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Weight Gain and Infant Massage

Oil Massage in Neonates

Original Article

Oil Massage in Neonates: An Open Randomized Controlled Study of Coconut versus Mineral Oil

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Introduction: *Oil massage for newborns is reported to improve weight gain by better thermoregulation. A role for transcutaneous absorption has also been suggested.* ***Aims and Objectives****: This study was undertaken to compare the effect of massage with coconut oil versus mineral oil and placebo (powder) on growth velocity and neuro-behavior in well term and preterm babies.* ***Study design:*** *Open Randomized Controlled trial.* ***Setting:*** *The Premature unit and the postnatal wards of a major teaching hospital in a metropolitan city.* ***Material and methods:*** *Intramural preterm appropriate for gestational age babies weighing between 1500 to 2000 grams and term births weighing more than 2500 grams fulfilling the inclusion criteria constituted the two gestation age categories studied. Babies in each group were randomized to receive massage with either coconut oil, mineral oil or with placebo. Oil massage was given by a trained person from day 2 of life till discharge, and thereafter by the mother until 31 days of age, four times a day. Babies were followed up daily till discharge and every week after discharge for anthropometry. Neuro-behavioral outcome was assessed by the Brazelton Score at baseline, day 7 and on day 31.* ***Results:*** *Coconut oil massage resulted in significantly greater weight gain velocity as compared to mineral oil and placebo in the preterm babies group; and in the term baby group, as compared to the placebo. Preterm infants receiving coconut oil massage also showed a greater length gain velocity compared to placebo group. No statistically significant difference was observed in the neurobehavioral assessment between all three subgroups in term babies as well as in preterm babies.*

Key words: *Growth, Neurobehavioral outcome, Oil massage.*

TOPICAL oil massage is routinely practiced in many countries. For hundreds of years, populations especially in the Indian subcontinent have routinely applied natural oils to the skin of newborn. The practice of oil massage has gained favor in neonatal intensive care units in the developed countries as well(1).

The putative benefits to the newborn are twofold, those related to the oil application per se, and those related to tactile kinesthetic stimulation due to the massage. Topical oil application has been shown to improve skin barrier function, thermoregulation and also is suggested to have a positive effect on growth(2,3). A role for absorption of fats

through the thin skin of the preterm has also been suggested. Moreover, a number of studies have also demonstrated superior growth and development in preterm infants receiving tactile kinesthetic stimulation(4-8). Oil application may occasionally cause adverse effects in the form of skin rashes and a greater propensity for bacterial colonization(1).

This study was, therefore, undertaken to compare the effect of massage with coconut oil versus mineral oil and placebo (powder) on growth velocity and neuro-behaviour as well as adverse effects if any on well preterm and term babies.

Subjects and Method

This open randomized controlled trial was conducted in the premature unit and the postnatal wards of a major tertiary care center in a metropolitan city between 1st August 2003 to 31st January 2004. The study was approved by the hospital ethics committee.

Inclusion criteria

Intramural preterm appropriate for gestational age babies weighing between 1500-2000 grams and full term neonates weighing 2500 grams or more were included if they fulfilled the following inclusion criteria:

1. Apgar score >7 at 1 and 5 minutes with no resuscitation required at birth.
2. Medically stable with no requirement of drugs (other than mineral and vitamin supplements for the preterm babies), or any interventions/ procedures.
3. On breastfeeds or 'spoon-wati' feeds with expressed breastmilk (preterms).
4. Adequate family support.

Exclusion criteria

Sick babies, those with congenital anomalies or neuromuscular disorders were excluded. Babies of parents who were staying far away from the hospital and were therefore less likely to follow-up were excluded, as were babies of parents who refused consent for the study.

Outcome variables

The primary outcome measure was the weight gain velocity over the first thirty-one days of life. Secondary outcome measures included length gain velocity , head growth, neuro-behavioral outcome and incidence of adverse events.

Sample size

A sample size of 36 infants would be required in each group of preterm and term infants in order to detect a difference in weight gain velocity of 2 g/kg/day with a SD of 2.7 g/kg/day (based on observations from a pilot study), a power of 80% and error of 0.05 and allowing for a 20% loss to follow-up.

Randomization

Infants in preterm and term group were randomized in blocks of three by computer-generated numbers in closed opaque envelopes, to either coconut oil, mineral oil , or placebo (powder) groups

Details of the antepartum period including the obstetric history, mode of delivery, adequacy of family support, the socio-economic status, presence of risk factors for sepsis and the need for resuscitation at birth were recorded.

Massage technique

Oil massage was given by a trained person from day 2 of life till discharge, and thereafter by the mother (who was taught the technique) until 31 days of age. Babies in the placebo group received a massage using baby powder

and the method of application and the monitoring was the same as in the oil groups. Sessions began an hour after a feed. The total duration of each session was 5 minutes and was done four times a day.

The oil massage was given in the prone and supine positions to include head, neck, trunk and the extremities. At the end of the massage kinesthetic stimulation was provided in the supine position by passive flexion and extension movements of the limbs at each large joint (shoulder, elbow, hip, knee and ankle) as 5 events of 2 seconds. The procedure for the massage and stimulation were as per the procedure described by Mathai *et al.*(4). If the baby started crying or passed urine or stools during the session it was temporarily stopped till the baby was comfortable again.

During the massage, preterm infants were nursed naked and under a radiant warmer with skin mode of temperature control. Oxygen saturation was continuously monitored through out the duration of the procedure using pulse oximeter (Novametrix 515 C). Readings were recorded of heart rate, respiratory rate, temperature and oxygen saturation in the three subgroups before, during and immediately after the massage. Term infants were massaged in a draught free room. Similar parameters were recorded.

In accordance with unit protocols all term and preterm neonates above 1700 grams were breast fed from day1. Babies between 1500 - 1700 gram birth weight were put on enteral feeds of expressed /banked human milk starting at 80 mL/kg /day on day one. The milk was fed by *wati* and spoon or gavage till babies were able to accept full volume per feed by *wati*-spoon /breastfeeds. All preterm infants were given oral calcium, phosphorus and vitamin supplements. Mothers were allowed to touch and hold their infants as often as they wished in all the subgroups. On discharge all mothers were advised to carry out the massage in a draught-free room and limit the procedure to 5 minutes per session.

Weight of infants was taken without clothes on an electronic weighing scale (Phillips) with an accuracy of ± 5 grams. Head circumference was measured with a non-stretchable cloth-tape and length with an infantometer.

Babies were followed up daily during their stay in the hospital and then once every week till 31 completed days of life.

Neonatal behavioral assessment

The Brazelton Neonatal Behavioral Assessment Scale (BNBAS)(9,10) was administered to each infant in the study on three occasions before the first massage, on day 7-10 and on follow-up (at 28-31 days). All the tests were done by a single trained person. Infants were tested mid-way between two feeds in a quiet room.The parameters assessed included 'habituation', 'orientation', 'motor' maturity, 'range of state', 'regulation of state', auto-nomic stability', 'reflexes' and 'inter-active behavior'.

Statistical Analysis

Data collected was entered in Microsoft Excel 97 worksheet. Characteristics of infants included in the study were tabulated as averages (means) with standard deviation (SD). The groups were compared on each parameter using 't' test (2-tailed unpaired) for parametric data and chi square test for non-parametric data. The analysis was done using the SPSS version 11 for windows. A *'P'* value of <0.05 was considered as statistically significant and < 0.001 as highly significant.

Results

A total of 224 babies (112 preterm and 112

term babies) were enrolled. In each gestation strata, there were 38 babies in the coconut oil, 37 in the mineral oil and 37 babies in the placebo groups. In the preterm group, 32 (84.2%) babies completed the follow up in the coconut oil and mineral oil subgroups and 31 (83.8%) in the placebo group. In the term babies, 33 (86.8%) completed the follow up in the coconut oil group and 32 babies (86.5%) completed the follow up in the mineral oil and placebo groups. The difference was not statistically significant.

Table I shows the baseline characteristics of babies enrolled in the study groups. There was no statistically significant difference between babies enrolled in each of the groups as far as the birthweight, gestational age, total length and head circumferences were concerned.

Table II shows the growth characteristics of preterm babies in the three groups. Weight in the coconut oil group was significantly higher as compared to the placebo group both at 14 days as well as at 31 days. Weight at 31 days was significantly higher in the coconut oil group as compared to the mineral oil group. Weight gain velocity over first 31 days was higher in the coconut oil group as compared to the mineral oil and placebo groups. There was no statistically significant difference in the length and head circumference at 14 and 31 days in the three groups. However, length gain velocity was higher in the coconut oil group as compared to the placebo group.

TABLE I–*Baseline Characteristics in Preterm and Term Group*

Variable	Coconut oil	Mineral oil	Placebo
Birth weight (g)			
Preterm	1792.89 ± 149.56	1758.37 ± 79.91	1789.86 ± 182.90
Term	2771.27 ± 309.40	2771.74 ± 95.27	2852.33 ± 270.35
Gestational age (wk)			
Preterm	34.89 ± 1.27	34.76 ± 1.12	34.92 ± 1.19
Length (cm)			
Preterm	42.38 ± 1.52	42.79 ± 1.53	42.76 ± 2.13
Term	48.70 ± 2.22	48.65 ± 1.98	49.26 ± 1.99
Head Circumference (cm)			
Preterm	30.03 ± 1.29	30.26 ± 1.94	30.35 ± 1.21
Term	32.53 ± 0.88	32.34 ± 0.91	32.67 ± 1.06
Chest Circumference(cm)			
Preterm	27.86 ± 1.18	28.15 ± 1.78	28.26 ± 1.27
Term	30.85 ± 0.79	30.34 ± 0.99	30.70 ± 0.89
Total subjects			
Preterm	38	37	37
Term	38	37	37

Values are as mean (standard deviation).
P >0.05 for all parameters.

TABLE II–*Growth Characteristics in Preterm Group*

Variable	Coconut oil	Mineral oil	Placebo
Weight (g)			
at 14 days	1990.00 ± 196.42τ	1843.18 ± 223.76	1928.13 ± 228.01
at 31 days	2396.77 ± 208.94τ*	2234.38 ± 247.71	2260.94 ± 290.37
Weight gain velocity (g/kg/day)	10.99 ± 2.57τ*	9.02 ± 2.13	8.45± 2.75
Length (cm)			
at 14 days	43.78 ± 1.68	43.08 ± 1.66	43.53 ± 2.86
at 31 days	44.86 ± 1.55	44.94 ± 1.66	45.16 ± 2.40
Length gain velocity (cm/week)	0.63 ± 0.12τ	0.59 ± 0.16	0.56 ± 0.16
Head circumference (cm)			
at 14 days	30.90 ± 1.15	30.52 ± 2.21	31.06 ± 1.12
at 31 days	31.89 ± 1.26	32.13 ± 2.13	32.31 ± 1.43
Head circumference gain velocity (cm/week)	0.49 ± 0.05	0.48 ± 0.06	0.47 ± 0.09
Chest circumference (cm)			
at 14 days	28.53 ± 1.05	28.16 ± 2.04	28.38 ± 1.41
at 31 days	29.24 ± 1.44	29.34 ± 2.04	29.59 ± 1.48

Values are as mean ± standard deviation. τ : P<0.05 coconut oil vs placebo. * : P<0.05 coconut oil vs mineral oil.

Table III shows the growth characteristics of term babies in the three groups. There was no statistically significant difference in the weight at 14 and 31 days. Weight gain velocity over the first 31 days was higher in the coconut oil group as compared to the placebo group (P = 0.02). However, the weight gain velocity was not significantly different between the coconut oil and mineral oil groups. There was no statistically significant difference in the length and head circumference at 14 and 31 days in the three groups. No significant difference was noted in the length and head circumference gain velocities.

Neuro-behavioral outcome as assessed by the Brazelton scale was similar in the three groups for both preterm and term babies.

Adverse events

In the preterm group, adverse events occurred in 6 babies, 2 each in the coconut oil, mineral oil and the placebo group. All the adverse events were mild rash and did not require discontinuation of application. Among the term babies, 3 in the coconut oil group, 3 in the mineral oil group and 2 in the placebo group developed mild rash that did not require discontinuation of application.

Discussion

We studied the growth and neurobehavioral benefits of coconut versus mineral oil massage oil in term and preterm babies. Several studies have already documented the somatic and neurodevelopmental benefits of tactile kinesthetic stimulation in preterm infants(4,11). To determine whether the bene-

TABLE III– *Growth Characteristics in Term Group*

Variable	Coconut oil	Mineral oil	Placebo
Weight (g)			
at 14 days	3007.58 ± 366.60	2913.04 ± 246.90	2940.63 ± 332.27
at 31 days	3538.46 ± 413.82	3473.00 ± 289.60	3518.52 ± 336.60
Weight gain velocity (g/kg/day)	9.19 ± 1.55 τ	8.78 ± 1.67	8.22 ± 1.76
Length (cm)			
at 14 days	49.49 ± 2.37	49.49 ± 1.86	49.92 ± 2.20
at 31 days	51.13 ± 2.64	51.26 ± 1.97	51.83 ± 2.13
Length gain velocity(cm/week)	0.64 ± 0.18	0.66 ± 0.19	0.71 ± 0.21
Head circumference (cm)			
at 14 days	33.33 ± 1.09	33.15 ± 0.82	32.89 ± 1.02
at 31 days	34.42 ± 0.96	34.31 ± 0.92	34.46 ± 1.13
Head circumference gain velocity (cm/week)	0.48 ± 0.05	0.49 ± 0 .06	0.47 ± 0.09
Chest circumference (cm)			
at 14 days	31.15 ± 0.94	30.64 ± 0.92	30.67 ± 1.09
at 31 days	31.77 ± 0.93	31.54 ± 0.94	31.82 ± 1.09

Values are as mean ± standard deviation. τ : $p<0.05$ coconut oil vs placebo.

fits were due to the effect of the massage or due to the type of oil used, these two groups were compared with the placebo group who received massage with powder.

The weight of preterm babies in the three groups was comparable at baseline. However, at 14 days there was significant weight gain in the coconut oil subgroup as compared to the placebo subgroup whereas at 31 days, the weight was significantly higher in the coconut oil subgroup as compared to placebo as well as the mineral oil group. As weight gain in preterm neonates is also a function of their birth weight, we calculated the weight gain velocity over the 31-day period. We found that the weight gain velocity was significantly higher in the coconut oil subgroup as compared to the other subgroups and the difference was statistically significant. The length gain velocity was also significantly higher in the coconut oil subgroup as compared to the placebo subgroup.

Other studies have found better somatic growth after oil application. Application of a barrier such as oil or emollient prevents insensible water loss from the skin and helps to maintain temperature(12-14). Better thermo-regulation may promote better weight gain.

Though most studies have looked at weight gain in preterm neonates, we also wanted to study the growth in term neonates after oil application so that the benefits, if any, could be extended to this group. There was no significant difference in the weight at 14 and 31 days between the three groups. On analysis of the weight gain velocity, there was a statistically significant difference between the coconut oil and placebo groups.Though babies

Key Message

- Coconut oil massage has beneficial effects on the weight gain in preterm neonates compared to mineral oil massage.

in the coconut oil group had a better weight gain velocity as compared to the mineral oil group, the difference was not statistically significant.

The findings of this study suggest that coconut oil application improves the weight gain velocity in preterm and fullterm neonates over and above the benefits of tactile kinesthetic stimulation due to massage alone (placebo group). Preterm neonates also showed a higher weight gain velocity after application of coconut oil as compared to mineral oil application. This suggests a role for transcutaneous absorption of vegetable oil through the thin skin of the preterm neonate. The skin of a preterm baby allows significant absorption of fat, as it is thinner and more vascular(15,16).This may also result in greater caloric intake and hence a better weight gain(17).

Fernandez, *et al.*(17) reported a significantly higher serum triglyceride levels in preterm neonates weighing 1500-2250 g after application of corn oil every four hours for three days suggesting the likelihood of fatty acid absorption through the skin of preterm neonates. Soriano, *et al*(18) reported a significant increase in anthropometric parameters at one month of age in 30 consecutive preterm infants who were treated cutaneously with soybean oil compared to a control group, which received no cutaneous treatment. An increase in linoleic acid level in their blood was also observed

In preterm neonates, the length gain velocity was significantly higher in the coconut oil subgroup as compared to the placebo group. No significant difference was observed in the head circumference in the three groups at 14 and 31 days. There was no significant difference in the rate of head growth. In term neonates, there was no statistically significant difference in the length gain, head circumference, or in the in the rate of head growth, between the three subgroups at 14 and 31 days. In contrast, Agarwal, *et al*.(6) observed that full term infants at 6 weeks massaged with sesame oil showed a significant increase in length, midarm and midleg circumferences compared to infants receiving herbal oil,mustard oil, or mineral oil for massage daily for 4 weeks.

In the preterm group as well as in the term group, neurobehavioral outcome as assessed by the Brazelton Neonatal Behavioral Assessment Scale (BNBAS) did not show any statistical significance in the groups receiving oil massage compared to placebo. Mathai, *et al.*(4) have shown better neurobehavioral outcome after tactile kinesthetic stimulation with oil. However they compared the benefits after tactile kinesthetic stimulation with oil or powder with a control group who did not receive stimulation at all. Therefore, the benefits observed in their study were probably because of the tactile kinesthetic stimulation rather than the oil used.

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Contributors: SK participated in designing the study, supervising the randomization and data collection and drafted this paper. JM designed and coordinated the study and drafted the paper. MMC helped in designing the study and supervised data collection and analysis. JM will act as the guarantor for the manuscript. BMM, ARM and RYS were involved in designing the study, providing logistic support, supervising dispatch of samples, data management and manuscript preparation.

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Weight Gain and Infant Massage

Preterm Infant Massage Therapy Research

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Preterm Infant Massage Therapy Research: A Review

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Abstract

In this paper, preterm infant massage therapy studies are reviewed. Massage therapy has led to weight gain in preterm infants when moderate pressure massage was provided. In studies on passive movement of the limbs, preterm infants also gained significantly more weight, and their bone density also increased. Research on ways of delivering the massage is also explored including using mothers versus therapists and the added effects of using oils. The use of mothers as therapists was effective in at least one study. The use of oils including coconut oil and safflower oil enhanced the average weight gain, and the transcutaneous absorption of oil also increased triglycerides. In addition, the use of synthetic oil increased vagal activity, which may indirectly contribute to weight gain. The weight gain was associated with shorter hospital stays and, thereby, significant hospital cost savings. Despite these benefits, preterm infant massage is only practiced in 38% of neonatal intensive care units. This may relate to the underlying mechanisms not being well understood. The increases noted in vagal activity, gastric motility, insulin and IGF-1 levels following moderate pressure massage are potential underlying mechanisms. However, those variables combined do not explain all of the variance in weight gain, highlighting the need for additional mechanism studies.

Approximately 14% of infants in the United States are born prematurely (National Center for Health Statistics, 2007). Prematurity, in turn, is one of the leading causes of infant morbidity and mortality, and it results in approximately 15.5 billion dollars in hospital costs per year. Following intensive care treatment, weight gain becomes the main criterion for hospital discharge. Thus, several interventions have been designed to promote preterm infant weight gain including massage therapy.

Massage Therapy Studies

Randomized, controlled studies have documented greater weight gain in preterm newborns receiving moderate pressure massage therapy (see Field, Hernandez-Reif & Freedman, 2004; Vickers, Ohlsson, Lacy & Horsley, 2004 for reviews). These include our studies on preterm newborns who received 5-10 days of massage therapy and showed a 21-48% greater increase in weight gain and hospital stays of 3-6 days less than control infants (Diego, Field & Hernandez-Reif, 2005; Dieter, Field, Hernandez-Reif, Emory & Redzepi, 2003; Field, Schanberg, Scafidi, Bauer & Vega-lahr, 1986; Scafidi, Field, Schanberg, Bauer & Vega-Lahr, 1990; Wheeden, Scafidi, Field, Ironson & Valdeon, 1993) (see table 1). These weight gain

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findings have been replicated by at least 4 independent groups (Cifra & Sancho, 2004; De-Roiste & Bushnell, 1996; Goldstein-Ferber, Kuint, Weller, Feldman, Dollberg, Arbel & Kohelet, 2002; Mathai, Fernandez, Modkar & Kanbur, 2001).

The protocol in our randomized, controlled studies on the effects of massage therapy on NICU preterm infants involves moderate pressure stroking (tactile stimulation) and flexion and extension of the upper and lower extremities (kinesthetic stimulation) (see Field, Hernandez-Reif & Freedman, 2004 for a review). These sessions have varied between 10 and 15 minutes and have been held two to three times a day for 5-to-10-days. All studies have reported greater weight gain for the massage therapy versus the standard care control group.

In our early studies (Field et al. 1986; Scafidi et al., 1990; Wheeden et al., 1993) a 15-minute massage therapy protocol, three times per day, for ten days resulted in 21-47% greater weight gain than standard care alone (see Table 1). Those infants were also discharged six days earlier on average than control infants, saving approximately ten thousand dollars in hospital costs per infant. Examination of the daily weight gain curves across the 10-day treatment period revealed that the massaged infants exhibited greater weight gain than the control infants as early as day 5 in the 10-day study, suggesting that 5 days of massage might be sufficient to increase weight gain at a reduced cost. In a study assessing the shorter time period, preterm infants receiving only 5 days of massage therapy gained 48% more weight than control infants (Dieter et al., 2003; Table 1).

In a recent study by a research group in India, the same protocol resulted in a weight gain of 4.24 grams per day more than controls (Mathai, et al, 2001). On the Brazelton Scale the massage group showed statistically higher scores on the orientation, range of state, regulation of state and autonomic stability subscales. In a meta-analysis of several studies using the same protocol, massage increased the daily weight gain by 5.1 grams on average (Vickers et al, 2004), reduced the length of hospital stay by 4.5 days and had a positive effect on postnatal complications as well as weight gain at 4-6 months.

Other replications using this infant massage protocol were conducted in China. These studies also documented significant weight gain (Duan, Li & Shi, 2002; Ke, Ling & Li, 2001; Liu, 2005; Liu Chun Li, 2005; Lu Jiao, Li Ju Zhan & Wu Li Fang, 2005; Na Zhuo Hua, Zie Hui Yun & Huang Jian Hua, 2005; Shi Li & Xue Li Rong, 2002; Sun Hai Yun, Gao Xiang Yu & Zhao Xue Mei, 2005; Zhai, J., Pan Xian, R. & Hua, J.R., 2001). Some of these studies also reported increased length and head circumference (Duan et al, 2002; Ke, Ling, 2001; Liu, 2005; Lu Jiao et al, 2005; Na et al, 2005).

Exercise Studies

Greater weight gain has also been observed in preterm infants receiving passive limb movements. This exercise, which is a form of stimulation similar to the kinesthetic component of our massage protocol, involves flexing and extending the limbs (Eliakim, Nemet, Friedland, Dolfin & Regev, 2002; Moyer-Mileur, Brunstetter, McNaught, Gill & Chan, 2000; Nemet, Dolfin, Litmanowitz, Shainkin-Kestenbaum, Lis & Eliakim, 2002). The weight gain in these studies was less than in the massage therapy studies (0-38%). However, the exercise sessions in these studies were shorter than the typical 15 minute massage sessions, and they were held only once per day. Nonetheless, the infants showed increased bone mineral density. Thus, exercise or the kinesthetic form of stimulation appears to lead to weight gain (see table 2) as well as bone growth in preterm infants (Eliakim et al, 2002; Moyer-Mileur, Luetkemeier, Boomer & Chan, 1995, 2000; Nemet et al, 2002).

Preterm infants are at risk for developing bone disease and bone fractures due to the limited formation of bone mass in utero and to limited activity (Backstrom, Kuusela & Maki, 1996;

Rigo, De Curtis, Pieltain, Picaud, Salle & Senterre, 2000). Inactivity has been associated with decreased bone mineral density (Rodriguez, Garcia, Palacios & Paniagua, 1988), and physical activity promotes bone development (Myburgh, 1998). The passive movement or exercise of preterm infants' limbs has increased serum bone formation markers, most especially bone specific alkaline phosphates (Nemet et al., 2002) increased bone and body mass as determined by dual-energy-x-ray absorptiometry (Moyer-Mileur et al., 2000), and prevented bone strength deterioration as determined by bone speed of sound (SOS) measurements (Litmanovitz, Dolfin, & Friedland, 2003).

Inasmuch as our massage therapy protocol also involves passive movement of the limbs that is similar to the exercise protocol used in the bone growth studies, the increase in serum bone formation marker observed following exercise may also occur following massage therapy. This would be true especially because massage therapy leads to increased activity (Scafidi, Field, Schanberg, Bauer & Vega-Lahr, 1986). Preterm infant bone growth following passive movements or exercise of the limbs may be mediated by elevated IGF-1. IGF-1 levels play a critical role in the formation, maintenance and regeneration of bone mass (Yakar & Rosen, 2003).

Research on ways of Delivering MassageTherapy/Exercise

Other research in the area of preterm infant massage therapy has focused on the delivery of massage therapy protocols. This research includes studies on mothers or parents as the therapists, on the use of oils to enhance the therapy effects and on hospital cost savings.

Using Mothers As the Therapists

At least one study has documented equivalent effects of professionals and mothers performing the preterm infant massages (Goldstein-Ferber et al, 2002). The Goldstein-Ferber et al (2002) study replicated the results of increased weight gain following massage therapy by both mothers and professionals. In this study, preterm infants were assigned to three groups including one treatment group in which the mothers performed the massage and another in which professionals unrelated to the infant administered the treatment. These two groups were then compared to a control group. Over the 10-day study period, the two treatment groups gained significantly more weight compared to the control group suggesting that mothers were able to achieve the same effect as that of trained professionals. In addition, the mothers who massaged their infants in this study experienced a decrease in depression symptoms, which are often seen in mothers of preterm infants. In our study using mothers as the massage therapists, even one session was effective in lowering both the mothers' depression and anxiety symptoms (Feijo, Hernandez-Reif, Field, Burns, Valley-Gray & Simco, 2006).

Oil Enhances Massage Therapy Effects

Oil massage for newborns is reported to improve weight gain by better thermoregulation. Transcutaneous absorption has also been suggested as a possible mechanism. A recent study compared the effects of massage with coconut oil versus mineral oil and placebo (powder) on growth velocity and behavior in preterm infants (Sankaranarayanan, Mondkar, Chauhan, Mascarenhas, Mainkar & Salvi, 2005). Preterm infants were randomized to receive massage with either coconut oil, mineral oil or powder. Oil massage was given by a trained person four times a day until discharge and thereafter by the mother until 31 days of age. Coconut oil massage resulted in significantly greater weight gain velocity as compared to mineral oil and powder in the preterm infants' group. The preterm infants receiving coconut oil massage also showed a greater length gain velocity compared to the powder group.

A similar study compared the effects of essential fatty acid (EFA) rich-safflower oil and saturated fat rich coconut oil on the fatty acid profiles of massaged infants (Solanki, Matnani, Kalem Joshi, Bavdekar, Bhave & Pandit, 2005). The NICU infants were randomly assigned to three oil groups; 1) safflower oil; 2) coconut oil; and 3) no oil controls. In each group, the infants were massaged four times a day for five days under controlled temperature and feeding conditions. Pre and post oil massage blood samples were analyzed for triglycerides and fatty acid profiles using gas chromatography. Post oil triglyceride values were significantly increased in both oil groups and also in the control group. However, the increase was significantly greater in the oil groups as compared to the control group. Fatty acid profiles (gas chromatography) suggested a significant increase in EFAs (linoleic acid and arachidonic acid) in the safflower oil group and saturated fats in the coconut oil group. This study showed that topically applied oil could be absorbed in neonates and is probably available for nutritional purposes. The fatty acid constituents of the oil can influence the changes in the fatty acid profiles of the massaged babies.

Even massage with synthetic oil has positive effects. It is also less likely than natural oils to lead to an allergic reaction. In a study we conducted, massage with oil was compared to massage without oil (Field, Schanberg, Davalos, & Malphurs, 1996). As can be seen in table 3, those infants who were massaged with oil showed less motor activity, less averting behavior (grimacing and head turning), less stress behavior (mouthing and clenched fists), a greater increase in vagal activity and a greater decrease in saliva cortisol levels (see table 3).

Hospital Cost Savings

The greater weight gain documented by several investigators is associated with 3-6 days shorter hospital stays. A recent cost-benefit analysis suggested a hospital cost savings of approximately $10,000 per infant (or 4.7 billion dollars across the 470,000 preterm infants born each year) (Field, Hernandez-Reif & Freedman, 2004). Despite these benefits, a recent survey revealed that only 38% of NICUs offer infant massage or instruction to parents in infant massage (Field et al., 2004). The same 84 neonatologists polled in this survey suggested that preterm infant massage would not be widely adopted until underlying mechanisms are known.

Potential Underlying Mechanisms for the Effects of Massage Therapy

Some potential underlying mechanisms have been examined for the effects of massage therapy on preterm infant weight gain. Increased calorie consumption and/or greater calorie conservation was first explored as a potential mediator of the effects of massage therapy on weight gain. However, findings across our studies consistently showed that preterm infants receiving massage therapy did not consume more calories (Diego et al., 2005; Dieter, et al., 2003; Field et al, 1986; Scafidi et al, 1990; Wheeden et al, 1993). Also, contrary to our energy savings model (i.e. less activity leading to less calorie expenditure), the massaged infants spent more time being active than the control infants and, nonetheless, they gained more weight (Dieter, et al., 2003; Scafidi et al, 1986; Scafidi et al, 1990) (see Table 1).

In our recent model, we suggested that massage therapy led to weight gain via increased vagal activity, which, in turn, stimulated gastric motility. Increased vagal activity is supported by our recent finding that massage therapy with moderate pressure versus light pressure (SHAM) versus standard care (control) leads to increased heart rate variability, a marker of vagal activity (see Figure 1) (Diego et al., 2005). Vagal activity during massage therapy was significantly related to weight gain ($r = .66$, $p < .01$) Gastric motility (EEG) increased in the same study and was significantly related to weight gain ($r = .55$, $p < .01$) (Figure 1) (Diego et al., 2005). Taken together, these findings suggest that moderate pressure massage therapy leads to increased gastric motility and weight gain via increased vagal activity.

In a study to determine whether preterm infant massage leads to consistent increases in vagal activity and greater weight gain, EKG and EGG were recorded in 80 preterm infants randomly assigned to a moderate pressure massage therapy group or to a standard care control group to assess vagal activity and gastric motility responses to massage therapy (Diego, Field, Hernandez-Reif, Deeds, Ascencio & Begert, 2006). The massaged infants exhibited consistent increases in vagal activity and gastric motility on both the first and the last days of the 5-day study, and these increases were, in turn, associated with weight gain during the 5-day treatment period (see Figure 2).

Moderate Pressure is Critical

Moderate pressure may be an essential component of the infant massage, as a recent study by our group revealed that preterm infants who received moderate pressure stroking gained significantly more weight (26% more) than infants who received light pressure stroking (Diego et al., 2005) (see table 1). Similarly, static, light pressure touch does not result in greater weight gain as reported by others including the Cochrane Review based on the compilation of several data bases (Harrison, Williams, Berbaum, Stem & Leeper, 2000; Vickers et al., 2004).

Moderate pressure massage also leads to more organized behavior. In a replication study by our group, sixty-eight preterm infants were randomly assigned to a moderate or to a light pressure massage therapy group to receive 15 minute massages 3 times per day for 5 days (Field, Diego, Hernandez-Reif, Deeds & Figuereido, 2006). Behavior state, stress behaviors and heart rate were recorded for 15 minutes before and during the first 15-minute therapy session. Weight gain was recorded over the 5 day therapy period. The moderate versus light pressure massage group gained significantly more weight per day (see Table 4). During the behavior observations the moderate versus light pressure massage group showed significantly lower increases from the pre-session to the session recording on: 1) active sleep; 2) fussing; 3) crying; 4) movement; and 5) stress behavior (hiccupping) (see Table 4). They also showed a smaller decrease in deep sleep, a greater decrease in heart rate and a greater increase in vagal tone. Thus, the moderate pressure massage therapy group appeared to be more relaxed and less aroused than the light pressure massage group which may have contributed to the greater weight gain of the moderate pressure massage therapy group. Similar data were reported on another sample. Stress behavior and movement were diminished in the massage group by the last day of the study (Hernandez-Reif, Diego & Field, 2007) (see figure 3) Moderate pressure was also used in this study.

In our study, moderate pressure, but not light pressure massage increased vagal activity (high frequency component (HF) of heart rate variability) (HRV) (Diego et al., 2005), suggesting that the stimulation of pressure receptors increases vagal activity. In that study, only those infants who exhibited increased vagal activity exhibited greater weight gain. Although many tactile stimulation studies have been conducted with preterm infants, only those that involved moderate pressure massage resulted in greater weight gain (Diego et al., 2005; Field et al., 1986; Scafidi et al, 1990), suggesting that it is the stimulation of pressure receptors that mediates the effects of massage therapy on enhanced vagal activity, gastric motility and weight gain.

Data analyses conducted on a larger sample revealed the following (see figure 4 and tables 5 and 6) (Diego et al, 2007). Massage therapy explained 19% of the variance in the change in vagal activity, leaving at least 81% of the variance “unaccounted for” in the vagal tone change. This could be due to other factors such as stimulant use in preemie care or the fact that we dummy coded massage as yes or no versus using it as a continuous variable; 2) the amount of change in vagal activity, in turn, explained 41% of the variance in the change in gastric motility observed during the massage period; 3) the change in calorie consumption during the study

period was not related to whether infants received massage therapy or not. However, the change in calorie consumption during the treatment period explained at least 9% of the variance in weight gain during the treatment period; 4) the model supports a pathway where massage therapy leads to vagal activity, which, in turn, leads to weight gain. However, the effects of vagal activity on weight gain are only partially mediated by the change in gastric activity, as vagal activity contributed to at least 4% of the variance in weight gain independent of gastric motility. This might be explained by the vagus branching to other areas that may have contributed to the weight gain including the pancreas (insulin release) and HPA axis (decreased cortisol); and 5) the final model only explained 28% of the variance in preterm infant weight gain which in part relates to the fact that not all infants who received massage gained more weight. Also, other variables we did not measure would likely contribute to the variance. These include increased activity and increased IGF-1, which we have seen in our massage groups.

Our hypothesized massage therapy model is supported by several lines of evidence. For example, anatomical studies indicate that baroreceptors and, to a lesser extent, mechanoreceptors within the dermis (i.e. Pacinian corpuscles) are innervated by vagal afferent fibers projecting to the vagal nucleus of the solitary tract (NTS), the predominant source of afferent inputs to the efferent neurons of the nucleus ambiguous (NA) and the dorsal motor nucleus of the vagus (DMN) (Kandel, Schwartz & Jessell, 2000). The DMN, in turn, gives rise to most of the efferent fibers that provide parasympathetic control of the gastro-intestinal system in the form of the gastric (stomach, proximal duodenum), hepatic (liver) and celiac (pancreas, spleen, kidneys) branches of the vagus (Chang, Mashimo & Goyal, 2003; Kandel et al., 2000).

Direct stimulation of the vagus nerve can regulate gastric motility, can enhance food digestion and can increase the availability of nutrients (Chang et al., 2003). Greater nutrient availability can, in turn, increase IGF-1 levels (Thissen, Ketelslegers & Underwood, 1994). Vagal stimulation also promotes the release of insulin (Rozman, Bunc & Zorko, 2004), and insulin has been shown to stimulate the synthesis and release of IGF-1 (Kalme, Loukovaara, Koistinen, Koistinen, Seppala & Leinonen, 2001; Thissen et al., 1994). The stimulation of pressure receptors can also promote the release of insulin (Marchini, Lagercrantz, Feuerberg, Winberg, Uvnas-Moberg, 1987). Taken together, these findings suggest that stimulation of pressure receptors (as in massage) increases vagal activity, and vagal stimulation facilitates the release of insulin and indirectly leads to the release of IGF-1. Insulin-like-growth-factor-I (IGF-1) plays a key role in regulating preterm infant growth. IGF-1 is strongly correlated with placental weight, birthweight, body length and Ponderal Index (Colonna, Pahor, de Vonderweid, Tonini & Radillo, 1996; Klauwer, Blum, Hanitsch, Rascher, Lee & Kiess, 1997; Leger, Oury, Noel, Baron, Benali, Blot & Czernichow, 1996; Osorio, Torres, Moya, Pezzullo, Salafia, Baxter, Schwander & Fant, 1996), and can significantly predict growth velocity in preterm infants (Kajantie, Dunkel, Rutane, Seppala, Koistinen & Sarnesto, 2002).

Both insulin and IGF-1 were noted to increase in a recent study we conducted using massage therapy with preterm infants (Field et al, in review). In that study preterm neonates were randomly assigned to massage therapy or a standard treatment control group. Despite similar formula intake, the massaged preterm neonates showed greater increases during the 5 day period in: 1) weight gain; 2) serum levels of insulin; and 3) insulin-like growth factor-1 (IGF-1) (see figure 5). Increased weight gain was significantly correlated with insulin and IGF-1.

Summary

In this paper, preterm infant massage therapy studies are reviewed. Massage therapy has led to weight gain in preterm infants when moderate pressure massage was provided. In studies on passive movement of the limbs, preterm infants also gained significantly more weight, and

their bone density also increased. Research on ways of delivering the massage is also explored including using mothers versus therapists and the added effects of using oils. The use of mothers as therapists was effective in at least one study. The use of oils including coconut oil and safflower oil enhanced the average weight gain, and the transcutaneous absorption of oil also increased triglycerides. In addition, the use of synthetic oil increased vagal activity, which may indirectly contribute to weight gain. The weight gain was associated with shorter hospital stays and, thereby, significant hospital cost savings. Despite these benefits, preterm infant massage is only practiced in 38% of neonatal intensive care units. This may relate to the underlying mechanisms not being well understood. The increases noted in vagal activity, gastric motility, insulin and IGF-1 levels following moderate pressure massage are potential underlying mechanisms. However, those variables combined do not explain all of the variance in weight gain, highlighting the need for additional mechanism studies.

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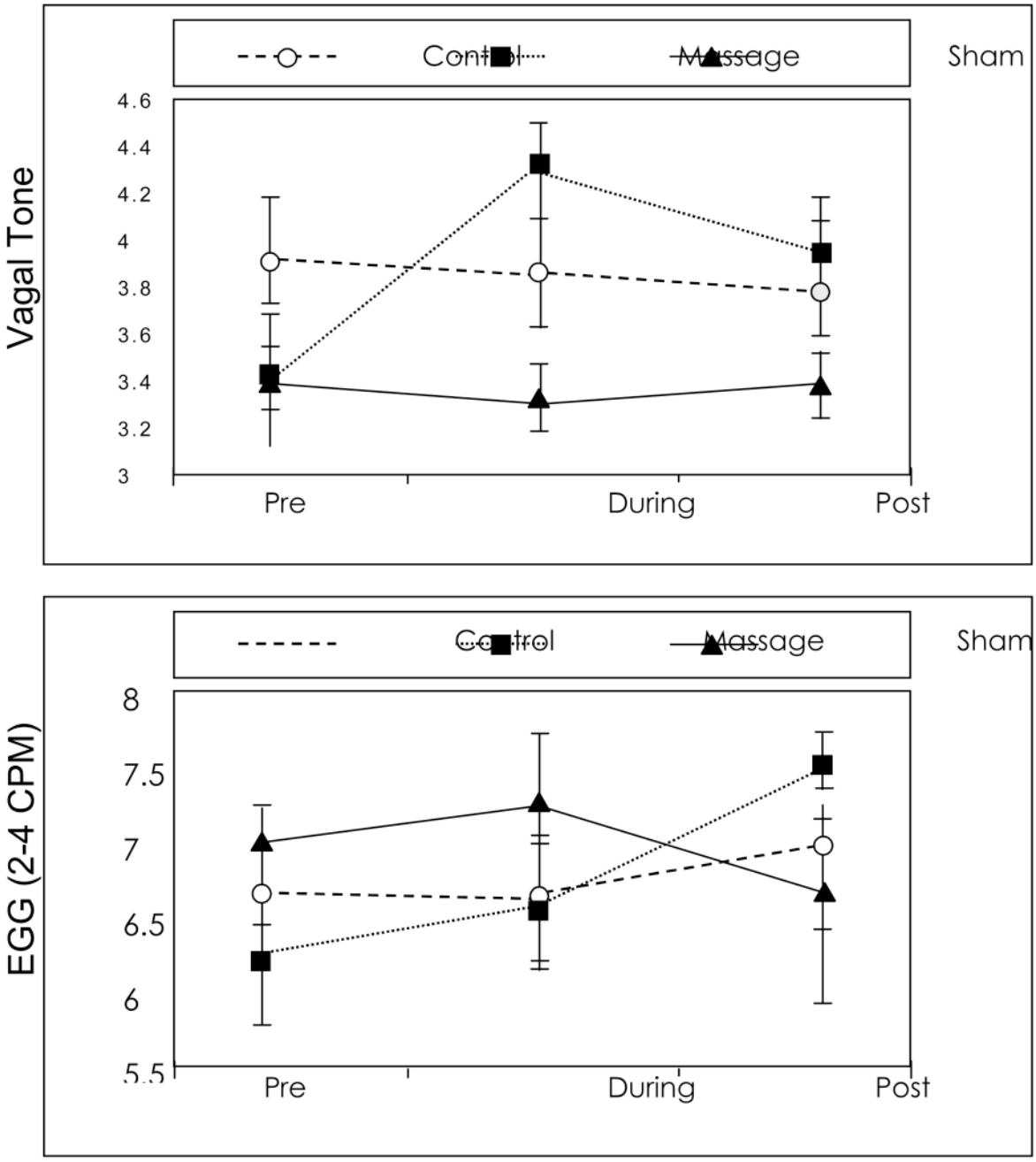

Figure 1.

Trend Analyses on Vagal Tone (high frequency component of heart rate variability) and Gastric Motility (2-4 cpm EGG) 15-minutes before, during and after treatment (error bars denote +- 2 SE) in massage (moderate pressure), sham (light pressure) and control groups. Preterm infants who received massage therapy exhibited increased HF during the massage ($F(1,15)=4.54$, $p<.05$, quadratic trend for massage group only) and increased gastric activity following the massage ($F(1,15)=10.66$, $p<.01$, linear trend for massage group only).

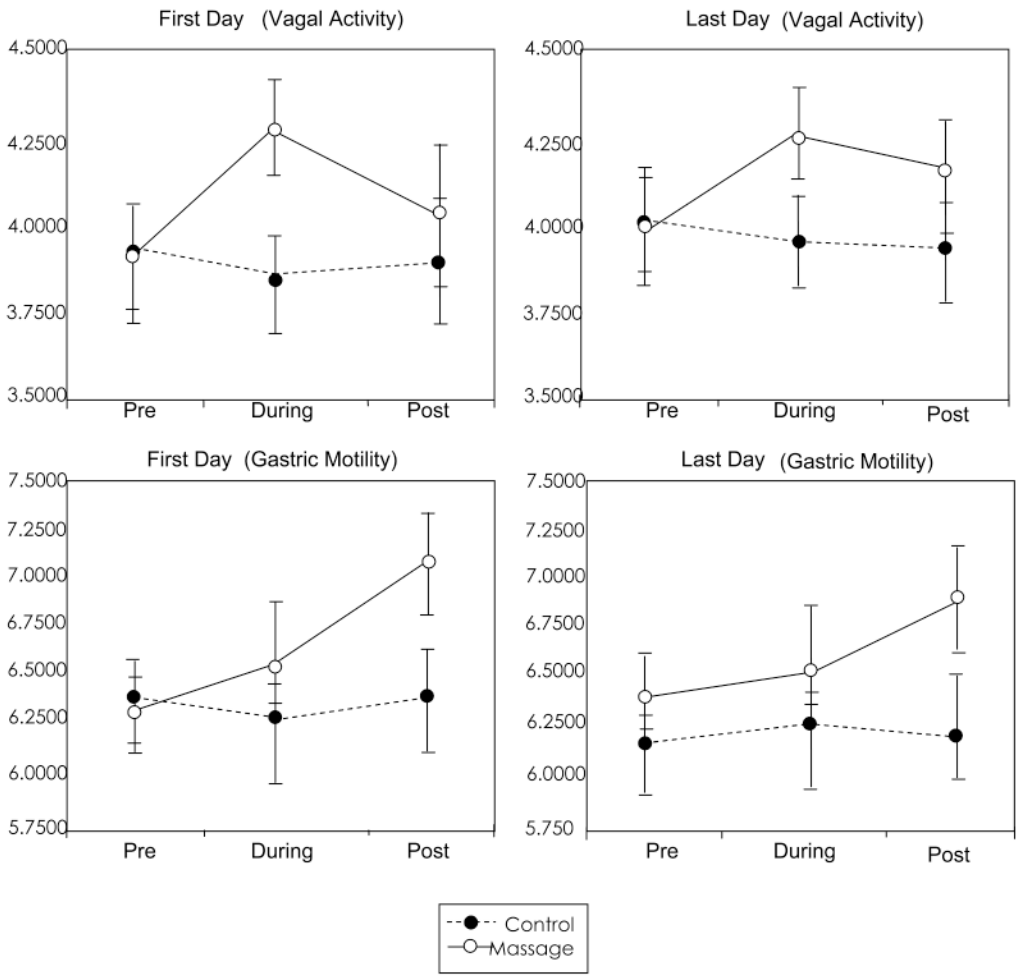

Figure 2.
Mean vagal activity and gastric motility on the first and last days of the study for preterm infants assigned to the control (closed circles) and massage group (open circles).

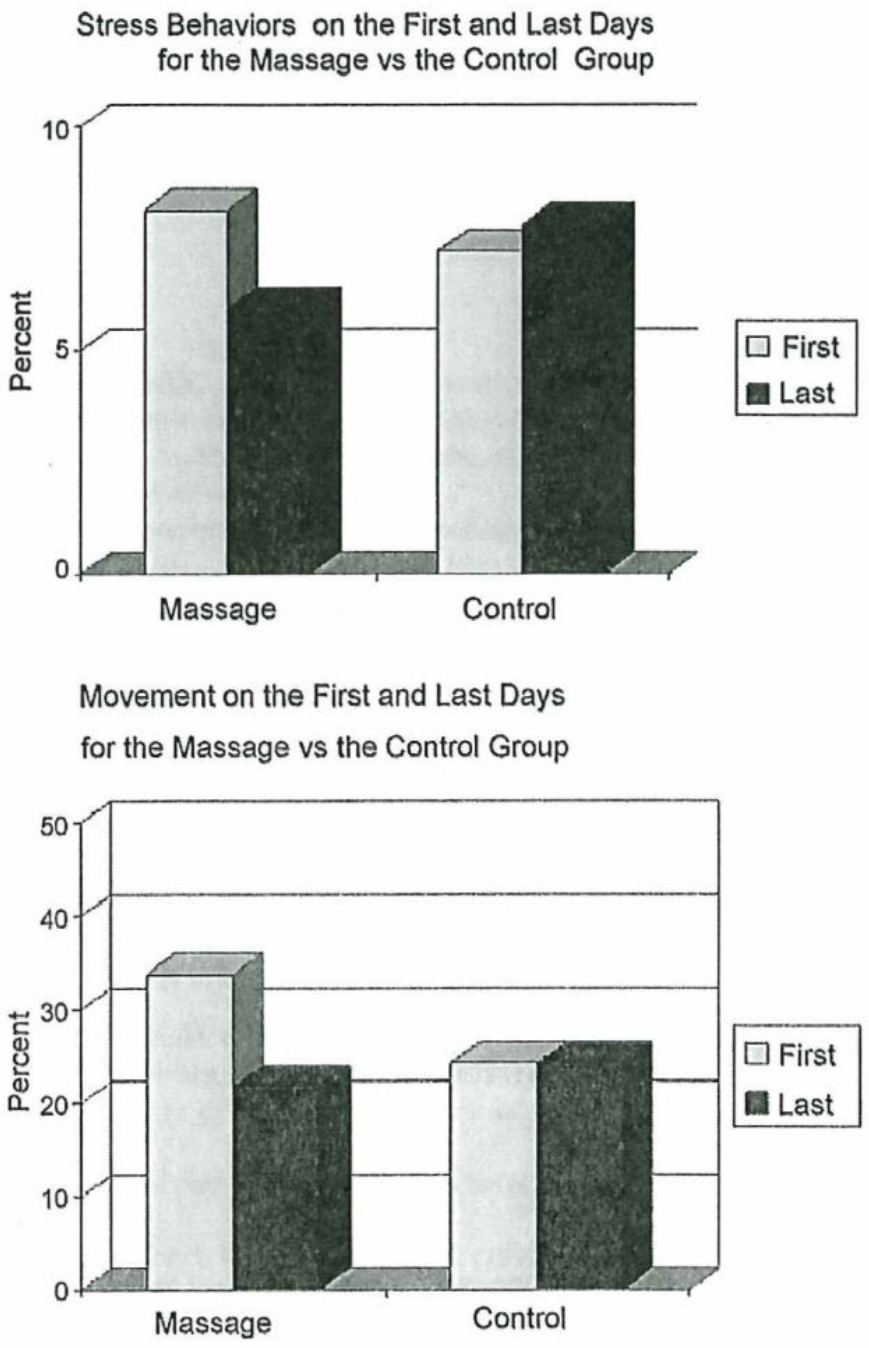

Figure 3.
Stress behaviors on the first and last days for the massage vs. the control group. Movement on the first and last days for the massage vs. the control group.

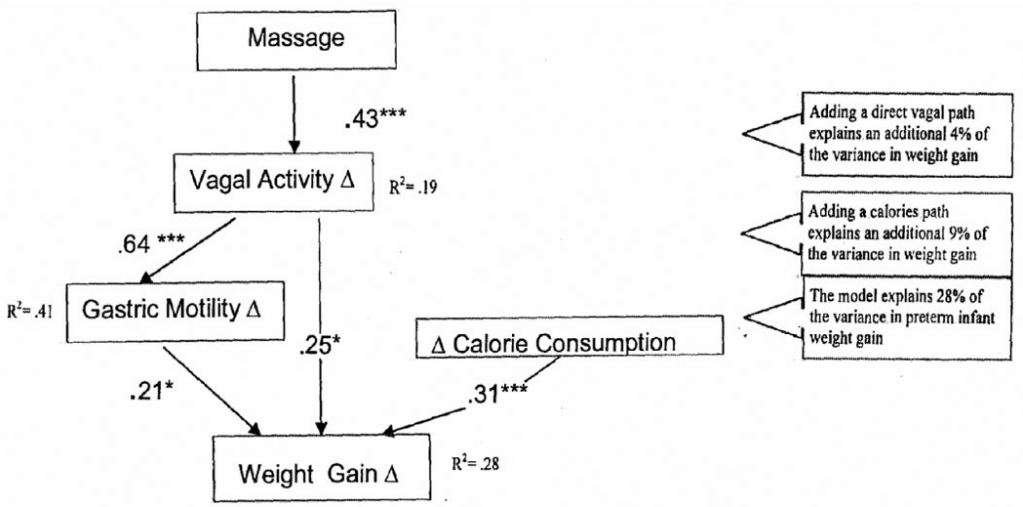

Figure 4.

A preliminary path analysis entering potential mediating variables for the massage therapy/ weight gain relationship.

Corrected Model, Chi^2 (5)= 6.96, p=.98

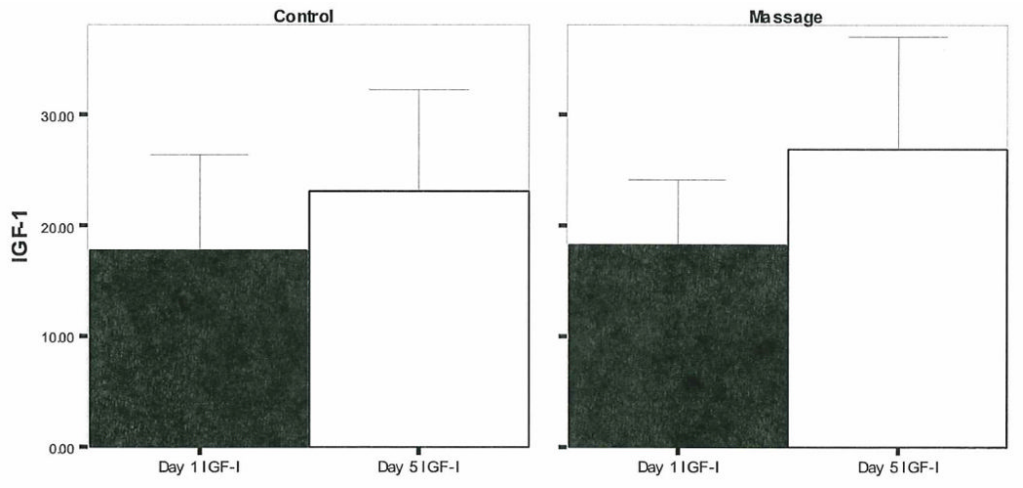

Figure 5.
IGF-1 levels increased from day 1 to day 5 for infants assigned to the moderate massage therapy ($t(20) = 2.25$, $p < .05$) but not the standard care control group ($t(20) = 1.65$, N.S.).

Table 1

Mean weight gain for our massage therapy studies (s.d.s in parentheses).

		Weight Gain/Day (g)			
	#Days	**Massage**	**Control**	**p**	**%Wt Gain**
Field et al., 1986 (n = 40)	10	25.0 (6.0)	17.0 (6.7)	.005	47
Scafidi et al., 1990 (n = 40)	10	33.6 (5.4)	28.4 (11.1)	.003	21
Wheeden et al., 1993 (n = 30)	10	33.0 (7.3)	25.7 (7.0)	.009	27
Dieter et al., 2003 (n = 32)	5	48.7 (36.9)	32.7 (12.2)	.01	48
Diego et al., 2005 (n = 32)	5	19.6 (3.9)	15.5 (3.7)	.01	25

* The 2 groups in each study were equal Ns S.Ds are in parentheses.

Table 2

Effects of Preterm Infant Exercise on Weight Gain (S.D.s. in parentheses) Weight Gain/Day (g)

	Exercise	Control	p	% Weight Gain
Moyer-Mileur et al. (1995)	17.8 (2.8)	13.4 (2.8)	.001	38
Moyer-Mileur et al. (2000)	16.3 (2.6)	14.6 (2.0)	.02	20
Nemet et al. (2002)	---	---	.05	31

Table 3

Means for behaviors and vagal tone and cortisol change in massage with Oil and massage with No Oil.

	Massage		
Variables	**Oil**	**No oil**	**p level**
Motor activity (% time)	45.00	56.00	.05
Averting behaviors			
grimacing	2.20	3.30	.05
head turning	1.40	2.60	.05
Stress behaviors			
mouthing	1.80	5.90	.05
clenched fists	3.70	9.20	.01
Vagal tone change	+.50	+.20	.05
Cortisol (ng/nl) change	-.98	-.03	.05

Table 4

Means for neonatal measures for moderate and light pressure massage therapy groups pre and during therapy.

	Groups			
	Moderate		Light	
	Pre	During	Pre	During
Weight gain (g)	22.2	27.8*	28.8	27.4
During sleep (% time)	38.9	35.9	34.5	7.9*
Fussing (% time)	0.1	0.2	0.0	16.0*
Crying (% time)	0.6	0.7	1.8	11.6*
Movement (% time)	6.9	6.1	9.9	18.0*
Hiccuping (% time)	1.6	2.6	2.9	7.7**
Heart rate (BPM)	171.1	164.6*	168.0	168.7

* p<05.

** p<.01.

Table 5

Mean changes (Δ) in weight gain, vagal activity, gastric motility and kilocalories.

	Control (N=38)	Massage (N=44)	F	p
ΔWeight Gain (g/kg/day)	-.25 (1.20)	.37 (.90)	7.17	p<01
ΔVagal Activity	-.03 (.29)	.43 (.61)	18.23	p<01
ΔGastric Motility	.02 (.89)	1.67 (1.65)	8.67	p<.01
ΔKilocalories	2.90 (9.9)	3.74 (10.25)	.14	N.S.

Table 6

Correlation analysis for changes in weight gain, vagal activity, gastric motility and kilocalories.

	Massage	Weight Gain	Vagal Activity G	astric Motility
ΔWeight Gain (g/kg/day)	r = .23, p<.05			
ΔVagal Activity	r = .43, p<.01	r = .40, p<.01		
ΔGastric Motility	r = .31, p<.01	r = .39, p<.01	r = .64, p<.01	
ΔKilocalories	r = .04, N.S.	r = .33, p<.01	r = .05, N.S.	r = .05, N.S.

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Research Article

Effect of Coconut Oil Massage on Weight Gain in Low Birth Weight Newborns: A Randomised Controlled Clinical Trial

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Introduction

Low birth weight (LBW) is a major health problem and a significant contributor to neonatal deaths in both industrialized and developing nations.[1] According to WHO every year about 20 million LBW baby born, 96% of them are in developing countries. LBW is common problem in our country with an incidence of 30-40% (term small for gestational age 20-30% and preterm 10-20%).[2]

The period of intrauterine growth and development is one of the most vulnerable periods in the human life cycle[3]. Any deficiency occurring during this period leads to poor growth and development of the newborn. Newborn infants require efficient and cost effective care to compensate for possible shortage of intrauterine development.[4]

Massage is one of the oldest therapeutic techniques in the world which has been used as a routine part of infant care in many cultures.[5] Infant massage could potentially benefit both physiological and psychological health of the baby.[6] One of the important effects of massage is promotion of optimal infant growth and development.[6] The mechanism of massage therapy affecting the weight gain is not yet known. Theories proposed to explain the positive effects of massage on weight gain in preterm and full term infants include hormone growth, vagal tone and gastric motility, in addition to improved circulation of blood and lymph fluids; however, need for further research has been suggested to confirm these mechanisms.[7] Coconut oil is composed entirely of medium-chain fatty acids (MCFAs), which are a source of highly efficient cellular food. When coconut oil is applied topically, the cells absorb the MCFAs converting them into energy thus promoting weight gain[8] and so can be used for nutritional purpose and faster weight gain in LBW infants.[9]

Effects of massaging on the growth of low birth weight infants with or without oils remain unresolved. Oil can act as heat and nutrition source, but the effect of oil individually upon the growth of low birth weight infants is not yet clear.[10] Using oil during massaging makes the

massage frictionless, the skin soft causing reduction in the skin dryness.[11]

The present study thus aims to explore if coconut oil massaging can have a positive impact on the weight gain status of low birth weight infants.

Objectives

1. To evaluate the effect of coconut oil massage on weight gain pattern in Low Birth Weight (LBW) infants admitted to NICU of a Tertiary care Teaching hospital.
2. To find the adverse effects of coconut Oil massage in Low Birth Weight infants.

Methodology

Massage: It refers to the scientific manipulation if soft tissue of the body for the purpose of normalizing those tissue and consist of manual technique that include applying fixed or movable pressure, holding and or causing movement of or to the body.

Coconut Oil: It refers to the oil extracted from meat of mature coconut .The plain term 'coconut oil' is usually used for refined coconut oil or 'RBD coconut oil' i.e Refined Bleached and Deodorized Coconut oil.

Weight Gain: It refers to significant increase in weight of the newborn after implementation of massage with or without oil.

Low Birth Weight (LBW): It refers to birth weight of the newborn infant equal or less than 2499 gram, regardless of gestational age. It is either caused by preterm birth (younger than 37 week of Gestation) or infant being small for gestational age or Combination of both.

The present was a Hospital based interventional study.

Study Area: The study was conducted at a neonatal intensive care unit (NICU) of Tertiary care Government Hospital of Western Maharashtra.

Study Design: Non Blinded Randomized controlled clinical trial.

Study Period: The research was conducted for 6 months.

Study Population: The study population was the Low birth weight new-born (birth weight <2000gram) admitted to NICU of a tertiary level teaching hospital.

Sample: The Low birth weight infants (Birth weight <2000 gram) admitted to NICU at tertiary care teaching Hospital, meeting the following inclusion criteria, was the sample for the study.

Inclusion Criteria

1. Newborn fed with breast milk.
2. The weight of newborn should be < 2000 gram.
3. The Gestational age of newborn should be between 28-37 weeks.
4. The 'APGAR' Score of 5th minute should be greater than or equal to 7.
5. No anomalies, No congenital and systemic diseases.
6. No history of hereditary diseases.

Exclusion Criteria

1. The Low birth weight newborn showing symptoms of fever, neonatal sepsis, respiratory distress and muscle stiffness.
2. The Low birth weight newborn showing sensitivity to coconut oil will be excluded from the study by the lack of completion of massage period.
3. The Low birth weight Neonates who requires oxygen supplementation, inotrope or ventilator support or had meningitis or encephalopathy.

Instrument and Techniques to be Used in the Study

The present study was a non blinded randomised controlled clinical trial conducted in a NICU of tertiary level teaching hospital. After explaining aims and objectives of the study, the informed consent was obtained from the parent of eligible neonates. The eligible neonates were randomised to one of the two groups by using a table of random number generated by the computer. The eligible low birth weight newborn in the intervention group was given massage with coconut oil and the control group was given massage without oil.

Clearance from Institutional Ethical Committee (IEC) was obtained before starting the study.

Massage Technique

There are no fixed guidelines describing the exact methodology of neonatal massage. Mathai et al, has described a standardised massage protocol which has been followed by most studies on massage therapy and adopted in this study also[12]. The Mathai's massage therapy consists of both tactile and kinesthetic stimulation. Neonates between the ages of 2 days to 20 days were chosen for the study.

Three massage sessions were given in a day, each session for 10 minutes.

Oil massage was given for 10 days. For first 2 days oil massage was given by trained person and thereafter by the mother (who was taught the technique) for next 8 days .Compliance of the mother was checked regularly by the NICU Nurse. It has been shown that mothers are as effective as trained professional in delivering the massage and in addition, mothers who massage their neonates have lower depression and anxiety[13]. Babies in the control group received a massage without oil and the method of application and the monitoring was the same as in the oil groups.

The massage Session was initiated an hour after a feed to avoid regurgitation or vomiting of the feed. The infant in the intervention group was given coconut oil massage with 5mL/kg of body weight being applied per session.

During massage, the neonates were placed completely naked on a plastic cover. The nurse or the mother was instructed to warm and lubricate her hands before starting of massage and to remain silent during intervention. If the baby started crying or passed urine or stools during the session it was temporarily stopped till the baby was comfortable again. The massage protocol is as follows.

Phase I: This was done in the prone position. Twelve firm strokes with palms of the hands of 5 seconds each, were provided in each area as follows: (a) Head from forehead hariline over scalp down to neck with alternate hands; (b) Neck from midline outwards with both hands simultaneously; (c) Shoulders from midline outwards with both hands simultaneously; and (d) Back from nape of neck down to buttocks with firm, long stroke with alternate hands.

Phase-II: This was done in the supine position. Twelve firm stroke with palms of the hands, of 5 seconds each, were provided in each area as follows: (a) Forehead - From midline, outwards with both hands simultaneously; (b) Cheeks - From side of nose, with both hands simultaneously in rotating and clockwise direction for left cheek and anticlockwise direction for right cheek; (c) Chest- 'butterfly' stroking from midline upwards, outwards, downwards and inwards back to initiating point; (d) Abdomen - From the appendix, in a clock wise direction around abdomen avoiding the epigastrium and probes, with gentle strokes; (e) Upper limbs (each separately)- from shoulders to wrist using alternate hands for stroking; (f) Lower limbs (each separately) - from hips to ankles using alternate hands for stroking; (g) Palms - from wrist to finger tips using alternate hands for stroking; and (h) Soles- from heel to toe tips using alternate hands for stroking.

Phase-III: This was done in the supine position and consisted of passive flexion and extension movements of the limbs at each large joint (shoulder, elbow, hip, knee and ankle) as 5 events of 2 seconds each in each area.

The weight of LBW neonate in both the groups was measured and recorded everyday by the NICU nurse. In this way the study was conducted for a period of 6 months and the data was collected, tabulated and analysed.Adverse effects due to the massage were also looked for but none so happened.

Instrument Used

The weight of the preterm infant was measured everyday by 'SEICO' 24 Bit Technology digital weighing machine with precision of ± 10 gm without diapers and clothes at 11 a.m. The

Refined type of coconut oil was used in this present study i.e. Refined Bleached and Deodorized Coconut oil.

Data Analysis and Data Presentation

This study was conducted for the duration of 6 months August 2017 to January 2018. After collecting the data from the study, the data was analysed by using descriptive statistics i.e. mean ± standard deviation and frequency with percentage. The data was analyzed with Statistical Package for Social Sciences (SPSS) for Windows 24.0 (SPSS, Inc.chicago, Illinois). Independent t-test was applied to compare mean birth weight among 'coconut oil massage' group and 'only massage' group. Confidence intervals were set at 95% and p value < 0.05 were interpreted as statistically significant. The analyzed data was represented in the form of tables and graphs.

Results

Fifty five patients were excluded from the study and the design and conduct of this trial was straightforward, and we did not have any losses to follow-up. Finally, 72 neonates including 37 girls (51.3%) and 35 boys (48.6%) of gestational age between 27 – 39 weeks were evaluated. The infants mean ± SD age in days and birth weight in grams was 9.93 ± 3.705 and1434.17 ± 271.691 respectively. There were 36 neonates in coconut oil massage group and 36 neonates in only massage group. There were 60 preterm infants (<37 week) and 12 terms infants (>37 week). The birth weight was ranging from 940-1920 grams. Comparison of baseline characteristics of the neonates in intervention and control arm is shown in (table I) and it shows that data is comparable among the groups.

Table 1: Baseline Characteristics of the Study Groups

Variable	Coconut Oil massage	Only massage
Birth weight (gm) (Mean, SD)	1431.94 (268.54)	1436.38 (278.58)
Gestation (weeks) (Mean, SD)	31.5 (2.59)	31.36 (2.69)
Sex (Male, Female) (n)	14/22	21/15
Apgar score (Median, Range) 1minute 1 minute	9 (7-9) 9 (7-9)	9 (7-9) 9 (7-9)
Apgar score (Median, Range) 5 minute	9 (8-9)	9 (8-9)
Education of mother (in completed yrs) (Median, Range) (Median, Range)	10 (0-15)	10 (8-15)
Maternal Age (yrs) (Mean, SD)	25.17 (4.62)	25.61(4.47)
Socio- Economic Class (Median, Range)[#]	3 (1-4)	3(2-4)
Infant age (days) (Mean, SD)	9.41 (3.41)	10.44 (3.95)
Enteral intake at enrolment (mL/kg/day) (Median, Range)	180 (120 – 300)	186 (120-300)

[#] - Socioeconomic status scale by kuppuswamy (14); SD – Standard deviation

Table 2: Comparison of the Demographic Details at Baseline

Variables	Coconut Oil massage	Only massage	t-value	p-value
Birth weight (Mean, SD)	1431.94 (268.65)	1436.39 (278.59)	-0.069	.945
Gestational age (Mean, SD)	31.56 (2.59)	31.36 (2.69)	.312	.756
Maternal Education (years) (Mean, SD)	9.97 (2.95)	10.50 (1.75)	-.923	.359
Maternal Age (Mean, SD)	25.17 (4.62)	25.61 (4.47)	-.415	.680

Table 2 shows that no statistically significant differences were seen in comparison of sociodemographic profile of infants and mothers in terms of birth weight, mean gestational age, mean maternal education and mean maternal age.

Table 3: Comparison of Anthropometric Data in the Study Groups

Variable	Coconut Oil massage	Only massage	t value	p-value
Weight in grams (mean, SD) At Day 1	1435.83 (284.67)	1440 (285.41)	-.062	0.951
Weight in grams (mean, SD) At 10th days	1615.83 (301.06)	1549.72 (301.08)	.932	0.355
Weight change in gm	180 (23)	109.72 (23)	12.89	0.0001*
Weight gain (g/kg/day) (mean, SD) (over 10 days)	12.81 (1.85)	7.70 (1.33)	13.42	0.00*
Duration of hospitalization Mean, SD	23.81,6.3	25.39,6.47	-1.05	0.297

*Statistically significant (p value - <0.05)

Table 3 shows comparison of anthropometric data in coconut oil massage group and in only massage group. The mean weight ± SD of infants in both groups at day 1 was 1435.83 ± 284.67 and 1440 ± 285.41 respectively. The mean weight ± SD of infants at day 10 was 1615.83 ± 301.06 and 1549.72 ± 301.08 respectively. The mean and SD of weight gain in gm during 10 days for 'coconut oil massage' group was 180 ± 23 gm and in 'only massage' group was 109.72 ± 23 gm.(Figure 1).The weight gain was greater in 'coconut oil massage' group than 'only massage' group. Independent t test shows that weight gain is statistically significant in 'coconut oil massage' group than 'only massage' group (P=0.0001 t = 12.89) revealing the effect of intervention. Also, the mean (± SD) of weight gain in gm/kg/day in 'coconut oil massage' group 12.81± 1.85 was statistically higher as compared to 'only massage' group 7.70 ± 1.33 (P<0.0001 t = 13.42, figure 2). The mean and SD duration of hospitalization in massage with coconut oil group was 23.81 ± 6.3 and in massage without oil was 25.39 ± 6.47 in days. Independent t- test showed that the mean duration of hospital stay between two groups was not statistically significant (P= 0.297 t = -1.05).

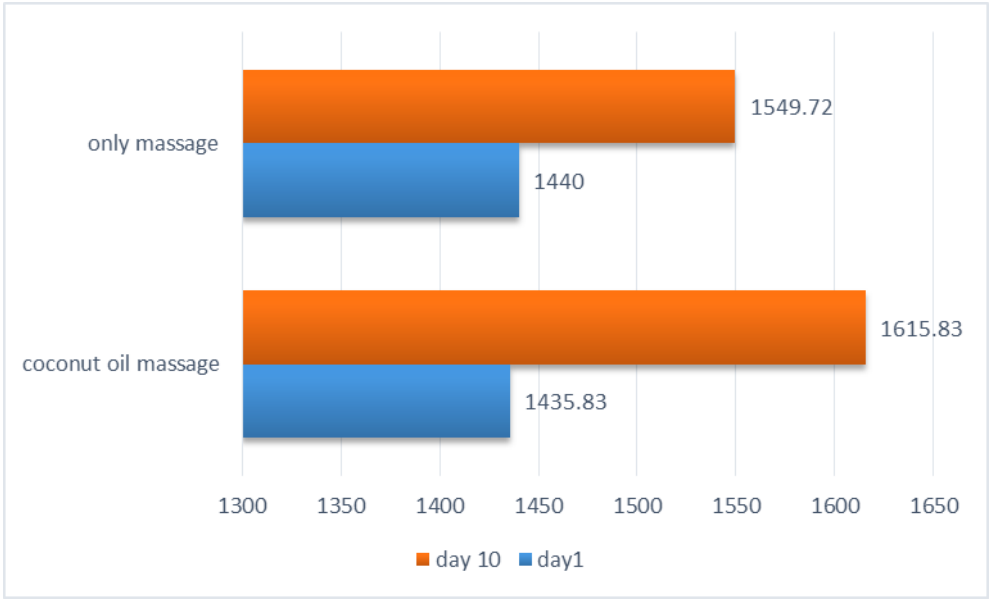

Figure 1: Weight in grams at baseline and after intervention.

Figure 1 showed the comparison of mean weight at day 1 and day 10 in both groups. The mean weight at day 1 and day 10 was 1435.38, 1440 and 1615.83, 1549.72 in coconut oil with massage group and in only massage group respectively.

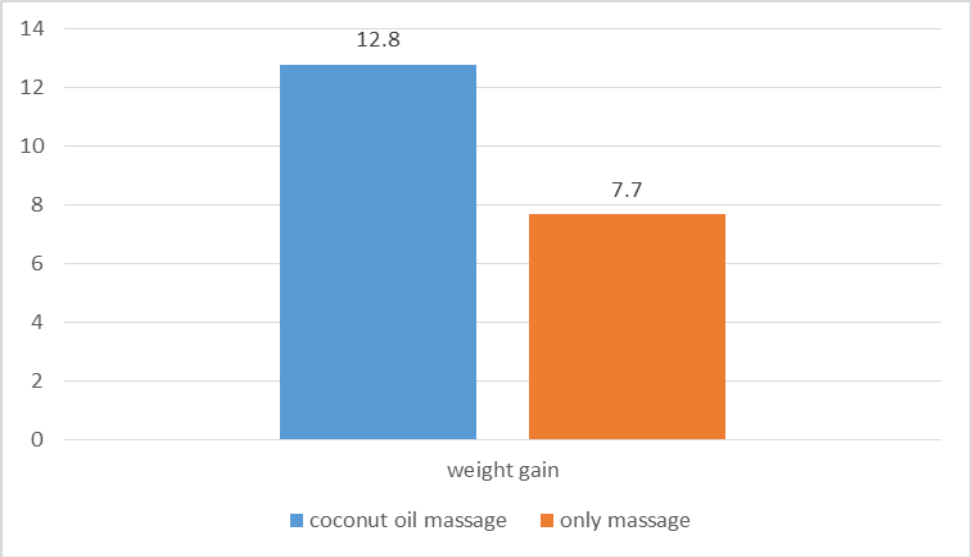

Figure 2: Weight gain in gm/kg/day across groups

Figure 2 showed that the mean weight gain in gm/kg/day during 10 days of massage in coconut oil group was12.81 and in only massage group was 7.70. Independent t- test revealed that this difference is statistically significant (P<0.0001 t = 13.42).

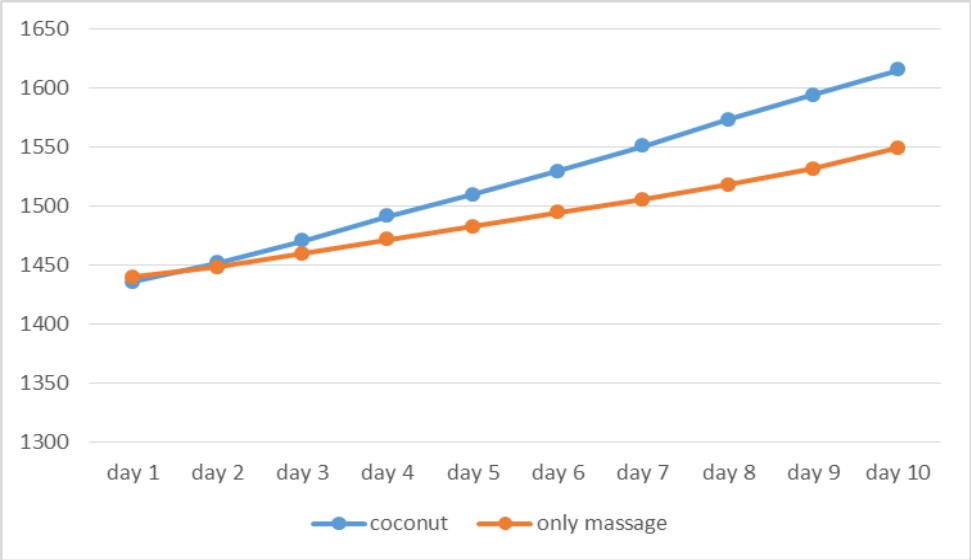

Figure 3: Daily mean weight change in both groups (n=72)

Figure 3 represents trend of infant's mean weight change in both groups over 10 days of massage. The repeated measurement analysis showed that the weight gain over the course of 10 days was different in the two groups, and the rate of weight gain with coconut oil massage was more than in massage without oil (*P*< 0.0001).

Discussion

We examined the effect of coconut oil massage on weight gain pattern in LBW infants admitted in NICU of tertiary care teaching Hospital in Kolhapur, a city in western Maharashtra, India. This centre receives baby from adjacent districts like Ratnagiri, Sindhudurgoros and Sangali also. Intolerance to food is commonly associated with LBW and preterm neonates as they have many feeding difficulties. This is more prominent for the first few days after birth. Also increasing the food volume and density may complicate their stay in NICU[15]. The Massage with coconut oil is traditional practise in many countries and Several

studies like Mathai, Agrawal, have already documented the somatic and neurodevelopmental benefits of tactile kinesthetic stimulation in preterm infants[12,18]. However the adverse and beneficial effect of massage on growth of LBW infants with or without oil has remained unresolved. Thus, the researchers in this study tried to tackle this issue by conducting a clinical trial study.

The present study demonstrates significantly higher weight gain in coconut oil massage group (12.81 + 1.85 g/kg/day) compared to only massage group (7.70 + 1.33 g/kg/day) with over 10 days of massage (P value <0.0001). Duration of each massage session was 10 min for 3 times/day until 10 days and all infant's massage was performed by a trained person for first 2 days thereafter by the mother (who was taught the technique) till the next 8 days of age. The results of our study were similar to the studies done by saeedi et al, Vickers et al, Arora et al, Agrawal et al, about effect of massage on weight in LBW neonates [16,17,10,18]. In a randomised controlled trial by Saeedi et al in Mashhad, Iran, reported that the mean weight gain on the 7th day in the oil massage group was 105±1.3gm and 52±0.1gm in the massage group; whereas 54±1.3gm weight loss was observed in the control group. In the mentioned study significant differences were observed between the oil-massage group and the other two groups, respectively (P=0.002 and P=0.000) suggesting the accelerated weight gain with medium-chain triglyceride oil massage therapy in premature neonates[16].

Vickers et al, in his meta-analysis study showed that body massage increased daily weight gain of neonates by 5.1 gm on an average and also weight gain at 4-6 months [17]. In another study by Arora et al. showed that weight gain was significantly higher in oil massage group (11.6 ± 4.3 g/kg/day) than in the massage-only group (8.7 ± 4.6 g/kg/day) and no-massage group (8.3 ± 4.9 g/kg/day). However a notable point was that the main increase happened in height, head circumference, skin fold thickness and behavioural score during 28 study days, in the oil-massage group. But it was not statistically meaningful when it was compared to other two groups[10.] Agarwal et al., examined the effect of massage therapy and oil on the sleep pattern of healthy term infants, the weight and blood circulation. They reported that massage in infants improved growth indices (weight, height, and arm and calf circumference) and also the neonates' sleep pattern. Also, among the different types of applied oil in this study (herbal oil, sesame oil, mustard oil and mineral oil), only sesame oil showed a significant improvement [18.]

An open randomized controlled trial was conducted by shankarnarayanan et al. to compare the effect of massage with coconut oil versus mineral oil and placebo (powder) on growth velocity and neuro-behaviour in well term (112) and preterm (112) babies. Oil massage was given by a trained person from day 2 of life till discharge, and thereafter by the mother until 31 days of age for four times a day. They concluded that coconut oil massage therapy increased weight gaining in comparison to mineral oil and control groups. In addition, the premature neonates receiving coconut oil massage therapy showed a higher increment in height compared to the control group. However, no significant difference in neurobehavioral was observed between the three groups[19].

In their trial of 60 preterm neonates by Soriano et al, they reported significantly higher weight gain over a 30 days period in the oil massage group compared to those who received routine care (703 + 129 g vs 576 + 140 g; P <0.05) [20]. In another study by Solkoff, et al, there was no significant difference in weight gain even with massage over 10 days. This study however had a sample of only 16 neonates [21].

The quasi-experimental study by Smiti Arora et al reported that no significant increase in weight or neurobehavioral response was observed after the coconut oil massage therapy in LBW neonates for 7 days(2 times/day). This revelation was contrary to the present study where massage was given for

10 days (3 times/day). These discrepancies may be because of differences in: sample size, gestational age, and method of massage [22].

The findings of this study demonstrated that coconut oil application improves the weight gain velocity in LBW infants over and above the benefits of tactile kinesthetic stimulation due to massage alone. This suggests a role for transcutaneous absorption of oil through the thin skin of the preterm and LBW neonate. The skin of a preterm baby allows significant absorption of fat, as it is thinner and more vascular[19]. This may also result in greater caloric intake and consequently a better weight gain[23]. Fernandez, et al. in an elegant study in Mumbai reported that a significantly higher serum triglyceride levels in preterm neonates weighing 1500-2250 g after application of corn oil every four hours for three days. This was attributed to fatty acid absorption through the skin of preterm neonates and alsodemonstrated the value of oil massage in thermoregulation of small preterm babies[23]. Soriano et al reported a significant increase in anthropometric parameters at one month of age in 30 consecutive preterm infants who were treated cutaneously with soybean oil compared to a control group, which received no cutaneous treatment. They observed an increase in linoleic acid level in neonate's blood[20]. This is the probable mechanism of weight gain in LBW and preterm neonates reported by these studies. In addition, no relationship was found between infant weight and gender likewise in the present study[18, 24].

Surprisingly, there was also a finding in the present study that the mean duration of hospital stay between two groups was not statistically significant (P value >0.05). This was similar to the finding of Massaro et al study in Washington [25]. But in the study by Mendes and Procianoy in Brazil, it was reported that massage therapy by mothers had no significant effect on the increase in weight gain in infants <1500 g. However, the hospital stay in the intervention group was 7 days less than the control group ($P = 0.007$)[26].

On comparison of the results of previous studies and this study, it can be indicated that topical oil administration in neonates, especially premature neonates, might be useful in temperature regulation and prevention of hypothermia in newborns[27]. This is because the neonates have increased vascularity and high skin permeability. Also the fatty acid components of tropical oils can alter the lipid profile of the newborn's body in terms of both quality and quantity. Additionally, it can also improve the general growth in stored fat cells as a source of energy and accelerate weight gain without significantly affecting the body's lipid metabolism. Oil massage therapy can be used as a beneficial feeding method in premature neonates with problems like intolerance to feed, inability to breast fed and lack of coordination in sucking, swallowing and respiration reflexes[16].

Conclusion

It can be concluded that coconut oil has a positive effect on weight gain in LBW infants. The technique of oil massage therapy is free from any complications or side effects and does not cause any deviation or complications arising from the general health of neonates. The traditional and harmless intervention of oil massage is an easy, cost effective practise improving the weight and general health of LBW neonates. The research also points to the potential value of oil massage as an essential and integrated part of daily nursing care for low birth weight neonates both in hospital and at home. Moreover, probably due to the culture of developing country like India where mother were young at the time they bore first baby; this study can help the mother to learn the technique of oil massage, thus educating the community about the benefits of coconut oil massage.

However, the study had following limitations:

1. As this study was conducted on infants weighing <2000 g, so results of this study could not be generalised to infants weighing >2000.

2. The sample size was limited to 72 hence generalization of findings is restricted.
3. The result of this study cannot be generalized to full term, high risk, very low birth weight neonates.

However separate analysis of infants with appropriate and retarded intrauterine growth could not be done because of inadequate sample size. (whether growth retarded and appropriately grown babies benefit equally from oil massage need to be further evaluated.)

However, further studies should be encouraged to carry out effectiveness of oil massage on weight gain in LBW neonates with different weights as the individual differences can affect the rate of weight gain in individuals. The study was conducted over short period of time, further research is to be needed to determine long term effect of oil massage before generalise conclusion can be drawn. Furthermore, other studies can be carried out on comparing the effectiveness of massaging with different oil on weight gain in LBW infants.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

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