How the Clamping Distance of the Umbilical Cord affects Microbial Colonization and Cord Separation Time: A Randomized Trial

Deniz Akyildiz, PhD*; Ayden Çoban, PhD†

Objective: This study aimed to explore how umbilical cord separation time and microbial colonization are affected by umbilical cord clamping distance.

Methods: The randomized controlled study included 99 healthy newborns and was conducted at a hospital in Kahramanmaras, Turkey. The newborns were randomly divided into 3 groups: intervention group I (cord length: 2 cm); intervention group II (cord length: 3 cm; control group (not measured). On postpartum day 7, a sample of the umbilical cord was taken to assess microbial colonization. The mothers were contacted via mobile phone on the 20th day for an at-home follow-up. The data were analyzed by applying Pearson's chi-square test, Fisher's exact test, a 1-way analysis of variance test, and Tukey's post hoc Honest Significant Difference test.

Results: The mean umbilical cord separation time of the newborns was found to be 6.9 (±2.1) days in the intervention group I, 8.8 (±2.9) days in the intervention group II, and 9.5 (±3.4) days in the control group. The difference between the groups was statistically significant (*P* < .01). Microbial colonization was detected in 5 of the newborns, across the groups; no significant differences were found between the groups (*P* > .05).

Conclusion: In this study, it was determined that clamping the umbilical cord from a distance of 2 cm in vaginally delivered full-term newborns contributed to the shortening of the cord fall time and did not affect microbial colonization. [*P R Health Sci J 2023;42(1):50-56*]

Key words: Colonization, Midwives, Newborn, Separation time, Umbilical cord

A country's neonatal mortality rate is an indication both of that country's level of development, economically speaking, and of the degree to which said development affects the health of the population. Infection-related fatalities are significantly associated with neonatal death (1), and infections of the umbilical cord form a significant part of neonatal infections (2).

Subsequent to the birth, the umbilical cord is clamped and cut off (2 to 3 centimeters from the abdominal wall of the newborn), bringing the cord's function to completion (3). The remaining necrotic tissue provides an ideal environment for bacterial growth (4,5). In the next 5 to 15 days, the cord dries out and falls off (5,6), with the precise length of time that it takes having a direct effect on the newborn child's health. With respect to the last, it is important that any elements that might, ultimately, affect that length time be understood. Studies that explore the time that it takes for the umbilical cord to fall off tend to focus on comparing the techniques used to care for said cord (8–10). A number of factors have been found to affect the separation of the cord: the newborn's birth weight, gestational age, and gender; the mode of delivery; the complications—if any—that attended the pregnancy; the antibiotics—if any—that were administered to the newborn; the child's having a low neutrophil level; and parenteral feeding (11–13). Researchers have determined that the microbial colonization of the navel cord can be affected by a variety of factors that include birth weight, preterm labor, cesarean delivery, pregnancy complications, childbirth under unsanitary conditions, and incorrect or other types of cord-care techniques (11,13).

However, research exploring the impact of the distance between the newborn's abdominal wall and the site at which the umbilical cord is clamped is lacking, despite evidence that this distance may despite evidence that the clamping distance of the umbilical cord may be among the factors that impact the separation time of the cord. Also, no measuring instrument is used to determine the clamping site or to cut off the umbilical cord, with the result being that midwives adopt a variety of

*Assistant Professor, Kahramanmaras Sutcu Imam University, Faculty of Health Sciences, Department of Midwifery, Kahramanmaras, Turkey; †Professor Dr. Aydın Adnan Menderes University, Faculty of Health Sciences, Department of Midwifery, Aydın, Turkey

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Address correspondence to: Deniz Akyildiz, PhD, Kahramanmaras Sutcu Imam University, Faculty of Health Sciences, Division of Midwifery, Kahramanmaras, Turkey. Email: denizbtm@gmail.com

practices when carrying out this procedure. The lack of adequate information about cord clamping distance and the absence of a standard procedure among midwives for accomplishing same point to the need for a study exploring this matter. This randomized controlled study was therefore designed to explore how separation time and microbial colonization are affected by umbilical cord clamping distance.

Study hypotheses

Hypothesis 1. The distance at which the umbilical cord is clamped has no effect on how long it takes for the cord to separate.

Hypothesis 2. The distance at which the umbilical cord is clamped has no effect on microbial colonization.

Materials and Methods

Study design and participants

This research consisted of a prospective, single-center, 3-arm parallel group, randomized controlled experimental trial. The recommendations of the Consolidated Standards of Reporting Trials (CONSORT) statement were followed.

This study was conducted at the maternity and children's hospital located in Kahramanmaras, Turkey, from June 2018 through March 2019. Mothers arriving at the hospital who met the inclusion criteria were randomly selected to participate. Those who were not excluded after the birth of their child remained and that child made part of the overall sample group. The inclusion criteria, applied prior to the birth of the child, were are follows: The mother had to be at 38 to 42 weeks of gestation, be 18 years old or older, have a primary school education or better, be able to both understand and speak Turkish, be able to communicate with no significant difficulties, not have an active vaginal infection at the time of selection and not have a history of such an infection, live in the metropolitan area of Kahramanmaras, be amenable to receiving home visits during the follow-up phase of the study process, and agree to take part in the study. After the birth of her child, mother and child were excluded if the child was delivered by cesarean, if the mother experienced a premature rupture of membranes, if the child was born with severe congenital anomalies, if the newborn required hospitalization immediately after birth, or if the infant's birthweight was below 1500 g.

Ethics

The randomly selected mothers were informed about the study's content and purpose and written consent was obtained from those interested in participating. In addition, the study protocol (protocol number: 2018/35) was approved by the Non-invasive Clinical Studies Ethical Board on 30 May 2018.

Intervention

Recommendations in the literature suggest that the umbilical cord be clamped at a distance of 2 to 3 centimeters from the newborn's abdominal wall. There is a significant difference between 2 cm and 3 cm, and it is important to know which one is most effective. Therefore, these respective distances were used for intervention groups I and II. Because the clamping distance is sometimes estimated by eye, a third group—the control—included newborns whose umbilical cords had been clamped and cut at non-measured distances.

A single member of the study team measured (using a pre-prepared 2-cm-long cut-to-size ruler), clamped, and cut the umbilical cords of the newborns in intervention group I at 2 cm from each infant's abdominal wall (Figure 1); the tool was cleaned with a disinfectant after each use.

Figure 1. Umbilical cord distance measurement and clamping in intervention group I and II

For the newborns in intervention group II, the clamping distance was 3 cm. Again, a single researcher—using a similarly pre-prepared measuring tool, this one being 3 cm long—performed the measuring, clamping, and cutting (Figure 1). The same disinfection process was utilized for the measuring tool after each use.

A healthcare worker estimated (by eye) the placement of the clamp on the umbilical cord of each infant in the control group, after which, the same study member who had measured the clamp placement on the cords of the children in the 2 intervention groups used a measuring tape to determine the precise distance between the abdominal wall and the clamping point. This individual also cut the umbilical cords of the babies in the control group.

Different umbilical cord care practices and bath types affect the umbilical cord separation time and microbial colonization. Since such practices might have affected the results of the study, before discharge, the mothers in all 3 groups were advised not to bathe their babies before the umbilical cords fell off. In addition, "dry care," which is followed by dry care using no substances, was recommended for umbilical cord care.

Outcome measures

The primary outcome of this study focused on umbilical cord separation time. That time was assessed using a Turkish-language form that tracks umbilical cord separation for as long as 20 days. The participating mothers were contacted on the 20th day and were asked for the information required to fill in the Turkish-language form.

The second main outcome of this study involved umbilical cord microbial colonization, which was assessed by sampling (with a swab) the umbilical cord on the seventh day, even if the umbilical cord of the newborn had fallen off during this period. Transport swabs were used to take the swabs to the laboratory for culture The cultures were left for 48 hours, after which they were assessed to determine whether they represented the microbial colonization of the newborn.

Sample size

The number of individuals to be included in the sample was calculated using the software G*power, version 3.1.3. The sample size was calculated at a power of 0.8 and a significance of P value < .05. Since no previous study was found on this subject, a medium effect size of 0.25 was used (14). The number of healthy newborns necessary for the study was found to be 99: 33 for intervention group I, 33 for intervention group II, and 33 for the control group. A total of 108 newborns (36 for intervention group I, 36 for intervention group II, and 36 for the control group) were recruited as it was estimated that 10% of the participants would leave the study during the process. The recruitment process ended when the target sample number was reached.

Randomization

A basic randomization method (https://www.randomizer.org/) was used to determine whether or not to include the mothers in the 3 groups, intervention groups I and II and the control group. The randomization process was carried out by an independent researcher; the results led to each of the individuals being assigned to a group, which one having been determined by this method. This was carried out by an independent researcher. Individuals were assigned to groups according to the numbers determined by this method. The data were collected by the first author, and the collected data were not blinded.

Data collection

The data were collected using a structured questionnaire comprising 3 parts (a form with the information of the mother and newborn, a form for the seventh day of umbilical cord follow-up, and a form for the 20th day of umbilical cord follow-up) and 39 items; it was developed by the researchers based on the literature (5,11,15,16). The structured questionnaire was given to 10 faculty members in the midwifery and nursing departments for their expert opinions.

The researcher began collecting data from each pregnant women upon her admission to the hospital for when each pregnant woman was admitted to the hospital for delivery, after she agreed to participate in the study. The researcher asked all participants to fill out the maternal information form; later, the newborn information form was filled out by the researcher while observing each child during its stay in the hospital nursery.

Home visits were made to evaluate the umbilical cords of all the newborns at their respective postpartum day 7, and a sample of that child's umbilical cord was taken to assess umbilical microbial colonization. The researcher filled in the form concerning the umbilical cord seventh-day follow-up during this visit. On the 20th day, the form for the final umbilical cord follow-up was filled in by the researcher during interviews with the mothers that took place via mobile phones. The mothers were asked when the umbilical cord had fallen off, whether it had not fallen off by the seventh day, and whether there were any signs of cord infection.

Statistical analyses

The data were analyzed using SPSS 22.0, a statistical software package. The Shapiro–Wilk test was used to check whether the continuous variables conformed to normal distribution. Pearson's chi-square test, Fisher's exact test, and a 1-way analysis of variance (ANOVA) test were used to show whether the groups were homogeneous. The continuous variables in the independent groups were compared using 1-way ANOVA and Tukey's post hoc Honest Significant Difference (HSD) test; categorical variables were compared using Pearson's chi-square and Fisher's exact tests. A P value lower than .05 was required for statistical significance.

Results

Of the 445 newborns assessed in this study, the mothers of 108 fulfilled the inclusion criteria, with the infants themselves not meeting any of the exclusion criteria; therefore, all 108 were randomized into one of the intervention groups or the control group. Nine of the 108 newborns were excluded during the study because ineligibility factors. Thus, the final total sample

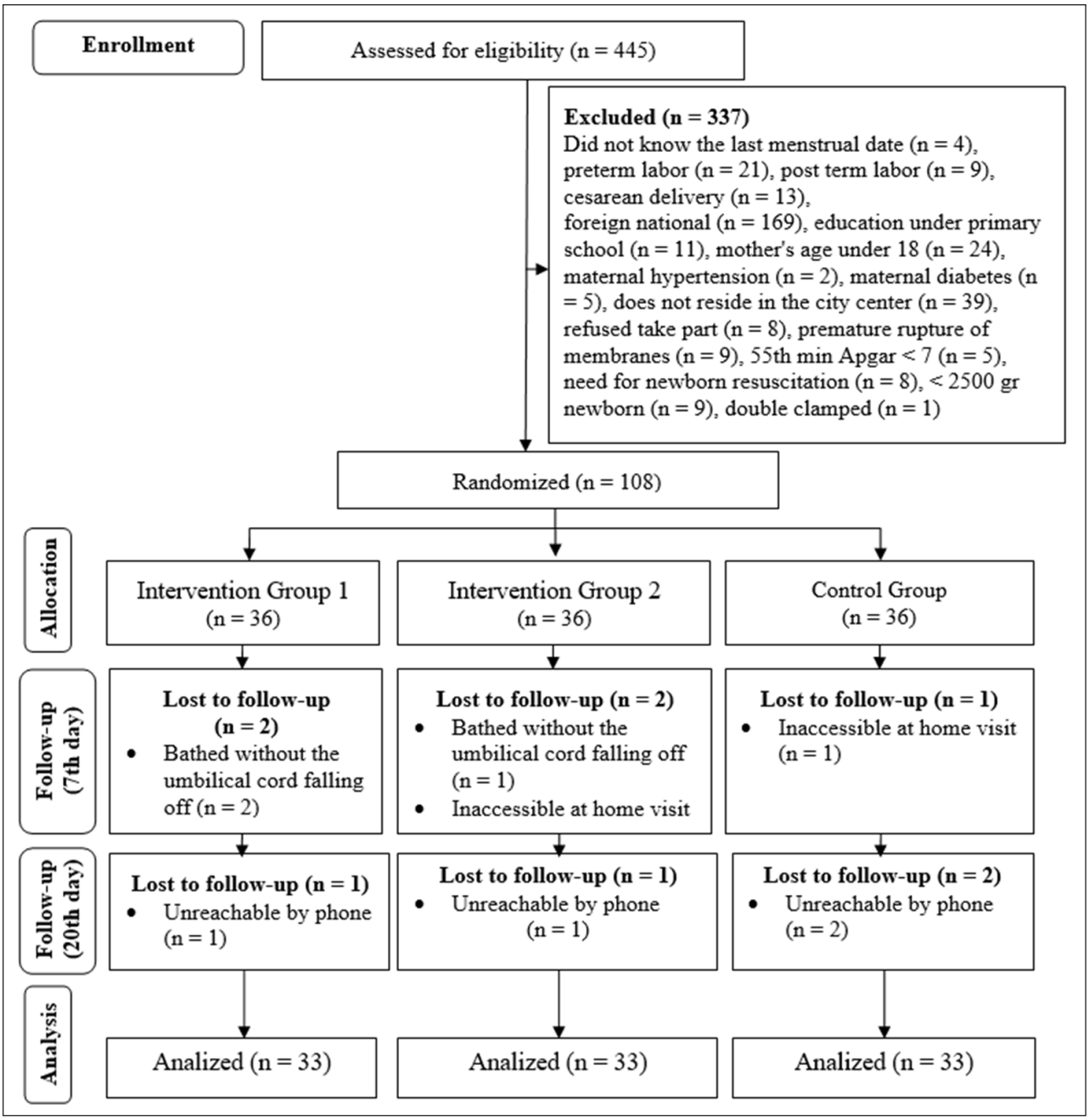

Figure 2. CONSORT diagram

size of the 3 groups (intervention I, intervention II, and control) combined was 99 newborns (Figure 3).

The ages of the mothers were similar across the groups (26.6 ± 5.9 years, 26.2 ± 5.8, and 28.4 ± 6.4, respectively; P = .294). Upon comparing maternal characteristics, no significant differences were found in terms of education level (P = .525), social security (P = .816), or income level (P = .121). The mean gestational ages in weeks (39.2 ± 0.7, 39.3 ± 0.7, and 39.2 ± 0.9, respectively; P = .664) and birth weights (P = .870) of the newborns were also similar. The newborns were mostly female (69.7%, 72.7%, and 63.6%, respectively; P = .720) and had no Rh incompatibilities (87.9%, 84.8%, 93.9%, respectively; P = .489). Other sociodemographic characteristics are shown in Table 1.

The mean (±SD) umbilical cord clamping distance in the control group of newborns was 1.4 (±1.1) cm and the lengths of the umbilical cords from the points at which they had been clamped ranged from 0.4 to 4.8 cm. The clamping distances of the umbilical cords and the separation times of the cords by clamping distance in the control group of newborns can be seen in Table 2.

The umbilical cord separation times of all newborns included in the study were from 3 to 19 days. When the mean (±SD)

Table 1. Sociodemographic characteristics of mothers and newborns

Variable	Groups			
	Intervention I (n = 33)	Intervention II (n = 33)	Control (n = 33)	*P* value[a]
Maternal age, years (SD)	26.6 (5.9)	26.2 (5.8)	28.4 (6.4)	.294
Maternal educational level (%)				
Primary school	7 (21.2)	8 (24.2)	13 (39.4)	.525[b]
Middle school	17 (51.5)	17 (51.5)	13 (39.4)	
High school	6 (18.2)	4 (12.1)	6 (18.2)	
University	3 (9.1)	4 (12.1)	1 (3.0)	
Social security (%)				
Yes	28 (84.8)	26 (78.8)	27 (81.8)	.816
No	5 (15.2)	7 (21.2)	6 (18.2)	
Income level (%)				
Income is lower than expenses	20 (60.6)	17 (51.5)	25 (75.8)	.121
Income is equal to expenses	13 (39.4)	16 (48.5)	8 (24.2)	
Gestational age, weeks (SD)	39.2 (0.7)	39.3 (0.7)	39.2 (0.9)	.664
Newborn's birth weight, gr (SD)	3345.7 (417.6)	3345.1 (424.5)	3393.0 (423.4)	0.870
Newborn's gender (%)				
Female	23 (69.7)	24 (72.7)	21 (63.6)	.720
Male	10 (30.3)	9 (27.3)	12 (36.4)	
Rh incompatibilities (%)	4 (12.1)	5 (15.2)	2 (6.1)	
Yes	29 (87.9)	28 (84.8)	31 (93.9)	.489[b]
No				

[a]Chi-square test and 1-way analysis of variance test for categorical and continuous variables. [b]Fisher's exact test.

umbilical cord separation times of the newborns were examined, they were found to be 6.9 (±2.1) days in intervention group I, 8.8 (±2.9) days in intervention group II, and 9.5 (±3.4) days in the control group. One-way ANOVA test results showed that the difference between the groups was statistically significant ($P < .01$). According to Tukey's post hoc HSD multiple comparison test, there was a significant difference between intervention group I and intervention group II ($P < .05$). It was also determined that there was a significant difference between intervention group I and the control group ($P < .01$). However, no significant difference was found between the mean of intervention II group and that of the control group ($P > .05$) (Table 3).

Colonization was detected in the umbilical cords of 5 newborns. However, Fisher's exact test determined that the difference between the groups was not significant ($P > .05$). It was determined that the colonized microorganisms were gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli*. Colonization was detected in 2 newborns in the control group. In one, the umbilical cord had been clamped at 0.4 cm and had fallen off on the 14th day; in the other, the cord had been clamped at 4.6 cm and had fallen off on the 19th day (Table 4).

Discussion

The aim of this study was to examine the way in which the placement of the umbilical cord clamp (distance from the newborn's abdominal wall) affects separation time and microbial colonization. We found that the umbilical cord separation times of newborns with umbilical cords clamped at a distance of 2 cm from the abdominal wall were shorter. Another finding was that the clamping distance did not influence microbial colonization.

The advice in the literature is to clamp the umbilical cord at a distance of 2 to 3 cm from the abdominal wall (3,15). However, there is no research on the effects of this specified distance. It is also worth noting that no specific or recommended measurement technique is used in the clamping of the umbilical cord and that it is a procedure that uses a visual estimate.

We observed that the umbilical cords of the newborns in the control group had been clamped at a distance of 0.4 to 4.8 cm. This led to the discovery that the umbilical cord clamping procedure that was used in the delivery room where the participating mothers gave birth was carried out without the help of any apparatus and that the clamp was placed at a variety of distances, from one patient to the next. This may have been because of the differences in the midwives' training or in their work experience or may have stemmed from differences in their personal skills.

When the umbilical cord clamping distance of 2 cm was compared to that of 3 cm, it was observed that clamping at 2 cm led to an earlier separation of the cord (by approximately 2 days) than did clamping at 3 cm; non-measured clamping, however, resulted in an even earlier separation (3 days). Gradually

Table 2. Clamping distance ranges and separation times of newborns in the control group (n = 33)

Umbilical cord clamping distance	Umbilical cord separation time
0.4 cm (n = 1)	14th day
0.5 cm (n = 1)	12th day
0.7 cm (n = 1)	9th day
0.9 cm (n = 1)	10th day
1.1 cm (n = 3)	8th day, 9th day, 10th day
1.3 cm (n = 1)	11th day
1.5 cm (n = 2)	8th day, 9th day
1.6 cm (n = 3)	8th day, 8th day, 10th day
1.8 cm (n = 1)	7th day
2.2 cm (n = 2)	4th day, 7th day
2.3 cm (n = 1)	8th day
2.4 cm (n = 1)	6th day
2.5 cm (n = 5)	5th day, 6th day (2 newborns), 7th day, 9th day
2.6 cm (n = 2)	7th day, 10th day
3.2 cm (n = 1)	12th day
3.4 cm (n = 1)	10th day
3.6 cm (n = 2)	11th day, 12th day
4.0 cm (n = 1)	13th day
4.2 cm (n = 1)	16th day
4.6 cm (n = 1)	19th day
4.8 cm (n = 1)	16th day

increasing vasoconstriction takes place in the vascular structures of the umbilical cord after birth, leading to tissue necrosis, which causes the cord to fall off after a while (17). In connection with this, we argue that allowing the length of the umbilical cord tissue to be too long can extend the time at which necrosis develops, which prolongs the separation time.

Our finding was that the umbilical cord clamping distance affected separation time but did not affect colonization. The reason for this may have been that the factors causing colonization had been excluded from the study at the design stage. Another reason may have been the sample size. Future studies using larger samples might contribute to clarifying this point.

Table 3. Comparison of umbilical cord separation time outcomes of newborns between groups and post hoc test results regarding the differences in umbilical cord separation times

Variables	Groups			
	Intervention I (n = 33)	Intervention II (n = 33)	Control (n = 33)	*P*[a]
Separation time, mean (±SD)	6.9 (±2.1)	8.8 (±2.9)	9.5 (±3.4)	.001
Separation time range, min-max	3 – 14	4 – 15	4 – 19	-
Groups (I)	**Groups (J)**	**Mean difference (I-J)**	**Sh**	***P*[b]**
Intervention I	Intervention II	-1.909	0.716	.024*
	Control	-2.636	0.716	.001**
Intervention II	Intervention I	1.909	0.716	.024*
	Control	-0.727	0.716	.569
Control	Intervention I	2.636	0.716	.001**
	Intervention II	0.727	0.716	.569

min-max: minimum-maximum. [a]1-way analysis of variance test. *P < .05; **P < .01. [a]Tukey's post hoc Honest Significant Difference test

In addition, the lack of a difference in the colonization results between the groups may have been because in this study, colonization was tested only once due to the laboratory expenses needed for the procedure. It has been established in the literature that colonization increases on the fifth and seventh days postpartum (5). There is evidence of differences between colonization samples taken at different times. For example, Lyngdoh et al. found differences in umbilical cord colonization results assessed at the 12th and 72nd hours after birth (10). Similarly, in another study, differences in colonization were found in samples taken on the second and third days and on the seventh day (13). In our study, the cultured samples taken from the umbilical cords of the participating newborns revealed that the colonizing microorganisms were *Staphylococcus aureus* and *Escherichia coli*. The practice of dry cord care used in this study might explain this, as other studies have found that the practice of dry cord care often leads to *Staphylococcus aureus* and *Escherichia coli* colonization (18).

In terms of limitations, firstly, we were not able to conduct a blinded study. As the research was conducted as part of a doctoral thesis project, the collection of the data by the same researcher was a barrier to blinding in the follow-up. Secondly, the assessment of the newborns and their umbilical cords on the 20th day was based on the responses of the mothers.

Nonetheless, the study is of significance since it is the first to examine the effects of umbilical cord clamping distance on cord separation time and colonization. Our study revealed that when the umbilical cord was clamped at a distance of 2 cm, the separation time of the cord was significantly shorter than when the cord was clamped at a distance of 3 cm, which was also the case when the clamping distance was not measured at all. In addition, the clamping distance of the umbilical cord was found to have no effect on cord colonization.

Based on these findings, this paper ends with 2 recommendations for practice and 1 for future research. 1) Midwives in attendance in the delivery room who have completed a formal (and relevant) course of education should be trained and their awareness raised so that they will be cognizant that clamping the umbilical cords of newborns at a distance of 2 cm from the abdominal wall is an effective technique; 2) an apparatus should be devised that can measure the 2 cm distance that is ideal for umbilical cord clamping; 3) further studies should implement a similar method to premature and postmature infants and infants born by cesarean section; 4) in addition, similar studies with larger sample sizes should be undertaken to overcome the limitations of the present study.

Resumen

Objetivos: Estudio dirigido a ver cómo el tiempo de separación del cordón umbilical y la colonización microbiana se ven afectados por la distancia de pinzamiento del cordón umbilical. Métodos: Estudio aleatorio de 99 recién nacidos

Table 4. Distribution of umbilical cord separation time, clamping distance, and microbial colonization type, by groups

Groups	Separation time (day)	Clamping distance (cm)	Microorganism type	Colonized bacteria
Intervention I (n = 1)	13	2	Gram (+) bacteria	*S. aureus*
Intervention II (n = 2)	14	3	Gram (+) bacteria	*S. aureus*
	12	3	Gram (-) bacteria	*E. coli*
Control (n = 2)	14	0.4	Gram (+) bacteria	*S. aureus*
	19	4.6	Gram (+) bacteria	*S. aureus*

S. aureus: Staphylococcus aureus; E. coli: Escherichia coli.

sanos y realizado en un hospital de Kahramanmaras, Turquía. Los recién nacidos eran 3 grupos: grupo de intervención I (longitud del cordón: 2 cm); grupo de intervención II (longitud del cordón: 3 cm; grupo de control (no se midió). En el séptimo día posparto, se tomó una muestra del cordón umbilical para evaluar la colonización microbiana. Se contactó con las madres por teléfono móvil el día 20 para el seguimiento en casa. Los datos se analizaron aplicando la prueba de chi-cuadrado de Pearson, la prueba exacta de Fisher, la prueba de análisis de varianza de 1 vía y la prueba de diferencia significativa honesta post hoc de Tukey. Resultados: El tiempo medio de separación del cordón umbilical de los recién nacidos fue de 6.9 (±2.1) días en el grupo de intervención I, 8.8 (±2.9) días en el grupo de intervención II y 9.5 (±3.4) días en el grupo de control. La diferencia entre los grupos fue significativa ($P < 0.01$). Se detectó colonización microbiana en 5 de los recién nacidos, en todos los grupos; no se encontraron diferencias significativas entre los grupos ($P > 0.05$). Conclusiones: En el estudio se determinó que el pinzamiento del cordón umbilical a una distancia de 2 cm en los recién nacidos a término por vía vaginal contribuyó a acortar el tiempo de caída del cordón y no afectó a la colonización microbiana.

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