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The Positive Association Between Duration of Skin-to-Skin Contact and Blood Glucose Level in Full-Term Infants

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ABSTRACT

The aim of this study was to evaluate the contribution of the duration of skin-to-skin contact (SSC) on blood glucose levels at 2 hours after birth in healthy full-term infants. This observational study was done at one of the baby-friendly hospitals located in Aichi, Japan in 2009. Sixty newborn infants who were born vaginally from uncomplicated pregnancies were participated. All infants were held SSC within 5 minutes. All data regarding neonatal information, blood glucose levels at 2 hours of age, and maternal information were obtained from their medical history. Multiple linear regression analysis was performed to identify the independent contribution of the duration of SSC. The mean duration of SSC was 59.6 ± 13.6 minutes (range: 11.0-97.0 minutes) and the infant blood glucose level was 53.1 ± 9.5 (range: 30.0-80.0 mg/dL) mg/dL. The duration of SSC (β [95% confidence interval] = .282 [range: 0.037-0.357], standardized β = .282, $P < .017$) was significantly and positively associated with infant blood glucose levels independent of gestational age, birth weight, sex, length of second-stage labor, and mode of delivery. Thus, the longer early SSC was associated with higher blood glucose level at 2 hours of age in healthy full-term infants.

Key Words: blood glucose, full-term newborn infant, skin-to-skin contact, vaginal delivery

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The newborn infant is required to make very significant adaptations from the in utero environment to the outside world immediately after birth. Previous studies[1,2] have shown that the infant's temperature drops naturally and rapidly by 2°C to 4°C in the first few minutes after birth. However, infants are not able to generate heat because of the lack of the shivering mechanism and immature brown fat metabolism immediately after birth.[3] Therefore, at the critical period, one of the most important nursing cares for newborn infants is to prevent heat loss and to keep neutral temperature warm because the infants are wet and their surface area is large for weight.

At the same period, a physiologic decrease in glucose levels normally occurs and continues for the first 2 to 3 hours of life.[4] Hypoglycemia is the most common metabolic problem in newborn infants. Severe or prolonged hypoglycemia may result in neurologic damage including mental retardation, developmental delay, personality disorders, and recurrent seizure activity. Each infant may present symptoms differently.[4,5] Thus, medical stuff must not only monitor carefully for these symptoms and immediately treat but also review the mother's prenatal record and history of labor and birth and assess the newborn's risks and conditions after birth.

Skin-to-skin contact (SSC), an intervention entailing holding the unclothed, diapered newborn infant on the mother's bare chest immediately after birth, may have potential for simultaneously solving 2 problems as mentioned previously. From a physiological point of view, SSC is well known as an important component of care immediately after birth[6] to improve thermoregulation and cardiopulmonary stabilization.[7–13] On the contrary, there is not enough research examining the efficacy of SSC metabolically. Regarding the effect of SSC on infant's blood glucose, only a few randomized control trials have shown that infants who were held in SSC had higher blood glucose levels than infants who were not.[7,14] However, these previous studies did not consider the information about progress of labor and infants' characteristics, which could have an effect on an infant's blood glucose levels. One of the reasons is most likely because American Academy of Pediatrics state that routine monitoring of blood glucose in healthy full term infants is unnecessary due to single concentration or range of plasma glucose concentrations is not associated with clinical signs.[15] Under the circumstances, further evidence regarding the efficacy of SSC for healthy full-term newborn infants is needed.[16]

Our team studied how the duration of SSC influences the infant's adaptation after birth. The aim of this study was to evaluate the effect of duration of SSC on blood glucose levels at 2 hours after birth in healthy full-term infants who were delivered vaginally at a baby-friendly hospital in Japan.

METHODS

Design

This study was an observational study that was part of a larger study.[10] The study protocol was approved by the Ethics Review Committee of the Nagoya University School of Medicine, Nagoya, Japan (565).

Participants and setting

We evaluated 72 consecutive infants who were vaginally delivered and had SSC immediately after birth at a baby-friendly hospital in Aichi Prefecture, Japan, from January to April 2009. The parents provided written informed consent to participate and for the use of personal information concerning pregnancy and delivery in the medical records and laboratory data during the admission of the mothers in the hospital. The subjects were healthy full-term infants who started SSC within 5 minutes after birth and were selected according to the following criteria: maternal inclusion criteria were vaginal delivery, singleton full-term infant, and uncomplicated pregnancy such as no diabetes and hypertension, and delivery courses. Maternal exclusion criteria were dysfunctional labor, dystocia, and sign of fetal distress during labor, general anesthesia during delivery, and cesarean section. In addition, infant exclusion criteria were any congenital anomaly and obvious birth asphyxia as assessed by either 1- or 5-minute Apgar of 7 or less.

SSC procedure

At the maternity hospitals, infants were routinely examined by experienced midwives and obstetricians immediately after birth. The face, trunk, and extremities of each newborn infant were dried, and the umbilical cord was cut on the delivery bed by the midwife within the first minute of life. After the assessment of 1-minute Apgar score, the infants were placed on the mother's bare chest with putting a nappy, a dry cap, and covered prewarmed towel and blanket within 5 minutes after birth, which was continued for approximately the first 1 hour. Infants were cared for according to hospital routines including weighing and anthropometric measurements after SSC was stopped. After physical checking, the infants were back to the mothers and were supported during the first breast-feeding by the midwives who attended the birth within 2 hours before collecting their blood samples. The initiation and duration of SSC were directly measured all by a researcher.

Blood glucose level

Infants' blood glucose levels were collected from their medical history. At the hospital, the clinical staff at the nursery measured all newborns' blood glucose levels according to the hospital protocol using heel stick puncture at 2 hours of age. Infants' blood glucose levels were determined by using Antsense III (Horiba Medical, Kyoto, Japan) which is a light, compact, and portable electrode-type blood glucose meter. The measurement system is based on the enzyme electrode method, which integrates hydrogen peroxide electrode with glucose oxidase immobilized membrane. Only 5 to 20 μl of blood sample is needed to complete the measurement and displays the results in approximately 45 seconds. The measuring range is wider from 10 mg/dL to 250 mg/dL, and the coefficient of variation is from 1.5% to 2.5%, in the concentration range from low to high. In measurement with actual samples, Antsense III has strong correlation with Glucose Auto & Stat GA-1160, which is manufactured by Arcray USA, Inc (Minneapolis, Minnesota) using plasma glucose levels through the range from low to high concentration.[17]

Mothers' and infants' demographic data

Demographic, pregnancy, and delivery data of both mothers and infants were collected from the hospital records during hospitalization.

Statistical analysis

Statistical analysis was performed by using SPSS version 23.0 for Windows (SPSS, Chicago, Illinois). Descriptive statistics were used to summarize the demographic factors. All continuous variables were shown as mean ± standard deviation, and categorical data were presented as frequency and percentage and as medians and interquartile distances (Q25-Q75). The correlation of blood glucose levels with other study variables was determined by using the Spearman rank correlation coefficient. As for the association between glucose levels and categorical variables, the differences between the 2 groups were assessed by the Mann-Whitney *U* test. Multiple regression analysis was performed by using the forced entry method to estimate the contribution of SSC to blood glucose levels. The dependent variable was blood glucose level. The independent variables included the duration of SSC, the factors significantly associated with blood glucose levels by Spearman rank correlation analysis, and the Mann-Whitney *U* test ($P < .05$). The clinical confounding factors known or suspected to modify infant's glucose level were also included. A *P* value of less than .05 was considered statistically significant.

RESULTS

Participant characteristics

In this study, 60 healthy full-term infants participated. The mean infants' blood glucose levels at 2 hours of age were 53.1 ± 9.5 mg/dL (range: 30-80 mg/dL). The mean maternal age was 28.7 ± 5.2 years (range: 18.0-39.0 years) and 39 women (65.0%) were multiparous. The mean length of first-stage labor was 8.9 ± 8.9 hours (range: 1.0-59.0 hours) and that of second labor was 41.6 ± 49.2 minutes (range: 1.0-230 minutes) of which 42 deliveries (70.0%) were spontaneous onset of labor and 18 deliveries (30.0%) were induction labor. The mean initiation of SSC was 1.6 ± 1.1 minutes (range: 0.0-5.0 minutes) and the mean duration of SSC was 59.6 ± 13.6 minutes (range: 11.097.0 minutes). The mean gestational age (GA) of infants was 39.8 ± 1.1 weeks (range: 37.0-41.7 weeks), and the mean birth weight was 3104.6 ± 371.5 g (range: 2276.0-4098.0 g). The mean Apgar scores at 1 and 5 minutes were 9.0 ± 0.5 (range: 7.0-10 minutes) and 9.4 ± 0.5 (range: 9-10 minutes), respectively. The umbilical cord pH value was 7.3 ± 0.1 (range: 7.2-7.4). Other participant characteristics are shown in Table 1.

Correlations of variables with infant blood glucose levels

Table 2 presents the association of obstetric factors with infant's blood glucose level. Spearman correlation coefficients (ρ) indicated that positive associations were found between blood glucose levels and the duration of SSC ($\rho = 0.283$, $P = .029$) and GA of infants ($\rho = 0.381$, $P = .003$). The blood glucose levels of female infants were significantly higher than those of male infants ($P = .001$). Other variables were not significantly associated with blood glucose levels.

Table 1. **Characteristics of study subjects (*N* = 60)**

	Mean ± SD	Minimum-Maximum
Infants		
Birth weight, g	3104.6 ± 371.5	2276.0-4098.0
Blood glucose levels at 2 h after birth, mg/Dl	53.1 ± 9.5	30.0-80.0
Gestational age at birth, wk	39.8 ± 1.1	37.0-41.7
Apgar score at 1 min	9.0 ± 0.5	7.0-10.0
Apgar score at 5 min	9.4 ± 0.5	9.0-10.0
Umbilical cord pH at birth	7.3 ± 0.1	7.2-7.4
Initiation time of SSC, min	1.6 ± 1.1	0.0-5.0
Duration of SSC, min	59.6 ± 13.6	11.0-97.0
Axillary temperature at 120 min, °C	36.9 ± 0.4	36.1-37.7
Boys/Girls	27 (45.0%)/33 (55.0%)	
Maternal		
Maternal age, y	28.7 ± 5.2	18.0-39.0
Primi/Multi	21 (34.4%)/40 (65.6%)	
Length of first-stage labor, h	8.9 ± 8.9	1.0-59.0
Length of second-stage labor, min	41.6 ± 49.2	1.0-230.0
Total length of labor, h	9.6 ± 9.1	1.1-60.0
Meconium staining of amniotic fluid, n (%)	5 (8.3)	
Mode of labor		
Spontaneous labor, n (%)	42 (70.0)	
Labor induction, n (%)	18 (30.0)	

Abbreviation: SSC, skin-to-skin contact.

Table 2. **Correlation and mean of variables with infants' blood glucose levels ($N = 60$)[a]**

	r	*P*	Median	25% tiles to 75% tiles	*P* for difference
Initiation time of SSC	− 0.14	.29			
Duration of SSC	0.28	.03[b]			
Birth weight	− 0.03	.83			
Gestational age	0.38	.003[c]			
Apgar score at 1 min	− 0.02	.87			
Apgar score at 5 min	0.14	.27			
Umbilical cord pH	− 0.06	.66			
Axillary temperature	0.20	.12			
Gender[b]			52.5	46.3-59.0	
Boy ($n = 27$)			50.0	44.0-54.0	.001
Girl ($n = 33$)			57.0	48.0-65.5	
Maternal age	0.08	.63			
Primi/Multi[b]			52.5	46.3-59.0	
Primi ($n = 21$)			51.0	45.0-60.0	.515
Multi ($n = 40$)			53.0	47.0-59.0	
Length of 1-stage labor	− 0.01	.96			
Length of 2-stage labor	− 0.04	.79			
Mode of labor			52.5	46.3-59.0	
Spontaneous labor ($n = 42$)			52.0	45.8-58.0	.175
Labor induction ($n = 18$)			55.5	46.5-66.3	
Meconium staining[d]			52.5	46.3-59	
Yes ($n = 5$)			57.0	52.5-66.0	.130
No ($n = 55$)			52.0	45.0-59.0	

Abbreviation: SSC, skin-to-skin contact.
[a]Spearman ρ correlation was presented.
[b]$P < .05$.
[c]$P < .01$.
[d]Mann-Whitney *U* test for categorical data. The results were shown by median and 25 to 75 percentiles.

Associations between duration of SSC and infant blood glucose levels

The association of duration of SSC with infant's blood glucose level by multiple regression analysis is shown in Table 3. Of the study variables, other than the duration of SSC, both GA and sex were significantly associated with glucose level. Furthermore, the length of second-stage labor, mode of delivery, and birth weight were considered factors affecting infants' blood glucose, though the associations of those factors with glucose levels were not significant. After performing multiple regression analysis with the forced entry method, the duration of SSC (β [95% confidence interval] = .20 [0.04-0.36]; standardized β = .28, P = .02), GA (β [95% confidence interval] = .48 [0.16-0.81]; standardized $\beta = .39$, $P = .005$) was mutually and independently associated with infants' blood glucose levels ($F = 4.695$, $R^2 = 0.347$, adjusted $R^2 = 0.273$). In other words, the

Table 3. **Multiple regression analysis of factors related to infants' blood glucose levels ($N = 60$)[a]**

	Unstandardized β	95% Confidence interval (lower-upper)	Standardized β	*P*
Duration of SSC	.20	0.04-0.36	.28	.02
Gestational age	.48	0.16-0.81	.39	.01
Birth weight	.002	−0.01 to 0.004	− .09	.47
Gender	3.87	−0.80 to 8.53	.20	.10
Length of 2-stage labor	− 1.80	−4.49 to 0.89	− .16	.18
Mode of labor	3.16	−1.68 to 7.99	.15	.20

Abbreviation: SSC, skin-to-skin contact.
[a]$F = 4.695$, $R^2 = 0.347$, adjusted $R^2 = 0.273$.
[b]The dependent variable; blood glucose level.

duration of SSC was significantly and positively associated with infant's blood glucose levels independent of GA, birth weight, sex, length of second-stage labor, and mode of delivery.

DISCUSSION

The present study is the first report elucidating that the duration of SSC was significantly and positively associated with infant's blood glucose levels independent of GA, birth weight, sex, length of second-stage labor, and mode of delivery in a healthy full-term infant. This is, to our knowledge, a novel finding.

Some possible mechanisms underlying our findings can be speculated from the findings shown by the relevant studies. Some previous studies showed that SSC increased infants' body temperature and kept it within normal range[7–9,16] when SSC was initiated immediately after birth. Another study demonstrated that SSC made maternal body temperature[7,8] as well as the infants' body temperature to increase.[17] Skin-to-skin contact is a strong vagal stimulant, through sensory stimuli such as touch, warmth, and odor, which among other effects release maternal oxytocin.[18] Oxytocin causes the maternal skin temperature to rise, which provides warmth to the infant.[8] The integration of mother and newborn infant serves as a useful intervention to increase each other's temperature immediately after birth. When the infant fails to maintain temperature, the cooling increases sympathetic activity, which causes norepinephrine to be released. Increased norepinephrine induces vasoconstriction response and decreases peripheral blood flow, leading to higher anaerobic metabolism. Under such circumstances, lactic acid accumulates and the cardiovascular and respiratory systems must work harder to get oxygen into the blood. This sequence of reactions requires higher energy consumption, causing blood glucose to decrease in newborn infants whose glycogen stores may be depleted immediately after birth.[19] In our study, the duration of SSC was positively associated with infants' axillary temperature ($\rho = 0.14$), and the temperature was also positively associated with blood glucose levels ($\rho = 0.20$), though each association was not significant. Our findings may be partly explained by the aforementioned mechanism.

Christensson and colleagues[7,18] examined metabolic adaptation using blood glucose levels in 50 healthy full-term newborn infants who were randomized by being kept either in SSC for 90 minutes or next to the mother in a cot and reported that infants who were held with SSC had significantly higher blood glucose levels. In addition, they presented that infants placed in a cot during the first 90 minutes after birth cried almost 10 times as much as those kept in SSC with their mothers. In the randomized controlled trial study by Mazurek and colleagues,[14] infants who had SSC for 75 minutes had higher glucose levels (mean levels = 60.1 mg/dL) than those who were swaddled beside their mothers (mean levels = 52.5 mg/dL) or those who were separated from their mothers (mean levels = 49.6 mg/dL). Similarly, the duration of crying was shorter among infants who had SSC than the other 2 groups. Moreover, Ferber and Makhoul[20] suggested that infants in the SSC group slept longer, were mostly in a quiet sleep state, and exhibited more flexor movements than the infants in the nursery. The decrease in physical activity induced by SSC may also cause newborn infants to preserve their energy and avoid decreased blood glucose, though, unfortunately, neither the state of crying nor sleeping was measured in our study.

Previously, Takahashi et al[10] reported that infants' salivary cortisol levels were lower when the infants had SSC for more than 60 minutes than infants who had SSC for less than 60 minutes. This finding suggested that a stress-reducing effect of SSC, an inverse relationship between infant' stress and the duration of SSC since salivary cortisol levels, the positive association of which with blood cortisol levels is well known, reflects the extent of stress after birth. Reduced stress and lower cortisol level involve lower energy consumption, leading to the prevention of hypoglycemia under the situation in which glycogen stores of infants are depleted immediately after vaginal birth.

The following is a summary of the aforementioned text. The practical implications for having SSC immediately after birth can be suggested that SSC facilitates extra-uterine adaptations of newborn infants without consuming wasteful energy by decreasing sympathetic tone and increasing parasympathetic tone, resulting in the prevention of reduced glucose levels. Moreover, previous studies have shown that infants exhibit their spontaneous breast-seeking behavior during SSC.[20] Skin-to-skin contact is also suggested to facilitate the initiation and duration of breast-feeding[15,21–24] and prevent hypoglycemic change. Thus, SSC can be one beneficial practice that will facilitate improved prognosis in newborns, especially in low-resourced countries.

There are both strengths and limitations in our study. As data on many kinds of exposure during delivery and infants' characteristics known or suspected to modify infants' glucose levels were collected, we could elucidate the independent effect of SSC by multivariate adjustment. There is, to our knowledge, no previous study evaluating the effect of SSC on infants' glucose levels after adjusting the potential confounding factors. The first limitation was that our study included only healthy full-tem infants. Therefore, further studies, including infants delivered in different situations, such as some complications of pregnancy and premature delivery, are needed. Second, our results were derived just under such conditions that SSC was continued for 11 to 97 minutes among healthy full-tem infants. The adequate SSC could be provide the sufficient effects on healthy full term infants than this study.

CONCLUSION

The longer early SSC was continued, the higher the glucose level was at 2 hours of age in healthy full-term infants. The association was independent of GA, birth weight, sex, length of second-stage labor, and mode of delivery. Early SSC immediately after birth may be an initial intervention to prevent neonatal hypoglycemia. Therefore, clinical midwives and nurses should be encouraged to initiate SSC immediately after birth and continue it while conducting appropriate risk management.

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