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Massage therapy by mothers and trained professionals enhances weight gain in preterm infants

Sari Goldstein Ferber [a,b,*], Jacob Kuint [b,c], Aron Weller [d], Ruth Feldman [d], Shaul Dollberg [b,e], Eliana Arbel [a], David Kohelet [a,b]

[a] *Department of Neonatology, Wolfson Medical Center, Israel*
[b] *Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel*
[c] *Department of Neonatology, Sheba Medical Center, Ramat Gan, Israel*
[d] *Psychology Department, Bar Ilan University, Ramat Gan, Israel*
[e] *NICU, Lis Maternity Hospital, Tel Aviv, Israel*

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Abstract

Background: The method of "massage therapy" has consistently shown increased weight gain in preterm infants. The weight gain was apparent during massages administered by professionals. *Aims*: To replicate the results of increased weight gain in the course of "massage therapy" in preterm infants, and utilize a new, cost-effective application of this method by comparing maternal to nonmaternal administration of the therapy. *Study design*: Random cluster design. *Subjects*: The study comprised 57 healthy, preterm infants assigned to three groups: two treatment groups—one in which the mothers performed the massage, and the other in which a professional female figure unrelated to the infant administered the treatment. Both these groups were compared to a control group. *Results*: Over the 10-day study period, the two treatment groups gained significantly more weight compared to the control group (291.3 and 311.3 vs. 225.5 g, respectively). Calorie intake/kg did not differ between groups. *Conclusions*: Mothers are able to achieve the same effect size as that of trained professionals, allowing cost-effective application of the treatment within the neonatal intensive care unit.

Keywords: Premature infants; Weight gain; Massage therapy

* Corresponding author. Department of Neonatology, Wolfson Medical Center, 1 Halohamim Street, Tel Giborim, Holon 58100, Israel.

E-mail address: ferbers@post.tau.ac.il (S.G. Ferber).

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1. Introduction

"Massage therapy" has consistently increased weight gain in preterm infants [1–5] and neonates at risk [6,7]. Over the last two decades, this form of therapy was used in research on supplementary stimulation of preterm infants treated in neonatal intensive care units (NICU), suggesting various advantages for these infants [8]. Other studies showed that maternal behavior influences physical somatic growth in low-birth-weight neonates [9]; however, the effects of massage therapy given by mothers, as opposed to staff members, have not yet been assessed within one study. The aim of the present study was to assess the effect of massage therapy by mothers and staff members on the weight gain of preterm infants during their stay in the NICU.

2. Subjects and methods

Between April 1996 and May 1998, a study was conducted on 57 mothers and infants who were recruited from three medical centers in Israel. These three centers account for 24% of the very-low-birth-weight neonates born throughout the country. Infants were not included in the study if one or more of the following were present: (1) genetic anomalies, congenital heart malformations, gastrointestinal disturbances and central nervous system dysfunction; (2) age <5 days; (3) considered medically unstable and not weaned from ventilatory assistance; (4) receiving medication other than theophylline; (5) parenteral nutrition only; (6) gestational age <26 or >34 weeks; (7) birth weight <600 g or >2200 g; and (8) no parental consent.

The massage therapy protocol was adapted from Field et al. [1] and duration, setting and medium pressure massage were similar to Field's. The kinesthetic portion was omitted, and the massage session was extended from the original 5 to 15 min, administered three times daily, at the beginning of three successive hours, over a period of 10 days. Massage therapy was scheduled each day between feedings, and began after a specific feeding had been followed by a 20-min waiting period. The massages were scheduled during daytime only (8 am through 7 pm). The infant was left alone twice during the 45-min breaks between the three 15-min sessions. The protocol in all groups included one no-treatment day during the second half of the treatment period (i.e. between the 7th through 9th day). Weight gain and calorie intake calculations were measured continuously. Massage therapy comprised moderate pressure stroking all over the baby who lay in a prone position in the incubator on an open diaper. Each 15-min session was composed of two segments: one while the infant was lying prone, and the other while supine. Between the first and second segments the infant was turned over. Rhythm and shape of movements, as well as number of movements per second and the global approach to the different regions of the baby's body, were adapted from Brazy et al.'s [13] technique.

Each segment of the session lasted 7 min, 30 s, and comprised two parts: in the initiation part (10 s), two hands were laid on the baby's head without any movement. In the main treatment part (7 min, 20 s), the infant was stroked slowly by hand movements from the head towards the legs, and then again towards the head, back and forth. Smooth slow movements were used by raising only one hand at a time and with a minimum of direction

change in the stroking hands. Medium pressure was administered throughout the massage. Chest and stomach regions were not massaged. The massage was administered in a closed incubator through the incubator's portholes.

Neither additional medical interventions nor touching by the parents was provided during the 3 h of the three daily sessions and breaks, and during the matched times within the control group (CG) except for the treatment itself. The massage was considered part of the daily treatment schedule of the participating infants. The parents too provided their spontaneous touching approach to the baby in accordance with this schedule. To ensure uniform administration of the treatment, three telephone calls were made regularly to all mothers on days 1 or 2, 5 or 6, and 9 or 10. In addition, to ensure the massages were standardized, two site visits were made by the research assistant during the first and second halves of the study. Maternal performance and compliance with the treatment were monitored by the site visitor.

Mothers were excluded for reasons of noncompliance if they missed more than one 15-min session for more than 1 day, and if they massaged the infant during the 45-min periods between sessions on more than 1 day. The total refusal rate to participate after hearing the suggested group assignment was 14%. The total attrition rate for any reason after less than 3 days of participation in the study was 7%. Causes for dropout were parent's personal reasons, change in infant medical condition, or difficulties in conforming to the experimental procedure as observed by the research team. This information was monitored through the aforementioned telephone calls and site visits.

Massage therapy was provided for two treatment groups. Trained mothers treated one treatment group (mothers, $n = 21$) and the other treatment group (staff, $n = 17$) was treated by a trained research assistant who was unrelated to the infant. The control group (CG, $n = 19$) was not treated by massage therapy. The infants were randomly assigned and matched for gestational age and birth weight, and weight and age at the beginning of treatment. A random cluster design, assigning randomly small groups of matched subjects, was used to avoid parental bias. None of the mothers were assigned to different groups within the same care room during the study period. This prevented personal preferences that could occur during group assignment due to close and intimate relationships observed between mothers within each one care room. The assignment occurred in two phases: first—general details concerning the study were provided to a cluster of 3–4 mothers assigned randomly in one care room; This was followed by the stage of stratified allocation [11] to assure that the research sample had certain characteristics. During this second stage, birth weight and gestational age were matched and the specific group assignment was described to the mothers who were allocated and who also consented. Thus, the mothers ultimately approached within one randomly assigned cluster were those whose infants' birth weights and gestational ages most closely matched those same parameters in the other two groups. This was followed by a "wash-out" period, i.e. a waiting period during which mothers who had already completed their participation were still visiting their recovering infants. The next cluster was assigned after their babies were relocated to a different recovery room, i.e. a new cluster was not started in the same room until the baby was removed to a different room following improvement in medical status. Mothers who were excluded from the study were treated as "study subjects" for "wash-out" considerations.

Birth weight, gestational age weight and age at the start of the 10 days of treatment were recorded from the medical records. Two research assistants, supervised by four senior neonatologists and blind to the treatment allocation, calculated enteral and parenteral nutrition according to the calories/kg/day criteria: the total daily calorie content (breast milk + formula + TPN solutions) was calculated and divided by weight. For further comparisons, the total sum of accumulated calories provided to the infant during the entire study was documented. The calories of both parenteral and enteral nutrition were used. A different computation was used for the data of fluids in parenteral nutrition. The policy regarding the use of expressed breast milk and preterm infant's formula was similar in the three centers.

Two questionnaires, CRIB [12] and Nursery Neurobiological Risk Score [13] were completed by one of three neonatologists. These questionnaires deal with each baby's postnatal physiological status, predicting the medical assistance the baby would need to recover, as well as detecting the probability of a chronic illness. CRIB is sensitive to postdelivery states and the Nursery Neurobiological Score is also sensitive to the infant's possible complications during the continuing postnatal period. The two questionnaires were used to assure group similarity at baseline.

2.1. Statistical analysis

We calculated that a sample size of 50 infants is sufficient to show a significant effect of the therapy with the power of 80% and 5% risk of a type alpha error [10]. These calculations were based on the effect size found in a two-group design ($F[1,38] = 13.66$; difference of 5.2 g/day) in previous studies [2].

Analysis of variance (ANOVA) was used to compare weight gain. Duncan's tests were used for post-hoc analyses [14].

To assess the efficiency of calorie intake where R is the ratio, we evaluated a formula that equals delta (weight gain) during the study period, divided by the sum of calories given throughout this period. Therefore, $R = \Delta$ weight gain/total calories/kg.

Because the growth of preterm infants is usually characterized by nonlinear and inconsistent acceleration curves, the difference between groups in this formula was analyzed by a nonparametric test, i.e. the Kruskal–Wallis test for comparisons of mean ranks. For post-hoc analysis, we used the Wilcoxon–Mann–Whitney U-test for comparisons of mean ranks between two groups. Each of the two treatment groups was compared to the control group.

The Institutional Review Board for Human Experimentation in all three medical centers participating in the study approved the protocol and all parents provided written informed consent.

3. Results

The groups did not differ on the matched variables of gestational age, birth weight, age and weight on day 1 of the study, or the postnatal medical status and medical status during the study (Table 1). As shown, no significant differences were found between groups for

Table 1
Sample description

Variable	*n* (%)
Gestational age (weeks)	
26–29	10 (17.5)
30–32	27 (47.4)
33–34	20 (35.1)
Birth weight (g)	
600–1000	6 (10.5)
1001–1500	31 (54.4)
1501–2200	20 (35.1)
Adjustment to gestational age	
Small (SGA)	6 (10.5)
Adjusted (AGA)	51 (89.5)
Medications	
Theophylline	14 (24.5)
None	43 (75.5)
Weight at onset of study (g)	
600–1000	7 (12.2)
1001–1500	30 (50.8)
1501–2200	20 (37.0)

* Matched variables for cluster assignment (no significant differences between groups).

these variables. In addition, the groups did not differ in the number of days in which the infant received full or partial parenteral nutrition during participation in the study (Table 2). The ANOVA on mean calorie intake/kg/day revealed no significant differences between groups ($F[2,56] = 0.1013$, $P > 0.05$). (Table 3).

The ANOVA on mean weight gain showed that infants who were massaged by their mothers and those treated by the staff showed increased body weight of 26.4 and 28.3 g/

Table 2
Potentially intervening variables

	Mothers ($n = 21$), Mean ± SD	Staff ($n = 17$), Mean ± SD	Control group ($n = 19$), Mean ± SD	*P*
Gestational age	30.90 ± 1.94	31.88 ± 1.93	31.52 ± 2.22	0.33
Birth weight	1318 ± 333.81	1527 ± 34.63	1375 ± 370.66	0.18
Weight at onset of study	1358.14 ± 267.79	1453.82 ± 285.17	1387.89 ± 329.15	0.60
Age at onset of study	17.28 ± 10.95	12.47 ± 8.39	16.05 ± 13.88	0.42
CRIB Score	1.04 ± 1.24	1.11 ± 1.65	1.80 ± 2.48	0.36
Nursery Neurobiologic Risk Score	0.90 ± 1.33	0.64 ± 0.70	1.14 ± 1.71	0.53
Nursery Neurobiologic Risk Score during the study	0.00 ± 0.00	0.11 ± 0.33	0.38 ± 1.16	0.22
Parenteral nutrition: number of days during the study	0.80 ± 1.77	2.23 ± 3.01	2.10 ± 3.58	0.23

* Post-hoc data collection analyses.

Table 3
Daily evaluation of calorie intake/kg

Days	Mothers ($n=21$), Mean ± SD	Staff ($n=17$), Mean ± SD	Control group ($n=19$), Mean ± SD
1–5	707.41 ± 191.04	715.76 ± 183.34	741.59 ± 232.99
6–11	1001.74 ± 247.12	1022.80 ± 266.82	996.12 ± 359.25
1–11	1709.17 ± 432.98	1738.57 ± 442.46	1737.74 ± 585.80

day, respectively, during the study period (including one no-treatment day), whereas the increase in the control group was only 20.5 g/day and significantly smaller ($F[2,54]=3.87$; $P=0.03$). Separate analyses (ANOVA) of weight gain during the first and second halves of the study (days 1–5 and 6–11, respectively) revealed a significant effect only in the second half ($F[2,54]=3.56$; $P=0.04$). The post-hoc Duncan test showed that the two experimental groups were significantly different from the control group, but not significantly different from each other (Table 4).

To assess group differences in the ratio of calorie intake/weight gain, we used the Kruskal–Wallis nonparametric test. The results showed a significant difference between groups for the entire study period (chi-square = 7.98; $P=0.02$). In separate analysis, there was a significant difference for the second half of this period (chi-square = 7.04; $P=0.03$), but not for the first half. Post-hoc analysis using the Wilcoxon–Mann–Whitney U-test revealed a significant difference between the mothers group and control group ($U=136.0$; $P=0.03$), as well as between the staff group and control group ($U=86.00$; $P=0.006$). Considering the axioms of these nonparametric tests, these results show that a greater proportion of infants tended to use fewer calories per each gram of weight gain within the treatment groups, i.e. more efficient use of calories was detected among treatment subjects. In all three centers, total parenteral nutrition was started shortly after birth and enteral nutrition was introduced within the first week of life. The quantity of intermittent gavage via nasogastric tube was increased and tolerated by infants. Expressed breast milk and preterm infant formula (Similac Special Care Formula, Ross, Colombus, OH, USA) were used in all three centers. Six infants who were equally distributed between groups were

Table 4
Body weight gain (in grams)

Days	Mothers ($n=21$)	Staff ($n=17$)	Control group ($n=19$)
1–5			
Mean ± SD	118.33 ± 39.60	117.64 ± 53.48	86.42 ± 67.18
Range	30–190	40–232	−27–230
Median	125	111	90
6–11			
Mean ± SD	173.00 ± 14.47	193.70 ± 48.40	139.10 ± 68.11
Range	45–290	100–273	−25–240
Median	160	200	170
1–11			
Mean ± SD	291.33 ± 95.54	311.35 ± 86.48	225.52 ± 109.74
Range	125–460	180–440	−5–380
Median	300	300	300

partial-parenterally fed during the first 3 days of the study. The remaining infants were fully enterally fed during the study period. In centers A, B and C, 8/12, 17/21 and 19/24 infants respectively were fed by expressed breast milk. Mothers expressed breast milk before feeds and when breast milk could not be obtained, the preterm infant's formula (see above) was used.

4. Discussion

The results showed that as in previous studies, mostly originating from one research team, weight gain increased following massage therapy, compared to controls [1,2,5–7,15]. Infants treated by their mothers achieved a similar effect size as those treated by a staff member. In addition, the calorie intake process was apparently more efficient in the treated groups than in the control groups, as shown in the nonparametric tests. The differences between groups are not related to the methods of feeding, since there were no differences between centers and between groups in the policies of total parenteral nutrition or expressed breast milk feeding, nor were there differences in the formula. In addition, enteral and parenteral nutrition between groups did not differ significantly. The 6-g increase in weight gain in the mothers group and 8-g increase/day in the staff group, above and beyond the weight gain rate/day in the control group, resembles previous reports of massage therapy effects: an extra 5.2 g/day in treated subjects compared to control groups [2], and elsewhere, an additional 8 g/day, respectively [1]. The validation of massage therapy and its specific effect in grams is further supported by achieving it in this study within a wide range of gestational ages. The result of having an explicit significant effect during the second half of the study period as reported earlier by others [2,15] may be due to the function of two underlying processes involved in the improvement of weight gain. One may be considered an habituation phase to the treatment operating during the first half of the treatment period, and the other may operate during the second half of the treatment and may account for different hormonal processes that provide the infant with the possibility of improved weight gain. These processes should be further studied.

This study provides evidence, for the first time, that the effect of massage therapy utilized by mothers and by staff members is similar. This supports the view that the method affects weight gain and the identity of the person performing it is of less significance. These results are in accordance with current developments in attachment theory that describe each member of the family as having a specific attachment style with the growing infant [16], provided that the family member is reliable, predictable, available and sensitive. The important parameters for the development of an attachment style with the infant as currently under consideration, the accessibility, availability and sensitivity of the adult who relates to an infant, were all existent in this study by the scheduled and relatively long touch encounters of the person performing the massage with the infant. In addition, in this study, the massaging persons acted as a time signal for the infant, apparently providing the infant with a more predictable environment. The importance of this type of environment and its benefits for improved development were reported earlier [17]. Thus, it is concluded that according to the results of the present study, a predictable timetable of

human touch accessibility is more important than the identity of the person available for the infant at the beginning of life.

Most relevant is the Cochrane review [18] that analyzed studies conducted to investigate the effect of massage as means for promoting growth. Given that this review concludes that although massage treatments improved daily weight gain by 5 g ("95% confidence interval 3.5, 6.7") the authors felt that wider use of preterm infant massage therapy is not warranted. The differences may be due to methodological and other differences in utilizing the procedure, as our current study was conducted to investigate touch only, with the kinesthetic portion of massage therapy being omitted.

This study is the first validation of the touch therapy procedure outside the United States. Further validations in different cultures are required, since it has been reported that in eastern societies mothers have a closer physical contact with their infants compared to western mothers, and that this may be correlated to infant behavior and biological processes [19]. This could affect the results of the treatment when utilized by mothers. Other limitations of the study are revealed in the absence of follow-up measures of weight gain. Thus, our conclusions at this stage are strongly related to the period during which the preterm infant was in the hospital. In addition, the necessity to carry out the study, carefully accounting for many possible intervening variables within NICUs that required a random cluster design, set a limitation on our sample size. The alternative of a long-term follow-up study would presumably be impeded by several complications, e.g. changes in staff members, equipment, policies, and atmosphere over the study period. Nevertheless, these findings have cost-effective clinical implications for the NICU, where mothers can be trained to assist in promoting their infant's growth. On the other hand, staff members are able to achieve a developmental effect, which is as good as that of the mothers, thereby providing means for cases where the mother is not available, or is periodically absent.

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