COMPARISON OF PULSE OXYMETER AND CEREBRAL OXYMETER VALUES IN HEALTHY NEWBORNS IN THE FIRST FIVE MINUTES OF LIFE

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ABSTRACT

Objective: *Practical approaches in delivery rooms have been discussed about oxygen usage in recent years. In this study, it was aimed to correlate preductal arterial oxygen saturation (SpO_2), heart rate per minute and serebral oxygen saturation (SbO_2) values of first five minutes of life and to try the pulse oxymeter (PO) and cerebral oxymeter (SO) usage practice in delivery room.*

Material and Method: *A hundred healthy term uncomplicated newborn babies, who were born via normally spontan vaginal route, were included in the study. SpO_2, SbO_2, heart rate measurements and blood gase analysis of first five minutes of postnatal life were completed. Babies, who needed oxygen during measurements, were not taken in to the study..*

Results: *While postnatal 1st minute SpO_2 value was 83.0±4.4 (74-94)%; at 5th minute these measurements reached to 92.9±3.5 (85-98)% with gradually increment. Except values of 4th and 5th minutes; SpO_2 values were found statistically significant high with each other ($p<0.05$). At SbO_2 measurements, suitable data was taken from 100% of the babies in first minute of life. While postnatal mean SbO_2 value of the first minute was 48.9±9.9 (32-74)%; these measurements were reached to 69.9±9.5 (46-89)% at 5th minute gradually increment as like as SpO_2 values.*

Conclusion: *SO is complementary to PO in delivery room and can be used routinely. It was seen also in our study; oxygen need of newborns can be determined faster and more accurately with SO use in delivery room so unnecessary oxygen usage and its potential risks can be avoided..*

Key Words: *Newborn, monitoring, delivery room, cerebral oxymeter*

SAĞLIKLI YENIDOĞAN BEBEKLERDE DOĞUMDAN SONRAKI İLK BEŞ DAKİKADA NABIZ OKSİMETRE VE SEREBRAL OKSİMETRE DEĞERLERİNİN KARŞILAŞTIRILMASI

ÖZET

Amaç: Son senelerde doğumhanede oksijen kullanımı ile ilgili pratik yaklaşımlar tartışılmaya başlanmıştır. Bu çalışmada, komplikasyonsuz vajinal doğum ile doğan sağlıklı term bebeklerde, yaşamın ilk 5 dakikasında preduktal arteriyel oksijen saturasyonu (SpO_2), kalp tepe atımı (KTA) ve serebral oksijen saturasyonu (SbO_2) değerlerinin karşılaştırılması ve doğumhanede nabız oksimetre (PO) ve serebral oksimetre (SO) kullanma pratiğinin denenmesi amaçlandı.

Materyal ve Metot: Normal spontan vajinal yol ile komplikasyonsuz doğan sağlıklı 100 term yenidoğan bebeğin ilk 5 dakika içerisinde nabız ve serebral oksimetre, KTA kayıtları ile kordon kan gazı analizleri yapıldı. Serebral oksijen saturasyonu ölçmek için SO cihazı kullanıldı. Ölçümler esnasında oksijen ihtiyacı olan bebekler çalışmaya alınmadı.

Bulgular: Postnatal ilk dakikadaki ortalama SpO_2 değeri %83,0±4,4 (74-94) iken bu ölçümler giderek yükselerek 5. dakikada %92,9±3,5 (85-98)'e kadar ulaştı. SpO_2 değerleri 4. ile 5. dakika değerleri dışında birbiri ile istatistiksel olarak anlamlı yüksek bulundu ($p<0,05$). SbO_2 ölçümlerinde ise yaşamın ilk dakikasında, bebeklerin %100'ünden uygun veri elde edildi. Postnatal ilk dakikadaki ortalama SpO_2 değeri %48,9±9,9 (32-74) değerlerinde iken bu ölçümler SpO_2'deki gibi giderek yükselerek 5. dakikada %69,9±9,5 (46-89) değerlerine ulaştı.

Sonuç: SO doğumhanede PO'yu tamamlayıcıdır ve rutin olarak kullanılabilir. Çalışmamızla da görülmüştür ki yenidoğan bebeklerde doğumhanede SO kullanımı ile daha çabuk ve doğru derecede oksijen ihtiyacı tespit edilebilir ve böylece de gereksiz oksijen kullanımı ve olası risklerinden kaçınılabilir.

Anahtar Kelimeler: Yenidoğan, gözlem, doğum odası, serebral oksimetre

INTRODUCTION

It is reported that the exposure to pure oxygen (100%) following delivery, even for a short period of time, creates radical damage, causes serious adverse effects in short- and long-term (retinopathy of prematurity, bronchopulmonary dysplasia, intraventricular hemorrhage, necrotizing enterocolitis) and increases mortality.[1] The most appropriate oxygen concentration and target preductal arterial oxygen saturation (SpO_2) for the stabilization of the infant are not yet evident. Newborns are born with low oxygen saturation (<85%) in the first minutes of life and their levels of oxygen saturation reach those of adults in minutes.[2,3] Near-Infrared Spectroscopy (NIRS) is an optic technique, technically similar to pulse oxymeter (PO), which uses infrared light, penetrates into living tissues, calculates brain tissue oxygenization by measuring the infrared light absorbed through the tissue, including pigments, and allows the permanent and non-invasive visualization of brain oxygenization.[4] Cerebral oxymeter (SO) is a non-invasive optic technique based on NIRS which allows continuous and synchronous monitoring of cerebral oxygen saturation (SbO_2).

With this study, we aimed to compare cerebral oxygen flow within the first 5 minutes in healthy newborns with pulse oximetry values and to avoid non-essential oxygen therapy, to determine the normal values of SbO_2 in healthy newborns, to test the routine applicability of SO device in the delivery room, to compare SbO_2 with SpO_2 in healthy (normal) newborns, and to demonstrate the relation between SO measurements, PO measurement and peak heart rate (PHR).

MATERIAL and METHOD

One hundred and fifteen infants delivered via the normal spontaneous vaginal route in Yüzüncü Yıl University Research and Practice Hospital Obstetrics and Gynecology Service's Delivery Room between October 2010 and February 2011 were enrolled in this prospective study. Study inclusion criteria were as follows: those with gestational age above 38 weeks and birth weight ranging between 2500 g and 4200 g, clinically well-born infants, PHR>100/min, being active, sufficient respiration, the mother being under prenatal follow-up and suffering no problems throughout pregnancy, and healthy term infants born by the vaginal route without any complications. Premature infants, those with intrauterine growth retardation, infants required neonatal resuscitation, those with congenital malformation, developing respiratory distress, multiple pregnancies, deliveries with complication, and infants whose mothers suffered maternal diabetes mellitus, preeclampsia/eclampsia, and/or hypertension were excluded. Infants who could not be evaluated until the 1st minute due to movement artefact, the presence of vernix, edema, high-intensity light, being overweight, and/or who had chapped and crumpled skin were not included in the study. Infants with gestational week ≥42 (n=1), birth weight ≤2500g (n=4) and ≥4200g (n=3), and who required oxygen due to respiratory distress (n=7) were also excluded. After informing the parents of infants who were to be enrolled in the study, their consents were obtained. The postnatal routine care of infants was accomplished by the delivery room staff. The right wrists of infants were cleaned for preductal SpO_2 and SbO_2 measurement and a pulse oximetry probe (Nellcor 7302) was attached as soon as possible (<1 min). The saturation probe was connected to Novametrix 515A PO, and SpO_2 and PHR values were measured. A probe of Somanetics 5100C cerebral oximetry device (Invos oximetry cerebral/somatic Troy, MI, USA) was attached to infants so as to include the mid-region of their foreheads and measured data of SbO_2 were recorded starting with the first minute. Measurements performed with both devices continued from the 1st minute to the 5th minute. PHR and SpO_2 (%), and SbO_2 (%) levels of the infant were measured for five minutes. Infants from whom no measurements could be obtained within the first minute were excluded. All the measurements were carried out by the same researcher. The blood gas of all cases, which had been acquired from the cord blood by blood gas analyzer (ABL-5), was studied and pH, PCO_2, PO_2, HCO_3, and base excess values were recorded. Findings were recorded by statistical software (SPSS v15.0 for Windows). In the evaluation of the findings, along with graphics and mean values, One Way Anova, Student-t test and Pearson correlation test were used. Findings were evaluated by the criteria of statistical significance and those with a p value below 0.05 were regarded as significant. The study was approved by the Yüzüncü Yıl University Ethics Committee. The study was explained to all families, and the requisite written consent was obtained.

RESULTS

The demographic characteristics of our patients are shown in Table 1. APGAR scores of our patients were shown in Table 2. Blood gas pH values obtained from the umbilical cords of infants were 7.20 at the lowest, 7.50 at the highest and mean value was 7.30±0.1. pCO_2 values were 20 at lowest, 57 at highest and mean value was 36.5±7.6 mmHg. pO_2 →

values were 8 at lowest, 95 at highest and mean value was 45.1±18.9 mmHg. HCO_3 values were 16 mmol/L at lowest, 29 mmol/L at highest and mean value was 21.7 ±2.6 mmol/L. Base excess values were -11 at lowest, 4 at highest and mean value was -2.4±2.2.

Pulse, cerebral oximetry and peak heart values of newborn infants, which were measured starting with the first minute, are presented in Table 3 as minimum, maximum, mean and standard derivation values.

SpO_2, SbO_2 and PHR values obtained from the infants included in the study have been correlated with each other. Accordingly, SpO_2 and SbO_2 values measured within the first minute were found to be significantly correlated (r=0.415, p<0.001). However, PHR values were not significantly correlated with SpO_2 and SbO_2 values (r=0.197, p=0.06 and r=0.44, p=0.693). While PHR value and SpO_2 value were correlated as statistically significant (r=0.382, p<0.001), no significant correlation was recorded regarding SbO_2 (r=0.008, p=0.934). SpO_2 and SbO_2 values measured in the 2nd minute were found significantly correlated (r=0.210, p=0.036). However, PHR values were not significantly correlated with SpO_2 and SbO_2 values (r=0.169, p=0.093 and r=0.041, P=0.684). SpO_2 and SbO_2 values measured in the 3rd minute were not found to be significantly correlated (r=0.154, p=0.127). PHR values were not significantly correlated with SpO_2 and SbO_2 values (r=0.301, p=0.002 and r=0.032, p=0.749). SpO_2 and SbO_2 values measured in the 4th minute were found to be significantly correlated (r=0.257, p=0.010). PHR values were not significantly correlated with SpO_2 and SbO_2 values (r=0.108, p=0.286 and r=0.062, p=0.542). SpO_2 and SbO_2 values measured in the 5th minute were found to be significantly correlated (r=0.306, p=0.002). PHR values were not significantly correlated with SpO_2 and SbO_2 values (r=0.016, p=0.875 and r=0.104, p=0.304).

Table 1. Demographic characteristics

Sex	Female n (%)	53 (53%)
	Male n (%)	47 (47%)
Pregnancy week (week)		38-42 (40.4±1.5)*
Weight (gr)		2500-4200 (3199±373)*
Maternal age (year)		17-44 (28.0±6.9)*

*: Minimum-maximum (Mean±SD)

Table 2. APGAR scores

APGAR	1. minute n (%)	5. minutes n (%)	10. minutes n (%)
6	1 (1)	0 (0)	0 (0)
7	46 (460)	0 (0)	0 (0)
8	48 (48)	0 (0)	0 (0)
9	5 (5)	46 (46)	2 (2%)
10	0 (0)	54 (54)	98 (98%)
Total	100 (%100)	100 (100%)	100 (100%)

Table 3. Pulse oxymeter, cerebral oxymeter and heart rate values

Time (minute)	Pulse Oxymeter (%) Mean±SD (minimum-maximum)	Cerebral Oxymeter (%) Mean±SD (minimum-maximum)	Heart rate (minute) Mean±SD (minimum-maximum)
0	83.0±4.4 (74-94)	48.9±9.9 (32-74)	144.9±13.7 (100-187)
1	86.3±4.9 (76-96)	56.6±11.0 (39-89)	150.5±14.2 (105-187)
2	89.0±4.6 (78-99)	62.9±12.2 (42-94)	154.7±11.4 (110-176)
3	90.6±4.3 (80-98)	66.2±10.6 (42-91)	156.9±11.1 (110-176)
4	92.1±4.2 (81-99)	68.3±9.8 (44-88)	158.4±10.0 (120-176)
5	92.9±3.5 (85-98)	69.9±9.5 (46-89)	159.6±9.1 (134-179)

SD: Standard deviation

DISCUSSION

NIRS is similar to PO and it's an optic technique. NIRS use infrared light, penetrates into alive tissues such as brain tissue. NIRS measures the infrared light absorbed through the tissue including pigments which allows continuous and non-invasive viewing of brain oxygenation.[4] Pulsatile flows are not required for NIRS. Thus, it is utilized during cardiopulmonary arrest and other non-pulsatile conditions such as hypotension and shock.[5] PO is reliable, a non-invasive and painless method for measuring oxygen saturation in blood. SO provides a direct method for measuring SbO_2.[6]

Practical approaches regarding oxygen usage in the delivery room have been discussed in recent years.[7] There is no evidence-based data supporting the high oxygen concentration which is applied when commencing resuscitation, and that the use of oxygen should be recommended for infants with persistent central cyanosis.[8] No clear answer could yet be obtained to the question of what is the most appropriate oxygen concentration required to be used in neonatal resuscitation. Most clinicians prefer oxygen administration according to pulse oximetry data in the delivery room.[9,10] Furthermore, information on the normal values of SpO_2 within the first minutes of life is insufficient. In their study, O'Donnell et al. demonstrated a diversity that varied between 10% and 100% in the SpO_2 values of infants who were commonly perceived as pink by observers.[11] Color evaluation is difficult, thus it is a poor criterion for tissue oxygenization within the first several minutes of life. Percentage of obtaining SpO_2 measurements within the initial minute just after the delivery varies as well. Studies showed that →

percentage of obtaining SpO_2 measurements within the 1st minute just after delivery varied between 20% and 100%.[12-14] In a large series conducted on 175 infants, Kamlin et al. could perform measurements within the first minute in only 92 (53%) of cases.[12] Parallel to these studies, we acquired a rate of 95% within the first minute. In studies, the rate of success in the 5th minute increased up to 63-100%.[14-17]

In the study of Sendak et al., which is among the first studies presenting the postnatal SpO_2 values in term infants, the mean SpO_2 value in the 1st minute in infants delivered via vaginal route was found to be 61%, whereas it was 50% in those born by caesarean section.[18] SpO_2 increased up to 78% and 70% in the 5th minute and to 80% and 80% in the 7th minute for vaginal and caesarean groups, respectively. In one of the two studies published recently, Kamlin et al. presented data determining the preductal SpO_2 range within the first minutes of life in healthy term and preterm infants.[12] According to these data, the median SpO_2 value in the 1st minute in vaginal and caesarean deliveries was found to be 63% (54-67) for both groups. SpO_2 increased over time and saturation increased up to 90% (77-89) in the 5th minute. In another study, Rabi et al. measured SpO_2 levels within the first 10 minutes of life in 115 healthy infants above 35 weeks and reported the median SpO_2 level in the 5th minute as 87% (79-94) in vaginal group and as 81% (74-82) in caesarean group.[19] SpO_2 could not reach 90% in either group until the 8th postnatal minute. In our study, the increase of SpO_2 over 90% lasted approximately 3 minutes. In our study, SpO_2 values in the 1st and 5th minutes were higher compared to those obtained from the study by Kamlin et al.[12] The presence of infants with developing respiratory distress in the case group of Kamlin et al., where a new-generation pulse oximetry was applied and mean SpO_2 values were obtained may be the reason for that.[12] Additionally, it was another factor increasing the strength of our study that the pre-/perinatal asphyctic infants were excluded from the study as the result of examination of pH, pCO_2 and pO_2 by umbilical blood gas analysis. Thus, infants whose data were studied constituted a sample of healthy infant population delivered via normal route. Additionally, the fact that the measurements were conducted by a single individual experienced in this subject and that they were performed according to the standards increased the reliability of data.

There are two studies performed regarding the guidance of PO in interventions for the transition into neonatal life. Deckardt et al. used SpO_2 measurements as a guide to evaluating infants with regard to receiving continuous positive airway pressure (CPAP) by mask or 100% oxygen 5 minutes after the delivery.[15] When SpO_2 measurement still remained below <80% in the 5th minute, CPAP was performed and when the value exceeded 90% once, CPAP was terminated. Kopotic et al. conducted a study on 50 infants with respiratory distress, and half of the infants were evaluated by PO, whereas the remaining infants were evaluated without PO.[20] It was detected that infants evaluated by PO received less special care. Although studies of Kopotic and Deckardt were non-blind and non-randomized, it was observed that they might lead to improvements in short-time results, such as admittance to nursery care, and oxygen and CPAP usage. However, there are no reports indicating that SpO_2 measurement performed right after the delivery may alter long-term results.

In our study, PHR values of cases within the first five minutes following delivery were also measured by PO. Kamlin et al. evaluated the accuracy of PHR measurement by new-generation PO in the delivery room and according to this study, it was put forth that PHR was accurately measured by PO.[21] Although auscultation is superior to palpation, both methods are intermittent and have no certain accuracy. However, PHR evaluation by stethoscope still remains the most frequently used diagnostic method due to routine inapplicability of PO usage in the delivery room and caesarean operating rooms. We found a significant difference between the first minute values, measured in a similar way to SpO_2 values, and other minutes ($p<0.05$). However, there were no significant differences after the 3rd minute and values progressed in a stable manner from then onward. We considered this as an indication of the fact that adaptation to extrauterine life started to be completed after the 3rd postnatal minute.

Grubhofer et al. found mean SbO_2 values in the first three days of newborn premature infants to be 54-65.7%, 61.9-82.3% and 67.8-80.1% and indicated that these values had no relationship with SpO_2 or other physiological variables.[22]

There are a number of studies in the literature related to SO usage in the delivery room. In a pioneering study conducted by Isobe et al. oxyhemoglobin, deoxyhemoglobin, total hemoglobin concentrations and SbO_2 levels of seven newborn infants were measured by NIRS just after delivery, and it was recorded that the oxyhemoglobin level rapidly increased 2-3 minutes after delivery.[23] At the same time, a transient increase in total hemoglobin concentration occurred, which was followed-up →

by a decrease, along with deoxyhemoglobin. On the other hand, SbO_2 rapidly increased following the delivery, and reached 18% at 1.5 minutes and approximately 55% in the 5th to 6th minute. This was followed-up by a gradual increase of 10%. Brain oxygenization occurred later in three cases that were administered oxygen immediately following the delivery, compared to those of not receiving oxygen. In this pioneering study, they emphasized that dynamic changes took place as part of physiological changes in cerebral circulation and oxygenization, which were revealed after the delivery.

We found the mean SbO_2 value within the first minute to be 48.9±9.9% and that it gradually increased up to 69.9±9.5% at 5th minute. These values were higher compared to the study by Isobe et al.[23] We thought that this issue might be related to the larger series we used in our study. Yet again, similar to SpO_2 and PHR measurements, a statistically significant difference was found between the first 1st and 2nd minutes, and other minutes. There was no statistically significant difference between values obtained in the 3rd and 5th minute; however, a significant difference was found in the 5th minute. No statistically significant differences were present between the 4th and 5th minute.

The oxygen need in newborn infants can be detected accurately by SO usage in the delivery room and thus, unnecessary oxygen administration and its possible risks can be avoided. SO is complementary to PO in the delivery room and they can be routinely applied together.

* The authors declare that there are no conflicts of interest.

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