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Comparison of Milk Output from the Right and Left Breasts During Simultaneous Pumping in Mothers of Very Low Birthweight Infants

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ABSTRACT

***Purpose*: Milk output from the right and left breasts was compared in mothers who were pumping exclusively and had not yet fed their infants at breast.**

***Methods*: Thirty-five mothers of very low birthweight infants established lactation with a hospital grade, electric, dual pump, and recorded milk output separately for each breast during every pumping session from enrollment until completion of the study (mean = 19.8 days) using a standardized milk log. Milk output from each breast was also weighed during six observed milk expressions over a 2-week period during the study.**

***Results*: For the observed pumping sessions (n = 210), milk output was greater from the right breast in 65.7% of the sessions. For the milk log data (n = 3099 pumping sessions) milk output was greater from the right breast in 47.6% of the sessions, greater from the left breast in 28.0%, and equal from both breasts in 24.4% of the sessions. The mean difference in milk output between the right and left breasts was 6.6 mL (SD = 12.1) for the observed sessions, and 5.0 mL for the milk log data (SD = 10.9). The mean right-to-left breastmilk output ratio was 1.20 for the observed sessions and 1.17 for the milk log data. The right-to-left breastmilk ratios were not associated with time of day, day of pumping, total milk output, maternal handedness or the breast pump suction pattern. The right-to-left breast differences were associated with parity and breastfeeding experience, with primiparous women and first-time breastfeeders demonstrating the greatest differences.**

***Conclusions*: These findings suggest that differences in the milk output from the right and left breasts are common, and that milk output is often greater from the right breast. The differences appear early in lactation, are not related to total milk output, and are relatively consistent throughout the day and over the first weeks of lactation.**

INTRODUCTION

LACTATING MOTHERS often comment that they notice a difference in the amount of milk produced by the right and left breasts. They describe observations such as one breast being consistently fuller than the other, milk flowing more freely from one breast, or infants' consistently "preferring" one breast to the other. Similarly, mothers and clinicians frequently note a

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difference in the milk output from the right and left breasts during mechanical breast pumping, leading mothers to question whether these differences are "normal." Although anecdotal reports suggest that a difference in milk output from the two breasts occurs frequently, this phenomenon has not been studied extensively.

As early as 1954, differences in the milk output from the right and left breasts obtained by mechanical pumping were reported, but the differences were attributed to which breast had been suckled last at the most recent breastfeeding.[1] Differences in the milk output from the right and left breasts were not addressed extensively in the literature again until a series of studies from the University of Western Australia consistently reported differences in the milk output between the two breasts in mothers of healthy infants, with greater outputs more frequently reported for the right breast.[2–9] These studies reported milk output for 24-hour intervals, eliminating the effect of the most recently suckled breast on the milk output at a subsequent feeding or pumping. Participants for these well-controlled studies included mothers who had an established milk supply and healthy infants who fed at breast. Thus, the observed milk output differences may have been a result of cultural practices that stimulated milk production disproportionately in one breast, such as the Muslim tradition of always initiating a feeding session with the right breast[10] or feeding from only one breast.[11] Similarly, milk output differences may have been influenced by maternal handedness[12] or by mothers' preference to hold the infant on one side (cradling).[12,13] Alternatively, these differences may have been influenced by the infant's preference for a particular breast[12,14] or the infant's preferred direction of head turning (laterality).[12,15] Thus, it is unknown whether the differences in milk output between the two breasts was due to maternal cultural practices, maternal–infant preferences such as handedness, cradling, and head turning, or due to a biological difference in the breasts.

The purpose of this study was to describe the direction and magnitude of differences between the milk output from the right and left breasts in mothers of very low birthweight (VLBW, <1500 g) infants who were pumping exclusively and had not yet fed their infants at breast. This unique group of mothers provided the opportunity to compare milk output from the two breasts while eliminating the effects of breastfeeding practices and maternal–infant preferences on these differences. Additional purposes were to determine whether these differences were present at the onset of lactation or developed over time, and if the differences were related to time of day, total daily milk output, the breast pump suction pattern, maternal handedness, parity, or previous breastfeeding experience.

MATERIALS AND METHODS

Design

This study was a part of a larger randomized clinical trial which compared the comfort, convenience, efficiency, and efficacy of three different suction patterns in a hospital grade, dual electric breast pump (Symphony Pump; Medela, Inc., McHenry, IL). Thirty-five mothers of VLBW infants who agreed to establish lactation by simultaneous mechanical breast pumping were enrolled within 48 hours of initiating pumping. Mothers completed a log documenting the milk output from each breast during every pumping session from enrollment until completion of the study. Milk output from each breast was also measured during six observed pumping sessions for each mother. The observed pumping sessions were conducted at approximately the same time each day over a 2-week period, and each of the three suction patterns was used for two of the observed sessions.

Sample and setting

This study was conducted in the Neonatal Intensive Care Unit at Rush University Medical Center. Criteria for inclusion in this study were: birth of a VLBW infant; willing to initiate lactation using a hospital grade, electric, dual breast pump (Classic, Medela, Inc.); and achievement of total daily milk output of at least 350 mL per day for at least 5 consecutive days before testing three new suction patterns in the observed pumping sessions. No mother

meeting the inclusion criteria was excluded from this study, and no mothers declined to participate. Characteristics of the study sample are described in Table 1.

Procedures

Eligible mothers who consented to participate were given a hospital grade, electric, dual pump (Classic, Medela Inc.) to initiate lactation and were instructed and assisted in using the equipment and collecting, measuring and storing their milk. Mothers were advised to pump both breasts simultaneously at least six to eight times a day. Mothers measured milk output from each breast at each pumping session volumetrically, by using the markings on the graduated milk collection and storage containers, which were marked in 10-mL increments. Participants were also instructed in using a milk log to document the milk output from each breast for each pumping session. A separate milk log was completed for each breast from enrollment until completion of the study.

Once mothers achieved a total daily milk output of at least 350 mL for 5 consecutive days, they tested three different suction patterns in a hospital grade, electric, dual pump (Symphony, Medela, Inc.). Mothers used each of the three suction patterns for two randomly ordered pumping sessions, for a total of six observed pumping sessions. These observed pumping sessions took place at the same time each day (±1 hour) over a 2-week period under the direct supervision of a research nurse. The milk output from each breast was weighed using an electronic scale (Tanita Model 1479S, Japan) that was accurate to ±0.1 g.

Milk storage capacity for each breast was estimated using a modification of the procedures described by other researchers.[4] The calculation of milk storage capacity involved two steps. First, once the woman had achieved a total daily milk output of at least 350 mL per day for 5 consecutive days, milk drops (<1 mL) were collected from each breast immediately before the onset and again at the completion of pumping for a 24-hour period. The high and low creamatocrit values were determined and then used to calculate the degree of breast fullness associated with each creamatocrit value. Then, milk drops (<1 mL) were collected from each breast immediately before the onset and again at the completion of pumping for each observed pumping sessions. These creamatocrit values were used in combination with the creamatocrits and milk outputs from the observed pumping sessions to estimate the storage capacity of each breast.

Table 1. Characteristics of the Study Sample (N = 35)

Characteristic	*Mean (SD)*
Maternal age (years)	29.1 (7.4)
Infant birth weight (g)	1016.1 (288.3)
Infant gestational age at birth (weeks)	27.4 (2.4)
	n (%)
Race	
African-American	14 (40%)
Non-Hispanic Caucasian	14 (40%)
Hispanic	6 (17.1%)
Native-American	1 (2.9%)
Family income	
<$30,000 annually	13 (37.1%)
≥$30,000 annually	22 (62.9%)
WIC eligible	
Yes	18 (51.4%)
No	17 (48.6%)
Breastfeeding experience	
Yes	14 (40.0%)
No	21 (60.0%)
Parity	
Primiparous	15 (42.9%)
Multiparous	20 (57.1%)
Multiple gestation	
Yes	9 (25.7%)
No	26 (74.3%)

Analysis

Data were analyzed using Microsoft Excel 2003 (Redmond, WA) and SPSS for Windows version 14.0 (Chicago, IL). Descriptive statistics were used to describe continuous variables, and frequencies were used to describe discrete variables. The net and absolute differences in milk output from the right and left breasts (right–left = difference) were calculated (mL) for each pumping session, and these differences were described using means, standard deviations, and maximal differences. Two additional statistics were developed to more completely characterize the differences in milk output between the right and left breasts. The first statistic, the percentage of right–left difference

in total milk output, was developed to quantify the *magnitude* of difference across milk output values regardless of the direction of difference. This statistic was calculated using the absolute difference in milk output from each breast as a percentage of the total milk output from both breasts {([absolute (right − left milk output)]/total milk output) × 100}, for each pumping session. The second new statistic, a ratio of the right-to-left milk output (right milk output/left milk output), was developed to *standardize* the right-to-left difference in milk output regardless of the total milk output, and was also calculated for each pumping session. Values above 1.0 indicated greater milk output from the right breast and values below 1.0 indicated greater output from the left breast. The percentage of difference in storage capacity between the breasts was calculated by using the following equation: {([absolute (right − left storage capacity)]/total storage capacity) × 100}.

A Type I error of 5% was used for all tests of statistical significance. To avoid the problems of unequal numbers of observations for each woman in the milk log data and the potential violation of independence in statistical analyses, the overall mean values for each woman were used for statistical comparisons of the data from the milk logs and observed pumping sessions. Wilcoxon signed-rank tests were used for paired statistical comparisons and Mann-Whitney tests were used for statistical comparisons involving two independent groups. Pearson's correlation coefficient was used to determine the association between the mean right-to-left milk output ratio, the mean total milk output during the observed pumping sessions, mean total daily milk output in the milk log data, and the percentage of difference in the storage capacity of the breasts. Repeated-measures analysis of variance was performed to determine whether the pump suction pattern was associated with the right-to-left milk output ratio.

Ethical considerations

The Institutional Review Board of Rush University Medical Center approved this study. Mothers provided written consent to participate after the study was described and the voluntary nature of participation was explained. With the exception of the drops of milk collected to measure creamatocrit values, all milk obtained during this study was saved for the mother's infant.

RESULTS

There were a total of 210 observed pumping sessions in 35 women (six sessions for each women) for which a research nurse weighed the pumped milk output. The milk log data included 3099 pumping sessions for 34 of the 35 women (one mother's records were lost) for which milk output was measured volumetrically and recorded in the milk log by the mother. Milk log data were recorded for a mean of 19.8 days (SD = 5.7, range = 5–37 days). The mean number of pumping sessions recorded by the individual women was 91.2 sessions (SD = 32.3, range = 28–158 sessions). The differences in milk output from the right and left breasts for both the observed pumping sessions and the milk log data are described in Table 2.

Factors associated with right-to-left differences

Differences in the right-to-left milk output ratio were examined in relation to maternal factors such as handedness, parity, and previous breastfeeding experience. These findings are summarized in Table 3. Maternal handedness was not significantly associated with the right-to-left milk output ratio. However, parity and previous breastfeeding experience were significantly associated with the right-to-left milk output ratio, with primiparous women and those with no prior breastfeeding experience having the largest ratios. The mean milk output ratio was also significantly correlated with the percentage of difference in the storage capacity of the breasts for both the observed pumping sessions ($r = 0.55$, $p < 0.01$) and the milk log data ($r = 0.58$, $p < 0.01$).

Differences in the right-to-left milk output ratio were also examined in relation to the total milk output. The mean total milk output per pumping session was not significantly corre-

Table 2. Description of the Milk Output Differences for the Right and Left Breasts

	Observed pumping sessions (n = *210*)	*Milk log data* (n = *3099*)
Milk output directionality		
Greater in the right breast	65.7%	47.6%
Greater in the left breast	34.3%	28.0%
Equal from both breasts	0.0%	24.4%
Mean milk output difference (Mean ± SD, in mL)	6.6 (12.1)	5.0 (10.9)
Maximum milk output difference in a single pumping session (mL)	94.2	140
Mean percentage of right-to-left difference in milk output (Mean ± SD)	11.4% (9.1)	10.2% (8.5)
Mean right-to-left milk output ratio	1.20 (0.37)	1.17 (0.41)
Milk storage capacity (Mean ± SD, in mL)		
Right breast	198.5 (119.8)	—
Left breast	183.0 (96.6)	

lated with the mean right-to-left milk output ratio during the observed pumping sessions ($r = -0.22$, $p = 0.22$). Similarly, the mean daily total milk output was not significantly correlated with the mean right-to-left milk output ratio in the milk log data ($r = -0.22$, $p = 0.22$).

The pattern of right-to-left milk output ratios over the course of the day and over the duration of the study were also examined to determine stability of the ratios over time. The pattern of the mean right-to-left milk output ratios for each pumping session over the course of the day (beginning at midnight) in relation to the mean total milk output per session are displayed in Figure 1. Although total milk output per session was consistently highest for the first pumping of the day (early morning) and declined over the day, the mean right-to-left milk output ratios were relatively stable throughout the day. The right-to-left milk output ratios over the course of the study (beginning at day of enrollment) were also relatively stable, even though the mean total daily milk output changed over time (Fig. 2). These serial data were also analyzed to determine if the mean milk output ratio for the first 5 days of milk output was significantly different from the last 5 days of the study. The mean right-to-left milk

Table 3. Relationship between the Right-to-Left Milk Output Ratio and Maternal Handedness, Parity, and Breastfeeding Experience

	Observed pumping sessions (n = *210*)			*Milk log data* (n = *3099*)		
Characteristic	n	*Right-to-left milk output ratio*	p-*value*	n	*Right-to-left milk output ratio*	p-*value*
Handedness						
Right-handed	21	1.20 (0.23)	0.69	20	1.15 (0.23)	0.41
Left-handed	3	1.19 (0.35)		3	1.05 (0.20)	
Parity						
Primiparous	15	1.37 (0.50)	0.05	14	1.34 (0.58)	0.05
Multiparous	20	1.08 (0.14)		20	1.05 (0.12)	
Breastfeeding Experience						
Breastfeeding experience	14	1.05 (0.08)	0.01	14	1.02 (0.10)	0.04
No breastfeeding experience	21	1.31 (0.45)		20	1.27 (0.50)	

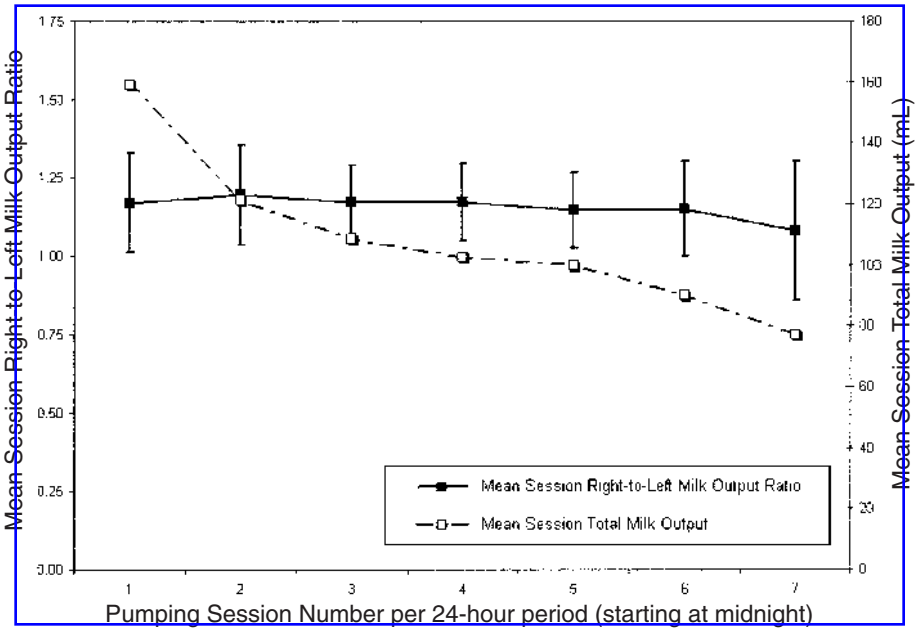

FIG. 1. Mean right-to-left milk output ratio throughout the day in relationship to the mean milk output at each pumping session.

output ratio did not change significantly over time (1.15 versus 1.13, respectively; $p = 0.79$). Similarly, the mean right-to-left milk output ratios varied slightly across the breast pump suction patterns but were not significantly different: one-phase = 1.25, two-phase = 1.20, and three-phase = 1.17; $F(2,68) = 1.29$, $p = 0.28$.

DISCUSSION

The findings from this study demonstrate that there are often differences in milk output from the right and left breasts and, for some mothers, these differences are large and stable over time. The results of this study are consis-

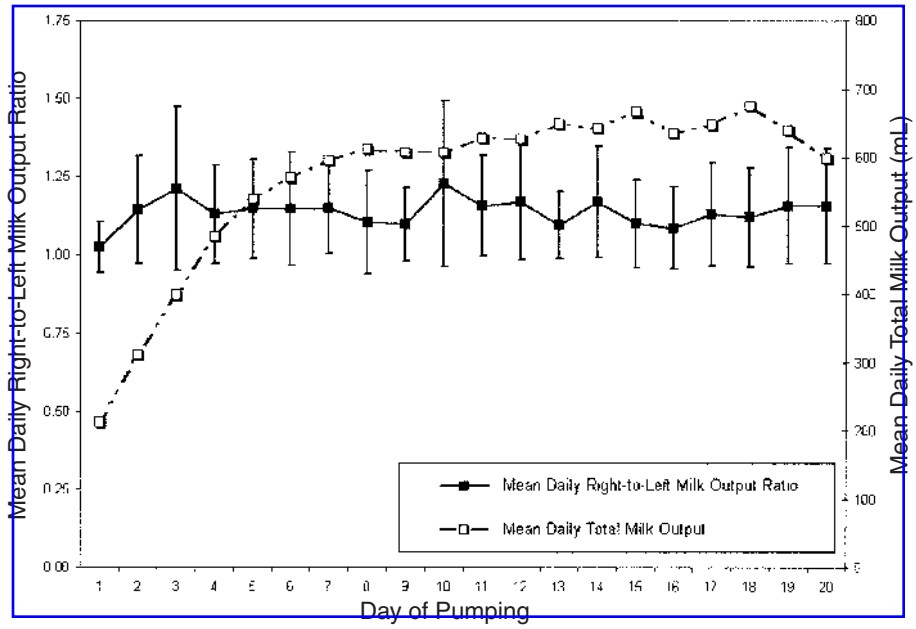

FIG. 2. Mean right-to-left milk output ratio throughout the first 20 days of pumping in relationship to the mean total daily milk output.

tent with clinicians' and mothers' anecdotal observations and with the findings of published research.[2–9] Also consistent with the findings of previously published research was the finding that milk output is more frequently greater for the right versus the left breast.[2–9] The findings from this study extend the results of previously published research by demonstrating that the differences in milk output are *not* due to maternal and infant breastfeeding practices and preferences such as handedness and preferred cradling and head turning. The mothers in this study were pump dependent from the onset of lactation and throughout the study duration, and the milk expression procedures were standardized as a part of a randomized clinical trial. Thus, this study provided the unique opportunity to eliminate the potential influence of maternal and infant breastfeeding practices and preferences that could have influenced the differences in milk output between the two breasts found in this study.

Overall, the differences in milk output appeared during the first few days of lactation, remained relatively stable throughout the day and over the first weeks of lactation, and were unaffected by the type of suction pattern in the breast pump. The directionality of difference remained relatively constant over time, with milk output from the right breast more frequently exceeding that from the left breast. Cumulatively, these findings suggest that differences in milk output between the right and left breasts may have a biological explanation.

One biological explanation is that there may be a real anatomical difference between the breasts. This hypothesis is supported by animal and human studies documenting the lack of perfect symmetry in paired body structures throughout the animal kingdom, and is known as "fluctuating asymmetry."[16] Greater degrees of asymmetry have been associated with unfavorable health outcomes, a reduced chance of finding a suitable mate, and decreased reproductive success.[17–19] One could hypothesize that the mothers in this study may have had more asymmetry, which in turn, may have been associated with poorer reproductive outcomes such as preterm birth. Thus, future studies should further explore right-to-left milk output differences in other populations of women. Recent research also suggests that asymmetry in breast size is a risk factor for later breast cancer,[20] so future studies may examine whether the magnitude of asymmetry in milk output has any predictive value in identifying women at risk for subsequent breast disease.

Although our findings and those of previous researchers indicate that milk output is more often greater from the right breast, there are several reasons to think that the *left* breast would have the greater milk output. First, the left breast is usually larger than the right breast.[21,22] Second, during the act of breastfeeding several maternal and infant characteristics facilitate feeding at the left breast, which would result in greater stimulation and milk output for the left breast over time. For example, a right-handed mother instinctively uses the right hand to position the baby and breast, thereby making it easier to feed from the left breast. Also, more infants preferentially turn the head to the right, which would facilitate feeding from the left breast.[12,15] Finally, in all cultures throughout the world there is a preference of mothers to cradle their infants in the left arm, thereby facilitating feeding at the left breast.[12,13]

The right breast may have an underlying anatomical advantage that allows more milk to be synthesized, stored, and/or withdrawn by the pump or infant. The theoretical causes of such a difference may be a discrepancy in the onset, speed, or extent of embryonic development of the right and left mammary glands. However, since the left breast is larger, a more plausible explanation may be a difference in blood flow to the breasts. Findings from a recent study using Doppler ultrasound in women with established lactation suggested that the right breast received more blood flow than the left breast.[23] While speculative, the statistically significant associations between the right-to-left milk output ratios and parity and previous breastfeeding experience is consistent with this explanation, because both of these maternal characteristics would result in more mature glandular, ductal, and/or vascular development in the mammary gland.

Although the reasons for asymmetry in milk output from the right and left breasts remain speculative, the findings of this study have im-

portant implications for clinical practice and research. Clinically, this information is useful when providing anticipatory guidance to mothers, especially women for whom the milk output is visible, such as those who are pump-dependent. Previous research indicates that some women have negative feelings about pumping and milk production,[24] and these women may be discouraged by observing differences in the milk output from each breast. Thus, mothers can be informed that differences in milk output between the breast are "normal," and that many women have large and consistent differences between the breasts. Similarly, women can be reassured that the "total" milk output from the two breasts combined is important for infant intake—not the individual milk output from the breasts separately.

While it is appropriate for the clinician to reassure mothers about the normalcy of discrepant milk output from the two breasts, it is equally important to eliminate other diagnoses that can manifest in milk output differences. For example, a plugged duct or recent mastitis can significantly reduce milk output in the affected breast.[25,26] A tightly fitted breast shield frequently results in reduced milk output in breast pump-dependent women, and some women require different breast shield sizes for the two breasts.[27] Similarly, previous unilateral breast surgery, biopsy, or nipple piercing can result in markedly different milk output between the breasts due to a reduction in overall glandular tissue or to obstruction in the ductal system draining an area of the breast.[28] None of the women in this study had any of these diagnoses, and breast shield sizing was standardized as a part of the research protocol. However, these maternal conditions are common in clinical practice, and the clinician should use careful assessment techniques to diagnose and manage these conditions.

In summary, our findings are the most recent in a series of studies that indicate milk output differences between the two breasts is a common occurrence, with the milk output more commonly greater from the right breast. The data from the pump-dependent women in this study suggests that these differences appear early in the postbirth period and remain relatively constant throughout the day and over the first weeks of lactation. While clinicians should assure mothers of the normalcy of these findings, other breast pathologies that manifest in discrepant milk output should be eliminated. Finally, these findings underscore the importance of reporting milk output separately for the right and left breasts in research on this topic.

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