Saturation With Oxygen for Ductal Dependent Congenital Heart Diseases Before and After the Prostaglandin Therapy

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Abstract

Ductal dependent congenital heart diseases represent 14-20 % of all congenital heart diseases. A primary goal of the treatment of these diseases is to retain ductus open until the final cardiosurgical treatment. Prostaglandins are presently the only medicaments, which have a capability to keep ductus open. By means of a retrospective study in a period from January, 2000 until December, 2002 at the Paediatric clinic of the Clinical centre of the University in Sarajevo, 14 patients (treated with prostaglandins) diagnosed with ductal dependent congenital heart diseases were analyzed. In our sample, there are 9/14 male patients (64.3 %), 11/14 (78.6%) were full-term newborns, while 10/14 (71.4 %) were eutrophic at birth. An average saturation increase, after the prostaglandin therapy, measured in blood from the capillaries is 29, and measured transcutanlly is 32 units. Duration of prostaglandin therapy in our study was on average 17.2 days. The most common cause of death was insufficientia cardiorespiratoria (4 out of 11), but sepsis/infection (3 out of 11) and insufficientia renalis were also common. 78.6 % (11 out of 14) patients died partly because of the complexity of these diseases, but also because a cardiosurgical treatment is delayed. A goal of this study is evaluation of saturation with oxygen before and after the prostaglandin therapy.

KEY WORDS: saturation, duct dependent, congenital heart disease, prostaglandin

Introduction

Congenital cardiac diseases have an incidence of 0.8 % (1) and ductal dependent congenital heart diseases are represented with 14-20 % (2). Ductus arteriosus in a foetal period exists as a large vascular structure, with a diameter equal to lung truncus and descending aorta. About 55-60 % of foetus systemic circulation flows from the right to the left side of circulation through ductus. Lung resistance decreases with a first breath intake, ductus constriction starts and it is functionally closed 10-18 hours after the birth. Structural closure of ductus usually ends between the 15 th and the 21. day (3). Newborns with ductal dependent congenital heart diseases can be symptomatic until the moment ductus closes, so a number of children are sent home as healthy. Decrease of blood flow through ductus causes dangerous hypoxia or cardiogenic shock, metabolic acidosis, multisystemic failure and death. Ductal dependent congenital heart diseases consist of the following congenital heart disease groups:

A. **Ductal dependent pulmonary circulation**: pulmonary atresia with intact intraventricular septum, tetralogia Fallot (more serious forms), tricuspid atresia, univentricular heart with critical stenosis or with pulmonary artery atresia;

B. **Ductal dependent systemic circulation**: hypoplastic left heart syndrome, critical aortic stenosis, critical aortic coarctation, aortic arch obstruction;

C. **Ductal dependent congenital heart diseases without an adequate blood mixing**: transposition of great arteries.

A common order of therapeutic measures for the above stated heart diseases is prostaglandin therapy, intubation and sedation, oxygen therapy, correction of acidosis, hypoperphusion and hypotension (4,5,6) A primary goal for the patients with ductal dependent congenital heart diseases is to medicamently retain their ductus open. Prostaglandins are presently the only medicaments, which keep ductus open. The usual starting dose is 0.05 to 0.1 mcg/kg/BW*/min, and a maintenance dose is lower and can be as low as 0.01 mcg/kg/BW/min in a continuous infusion. The drug side-effects are numerous, and some of them are: apnoea, convulsions, vasodilatation, arrhythmia, hypotension, fever, infection, hypoglycaemia, hypocalcaemia, bleeding, thrombocytopenia and diarrhoea (7,8).

Patients and Methods

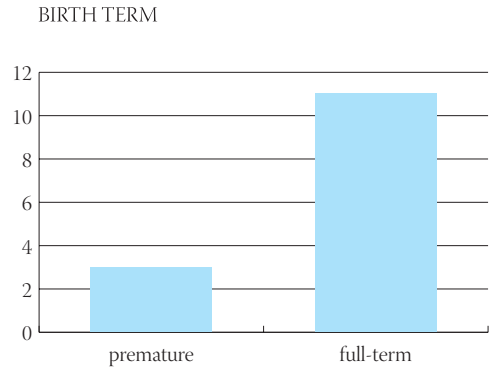
During the period from January, 2000 until December, 2002, 14 patients who were treated with prostaglandins at the Paediatric clinic of the Clinical centre of the University in Sarajevo, neonatology unit, with ducal dependent congenital heart diseases have been analyzed by a retrospective study. A source of information were patient records (disease histories) and computer information bases. Diagnosis for heart disease in all cases was obtained with an echocardiography, after the history, physical findings, ECG, lung and heart X-rays, and a complete blood analysis with the acidobasic status (ABS). The group was analyzed according to sex, birth weight, weeks of gestation, time duration of prostaglandin therapy, final outcome and a death cause. All the patients received Alprostadil (prostaglandin E2) intravenously in a continuous infusion. Saturation with oxygen before and after the prostaglandin therapy was recorded transcutanly and from capillary blood.

Results

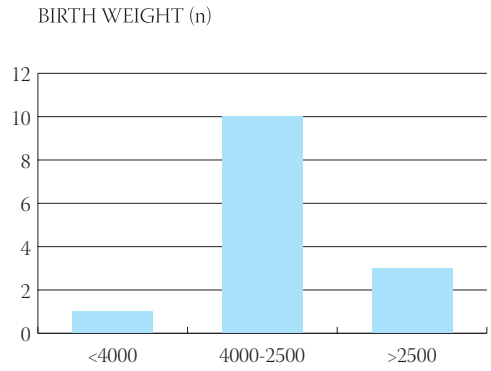
A total of 14 patients formed this study. Males were presented with 64% (9/14) which has been shown in Table 1. Out of a total number of newborns with ductal depen-

SEX	NUMBER (n)	PERCENT (%)
MALE	9	64
FEMALE	5	36

TABLE 1. Sex structure of ductal dependent congenital heart diseases (n=14).



GRAPH 1. presents that majority of patients with duct dependent congenital heart disease were full-term newborns 78.6 % (11/14), an average gestation age was 34 weeks, ranging from 31 to 40 gestation weeks.



GRAPH 2. Structure of ductal dependent congenital heart diseases according to the birth weight

dent congenital heart diseases - 71.4 % (10/14) were euthropic (Graph 2). Considering that oxygen exchange until birth is conducted through mother's placenta (as most important role), it is not a surprise that all the patients were well developed for their age at birth. An average increase of saturation after the prostaglandin therapy followed via gases analyses of capillary blood was 29 units, ranging from 18 to 45 (Table 2). From the same Table it is visible that increase of transcutan saturation was 32 units, ranging from 14 to 52 units as well as an average maintenance dose of prostaglandins: 0.033 mcg/kg/BW/min (from 0.01 to 0.09). Table 3 represents data on an average duration of prostaglandin therapy was 17.2 days ranging from 3 to 41 days. Out of 14 patients, 11 of them died (78.6%), and the three who survived were transferred to the cardiosurgical centres outside of Bosnia and Herzegovina. In Table 4: causes of death: four patients (36.3 %) died due to cardiac insufficiency, three died due to systemic infection and three because of renal insufficiency. In one newborn cause of death was massive intracranial haemorrhage.

Discussion

Usage of prostaglandins goes back to the 70's. The Nobel prize for a research on prostaglandins in 1970 won Von Euler, and in 1982 Suneu K. Bergstrom, John R.Vane. The drug Alprostadil - prostaglandin E1 is in use in neonatal cardiology, but also Dinoprost - prostaglandin E2. All the patients in our study received Alprostadil by infusion. However, use of prostaglandin E2 is recommended by Silove, because he found that they have fewer side-effects (4). Unwanted effects are in a close correlation with a dose. The most common complications are apnoea, febrile states and infection. Silove

AGE	WEIGHT WHEN ADMITTED (G)*	MAINTENANCE DOSE PGE1 (MCG/KG/MIN)	INCREASE OF SAT.(CAPILLARY BLOOD-ABS)	INCREASE OF SATURATION IN UNITS (ABS)	INCREASE OF SATURATION (TRANSCUT.)	INCREASE OF SATURATION IN UNITS (TRANS.)
5 h	1300	0.05	from 0.51 to 0.90	0.39	from 62 % to 92 %	30
1 day	2590	0.07	from 0.24 to 0.42	0.18	from 67 % to 87 %	20
1 day	3890	0.01	from 0.50 to 0.89	0.39	from 60 % to 85 %	25
8 days	3500	0.025	from 0.71 to 0.91	0.20	from 82 % to 99 %	17
7 h	3900	0.03	from 0.26 to 0.71	0.45	from 84 % to 98 %	14
1 day	2090	0.05	from 0.41 to 0,76	0.35	from 35 % to 67 %	32
2 days	3600	0.05	from 0.61 to 1.00	0.39	from 70 % to 100 %	30
1 day	3280	0.01	from 0.47 to 0.65	0.18	from 47 % to 61 %	14
1 day	3100	0.03	from 0.58 to 0.99	0.41	from 52% to 92 %	40
1 day	3820	0.01	from 0.58 to 0.96	0.38	from 54 % to 74 %	20
1 day	2700	0.01	from 0.56 to 0.90	0.34	from 47 % to 99 %	52
3 days	3650	0.01	from 0.70 to 0.94	0.24	from 67 % to 82 %	15
6 days	3200	0.09	from 0.63 to 0.73	0.20	from 57 % to 80 %	23
3 days	3540	0.02	from 0.58 to 0.90	0.32	from 66 % to 83 %	21

TABLE 2. Saturation with oxygen before and after the prostaglandin therapy recorded transcutanly and from capillary blood. g*=grams

recommends 0.03 mcg/kg/BW/min, while larger doses are given for a few hours at the beginning. An average maintenance dose in our study is 0.03 mcg/kg/BW/min. Prostaglandins directly effect smooth muscles of ductus arteriosus and dilate it. They cause vasodilatation of all the arterioles. They inhibit aggregation of platelets. A maximum effect of the drug occurs after 30 minutes from the start of infusion for cyanotic, and after a few hours for the obstructive lesions. They have to be given before ductus closes completely, because this drug cannot open it. An effectiveness of the drug depends on the starting values of pO2; the more serious hypoxia is, the more pO2 increases. Thus, we can say that age of a child and starting values of pO2 have a key role in effectiveness of the drug. A way of drug intake (venous or arterial), sex or pCO2 do not affect the drug effectiveness (6,10,12). In our study, 50 % (7/14) of the children started the prostaglandin therapy on the first day of life. An average increase of saturation measured in capillary blood was 29 units, ranging from 18 to 45 units. An average increase of saturation measured transcutanly was 32 units, ranging from 14 to 52. Prostaglandins are given for a relatively short period of time, a few hours to a few days, longest for a month. During that time, a child is cardiosurgically cared for. If a duration of the therapy is prolonged, side-effects are more common and more serious, and ductus becomes very brittle, so that during a surgical intervention it can potentially burst (7,8,11). In our study, 78.6 % (11/14) of the patients died. 8/14 had a complex congenital heart disease, (Transposition of Great Arteries - TGA), which needs to be corrected within the first 2-3 weeks after the birth, and that is currently not available in Sarajevo, because the cardiosurgical treatment of paediatric patients is done 3-4 times a year during the visits of the cardiosurgeons from Vienna. The local team has not yet been trained for surgical interventions of complex congenital heart diseases. High mortality is a consequence of a discontinued cardiosurgical treatment, prolonged prostaglandin therapy, as well as a long duration of mechanical ventilation with infections.

DEATH CAUSE	DEATHS (N)	PERCENT %
INSUFF. CARDIORESPIRATORIA	4	36.3
SEPSIS	3	27.3
INSUFF. RENALIS	3	27.3
HEMORAGIA INTRACRANIALIS	1	9.1

TABLE 4. Death causes for ductal dependent congenital heart diseases (n=11).

PATIENT	DIAGNOSIS	OUTCOME AT RELEASE	NUMBER OF DAYS ON PROSTAGLANDIN THERAPY
1	TGA, ASD	Died	41
2	ASD, DAP	Died	39
3	ASD	Died	23
4	TGA	Died	3
5	VSD	Died	5
6	TGA	Died	3
7	TGA, VSD	Died	23
8	TGA, VSD	Died	8
9	ASD, VSD	Died	16
10	TGA, DAP	Died	6
11	VSD, ASD	Survived	8
12	VSD, DAP, ASD	Survived	26
13	TGA, VSD	Survived	26
14	TGA, ASD, VSD	Died	14

TABLE 3. Diagnosis for ductal dependent congenital heart ; Diseases, mortality and time duration of prostaglandin therapy.

Conclusion

This randomized, clinically selected study confirms a justification for the use of prostaglandins in neonatal cardiology, and their useful effect. However, in order to increase a survival rate and life quality of these patients, it is necessary to improve and to establish a proper paediatric cardiosurgery in Bosnia and Herzegovina. Cardiosurgery in Bosnia has been improved during the past four years, which can be seen in a total number (160 patients) and outcomes (figures in correlation with European centres) of the treated patients by the local team and the cardiosurgeons from Austria. However, improvement concerns primarily a continuos prostaglandin supply, education in the foetal echocardiology (which would significantly decrease a number of complex congenital heart diseases) and a paediatric cardiosurgery, so that the patients with congenital heart diseases can have an adequate treatment on time.

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