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The Effect of Infant Massage on Weight Gain, Physiological and Behavioral Responses in Premature Infants

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Purpose. The purpose of this study was to evaluate the premature infants' responses to infant massage (tactile and kinesthetic stimulation). These responses measured by weight, physiological (vagal tone, heart rate, oxygen saturation) and behavioral responses (behavioral states, motor activities, and behavioral distress).

Methods. This study was conducted using an equivalent control pretest-posttest design. The sample was divided into two groups of 13 infants with gestational age less than 36 weeks at birth, birth weight less than 2000g, and no congenital anomalies. The experimental group received the massage intervention twice daily for 10 days. The data were collected for 10 minutes prior to and 10 minutes after the massage.

Results. The vagal tone was significantly higher after massage than before massage in the experimental group, while no change in the control group. The experimental group had significantly higher scores for awake state and motor activity than the control group. Significantly greater awake state, more fidgeting or crying, and increased motor activity were reported after massage than before massage.

Conclusions. The results of this study showed that massage therapy might enhance optimal physiological responses and behavioral organization of premature infants. Nursing staff in the NICU can use massage to promote the infant's capability to respond positively to his environment and to provide developmental support for healthy premature infants.

Key Words : Massage, Body weight, Infant behavior, Infant, premature

INTRODUCTION

Much research has conducted on the effects of stimulation in premature infants. The results suggest that the stimulation associated with handling and invasive procedures leads to adverse physiological reactions in premature infants (Peters, 1999). Minimal handling has therefore been the prescribed regimen (Liaw, 2000). However, recently researchers have reported that not all premature infants are too fragile to tolerate any stimulation, and that premature infants derive a great variety of benefits from different types of stimulation (Feldman, Eidelman, Sirota, & Weller, 2002; Harrison, Olivet, Cunningham, Bodin, & Hicks, 1996; White -Traut et al., 2002). When massage therapy is applied, premature infants respond with increased weight gain, improved developmental scores, and earlier discharge from the hospital (Bond, 2002; Dieter, Field, Hernandez-Reif, Emory, & Redzepi, 2003; Field, 2002; Field et al., 2004; Mathai, Fernandez, Mondkar, & Kanbur, 2001). Porges (1996) suggests that vagal tone is a sensitive index of neurophysiological regulation to stimulation, and measurement of vagal tone for routine clinical use has recently

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become feasible. However, very little research (Harrison, Williams, Leeper, Stem, & Wang, 2000) has done on the effects of touch on vagal tone. The purpose of this study was to evaluate the effects of massage therapy (tactile and kinesthetic stimulation) on weight gain, physiological (vagal tone, heart rate, oxygen saturation) and behavioral responses (behavioral states, motor activity, and behavioral distress) in premature infants.

LITERATURE REVIEW

Touch is a primary form of human communication and stimulation programs of various kinds influence long-term developmental outcome of premature babies through improved neurophysiological maturation and growth (Liaw, 2000; Lindrea & Stainton, 2000). Although the underlying mechanisms of massage therapy effects on growth and development are yet unknown, several possibilities have been proposed (Field, 2002). One possibility is that massage therapy increases vagal activity, which in turn releases food absorption hormones such as gastrin and insulin, thus explaining the weight gain in premature infants (Field, 2002).

A number of studies have been explored the benefits of providing touch and the results in most cases are promising. Field et al. (1986) assessed the effects of massage on weight gain with 40 premature infants for 10 days. Experimental infants averaged 8g per day more weight gain than the control group infants, even though the groups did not differ on average formula intake per day. Results of replication studies have consistently shown a greater average daily weight gain (Dieter et al., 2003; Ferber et al., 2002; Field et al., 2004; Mathai et al., 2001). In other studies, increased motor activity and alertness, and decreased behavioral distress in premature infants have reported (Lee, 1999). White-Traut et al. (2002) reported that infants who demonstrate increased alertness in response to touch are more likely to do well while unresponsive infants are likely to do less well.

The autonomic nervous system continuously regulates the visceral afferents in an attempt to maintain homeostasis in response to stressful situations (Porges, 1996). This regulatory process primarily mediates by the parasympathetic nervous system (PNS). Thus, measurement of PNS activity may provide an index variable for assessing stress and stress vulnerability. The most readily indexed measure of PNS activity derives from heart rate variability (HRV). HRV refers to the beat-to-beat fluctuations in heart rate. Although HRV is a manifestation of central nervous system mechanisms mediated primarily via the vagus nerve, HRV has multiple determinants, including nonvagal ones (e.g., blood pressure, temperature regulation, and blood gases). Thus, it has proposed that a sensitive measure of vagal influences may derive by extracting variations in HRV associated with breathing, commonly referred to as respiratory sinus arrhythmia (RSA). RSA, one of several variations in heart rate patterns, characterizes by rhythmic increases and decreases in heart rate associated with inhalations and exhalations, respectively. These rhythmic oscillations in heart rate reflect the efferent influence of the vagus nerve on the heart. Because the amplitude of RSA parallels vagal efferent traffic from the medulla to the heart, the quantification of the amplitude of RSA provides an accurate index of cardiac vagal tone (Porges, 1996). Measurement of cardiac vagal tone proposes as a method to assess, on an individual basis, both the stress response and the vulnerability to stress.

According to the polyvagal theory proposed by Porges (1996), vagal tone may be use a as a marker for assessing the effects of fetal and neonatal disorders on subsequent behavior and development. Mehta et al. (2002) reported that neonates exposed to cocaine before birth had lower vagal tone than normal neonates did. If exposure to cocaine while in-uterus was light, the infants recovered with a rebound in their vagal tone to levels of normal control babies. However, a similar rebound in vagal tone did not show in heavily cocaine-exposed infants. Levels of vagal tone in infants also are influenced by gestational age (Doussard-Roosevelt, Porges, Scanlon, Alemi, & Scanlon, 1997), sleep state (Villa et al., 2000), stimulation (Lee, 2002), a range of competent behaviors (Steward, Moser, & Ryan-Wenger, 2001) and levels of illness (Hanna et al., 2000). The data suggest that onset of a stressor results in a decrease in vagal tone and that vagal tone may be a predictive index of neurophysiological reactivity in infancy.

If massage interventions are beneficial to physiological regulation, providing massage intervention to premature infants would be increased the function of vagus and enhanced the regulation and coordination of heart rate and respiration by the polyvagal theory (Porges, 1996). Positive developmental outcomes (e.g., weight gain, improved state regulation, longer periods of alertness, and improved neurological development) would be the product of the improved regulation and coordination (Porges, 1996).

A review of the literature (Epstein, 2005) reveals that the major physiologic reactions to stress in premature infants increased heart rate, lower oxygen saturation, decreased weight gain, and rapid respiratory rate, while behavioral responses to stress occur as change in adaptation and regulation of motor and state behaviors. Motor and state behaviors, such as frantic body movements, jitteriness, startles, sudden change of state, prolonged alert state, change of sleep-wake state, and fidgeting/crying, are among the many motor and state behavioral indicators of ineffective responses to stimuli (Brandon, & Holditch-Davis, 2005; Modrcin-McCarthy., McCue, & Walker, 1997).

It was hypothesized that massage therapy would enhance levels of vagal tone, thereby promoting optimal physiological and behavioral responses, evidenced as a decrease in signs of stress such as decreased heart rate (within the normal range), an increase on weight gain and oxygen saturation, and an well regulated motor and state behaviors.

Hypothesis

1. The experimental group infants who received massage would gain weight more than the control group infants who did not.
2. There would be differences in physiological responses (vagal tone, heart rate, and oxygen saturation) before and after massage in the experimental group infants.
3. There would be differences in behavioral responses (behavioral state, motor activity, and behavioral distress) between the experimental group infants who received massage and the control group infant who did not.

METHODS

Sample

The participants were 26 premature infants recruited from Seoul University Hospital in Korea. The Seoul University Hospital Review Board approved the research protocol and parental consent was obtained for research participation. The selection criteria included all infants born less than 36 weeks gestational age with birth weight less than 2000g and without any of the following conditions: major congenital anomalies, sepsis, surgery, medications with central nervous system effects, seizures, or persistent mechanical ventilation.

Infants entered the massage protocol during the second day after starting enteral feeding, because the initiation of enteral feeding means that the infant is physiologically stable, thus able to tolerate the massage (Lee, 1999). The researcher determined if infants met the study criteria. After initial assessment, the infants were randomly assigned to either the control group or the experimental group. A minimal sample size of 15 per group was needed to show a significant effect of the massage therapy with the power of 77 % and 5% risk of a type I error. These calculations were based on the medium-large effect size (f=. 50) found from pilot research. Therefore, the original plan was to recruit 20 pairs of infants to allow for potential attrition. A number of premature infants did not complete the study and fewer premature infants who met the study criteria were born during the duration of this study than had been anticipated based on past data in the hospital. As a result, there were 13 infants in each group. For the sample of 13 per group, power was 65%. Table 1 shows the selected characteristics of the infants in the experimental and control groups. There were no significant differences between the groups (at an alpha level of .05) on any these characteristics. The mean age of mothers was 29.8 years (SD = 3.2) in the experimental group and 30.8 years (SD = 3.8) in the control group, a difference that was not significant.

Procedure

The Infants in the control group received the amount of touch associated with usual neonatal intensive care unit (NICU) care. In addition to the usual NICU care, the experimental group received 15-minute periods of massage intervention twice daily for 10 days. When the infant's eyes were opens and approximately 1 hour after a feed in the morning and in the afternoon, each massage provided by one of two trained nurses and always began at the end of a sleep cycle. A small amount of baby oil was used to decrease friction and this oil was removed with cotton after massage. The massage was immediately discontinued if the infant demonstrated signs of physiological distress (heart rate less than 100 or greater than 200 beats per minute for 12 seconds or more, or arterial oxygen saturation levels less than 90% for longer than 30 seconds)(Harrison et al., 1996). This study planned that there be at least a 1-hour delay before repeating the massage after signs of distress, but none of the infants exhibited signs of physiological distress during the massage periods.

The massage provided to 13 infants (experimental group) according to the tactile/ kinesthetic stimulation protocol used by Field et al. (1986). To ensure accuracy of massage procedure, the massage of two trained nurses was videotaped and their behaviors were compared in detail. The 15-minute stimulation period was comprised of three standardized 5-minute phases. The first and the third phase were tactile stimulation; the second phase was kinesthetic stimulation. During tactile stimulation of the first and the last phase, the infant was placed in a prone position. The flats of the fingers of both hands stroked the infant for 5 minutes over each region of the body. For kinesthetic stimulation, the infant was placed in a supine position. This phase contained 5 minutes of six passive flexion/extension movements lasting approximately 10 seconds apiece for each arm, then each leg, and finally both legs together.

Measures

Data collection for both groups was always initiated 1 hour after a feed in the morning and the afternoon. The infant did not receive any procedures or handling for at least 10 minutes before the start of data collection, because handling may have affected the physiological and behavioral status of the infant. Data on physiologic conditions (vagal tone, heart rate and oxygen saturation) and behavioral responses of the experimental group collected for 10 minutes pre- and post- massage. In the control group, the infants were monitored for heart rate, oxygen saturation, and behavioral responses for 10 minutes 2 times a day under similar conditions to which the experimental babies were exposed.

Continuous heart rate data was recorded from the infant's AFO 400 ECG portable monitor (made in Korea) on a laptop computer through the Wavelet software program (Lee, 2002). The Wavelet software program collects continuous ECG analog data and outputs a digitized file, which detects the peak of the R wave for each beat and quantifies sequential times between heartbeats (i.e., heart period) in milliseconds. These files were edited and analyzed to calculate mean heart period and an index of vagal tone using the Mxedit program developed by Porges (1985). The Porges method applies time series procedures to heart period data. The heart periods are resampling at 5 Hz. A 21-point moving polynomial filter is stepped through the time-sampled data to create a smoothed template of slow oscillations. The resulting trend is removed from the original time series yielding a residual series free of both linear (i.e., bad data) and higher order trends (i.e., bradycardia episodes). Finally, a band-pass filter extracts the variance within the respiration frequency band for this infant age group (0.3-1.3 Hz) and the natural logarithm of this variance quantifies RSA, the index of vagal tone (Porges, 1985).

Oxygen saturation was simultaneously measured by continuous recording from a Nellcor pulse oximeter. The detection probe of the pulse oximeter attached to the infant's hand or forefoot. The data was subsequently digitized and the voltage output converted to calibrated units ranging from 0% to 100% saturation. One of two trained research assistants assessed the reliability of the data at the beginning of each data collection period by ensuring that there was no more than a 5-beats per-minute difference between the heart rates. For the purposes of analysis, oxygen saturation values less than 90% were considered abnormal (Harrison et al., 1996).

Behavioral responses were measured by behavioral state, motor activity, and behavioral distress. Behavioral state, motor activity and behavioral distress were coded using a scale developed by Scafidi et al. (1990). In order to increase statistical power, the behavioral states of the Scafidi et al. scale (1990) were modified as follows, (a) sleep state, including quiet sleep, active sleep, and less rapid eye movement sleep, (b) awake state, consisting of quiet alert, active alert, and drowsiness, (c) fidgeting/ crying. The behavioral states criteria were as follows (a) sleep state-the infant's eyes are closed, and motor activity may or may not be present, (b) awake state-the infant's eyes are open or may open but are dull, and motor activity is present for the major part of the interval, (c) fidgeting/crying-fidgeting sounds or negative vocalizations are present. If fidgeting/crying were coded, the observer could not also code mouthing or facial grimace of behavioral distress. Motor activities were coded as single limb, multiple limbs, gross body movements, head turns, and startles. Coded behavioral distress included mouthing/ yawning movements, facial grimaces, and clenched fists. Methods to assess behavioral responses (behavioral state, motor activity, and behavioral distress) in premature infants were direct observations by a time-sampling method with 15-second observations followed by 15-second recordings during 10 minutes. One of two research assistants recorded each behavioral response (behavioral states, motor activity, and behavioral distress) on a sheet at the bedside. A total motor activity score and total behavioral distress score calculated by summing the percentage time the infant spent in each category. Each behavioral state score (sleep, awake, and fidgeting/crying) was calculated as the percent time the infant spent in any of these states.

To ensure reliability of coding of behavioral responses, two research assistants were trained to the criterion of 90% reliability with the researcher prior to the onset of the study. Inter-observer reliability was determined during the course of the study by the simultaneous observation and coding of 10 randomly selected behavioral state observations. Reliability coefficients were calculated by dividing the number of agreements (same behaviors coded for a given item by both observers) by the number of agreements and disagreements. Inter-observer reliability averaged .90 for all categories throughout the study.

The trained research assistants recorded weight, gestational age, and other medical data from the infants' charts. Nurses on the preceding night shift measured daily weight gain in the early morning.

Data Analysis

Independent t-tests and Chi-square analyses were conducted to determine whether the demographic characteristics of the two groups were equivalent prior to initiation of the massage. The hypotheses were tested with repeated measures ANOVA to compare weight gain and behavioral responses for two groups and paired t-test used to compare physiological responses between pre-massage and post-massage in the experimental group.

RESULTS

Weight Gain

The average weight was 1586 grams (SD = 232.7) in the experimental group and 1499.2 grams (SD = 201.7) in the control group at the beginning of massage. Independent t-tests revealed no significant difference between groups for initial weight and formula intake (Table 1). The average weight in the experimental and control groups were 1829.2 grams (SD = 259.9) and 1732.3 grams (SD = 220.5) at the end of the 10-day massage period. Repeated measures ANOVA showed no significant massage effect and no massage x day interaction effect. There was a significant effect for days ($F(1, 24) = 50.52$, p=. 001); both groups increased in weight, on the average, over the 10-day experimental period (Table 2).

Physiological Responses (Vagal Tone, Heart rate, and Oxygen Saturation)

Paired t-test were computed using vagal tone, heart

Table 1. Characteristics of the Infants in the Experimental and Control Groups

		Ex.(N = 13)	Con.(N = 13)	X^2 or t	p
Gender (male/female)	N	6 (7)	4 (9)	0.16	0.69
Gestational Age (at birth, in days)	M (SD)	224.2 (11.4)	217.4 (14.2)	1.34	0.19
Apgar at 1min	M (SD)	5.4 (2.6)	5.7 (1.7)	0.36	0.77
at 5min	M (SD)	7.3 (1.4)	7.1 (1.1)	0.46	0.65
Wt. at birth	M (SD)	1508.5 (249.3)	1377.7 (247.5)	1.34	0.19
Type of Delivery (NSVD/C-Section)	N	3 (10)	2 (11)	0.27	0.67
Received Phototherapy (Yes/No)	N	5 (8)	6 (7)	0.15	0.69
Wt. at onset of massage (g)	M (SD)	1586.2 (232.7)	1499.2 (201.7)	1.02	0.32
Formula Intake (cc per day)	M (SD)	285.3 (57.9)	265.1 (46.9)	0.98	0.34
Days hospitalized	M (SD)	35.5 (12.6)	36.2 (11.5)	0.15	0.89

Note : No group comparisons were significant
Wt. = weight Ex. = Experimental group Con. = Control group

Table 2. Mean Daily Weight in the Experimental and Control Groups

	Day												
	1	2	3	4	5	6	7	8	9	10	Source	F	p
Wt (Ex.)(g)	1586.20	1616.20	1633.80	1660.80	1685.40	1715.40	1739.20	1767.70	1800.00	1829.20	Day	50.52	0.001***
SD	232.70	225.80	226.60	228.50	226.30	236.70	239.00	251.90	258.40	260.00	Groups	0.83	0.59
Wt (Con.)(g)	1499.20	1513.10	1540.80	1562.30	1586.20	1610.80	1638.50	1661.50	1687.70	1732.30	Day×	0.83	0.59
SD	201.70	212.90	206.00	196.50	210.60	206.80	208.60	207.80	218.60	220.60	Groups		

Ex. = Experimental Group Con. = Control Group ***p< .001.

rate, and oxygen saturation as dependent variables across the two massage classifications (pre-massage and post -massage). There were significant differences in vagal tone on 1st day (t=-2.64, p=.02), 2nd day (t=-2.25, p=.03), 6th day (t=-2.64, p=.02), 7th day (t=-2.64, p=.02), 8th day (t=-2.21, p=.05) and 9th day (t=-2.21, p=.05) between pre- and post- massage. There was also significant difference in oxygen saturation on 9th day (t=-3.11, p=.01) between pre- and post- massage. However, there was no difference in heart rate between pre-massage and post-massage (Table 3).

Behavioral Responses (Behavioral State, Motor Activity, and Behavioral Distress)

There were significant effects of infant massage in sleep state (F (1, 470) = 26.12, p =.000), awake state (F (1, 470) = 26.52, p =.000), fidgeting or crying (F (1, 470) =4.23, p = .04), and motor activity (F (1, 470) =8.57, p = .0 04) between the experimental and control group (Table 4). The experimental group had greater mean percentages of awake state, fidgeting or crying, and motor activity after massage than the control group. Although there was no group difference in the total behavioral distress score, there was significantly more fidgeting or crying after massage in the experimental infants than the control infants. A comparison of the behavioral responses from pre- to post- massage showed that the infants experienced less sleep state (F (1, 490) = 12.31, p = .000), more awake state (F (1, 490) = 8.60, p = .004), more fidgeting or crying (F (1, 291) = 4.39, p = .037), and more motor activity (F (1, 490) = 11.88, p = .001) after massage (Table 5).

DISCUSSION

The major physiological findings of this study were significant differences in vagal tone after massage: vagal tone increased significantly from pre- to post-massage 6 days among 10 days in the experimental group. Although, there were no significant differences in heart rate and oxygen saturation after massage, the means of heart rate were lower (within the normal range) and the means of oxygen saturation were higher (within the normal range) after massage than before massage in the experimental group.

The finding that there was a significant difference from pre- to post- massage on vagal tone in the experimental group suggests that infant massage appeared to contribute to high vagal tone and had an effect on parasympathetic function. Previous research (White-Traut et al., 2002) has shown that a sympathovagal imbalance to prematurity appeared in premature infants. According to the polyvagal theory (Porges, 1996), beneficial intervention would stimulate specific visceral sensors to increase

Table 3. Heart Rate, Vagal Tone, and Oxygen Saturation Pre and Post-Massage in the Experimental Group across 10 Days

	Massage		Day 1	2	3	4	5	6	7	8	9	10
HR (per min)	Pre	M	152.46	152.56	155.11	158.97	157.02	154.86	156.35	159.58	158.23	156.91
		SD	17.73	16.90	17.13	17.47	15.11	14.45	11.13	13.47	14.48	16.29
	Post	M	149.80	149.79	149.32	155.46	155.19	153.94	153.20	154.48	156.39	156.44
		SD	15.48	16.88	17.24	16.20	17.06	12.78	11.33	11.47	14.03	12.86
		t	0.90	0.92	1.43	1.15	0.82	0.59	1.01	1.42	0.82	0.33
		p	0.30	0.30	0.17	0.26	0.40	0.59	0.26	0.18	0.40	0.84
Vagal Tone	Pre	M	2.31	2.58	2.66	2.24	2.35	2.38	2.30	2.18	2.17	2.37
		SD	0.92	1.05	1.05	0.95	1.05	0.80	0.93	1.11	1.04	0.92
	Post	M	2.87	3.06	2.98	2.61	2.64	2.93	2.85	2.59	2.58	2.59
		SD	1.05	0.91	1.02	1.09	1.12	0.91	1.02	1.01	0.96	0.89
		t	-2.64	-2.25	-1.30	-1.33	-1.12	-2.64	-2.64	-2.21	-2.21	-1.12
		p	0.02*	0.03*	0.18	0.18	0.20	0.02*	0.02*	0.05*	0.05*	0.21
Oxygen Saturation (%)	Pre	M	97.36	97.41	97.59	97.00	97.65	98.27	97.48	97.52	94.86	97.35
		SD	2.50	2.36	2.11	2.42	2.25	1.52	1.87	1.89	12.50	2.03
	Post	M	97.83	97.31	97.88	97.80	97.73	98.36	97.75	97.63	97.36	97.83
		SD	1.56	2.04	1.77	2.02	1.90	1.32	1.78	1.60	1.81	2.10
		t	-0.77	0.19	-0.48	-1.89	-0.19	-0.19	-0.48	-0.20	-3.11	-0.77
		p	0.45	0.61	0.64	0.06	0.61	0.61	0.64	0.61	0.01**	0.45

*p < .05 **p < .01

the function of the neomammalian vagus. Field (2002) proposed that massage promotes vagal mediation via the direct stimulation of peripheral nerves. The result that there was higher vagal tone post- massage than pre-massage in the experimental group also could interpreted as indicating that the infants after massage were in

Table 4. Behavioral Measures in the Experimental and Control Groups over 10 Days after Massage Therapy

	Group		Day 1	2	3	4	5	6	7	8	9	10	Source	F	p
Sleep	Con.	M	72.91	77.70	76.04	87.91	76.66	80.41	88.33	89.16	79.58	82.70	Day	1.05	0.251
(%)		SD	34.32	34.57	33.55	20.15	31.05	30.10	25.98	19.81	36.35	30.71	Group	26.12	0.000***
	Ex.	M	68.26	53.84	61.34	59.03	68.26	61.53	75.76	70.19	63.07	69.61	Day ×	0.51	0.665
		SD	36.54	41.60	40.21	38.93	42.63	41.68	27.26	39.40	37.47	32.73	Group		
Awake	Con.	M	22.50	16.87	22.29	10.41	22.91	16.25	10.83	8.33	17.29	13.95	Day	1.27	0.251
(%)		SD	28.96	30.85	32.03	19.16	30.03	26.50	24.78	15.51	31.99	28.81	Group	26.52	0.000***
	Ex.	M	27.50	42.11	36.34	40.19	30.19	36.34	20.38	24.23	29.23	24.80	Day ×	0.75	0.665
		SD	35.55	41.28	37.10	38.45	40.75	39.05	24.53	34.04	34.10	26.47	Group		
Fidget/Cry	Con.	M	4.37	1.25	1.66	1.66	0.41	3.12	0.83	2.50	2.91	1.25	Day	1.10	0.364
(%)		SD	11.82	4.48	4.58	5.45	2.04	9.87	2.40	6.25	8.06	3.68	Group	4.23	0.04*
	Ex.	M	3.26	4.03	2.30	0.76	1.34	2.11	3.84	7.11	7.69	5.57	Day ×	0.76	0.673
		SD	7.73	9.16	7.37	2.32	6.86	6.19	11.60	21.54	19.29	11.60	Group		
Motor	Con.	M	33.12	32.70	35.00	33.33	40.00	35.83	34.16	41.25	41.25	33.33	Day	0.52	0.857
Activity		SD	28.46	25.62	24.04	26.89	27.10	36.85	30.59	33.40	27.67	27.76	Group	8.57	0.004**
(%)	Ex.	M	42.88	41.34	39.80	48.84	39.42	47.30	45.76	34.23	52.30	56.53	Day ×	0.88	0.546
		SD	30.07	36.40	31.70	34.18	31.85	38.32	35.60	36.04	35.95	40.46	Group		
Behavioral	Con.	M	11.87	12.91	17.08	12.91	11.66	13.54	9.16	9.79	9.79	10.83	Day	0.50	0.874
Distress		SD	11.96	17.18	18.23	15.94	11.00	14.99	10.70	9.72	10.05	9.85	Group	2.29	0.131
(%)	Ex.	M	17.50	15.00	12.11	14.03	9.61	15.00	17.30	11.53	14.23	15.00	Day ×	0.79	0.623
		SD	15.95	18.33	11.32	12.88	11.12	20.78	22.28	12.78	18.79	15.29	Group		

Ex. = Experiment Group Con. = Control Group *p < .05 **p < .01 ***p < .001

Table 5. Behavioral Measures between Pre and Post-massage in the Experimental Group across 10 Days

	Massage		Day 1	2	3	4	5	6	7	8	9	10	Source	F	p
Sleep	Pre	M	70.19	73.84	76.15	66.15	84.23	82.30	75.57	69.42	83.26	79.61	Day	0.90	0.527
(%)		SD	36.17	32.07	36.72	36.14	22.61	30.47	35.95	39.32	29.32	33.64	Massage	12.31	0.000***
	Post	M	68.26	53.84	61.34	59.03	68.26	61.53	75.76	70.19	63.07	69.61	Day ×	0.75	0.662
		SD	36.54	41.60	40.21	38.93	42.63	41.68	27.26	39.40	37.47	32.73	Massage		
Awake	Pre	M	28.07	27.11	23.46	30.38	14.61	17.69	23.65	26.00	16.53	24.80	Day	1.21	0.284
(%)		SD	36.33	33.32	36.73	33.76	22.93	30.47	35.08	36.69	29.42	26.47	Massage	8.60	0.004**
	Post	M	27.50	42.11	36.34	40.19	30.19	36.34	20.38	24.23	29.23	24.80	Day ×	0.70	0.707
		SD	35.55	41.28	37.10	38.45	40.75	39.05	24.53	34.04	34.10	26.47	Massage		
Fidget/Cry	Pre	M	3.21	0.33	0.71	6.00	1.87	0.00	1.25	6.66	0.31	5.88	Day	0.90	0.524
(%)		SD	10.67	1.29	1.81	13.38	5.12	0.00	3.87	17.74	1.25	21.73	Massage	4.39	0.037*
	Post	M	3.26	4.03	2.30	0.76	1.34	2.11	3.84	7.11	7.69	5.57	Day ×	0.71	0.697
		SD	7.73	9.16	7.37	2.32	6.86	6.19	11.60	21.54	19.29	11.60	Massage		
Motor	Pre	M	34.61	32.69	31.34	49.80	31.92	24.23	38.07	33.65	36.73	36.34	Day	1.37	0.197
Activity		SD	25.88	29.12	25.59	37.85	28.18	33.69	34.84	29.03	31.84	28.93	Massage	11.88	0.001***
(%)	Post	M	42.88	41.34	39.80	48.84	39.42	47.30	45.76	34.23	52.30	56.53	Day ×	0.72	0.694
		SD	30.07	36.40	31.70	34.18	31.85	38.32	35.60	36.04	35.95	40.46	Massag		
Behavioral	Pre	M	13.84	12.88	7.11	18.46	13.07	9.80	11.15	11.92	11.53	9.42	Day	0.79	0.628
Distress		SD	15.89	14.50	10.31	27.19	14.28	17.85	15.18	13.64	18.09	11.34	Massage	2.35	0.126
(%)	Post	M	17.50	15.00	12.11	14.03	9.61	15.00	17.30	11.53	14.23	15.00	Day ×	0.69	0.721
		SD	15.95	18.33	11.32	12.88	11.12	20.78	22.28	12.78	18.79	15.29	Massage		

*p < .05 **p < .01 ***p < .001

better physiological condition than before massage. The results are consistent with several previous studies (Doussard-Roosevelt et al., 1997; Hanna et al, 2000; Steward et al., 2001) showing a relationship between neonatal well being and vagal tone. Newborns with high vagal tone were autonomic response to the external environment. These effects might happen in response to co-elicitation of both excitatory and inhibitory influences on the developing ANS, thus minimizing stress while supporting the ongoing development of more homeostatic balanced ANS response capabilities (Doussard-Roosevelt et al., 1997). Porges (1996) also reported a monotonic relationship between vagal tone and severity of clinical dysfunction in at-risk neonates as well as lower vagal tone in at-risk infants compared with full-term neonates, even when gestational age corrected. The findings indicate that higher vagal tone is a reflection of more optimal physiological function. This means that massage may exert direct or indirect influences on physiological organization, the presumed substrate underlying newborn behavior and development.

During stressful events in premature infants, an increase in heart rate and a decrease in oxygen saturation levels have been documented (Epstein, 2005; Modrcin-McCarthy et al., 1997). Porges (1996) proposed that heart rate deceleration accompanied "stimulus intake" while acceleration of heart rate occurred with "stimulus rejection." Although, there were no significant differences in heart rate and oxygen saturation between pre- and post- massage, the means of heart rate were lower (within the normal range) and the means of oxygen saturation were higher (within the normal range) at the post-massage period than pre- massage in the experimental group during 10 days. The higher vagal tone, lower heart rate, and higher oxygen saturation after infant massage could interpret that infant massage was not stressful and may reduce stress for these premature infants.

Premature infants have a greater proportion of drowsiness and active sleep than full-term normal infants do. As premature infants grow older, their amount of active sleep decreases and the proportion of quit sleep increase (Brandon, Holditch-Davis, & Beylea, 1999). Sleep-wake states throughout infancy have been shown to reflect brain maturation and severity of disease processes. Therefore, the development of sleeping and waking states and of related behaviors, such as crying and physical activity are important indicators to predict growth, healing, and health in infants. Sleep-wake states and cry behaviors also relate to neurological status and to long-term development outcome (Brandon & Holditch-Davis, 2005). In addition, sleeping and waking affects the infant's ability to respond to social stimulation (White-Traut et al., 2002). A comparison of behavioral responses between the experimental and control groups showed that the experimental group infants experienced less sleep, more awake, and more fidgeting/crying than the control group infants did. The experimental infants also showed more motor activity during the post-massage period. Results of earlier studies (Beachy, 2003; Dieter et al, 2003; Field, 2002; White-Traut et al., 2002) showed that massage group infants had more quiet sleep, less active sleep, more alertness, fewer periods with no movement, and more motor activity than the control group infants did. Beachy (2003), Field (2002), Field et al. (2004), and White-Traut et al. (2002) reported that infants who showed increased alertness and motor activity in response to massage showed better progress than infants who continued to sleep. White-Traut et al. (2002) proposed that the increases in alertness and motor activity are part of the normal process of maturation. Waking states, and particularly alertness, are necessary for the infant to respond to social interactions and are essential components of parent-infant relationship. The results of this study suggest that infant massage may enhance behavioral responses of infant to his or her environment.

However, prolonged alert state, more fidgeting or crying state, and more motor activity also could interpreted as indicating that the infant massage was stressful for the infants (Brandon. et al., 1999; Modrcin-McCarthy et al., 1997). Different interpretations from the same results indicate that there is a need for further research on whether the measurements used in this study to measure fidgeting/crying and motor activity are useful indicators of stress. Grunau, Holsti, Whitfield, & Ling (2000) reported that finger splay, facial grimace, and leg extension in premature infants might be stress indicators, whereas tremors, startles, and twitches may not relate to stress. Because these movements may be part of the normal behavioral repertoire of motor activity in premature infants, Grunau et al. (2000) recommended avoiding over interpretation of these data.

Field (2002) proposed that weight gain following the massage therapy mediates by an increase in vagal activity. Although there was significantly higher vagal tone post- massage than pre-massage in the experimental group in this study, there was no difference in weight gain between the two groups. This finding was somewhat surprising, given that massage increased weight gain with premature babies in the study of Mathai et al. (2001) and Field et al. (2004) and the protocol for massage was the same as that of Field et al. (1986). The reasons for the discrepancy in results could be that the number of subjects in this study was smaller than in the Mathai et al. study (N = 50). In addition, the number of massages per day was fewer: two times a day in the present study, but three times in the study of Mathai et al. (2001). The finding that there was no difference in weight gain between the two groups suggests that further research with more subjects and more massages per day needs.

The results of this study partially support a role for infant massage in reducing stress of infant in the NICU. As such, it may be an appropriate for nursing intervention. Although any type of stimulation provided to premature infants should be based on each infant's individual responses, results suggest that nursing staff in the NICU can use massage to promote the infant's capability to respond positively to his or her environment and to provide developmental support for healthy premature infants. If infant massage enhances behavioral responses of infant to his or her environment, this in turn may affect his or her interaction with caregivers in reciprocal fashion. However, the nurse in the NICU needs to know that infant massage may be inappropriate or too much stimulation for some fragile infants and the infant needs to be monitored continuously for signs of over stimulation and stress before, during, and after the massage.

Although higher vagal tone after massage, more alert state, and greater motor activity in the experimental group than the control group can be viewed as positive effects, further investigations is needed to confirm whether infant massage enhances the normal process of maturation. In spite of a significant difference in fidgeting or crying state after massage, there was no difference in the total behavioral distress score after massage between the two groups. This discrepancy suggests that further research should examine other measures of stress, such as hormonal reactions to clarify further the effects of infant massage.

Although the results of this study must be interpreted cautiously to other groups of premature infants because of the variability in age of the infants, and the low power estimates for sample size, the knowledge gained through this study helps to identify salient variables (vagal tone and behavioral responses) for larger study. Only after such a larger sample and more sensitive outcome measures to assess the effects of infant massage, will the researcher have the evidence to justify that infant massage improve growth and development of premature infants. Further research is needed with a larger sample and more sensitive outcome measures assessed over a longer period to adequately measure the effects of infant massage.

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