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ORIGINAL ARTICLE

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Oxygen saturation in healthy newborn infants immediately after birth measured by pulse oximetry

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Abstract Pre- and postductal arterial oxygen saturation (SpO_2) rates were measured in 50 healthy vaginally delivered newborn infants to establish reference values of SpO_2 rates immediately after birth. We compared the SpO_2 values in the pre- and postductal areas and assessed the influence of oxitocin and analgetics applied during delivery. Fifty neonates were examined by the 2 nd minute (min) of life using Nellcor N-3000 pulse oximeters on the right hand and foot. Measurements were carried out until a SpO_2 of 95% was achieved. Heart rates were registered simultaneously. Two min after birth the mean preductal SpO_2 was 73% (44–95%) and 67% (34–93%) in the postductal region. SpO_2 rates of >95% were reached after 12 min (2–55 min) preductally and after 14 min (3–55 min) postductally. Our results demonstrate that it takes 12–14 min for healthy neonates to reach an oxygen saturation of 95% pre- respectively postductal, in some cases even 55 min. All neonates were in good clinical condition and didn't require any supplemental oxygen. Additionally, we were able to show that epidural anaesthesia (PDA) during delivery increases the heart rate of the newborn infant.

Keywords Pulse oximetry · Newborn · Pre- and postductal circulation

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Introduction

Existing studies on fetal SpO_2 (arterial oxygen saturation) rates during delivery showed values of 30–60% [12]. However, optimal oxygen delivery to the important organs is guaranteed by the high oxygen affinity of fetal haemoglobin as well as the persisting intracardial right-to-left shunt [6]. After clamping the umbilical cord, major physiologic adjustments occur. The SpO_2 finally rises within several minutes to adult rates.

There are studies about SpO_2 rates of sick infants or healthy infants born in high altitude [5, 7, 8, 11, 14, 15, 16], but little is known about the O_2 saturation of healthy newborn infants. Only few studies examined the SpO_2 rates immediately after birth [1, 2, 13], most of them measured the oxygen saturation in the preductal circulation only [1, 13]. In these studies, almost all neonates received supplemental oxygen after birth [4, 9, 10].

We investigated pre- and postductal SpO_2 values of 50 neonates and questioned the effects of oxitocin and analgetics applied during delivery.

Methods

Written informed consent was obtained from the parents prior to delivery. Fifty neonates were studied (22 female, 28 male), 48 were delivered spontaneously and 2 by vacuum extraction. None of the mothers received general anaesthesia or oxygen by face mask. Neither did any infant require supplemental oxygen as part of delivery room care. After delivery, each child was always examined by the same, experienced obstetrician. Only newborn infants in a good clinical condition without obvious cardiorespiratory problems and a 1 min APGAR≥8 were included in the study. 2 min after delivery each baby was returned to her/his mother, and both the right hand and foot were cleaned with a gauze sponge.

Two Nellcor N-3000 pulse oximeters were used to measure SpO_2 continously with sensors placed around the ulna side of the right wrist and around the right midfoot, representing pre- and postductal SpO_2 value respectively. SpO_2 and heart rate were observed simultaneously and documented at two, five, ten, twenty and thereafter every 5 min until a stable SpO_2-level of 95% pre- and postductally was reached.

We recorded the application of oxitocin (n=29) and analgetics and whether or not there were gender differences in SpO_2 values.

Statistical evaluations were performed by analysis of variance. The Bonferroni correction was used when multiple comparison were made. Differences were considered significant when p<0,05.

Results

46 neonates were born at a gestational age between 38–43 weeks, 3 at an age of 37, and 1 at 35 weeks. Birthweights ranged from 2450–4290 g (median 3436 g), the body length from 47 cm–54 cm (median 50 cm). The APGAR score in the 1st, 5th and 10th min was in the median 10–10–10 (8–10,-10,-10). Cord arterial pH values were between 7,10 and 7,45 (median 7,25), venous pH values between 7,14 and 7,63 (median 7,36) (Table 1).

Pre- and postductal SpO_2 values were obtained from all 50 neonates. The mean pre- and postductal SpO_2 values are demonstrated in Table 2, Fig. 1, 2, 3. The mean preductal SpO_2 values at 2 and 5 min were significantly higher compared to the values measured postductally (p<0,05). From 10 min on these differences had diminished and were statistically unsignificant. We observed an alignment of the pre- and postductal SpO_2 rates 20 min postnatal (Fig. 2). The threshold of 95% SpO_2 was achieved after 12 min preductal (2–55) respectively 14 min postductal (3–55).

We saw a heart rate being 157/min after 2 min (89–199/min), decreasing to 148/min after 10 min (110–191/min) and 144/min after 20 min (123–178/min).

16 mothers received a PDA (epidural anaesthesia), 21 intramuscular anaesthesia (Pentazocin) and 13 no analgetics during delivery. There was no significant difference between the SpO_2 of neonates from mothers receiving PDA versus intramuscular or no analgesia. However, a significant (p<0,05) difference in the heart rate after 2 min could be found, which was higher in the group of PDA (166/min) versus the group without analgesia (153/min); it disappeared already after 10 min. The use of oxitocin as well as the gender of the neonates had no significant influence.

Table 1 pH art, pH ven, APGAR, weight, body length and gestational age

	Median	Minimum	Maximum
pH art.	7,25	7,10	7,45
pH ven.	7,36	7,14	7,63
APGAR	10/10/10	8/10/10	10/10/10
Weight [g]	3436	2450	4290
Length [cm]	50	47	54
Gestational age	40	35	43

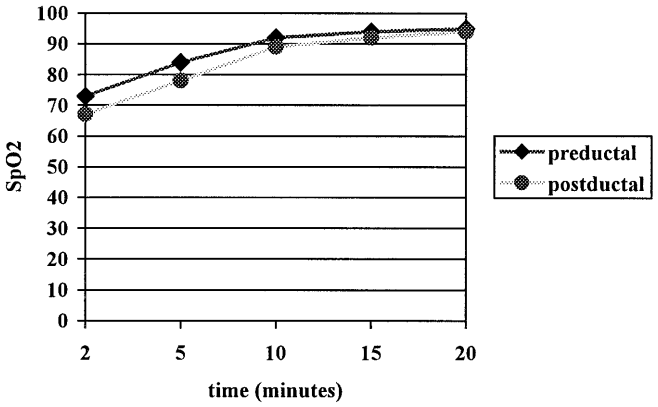

Fig. 1 SpO_2 rates 2–20 min postnatal, pre- and postductal circulation

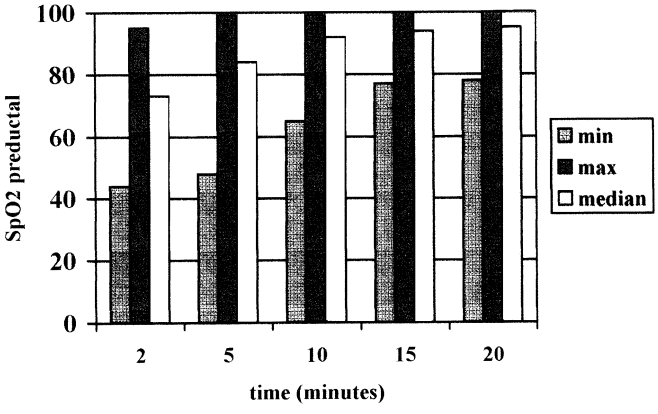

Fig. 2 SpO_2 rates, 2–20 min postnatal, preductal circulation

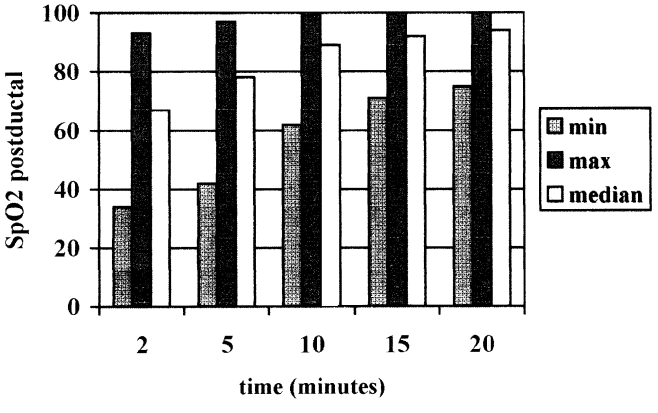

Fig. 3 SpO_2 rates, postductal circulation 2–20 min postnatal

Table 2 Pre- and postductal SpO_2 values, 2–20 min after birth

SpO_2	2 min	5 min	10 min	15 min	20 min
Preductal (%)	73 (44–95)	84 (48–99)	92 (65–99)	94 (77–100)	95 (78–100)
Postductal (%)	67 (34–93)	78 (42–97)	89 (62–99)	92 (71–100)	94 (75–100)

Discussion

In the first minutes of life a transition from placenta to lung respiration and circulatory changes occur, as the fetus becomes a neonate. There are only few methods for early detection of hypoxia in the delivery room. The APGAR score, dependant on the subjective estimation of the examiners, the umbilical arterial and venous cord pH values, the Saling acidity status and the pulse oximetry as a non-invasive method for arterial oxygen saturation measurement.

In accordance with previous studies our data show that neonates are oxygen desaturated immediately after birth [1, 2, 3, 4, 9, 10, 13]. The pre- and postductal SpO_2 values in our study range from 67–73% after 2 min. This confirms the SpO_2 rates in the first minutes of life reported in other studies [1, 2, 13]. Our data show a recovery to normal adult SpO_2 values within 15 min, what some studies couldn't clearly point out [2, 10, 13]. The postnatal period of desaturation can be explained by a transient persistence of a right to left ductal and/or atrial shunt. The importance of the closure of the arterial duct can be clearly shown by measuring SpO_2 values pre- and postductally.

In our study there is a statistically significant difference between pre- and postductal SpO_2 values 2 and 5 min after birth, the magnitude of the difference decreases after 10 min and becomes almost unimportant 20 min postnatal. Pre- and postductal saturation was determined only twice in literature and showed similar results [2, 6].

It is astonishing that in comparison with studies applying oxygen by face mask in the postnatal period the neonates of our study showed nearly the same SpO_2 rates without oxygen supplementation [2, 9, 10]. We conclude that O_2 supplementation doesn't seem to influence peripheral arterial oxygen saturation.

Altough oxitocin is commonly used in obstetric procedures, studies investigating the effects on the neonatal SpO_2 values do not exist. We were able to show that oxitocin do not influence SpO_2 or heart rates in neonates.

PDA as a method of intrapartual analgesia gains popularity. We examined the influence of different types of analgesia on neonatal SpO_2 and heart rates. As House [4] already showed, no influence on the peripheral saturation could be recorded regardless the analgetics applied. But we saw a significant difference in the heart rate 2 min after birth of the neonates from mothers receiving PDA in comparison to neonates from mothers with intramuscular or no analgesia. The underlying mechanism is not yet clear and should be subject of further studies.

Conclusions

In summary, we conclude that oxygen supplementation is not required immediately after birth, if the newborn is in good clinical condition. Neonates need approximately 15 min to reach adult SpO_2 values. The differences between the SpO_2 values in the pre- and postductal circulation could be explained with the persistent patency of the ductus arteriosus.

Our data suggest that a functional occlusion of the ductus arteriosus occurs in the first 20 min of life.

PDA seems to be an intrapartal stress factor for the baby and augments the initial heart rate postnatally.

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