory support post-operatively between the two groups. In both groups, there was no disruption of vascular lines, chest tubes and dislodgement of endotracheal tube post-operation. However, a significant drop in the mean body temperature (-0.36±0.64°C vs +0.15±0.97°C, p<0.005) post-operatively was observed in patients undergoing PDA ligation in the OT.

There was one hospital-mortality. It occurred in a premature baby boy, born at 28 weeks of gestation and with a body weight of 1320 grams at operation which was performed in the ICU. Attempts to isolate the PDA which measured 2 mm in diameter resulted in laceration of its posterior wall and uncontrollable torrential bleeding that led to the death of the patient. There was minimal blood loss in all other patients. There were no major surgical complications such as wound complications and empyema. All patients were transferred back to the referring neonatal intensive care unit the next day after surgery. None of the patients required readmission for management of surgical complications.

Discussion

A significant PDA with cardiomegaly and pulmonary congestion refractory to medical treatment requires closure. Surgical closure of PDA has been shown to be safe in premature infants[2,3] and it can be accomplished either in neonatal ICUs or in operating theatres by an experienced cardiac surgeon.

Controversies exist, as to whether a critically ill neonate should be transferred to the OT for ligation of PDA. Transferral of a sick neonate may be associated with significant morbidity, such as unstable haemodynamics,

Table 2 Surgical and post-operative data of patients

	ICU	OT	p value
Duration of anaesthesia (min)	56	54	NS
Mean change in FiO_2 requirement compared to pre-op	No change	-6%	NS
No. of patients requiring ventilation pre-op: post-op	15:14	8:7	NS
No. of patients requiring inotropic support pre-op: post-op	6:6	3:3	NS
Change in body temperature (°C)	+0.15±0.97	-0.36±0.64	<0.05

ICU, intensive care unit; OT, operating theatre; FiO_2, inspiratory oxygen concentration; Pre-op, pre-operation; Post-op, post-operation; NS, non-significant

hypothermia, disruption of vascular lines and chest tubes, and dislodgement of endotracheal tube. Furthermore, there may be delay due to the lack of the immediate availability of the operating rooms.[4] On the other hand, evidence has shown that PDA ligation in neonatal ICUs can produce results comparable to that performed in OT.[5]

Potential advantages of performing surgery in ICUs include the elimination of the aforementioned risks involved in transferring the critically ill premature infants and continuity of care provided by the ICU team pre-operatively, intra-operatively, and post-operatively. Furthermore, vital treatments like inhaled nitric oxide that may have to be discontinued during transfer to the OT can be continued in the ICU without disruption.

Disadvantages of performing surgery in the neonatal ICU include limited lighting and accessibility since the lightings in ICU are not designed for operative use and the beds in the ICU, unlike those in the OT, are not adjustable. The degree of asepsis achieved in the ICU is a concern as there is comparatively more traffic in the ICU than the OT and the airflow per minute in the ICU is less than that in the OT. The unavailability of the anaesthetic machine and thus gaseous anesthetic agents in the ICU, and the increased psychological stress for ICU nurses who may have to assist in surgery are also concerns for the anaesthetists and ICU nursing staff. Patients with multiple pathologies cannot be operated on in the neonatal ICU.

The preterm infants who underwent PDA ligation in ICU in our study had more associated comorbidities and were more sick compared with the group with operation done in the OT. Anaesthetic duration for ligating the PDA in ICU was comparable to that performed in OT. Avoidance of possible complications of transferral to the OT like hypothermia and the ability to provide continuous care in the pre-operative, intra-operative and post-operative period by the ICU team support the procedure to be performed in ICUs rather than in the OT. We did not encounter serious technical difficulties in ligating PDA in the ICU. Many of these difficulties can actually be overcome. For example, headlights can be used to improve lightings and side-wards can be used for operation so that asepsis is more achievable. Special training can be offered to ICU nurses so that they can assist in operations. Prior negotiation with anaesthetists regarding the use of intravenous instead of gaseous anaesthetic agents is usually possible.

Haemorrhage is a known complication of ligation of PDA in premature baby. On retrospective review, we believe that the torrential bleeding leading to the death of the baby operated in ICU was most likely due to the very fragile and friable ductal tissue and was unrelated to the physical environment in ICU setting.

Our study, like previous reports,[6,7] showed that surgical closure in ICUs is a safe and effective method for the treatment of PDA in preterm infants.

Conclusions

PDA ligation in neonatal ICU is safe and effective in premature babies. Surgical outcomes are comparable to that performed in the OT. It eliminates the risk of transferral and allows continuity of care by the neonatal ICU team during the whole process. Limitations exist, but most of them can be adequately tackled by an experienced multidisciplinary cardiac team which is essential for the success of such a practice.

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