MESENTERIC OXYGEN DESATURATION IN AN NEWBORN WITH INTRAUTERINE GROWTH RESTRICTION AND COMPLEX CONGENITAL HEART DISEASE WHO DEVELOPED NECROTISING ENTEROCOLITIS-CASE PRESENTATION

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Abstract

Congenital heart disease is a major risk factor for the development of necrotising enterocolitis (NEC), although its pathophysiology remains incompletely understood. NEC is a multifactorial disease that occurs in a high risk newborn. NEC incidence is inversely proportional to gestational age, only 10% of term infants develop disease.

We present the case of a term newborn with intrauterine growth restriction and complex congenital heart disease (CHD), who developed in the underlying disease, enterocolitis at 10 days of life. Early diagnosis was established using near-infrared spectroscopy (NIRS) which showed significant mesenteric oxygen desaturation secondary to significant decrease in aortic blood flow.

The standard treatment of NEC with antibiotics, enteral feeding cessation and cardio-circulatory support did not work in this newborn due to decreased mesenteric blood flow and significant ischemia. CHD that caused extremely low blood flow in mesenteric territory and which could not be surgically corrected caused child's death.

NIRS is a noninvasive diagnostic method that monitors highly accurate regional tissue oxygenation and could detect mesenteric ischemia in early stages.

The authors want to emphasize through this rare case of CHD, that any heart disease with decreased aortic flow lead to impaired mesenteric oxygen delivery beeing a risk factor for NEC. Tissue hypoxia secondary to decreases in mesenteric blood flow is the central pathophysiological cause of NEC in this term infant.

We also want to highlight the usefulness of NIRS for noninvasive measurement of tissue perfusion in all high risk neonates.

Keywords: term newborn, intrauterine growth restriction, complex congenital heart disease, necrotising enterocolitis , near-infrared spectroscopy, mesenteric oxygen desaturation.

Introduction

NEC is an inflammatory bowel disease of the newborn, beeing one of the most common gastrointestinal emergency in this age, causing a high mortality rate between 10-30%, surgical cases exceeding 50% (1).

NEC is considered a multifactorial disease that occurs in a high risk newborn. Despite the research conducted for understanding this disease, the pathophysiology of NEC is still incompletely understood. It is believed that involve a complex interaction among several factors: gestational age, infant milk formula, enteral nutrition, functional immaturity of the newborn gut, intestinal hypoxia-ischemia, treatment with antibiotics and the presence of infectious agents or toxins (2). The main pathogenetic link is represented by intestinal ischemia and reperfusion injury with an inadequate inflammatory response (3,4).

NEC incidence is inversely proportional to gestational age, over 90% of affected infants are preterms and only 10% of term infants develop the disease(5.) These term infants often present additional risk factors that may predispose to intestinal ischemia such as CHD, intrauterine growth restriction or asphyxia at birth (6,7,8,9). From CHD, increased risk in developing NEC have the following: obstruction of the aortic arch, hypoplastic left heart syndrome and common arterial trunk (6).

NIRS is a noninvasive, feasible and beneficial technology, that monitors regional tissue oxygenation reflecting the tissues perfuzional status. NIRS has the ability to continuously and simultaneously monitor tissue perfusion in different organs without interrupting pacient's routine care. Studies have demonstrated the efficacy of NIRS to monitor cerebral, intestinal and renal perfusion, to detect potential ischemic episodes. NIRS can help other monitoring methods currently used, to increase the degree of suspicion of abnormal perfuzional status in infants and thus reduce the risk of developing ischemic lesions (10,11,12,13).

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It utilizes light wavelengths (700-1000nm). The technique consists in placing probes on different areas of the body such as the forehead (cerebral), abdomen (mesentery) and lower back (renal). Each probe consists of a light source and 2 photodetectors to measure tissue oxygen levels at different tissue depths. One path length measures surface level tissue oxygenation and the other path length measures deep tissue oxygenation. The photons emitted from the light source scatter in the tissue bed and those that are not absorbed are returned to the skin photodetector. By measuring the amount of light (deep path minus surface path) returned to the skin, NIRS values represent the amount of spectral absorbtion that is occuring in the tissue bed. This measurement represents the weighted average of arterial, venous and capillary oxygenation at the tissue level and is reported as regional oxygen saturation (rSo2). In this way, the clinician can monitor directly, in real time, fluctuations in tissue oxygenation (14).

Case presentation

We present the case of a female newborn, the second child of young, healthy parents, undispensarized pregnancy , born at home, assisted by midwife, with gestational age of 39 weeks and birth weight 2300 grams. No significant family history. The child is brought in Neonatology Department of Emergency Municipal Hospital Timisoara 1 hour after birth. He presented good general status at birth, with good neonatal adaptation.

On the 6th day of life begins to present impaired general condition, hypotonic, pale, mottled skin, abdominal distension, hypothermia, cold extremities, prolonged capillary refill time, barely perceptible pulse, systolic murmur grade 1, cyanosis. The child develops respiratory distress syndrome with high oxygen necessary that worsen quickly, SaO2 reached 45% with FiO2> 50%.

It was initially diagnosed as a possible septic shock by infection with unknown germs. Has been decided intubation and mechanical ventilation, with improvement in oxygen saturation, then no episodes of desaturation. After 24 hours the clinical status of the baby has improved consistently, so we decided to detubate him. We administerd him oxygen under chefalic cort with a minimal FiO2 of 30% throughout the monitoring period. Since we have excluded the septic component of the neonatal shock, we performed an echocardiography.

Echocardiography showed interrupted aortic arch with ensuring blood flow in the descending aorta through the ductus arteriosus, wide ventricular septal defect, patent foramen ovale, severe pulmonary hypertension, suprahepatic veins and inferior vena cava dilatation (Figure 1).

Considering CHD presenting decreased aortic flow and therefore decreased mesenteric flow, we decided to initiate monitoring of regional cerebral and mesenteric oxygenation through near-infrared spectroscopy. One probe was placed on the abdomen child on the midline, below the umbilicus and above the pubic symphysis to measure regional mesenteric oxygenation and second probe was placed on the right side of the forehead to measure cerebral oxygen saturation. (Figure 2).

On the 9th day of life the baby begins to present digestive symptoms with gastric residue containing milk then bilious content, increased abdominal diameter, hepatosplenomegaly, without bowel movements, no femoral artery pulse. All this clinical symptoms raises the suspicion of NEC onset. Abdominal X-ray reveals intestinal air- fluid levels with intestinal pneumatosis without pneumoperitoneum (Figure 3). We established the diagnosis of NEC.

We stoped enteral nutrition and we instituted antibiotic therapy. Biological samples did not reveal thrombocytopenia, significant acidosis or bacterial infection. Continuous monitoring of mesenteric oxygenation highlights significant decrease in oxygen saturation (rSO2 = 25.2% ± 8.9%) compared with cerebral oxygenation (rSO2 = 72% ± 5%) during the monitoring period ($p < 0.0001$) (Figure 4).

As specific therapy it is tried by medication to keep open the ductus arteriosus, and decreasing pulmonary hipertension by selective pulmonary vasodilatory therapy (to decrease blood flow in the pulmonary circulation and increased mesenteric blood flow).

Despite the instituted therapy, after a short period of improvement of clinical symptoms and biological parameters, clinical status of the child deteriorates progressively with cardiorespiratory decompensation and worsening digestive symptoms, he died at 17 days of life (Table 1).

Discussion

NIRS has been used extensively to monitor cerebral perfusion in neonates, especially during cardiac surgery and cardiopulmonary bypass. More recently, it has been reported using of NIRS to measure perfusion in other tissues, such as those of the liver, the kidneys, and the lower abdomen (15,16,17).

In a study conducted by Fortune and his collaborators it was revealed the association between NEC and mesenteric oxygen desaturation. They monitored 40 neonates, 10 who had acute surgical abdomen (including 5 with NEC) and 30 neonates without abdominal pathology and they watched the changing of mesenteric-to-cerebral oxygenation ratios. The results showed that the control group had an median ratio of 0.96 while the study group had a much lower ratio of 0.66 ($P < 0.001$).The authors also reported that a ratio of less than 0.75 was predictive for intestinal ischemia (positive predictive value) and that a ratio of 0.96 or more excluded the diagnosis (17).

Stapleton and colleagues presented a case like ours, highlighting the significantly mesenteric oxygen desaturation measured by NIRS, in a newborn with CHD, that developed NEC (18).

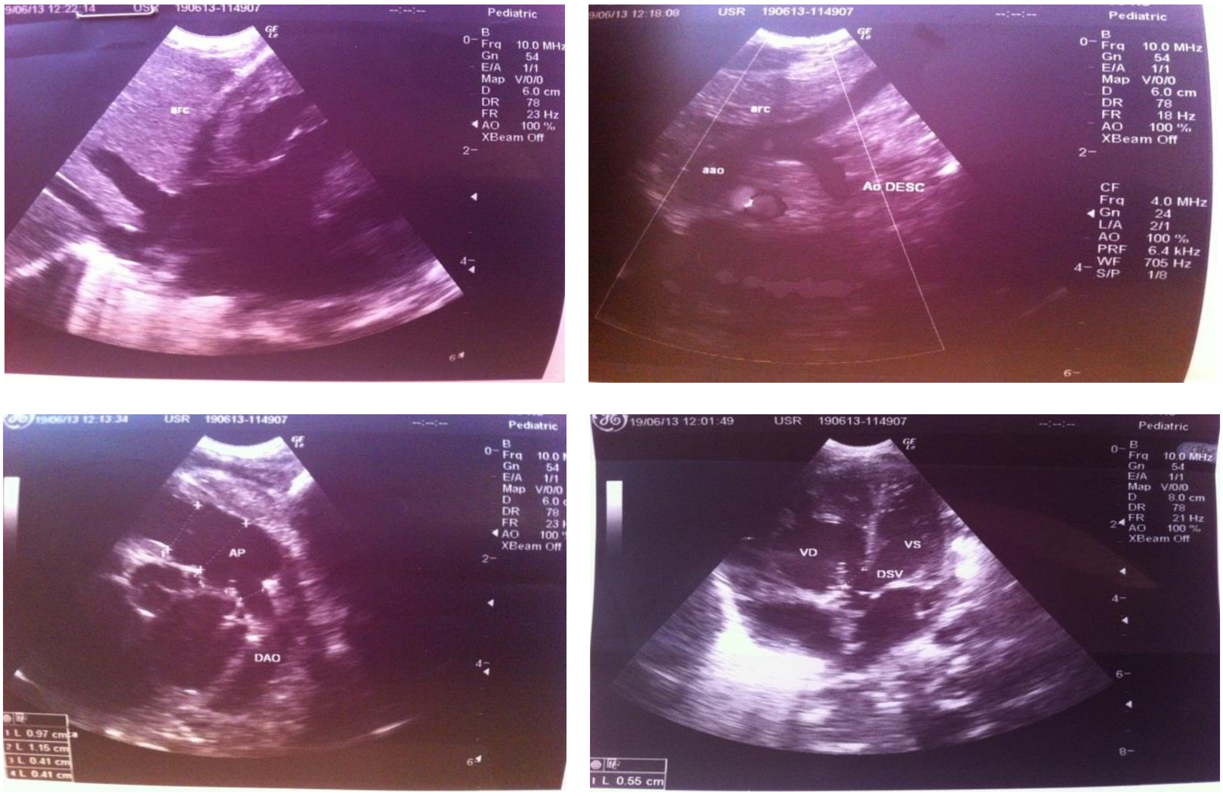

Figure 1. Echocardiography shows interrupted aortic arch, dilated pulmonary artery, wide ventricular septal defect.

Figure 2. The two positions of spectroscopy probes: cerebral and abdominal.

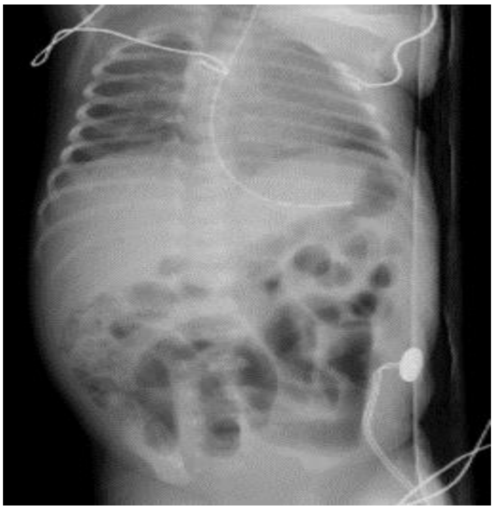

Figure 3. The X-ray reveals the appearance of NEC.

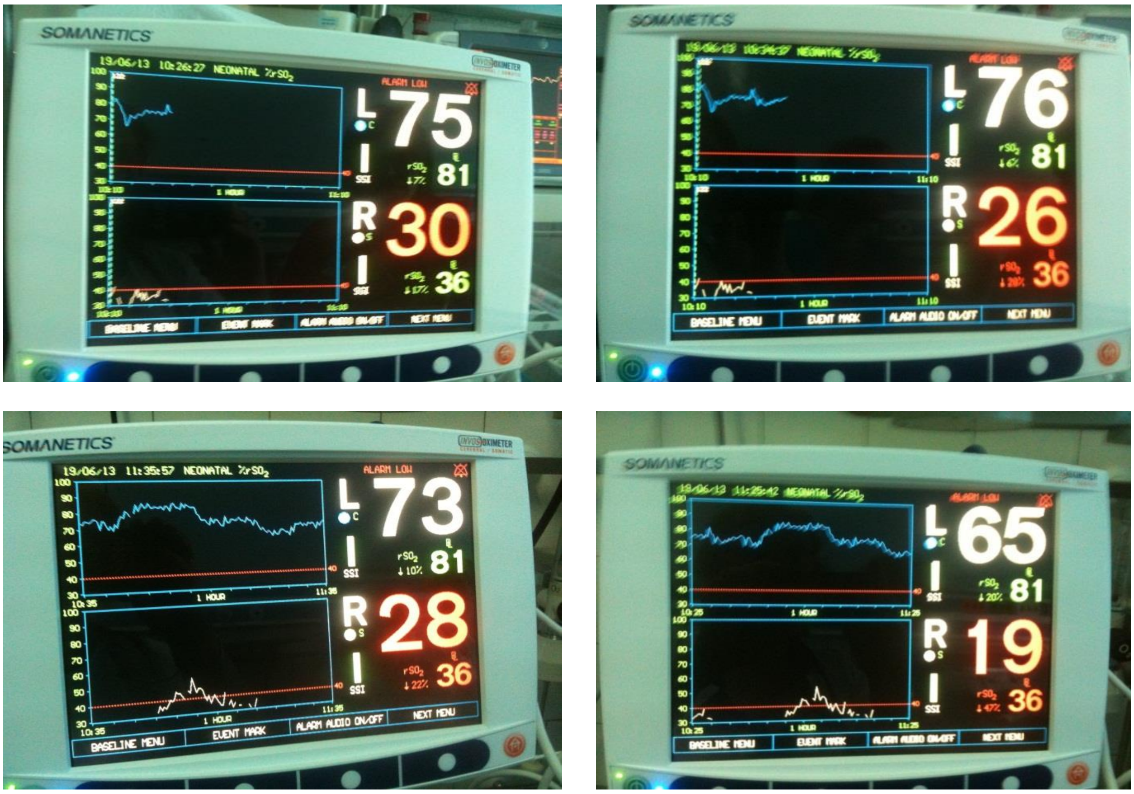

Figure 4. Regional cerebral and mesenteric oxygen saturation, measured by near-infrared spectroscopy after diagnosis of NEC.

Parameters	**D 9**	**D 10**	**D 11**	**D 12**	**D 13**	**D 14**	**D 15**	**D 16**	**D 17**
SaO2 %	96	95	97	95-97	89-95	85-92	83-92	<85	70-40
BP mmHg	83/60	80/60	115/75	100/70	62/41	130/73	80/60	82/55	70/50
HR b/min	141	125	150	160	150	165	172	175	180-60
D ml /24h	42	50	100	80	115	56	30	24	6
rSO2c	75	75	76	73	67	68	65	67	65
rSO2s	35	30	26	28	23	23	19	0	0

Table 1. The patient's vital parameters monitored from the time of NEC diagnosis until death.SaO2 = arterial oxygen saturation, BP = blood pressure, HR=heart rate , D = diuresis, rSO2c = regional cerebral oxygen saturation, rSO2s = somatic regional oxygen saturation, D = day

It is unknown whether gut ischemia is a primary or secondary factor in the development of NEC, but the finding that our patient experienced significant mesenteric desaturation during the early stages of NEC supports the hypothesis that tissue hypoxia is central to the pathophysiology of NEC, especially in term neonates with CHD.

The development of mesenteric desaturation may be due to decreased regional oxygen delivery that is secondary to decreased cardiac output and/or increased flow to the pulmonary vascular bed.

Conclusions

NIRS is a noninvasive, highly accurate, diagnostic method, that detects mesenteric ischemia in early stages. A specific target therapy for NEC in this phase may be saving.

The authors want to emphasize through this rare case of CHD, that any heart disease with decreased aortic flow lead to impaired mesenteric oxygen delivery beeing a risk factor for NEC. Tissue hypoxia secondary to decreases in mesenteric blood flow is the central pathophysiological cause for NEC in this term newborn.

Using this technology, of the near-infrared spectroscopy , for non-invasive measurement of tissue oxygenation in high risk neonates, it is likely that understanding and therapy management of these patients to improve.

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