

Association of Patent Ductus Arteriosus and Phototherapy in Infants Weighing Less Than 1500 Grams

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ABSTRACT

Background: Very preterm infants with patent ductus arteriosus (PDA) are more likely to be born prematurely or receive therapeutic treatments that reduce ductus arteriosus functioning smooth muscle number, reduce the response to oxygen-elicited vasoconstriction, or increase the concentration of circulating vasodilators. **Objective:** In this study we aimed to evaluate the association between PDA and phototherapy in low birth weight (less than 1500 grams) neonates. **Patients and Methods:** Between August 2020 and December 2021, 100 neonates admitted to the Al-Hussein Hospital, Al-Azhar University, who needed phototherapy participated in our study. Infants affected with congenital cardiac problems, severe congenital abnormalities, hydrops fetalis, or rhesus isoimmunization required exchange transfusions of blood. After the newborn clinical team established that phototherapy was essential for infants in group A, researcher's secured written approval from the parents. Group (A) involved 50 infants who underwent phototherapy, whereas Group (B) included 50 infants who did not get any phototherapy at all. **Results:** There was significant difference between Group (A) and B regarding PDA prevalence and ductal size in PDA patients. There is significant difference between the groups as regard L-to-R shunt > small. **Conclusion:** Phototherapy has been associated to an increased incidence of patent ductus arteriosus in very low and extremely low birth weight infants.

Key words: Infants, Patent ductus arteriosus, PDA, Phototherapy

INTRODUCTION

A decrease in the occurrence of conditions like patent ductus-arteriosus (PDA), bronchopulmonary dysplasia, or intraventricular hemorrhage has not been linked to an increase in the survival of very preterm newborns during the previous years ⁽¹⁾. PDA, which arises at a rate that is inversely proportional to gestational age in very preterm newborns, is still a concern. An intraventricular hemorrhage, necrotizing enterocolitis, a long-term ventilator-dependence, and bronchopulmonary dysplasia are all associated with PDA ⁽²⁾.

Very preterm infants with PDA are more likely to be born prematurely or receive therapeutic treatments that reduce ductus arteriosus functioning smooth muscle number, reduce the response to oxygen-elicited vasoconstriction, or increase the concentration of circulating vasodilators ⁽³⁾.

Phototherapy is a frequent treatment technique used to treat neonatal hyperbilirubinemia in extremely preterm newborns, especially during the first week of life when duct patency is a clinical concern. Phototherapy has been shown to have deleterious effects on gastrointestinal motility, skin temperature, hydration, peripheral blood flow, electrolyte balance, and cardiac output ⁽⁴⁾.

Phototherapy does not affect PDA via prostaglandins, and they are removed concurrently with ductus arteriosus closure, according to a new study by **Surmeli-Onay et al.** ⁽⁵⁾.

Prostaglandin levels may have no impact on the photorelaxation effect ⁽⁴⁾.

In this study we aimed to evaluate the association between PDA and phototherapy in low birth weight (less than 1500 grams) neonates.

PATIENTS AND METHODS

Between August 2020 and December 2021, 100 neonates admitted to the Al-Hussein Hospital Al-Azhar University, who needed phototherapy participated in our study. Infants affected with congenital cardiac problems, severe congenital abnormalities, hydrops fetalis, or rhesus isoimmunization required exchange transfusions of blood.

Patients were divided into 2 equal groups. Group (A) involved 50 infants who underwent phototherapy, whereas Group (B) included 50 infants who did not get any phototherapy at all.

There were phototherapy lights that were spaced 45 cm apart from the body surface for phototherapy. As a part of their phototherapy, the light spectrum, each infant received light irradiance was recorded every day. Newborns were breastfed in both prone and supine positions for the remainder of their stay, in accordance with the procedure of the facility. The full echocardiographic assessment of each patient included two-dimensional imaging, colour flow, pulsed and continuous-wave Doppler studies.

It was possible to obtain information on numerous parameters using colour flow and imaging, including whether or not the ductus was open, the smallest possible size; an estimate of the shunt's size and direction; pulmonary arterial pressure; the left atrial/aortic root (LA/Ao) ratio; and the pulmonary artery pressure. These evaluations were conducted before to and 48 hours after phototherapy, or sooner if phototherapy was ceased. A short time before the arrival of the echocardiographers, phototherapy was stopped and the chest cover was removed. The cardiologist who reported the scan was also uninformed of the study

Group (A) allocation. Perinatal data were collected, including the date and time of delivery, weight at birth, gender, and age at which phototherapy began and ended, as well as fluid balance before and during those times. Respiratory distress and sepsis were also recognised as inter-related issues.

Ethical approval:

Ethical permission for the research was obtained from the hospital Ethics Committee. After the newborn clinical team established that phototherapy was essential for each infant in group A, researcher's secured written approval from the parents. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

IBM-SPSS version 24 was utilized for data analysis. Quantitative data were presented as mean and standard deviation and were compared by independent t test. Qualitative data were presented as frequency and were compared by chi² or Fisher's exact test. We considered results statistically significant if the P-values were less than 0.05.

RESULTS

Phototherapy-treated newborns had a reduced percentage of ductal patency, with 11/36 of the shield group displaying a ductus against 23/38 of non-shield group, according to this research.

There was no significant difference between groups A and B regarding basal characteristics (**Table 1**).

Table (1): Basal characteristics of included subjects

	Group A (n = 50)	Group B (n = 50)	P
Gestation (Weeks Completed)	27 (2)	27 (2)	> 0.05
Birthweight (g)	1160 (325)	1152 (336)	> 0.05
Sex			
Male	35 (70%)	30 (60%)	> 0.05
Female	15 (30%)	20 (40%)	
Method of delivery			
Caesarean section	30 (60%)	31 (62%)	> 0.05
Vaginal	20 (40%)	19 (38%)	
Parity of mother			
Primipara	27 (54%)	28 (56%)	> 0.05
Multipara	23 (46%)	22 (44%)	

Data are presented as mean (Standard deviation) or as frequency

There was significant increase in daily consumption of fluids during first week in phototherapy group (Group (A) (**Table 2**).

Table (2): Daily fluids and blood culture sepsis

	Group A (n = 50)	Group B (n = 50)	P
Daily fluids during 1 st week (ml/kg)	136 (16)	118 (13)	< 0.05
Blood culture-positive sepsis	7 (14%)	8 (16%)	> 0.05

Data are presented as mean (Standard deviation) or as frequency

Mean age of starting of photo therapy was 31 hours and mean duration of phototherapy was 46 hours (**Table 3**).

Table (3): Phototherapy data

	Group A (n = 50)- Mean (Standard deviation)
Phototherapy starting age (hours)	31 (2)
Phototherapy starting SBR (mmol/l)	107 (13)
Phototherapy duration (hours)	46 (14)
Spectral irradiance (flux), mW	553 (102)

SBR: serum bilirubin, Data are presented as mean (Standard deviation)

There was significant difference between Group (A) and B regarding PDA prevalence and ductal size in PDA patients (**Table 4**).

Table (4): Ductus arteriosus characteristics in both groups

	Group A (n = 50)	Group B (n = 50)	P
Ductus patent	38 (76%)	26 (52%)	< 0.05
Ductal size in mm	1.4 (0.2)	1 (0.1)	< 0.05
L-to-R shunt > small	6 (12%)	0	< 0.05

Data are presented as mean (Standard deviation) or as frequency

There is significant difference between the groups as regard L-to-R shunt > small.

DISCUSSION

Our results suggest that phototherapy significantly increase patency of ductus arteriosus in very low and extremely low birth weight infants.

Using isolated ductal rings from adolescent lambs, **Clyman and Rudolph** ⁽⁶⁾ were the first to record and characterise the effects of photorelaxation on smooth muscle, indicating that despite oxygen activation, photorelaxation resulted in the avoidance of constriction. In order to avoid ductal closure, it's unclear exactly how light works. Light is said to affect arterial smooth muscle through nitric oxide, followed by an increase in cyclic guanosine monophosphate, according to one theory ⁽⁷⁾.

Trans illumination of the chest wall indicates that the thin chest wall of very preterm neonates allows light to permeate inner cavities in the setting of pneumothorax and clinical consequences on the newborn digestive system ⁽⁸⁾. Improved phototherapy technology has made it possible for newborns to quiet the smooth muscle of the ductus arteriosus to a greater extent.

Phototherapy-treated newborns had a reduced percentage of ductal patency, with 11/36 of the shield group displaying a ductus against 23/38 of non-shield group, according to this research. Based only on clinical evidence of a murmur and ductus, the real prevalence of PDA may have been underestimated. A cardiac echocardiography was only performed for individuals who had a PDA-like murmur. In terms of patients with big ducts, as evaluated by the left-atrial-root ratio over 1.2, the difference between the two groups did not reach statistical significance.

It was observed that phototherapy dramatically enhanced patent duct arteriosus in newborns with significantly low birth weight, according to a study by **Barefield et al.** ⁽⁹⁾ that looked at this association. **Benders et al.** ⁽¹⁰⁾ observed that more than half of preterm newborns undergoing phototherapy had patent ductus arteriosus. The re-opening of the ductus arteriosus may be induced by the Ca²⁺-dependent K⁺ channel being activated in the ascending aorta, left pulmonary artery, and ductus arteriosus of the preterm infant's chest wall ⁽¹¹⁾.

A correlation between the use of phototherapy and ductal patency has also been shown by **Scheidt et al.** ⁽¹²⁾ in his retrospective cohort studies.

CONCLUSIONS

Phototherapy has been associated to an increased incidence of patent ductus arteriosus in very low and extremely low birth weight infants.

Declarations:

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