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The Effects of Massage with Coconut and Sunflower Oils on Oxygen Saturation of Premature Infants with Respiratory Distress Syndrome Treated With Nasal Continuous Positive Airway Pressure

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ABSTRACT

Introduction: Nowadays particular emphasis is placed on the developmental aspects of premature infants care. Massage therapy is one of the best-known methods of caring. Due to the minimal touch policy in neonatal intensive care units (NICUs), massaging is not usually performed on premature infants. However, there is not sufficient evidence to support the claim that newborn infants with complex medical conditions should not be massaged. This study aimed to determine the effects of massage with coconut and sunflower oils on oxygen saturation of infants with respiratory distress syndrome (RDS) treated with nasal continuous positive airway pressure (NCPAP). ***Methods:*** This was a randomized controlled trial on 90 newborns who were admitted to Alzahra Hospital (Tabriz, Iran). The infants were divided into control and massage therapy groups (massage with coconut and sunflower oils). Data was collected using a hospital documentation form. A 15-minute daily massage was performed for 3 days. Respiratory rate (RR), fraction of inspired oxygen (FiO_2) and oxygen saturation were measured 5 minutes before the massage, 3 times during the massage, and 5 minutes after the massage. The collected data was analyzed using a mixed model. ***Results:*** In comparison to coconut oil and control groups, mean oxygen saturation of sunflower oil group was improved. In addition, the coconut massage group showed lower oxygen saturation than the control group but was all values were within the normal range. Although massage decreased oxygen saturation, there was no need to increase FiO_2. ***Conclusion:*** Massage therapy can provide developmental care for infants treated with NCPAP.

Introduction

Nowadays most of the infants admitted to neonatal intensive care units (NICU) are premature.[1] Immature lung tissue and respiratory distress syndrome (RDS) are the most common neonatal problems which indicate the need for intensive respiratory care.[2] Recent developments in non-invasive respiratory support devices[3] have resulted in the use of nasal continuous positive airway pressure (NCPAP).[4] Due to its simplicity and cost-effectiveness,[5] NCPAP is used to support premature infants with respiratory distress and to prevent alveoli collapse at the end of expiration.[4]

For neonatal care givers, it is important to focus on improvements in premature infants' health and to keep them alive.[6] Recently, the main emphasis has been put on supportive strategies for mental and developmental health.[7] It seems that supportive care of premature infants may reduce RDS.[8] Touching is one of the key principles of developmental care. Developmental care is an essential element of nursing practices for

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neonates in NICU.[9] Massage is thus an intervention that may be useful in premature infants and newborns with low birth weight. Performing massage therapy for infants in NICU is a kind of alternative treatment that has been the subject of long debates.[7] Studies have indicated that infants who receive massage are usually better adapted to environmental stressors and suffer less negative effects. However, hospitalization in NICU is itself a stressful experience for premature infants.[10]

There are generally two types of touching babies: touching for care and massage therapy. Touching for care is a daily process of infant care in NICU and includes feeding, diaper changing, and examinations. Infant massaging on the other hand, is a way for simulating the baby.[6] The positive effects of massage therapy include increasing weight gain, improving sleep/wake pattern, improving the development of the sympathetic nervous system,[6-11] and reducing stress, hospital infections, mortality rates.[6-12] Massaging also leads to early discharge from NICU,[6-12] coordination of the breath and heartbeat,[13] and reduction of hospital health care costs.[14] Yet because of safety concerns about touching infants, minimal touch policy was established in NICUs. Therefore, despite its benefits, therapeutic massage was not performed in most NICUs. According to new information however, the risks of massage therapy are different from those of touching for care. The minimal touch policy should hence be revised and changed if necessary.[6] Physiological indicators of stress and pain in premature infants are similar and may lead to decreased oxygen saturation and changes in respiratory rate.[15] Therefore, these physiological variables are considered as the consequences of stress.

In the past 37 years, several researches have been conducted on massage therapy of premature neonates with stable physiological conditions.[11] Although numerous studies evaluated incubated infants with RDS and a weight of 1500-2500 g and a gestational age of 32-37 weeks who received oxygen by hood,[16,17] they ignored severely ill patients hospitalized in 3 NICU levels, including infants treated with NCPAP. There is no explicit and sufficient evidence to prove the unsafely of massage therapy for infants with complex medical conditions such as those treated by NCPAP.[18] Moreover, according to our investigations, no published study has assessed the effects of massage therapy on premature infants treated by NCPAP hospitalized in 3 NICU levels.

The present study thus aimed to determine the effects of massage with coconut and sunflower oils on oxygen saturation in premature infants with RDS under treatment by NCPAP. If the benefits and safety of massage are proved, this group of patients can enjoy the advantages of receiving massage therapy.

Materials and methods

This was a randomized double-blind clinical trial from January 2010 to June 2011. After approval of the Ethics committee of Tabriz University of Medical Sciences, the study was registered in the Iranian Registry of Clinical Trials. The research population included 90 randomly selected premature infants in Alzahra Hospital (Tabriz University of Medical Sciences, Iran) who were treated with NCPAP. The sample size was determined (power of 80%, confidence of 95%) according to Lee's study using Pocock's formula.[19] The sample size was calculated as 30 in each group and by adding a sample loss of 20%, 90 subjects were finally included. The participating infants were randomly divided into 3 groups of massage with sunflower oil, massage with coconut oil, and control. Random allocation was performed using random blocks method (Fleiss)[20] and with the block size of 6 in Random Allocation Software (RAS).

The inclusion criteria were gestational age of 28-32 weeks, suffering from respiratory syndrome treated by NCPAP, weight of 1000-2000 g, 5-minute Apgar score greater than or

equal to 7, being at least 12 hours old, receiving NCPAP with fraction of inspired oxygen (FiO_2) of less than 70%, axiliary temperature of 36.5-37°c, minimal oxygen saturation of 92%, no contraindications to touching, and no congenital malformations, neurological and cardiovascular disorders, hereditary diseases, or history of drug abuse by the mother. Infants were only included after getting approval from a neonatologist. Exclusion criteria were the need for surgery or chest tube insertion, receiving NCPAP with FiO_2 of greater than 70%, receiving inotropic drugs, and diagnosis of septic shock or sepsis. Informed consents were obtained from the parents of eligible infants.

Massage of newborns can be done by using a lubricant to reduce the friction between the surfaces.[21] In order to choose an appropriate lubricant, availability, cost, and safety need to be considered. Among all lubricants, coconut oil and sunflower oil have been most commonly mentioned in literature about infant massage therapy.[12] We thus selected these types of oils for our investigation. They were poured into similar dark bottles (30 cc) and coded by the co-researcher. The caregivers and parents were hence not aware of the type of the lubricant used.

While the control group only received routine care, infants in the intervention groups were massaged using one of the oils in addition to standard cares. Massage therapy was performed for 15 minutes once daily on 3 consecutive days by one of the researchers using moderate pressure. Weiss massage therapy was performed on awakened newborns one hour after feeding.

Since all infants treated with NCPAP were placed naked under the radiant warmer, they were in the prone position at least 30 minutes before massage therapy. The masseur researcher first washed his hands thoroughly and then warmed them. He kept his hands close to the skin surface of the newborns' backs for one minute. He then put his hands on the back of the baby and massaged the length of the infant's body for 5 minutes. Massage movements began from the neck and back of the baby and continued to the lower limbs (2 minutes), back (5 minutes), upper extremities (hands) (2 minutes) and a final massage of the back (1 minute). Taped and intravenous (IV) lines were not rubbed. The co-researcher measured respiratory rate (RR), FiO_2, and oxygen saturation 5 minutes before massage, 3 times during the massage (at the 5^{th}, 10^{th} and 15^{th} minutes), and 5 minutes after the message. The values were recorded in the relevant checklist. It should be noted that massage was promptly stopped and postponed for one hour in case of physiological distress. The massage therapy procedure was then repeated or the case was excluded. According to Harrison, physiological distress happens when an infant's heart rate (HR), indicated by pulse oximeter, is less than 100 or more than 200 per minute for 12 seconds or more and the oxygen saturation level is below 90% for more than 30 seconds.[22] However, due to the sensitive conditions of newborns, these criteria were modified based on the advices of a neonatologist. Therefore, distress was considered as when the infant's HR, indicated by pulse oximeter, was less than 80 or more than 180 for 12 seconds or more and her/his oxygen saturation was lower than 90% for more than 30 seconds.

Data was collected using a hospital documentation form which consisted of a part to assess demographic characteristics and the chart of RR, FiO_2 and oxygen saturation. Data was recorded 5 minutes before the massage, at the 5^{th}, 10^{th}, and 15^{th} minutes of the massage, and 5 minutes after the message. During the intervention, a monitoring system (Masimo S1600, Pooyandegan Rahe Saadat Co., Iran) and an air-oxygen blender system (Medin Co.) were used to record oxygen saturation and FiO_2, respectively. RR (per minute) was observed and recorded. The validity of the device was confirmed according to its manufacturer company and by calibrating the device when setting the study. Content validity of data collection tools was measured using a panel of experts. After reviewing the literature, a

hospital documentation form was prepared and distributed among 7 faculty members of Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences as well as 5 neonatologists. The form was then modified according to their comments. Data was analyzed using $SPSS_{17}$ (SPSS Inc., Chicago, IL, USA). Quantitative and qualitative variables were reported as mean (SD) and frequency (percentage), respectively. We tested the mixed model using covariance structure of compound symmetry and a Sidak post hoc test to compare quantitative variables in different time points and dates. The chi-square test was used to compare gender distribution of the study subjects among the three groups. Analysis of variance (ANOVA) was applied to compare gestational age and birth weight among the subjects. P values less than 0.05 were considered as significant.

Results

A total of 90 premature infants, including 53 males (58.9%) and 37 females (41.1%), treated with NCPAP were evaluated in this study. None of the participants showed signs of physiological distress during the research. Most infants were null per os (NPO) (92.2%) and not exposed to phototherapy (68.9%). The majority of them were discharged with no NCPAP complications. The mothers had a mean age of 27.9 (5.8) years with an education level of 9.7 (4.37) years. While 73.3% of the mothers underwent cesarean section, the most common causes of labor included premature rupture of the membrane, preeclampsia, bleeding, and multiple pregnancies. The 3 groups were homogenous in demographic characteristics, gender, and gestational age ($p > 0.05$) (Table 1).

Statistical analyses showed a significant difference between oxygen saturation on the first and second days of measurement. However, the difference was no longer significant on the third day. Moreover, on the first day, oxygen saturation was significantly more in the sunflower oil group compared to the control group ($p = 0.03$). It was also higher than that of the coconut oil group on the second day ($p = 0.02$).

In general, significant differences were detected between the 3 studied groups during the 3-day course of study ($p < 0.01$). To be more precise, the sunflower massage and control groups and also the sunflower massage and coconut massage groups had significant differences. In other words, oxygen saturation in the sunflower group was more than the other 2 groups. Although oxygen saturation in the coconut oil group was a little less than the control group, the values were all within the normal range (Table 2).

Table 1. Comparison of demographic characteristics of the sunflower oil and coconut oil massage groups and the control group

	Sunflower oil N=30	**Coconut oil** N=30	**Control** N=30	**p**
Gender				
Female	11	14	12	0.72
Male	19	16	18	
Birth weight (g)				
Mean (SD)	1569.33 (295.24)	1519 (313.19)	1559.33 (360.91)	0.81
Min-Max	1040-2000	1020-2000	1010-2000	
Gestational age (weeks)				
Mean (SD)	30.80 (1.30)	30.13 (1.41)	30.2 (1.52)	0.13
28 weeks (n)	2	6	7	
29 weeks (n)	3	2	2	
30 weeks (n)	7	11	7	
31 weeks (n)	5	4	6	
32 weeks (n)	13	7	8	

Table 2. Comparison of the mean (SD) oxygen saturation levels of premature neonates treated with nasal continuous positive airway pressure in sunflower oil and coconut oil massage groups and the control group

		Control	Sunflower oil	Coconut oil	Test results
First day	5 min before intervention	96.87 (2.97)	97.6 (2.19)	97.47 (2.62)	F (2, 87) = 0.67, p = 0.51
	The 5th min of intervention	97.13 (2.92)	97.6 (1.67)	94.5 (16.12)	F (2, 87) = 0.93, p = 0.40
	The 10th min of intervention	97.33 (2.66)	97.53 (2.1)	96.93(2.56)	F (2, 87) = 0.47, p = 0.62
	The 15th min of intervention	96.67 (2.71)	97.67 (1.97)	97.3 (1.88)	F (2, 87) = 1.56, p = 0.21
	5 min after intervention	96.77 (2.71)	97.93 (2.03)	97.57 (1.96)	F (2, 87) = 2.09, p = 0.13
	Total mean of the first day	96.95 (2.77)	97.67 (1.98)*	96.75 (7.48)	-------
	Test results	F (4, 60) = 0.31, p = 0.87	F (4,54) = 0.18, p= 0.94	F (4, 49) = 0.54, p= 0.70	F (2, 362) = 3.53, p = 0.03
Second day	5 min before intervention	97 (2.46)	97.4 (2.43)	96.37 (2.72)	F (2, 87) = 1.26, p = 0.28
	The 5th min of intervention	97.23 (2.18)	96.93 (2.39)	96.63 (2.33)	F (2, 87) = 0.51, p = 0.60
	The 10th min of intervention	97.43 (2.31)	98 (2.35)	96.5 (2.7)	F (2, 87) = 2.84, p = 0.06
	The 15th min of intervention	97.3 (2.41)	97.87 (1.7)	96.93 (2.23)	F (2, 87) = 1.46, p = 0. 23
	5 min after intervention	97.07 (2.9)	97.6 (1.61)	97.5 (2.35)	F (2, 87) = 0.44, p = 0.64
	Total mean of the second day	97.21 (2.44)	97.56 (2.13)	96.79 (2.47)¥	-------
	Test results	F (4, 52) = 0.15, p = 0.96	F (4, 59) = 1.04, p = 0.39	F (4, 61) = 1.01, p = 0.40	F (2, 440) = 3.96, p = 0.02
Third day	5 min before intervention	97.83 (2.32)	95.88 (2.42)	95.93 (2.13)	F (2, 25) = 1.72, p = 0.19
	The 5th min of intervention	97.33 (3.08)	97.25 (1.67)	96.07 (2.79)	F (2, 25) = 0.77, p = 0.47
	The 10th min of intervention	97.5 (2.26)	97 (1.69)	96.93 (1.73)	F (2, 25) = 0.21, p = 0.81
	The 15th min of intervention	96.33 (3.33)	97.75 (1.67)	96.64 (2.31)	F (2, 25) = 0.75, p = 0.48
	5 min after intervention	96.83 (2.23)	97.25 (1.49)	97.14 (1.88)	F (2, 25) = 0.09, p = 0.91
	Total mean of the third day	97.17 (2.55)	96.03 (1.83)	96.54 (2.18)	-------
	Test results	F (4, 11) = 0.28, p = 0.88	F (4, 14) = 0.85, P= 0.51	F (4, 26) = 0.89, p = 0.48	F (2, 126) = 0.8, p = 0.45
Total	Mean of total	97.09 (2.6)	97.54 (2.04)*	96.73 (5.1)¥	-------
	Test results	F (2, 58) = 0.45, p = 0.63	F (2, 82) = 1.28, p = 0.28	F (2, 149) = 2.79, p = 0.06	F (2, 913) = 5.92, p = 0.00

* Difference between sunflower oil and control groups was statistically significant at 3 days ($p < 0.05$).

¥ Difference between coconut oil and sunflower oil groups was statistically significant at 3 days ($p < 0.05$)

Table 3. Comparison of the mean (SD) fraction of inspired oxygen (FiO2) in sunflower oil and coconut oil massage groups and the control group days

Group	Control	Sunflower oil	Coconut oil	Test results
FiO_2	26.22 (6.95)	26.68 (7.48)¥	28.29 (8.79)#	F (2, 926) = 6.56, p < 0.01

Difference between coconut oil and control groups was statistically significant at 3 days ($p < 0.05$)
¥ Difference between coconut oil and sunflower oil groups was statistically significant at 3 days ($p < 0.05$)

Massage did not affect FiO_2. During the 3 days of intervention, there was no need for increased levels of FiO_2 in infants in the massage therapy groups (Table 3). Comparison of the groups during the 3 days of the intervention showed significant differences in RR ($p < 0.01$) between the coconut oil and control groups and sunflower and control groups. RR was lower in the 2 intervention groups in comparison to the control group (Table 4).

Discussion

The results of the present survey confirmed the effectiveness of modified Weiss technique on oxygen saturation of infants with RDS treated with NCPAP. According to our findings, oxygen saturation of the participants in sunflower oil group was more than the control and coconut oil groups. Significant differences in oxygen saturation were found between the 3 groups. Similarly, Livingstone et al. assessed the effects of touch and massage on medically fragile infants. They evaluated premature infants in NICUs of Los Angles (7 in control group and 5 in massage therapy groups) and reported oxygen saturation of the infants to remain within the safe limits during the massage sessions.[18] Findings of the present study were also consistent with a survey conducted by Bostani-Khalesi et al. who performed a field study on 25 premature infants with RDS (in Alzahra Hospital, Rasht, Iran) to investigate the effects of massage on arterial blood oxygen saturation in neonates with RDS. The gestational age of infants varied between 32 and 37 weeks. They suggested a 3-day massage therapy to be able to significantly increase oxygen saturation of infants with RDS.[17] Likewise, Basiri-Moghaddam et al. conducted a study on 20 healthy premature infants admitted to NICUs of hospitals in Mashhad (Iran). They reported that using massage techniques can affect physiological response of this group of patients. Differences in oxygen saturation were significant between treatment and control groups ($p < 0.01$).[23] Baghcheghi et al. performed a similar study on 37 newborns with RDS admitted to NICUs of hospitals in Tehran (Iran) and indicated a positive significant relation between touching an infant and increased oxygen saturation.[16] The results of the present study were also consistent with those of a field study by Lee on 26 Korean premature infants which showed a significant difference in oxygen saturation before and after massage therapy ($p < 0.01$). In fact, arterial blood oxygen was elevated after massage.[24] Massaging the skin would undoubtedly cause catecholamine to be released. In addition, epinephrine affects beta-adrenergic receptors in the air ways and increases their diameter with no significant change in RR which in turn leads to increased alveolar ventilation. As a result, more oxygen enters the lungs and oxygen transportation is increased. This process finally leads to an improvement in mean oxygen saturation.[25]

In contrast, Harrison et al. evaluated the effects of a gentle touch (10 minutes, 3 times daily for 10 days) provided to 84 premature infants (aged 6-9 days) in 3 NICU levels in hospitals in southwest Alabama. They suggested that massage therapy may only slightly decrease oxygen saturation.[22] This inconsistency between our study and that of Harrison et al. could have been resulted from differences in touch frequency, the age of subjects and the clinical conditions.

The present study showed significant differences in RR between the 3 groups after 3 days of massage ($p < 0.01$). Similarly,

Table 4. Comparison of the mean (SD) respiratory rate (RR) of premature infants treated with nasal continuous positive airway pressure in sunflower oil and coconut oil groups and the control group

		Control	Sunflower oil	Coconut oil	Test results
First Day	5 min before intervention	59 (12.25)	55 (14.1)	57.57 (14.59)	F (2, 87) = 0.66, p = 0.52
	The 5th min of intervention	56.57 (14.97)	48.4 (14.07)	49.97 (9.27)	F (2, 87) = 3.33, p = 0.04
	The 10th min of intervention	56.7 (15.47)	48.07 (10.07)	52.27(12.37)	F (2, 87) = 3.4, p = 0.03
	The 15th min of intervention	58.7 (13.7)	51.6 (12.72)	54.17 (13.54)	F (2, 87) = 2.18, p = 0.11
	5 min after intervention	58.57 (14.9)	50.3 (12.59)	53.8 (11.28)	F (2, 87) = 3.05, p = 0.05
	Total mean of the first day	57.91 (14.15)	50.67 (12.87)*	53.55 (12.44)#	-------
	Test results	F (4, 56) = 0.2, p = 0.93	F (4, 57)= 1.42, p = 0.24	F(4, 57)= 1.65, p = 0.17	F (2, 445) = 11.84, p < 0.01
Second Day	5 min before intervention	55.87 (13.09)	55.33 (11.93)	54.5 (11.57)	F (2, 87) = 0.1, p = 0.90
	The 5th min of intervention	55.43 (10.97)	48.67 (8.1)	50.63 (9.25)	F (2, 87) = 4.02, p = 0.02
	The 10th min of intervention	57.57 (13.09)	48.87 (9.74)	49.4 (11.74)	F (2, 87) = 5.3, p < 0.01
	The 15th min of intervention	52.73 (11.31)	49.27 (9.86)	51.43 (11.18)	F (2, 87) = 0.79, p = 0. 45
	5 min after intervention	56.67 (12.62)	47.87 (9.34)	48.83 (12.21)	F (2, 87) = 5.3, p < 0.01
	Total mean of the second day	55.65 (12.19)	50 (10.11)*	50.96 (11.26)#	-------
	Test results	F (4, 60) = 0.71, p = 0.59	F (4, 53) = 2.14, p = 0.08	F (4, 53) = 1.09, p = 0.37	F (2, 429) = 11.96, p < 0.01
Third Day	5 min before intervention	54.83 (10.53)	57.63 (15.05)	55.5 (10.65)	F (2, 25) = 0.11, p = 0.89
	The 5th min of intervention	57.5 (11.88)	48.38 (9.64)	50.86 (7.91)	F (2, 25) = 1.73, p = 0.19
	The 10th min of intervention	55.33 (10.71)	49.75 (10.29)	53.21 (11.24)	F (2, 25) = 0.49, p = 0.62
	The 15th min of intervention	54.17 (10.68)	48.63 (11.19)	55.36 (8.99)	F (2, 25) = 1.19, p = 0.32
	5 min after intervention	58.17 (11.51)	50. 5 (13.16)	50.86 (7.88)	F (2, 25) = 1.22, p = 0.31
	Total mean of the third day	56 (10.41)	50.98 (11.91)	53.16 (9.39)	-------
	Test results	F (4, 9) = 0.14, p = 0.96	F (4, 12)= 0.6, p = 0.66	F (4, 28) = 0.94, p = 0.45	F(2, 132) = 2.71, p = 0.07
Total	Mean of total	56.71 (12.99)	50.41 (11.58)*	52.43 (11.47)#	-------
	Test results	F (2, 67) = 1.49, p = 0.23	F (2, 76) = 0.26, p = 0.77	F (2, 164) = 1.31, p = 0.27	F (2, 960) = 25.77, p < 0.01

* Difference between sunflower oil and control groups was statistically significant at 3 days (p <0.05)
# Difference between coconut oil and control groups was statistically significant at 3 days (p <0.05)

Livingstone et al.[18] and Basiri-Moghaddam et al.[23] found statistically significant differences in RR between treatment and control groups while the RRs were within normal range. However, unlike our results, Bostani-Khalesi et al.[17] and Harrison et al.[22] reported no significant differences in RR before and after the intervention. This might be due to diversity of medical conditions and using field technique. In addition, although we observed a significant difference in FiO_2 between the 3 groups after 3 days of massage ($p < 0.01$), no article was found in this category.

Generally, it can be concluded that using sunflower oil is more effective than the other two methods. Sunflower oil can thus be recommended as the preferred lubricant for therapeutic massage of premature infants treated with NCPAP. A limitation of this study was not performing the measurements on certain hours of the day which might have affected RR and oxygen saturation. Considering the short period of the present research, longitudinal studies with long-term follow-up are required to approve the safety of massage therapy. Furthermore, due to the importance of developmental care and the role of nurses as effective members of health care teams and considering the low cost and positive impact of massage therapy on development of infants, it is suggested to include therapeutic massage in executive instructions of nursing health care. Providing mothers with massage therapy training should also be integrated in our educational agenda. It is also recommended to perform similar studies with larger sample size in which therapeutic massage is given with or without whispering by parents. Oxygen saturation remained within the normal range while RR decreased and no exacerbation of symptoms in physiological distress was noted during or after therapeutic massage. It can hence be concluded that this type of massage is suitable for stress reduction and can be helpful in development care of infants with RDS treated with NCPAP. Therefore, massage therapy can be regularly performed by moving the baby gently and massaging it by a trained person. A massage therapy program needs to be withdrawn in case of signs of physiological distress and considering the individual responses of infants.

Conclusion

Modified Weiss massage therapy for infants treated with NCPAP is a safe tool to improve their development. It can reduce FiO_2 and RR. Therapeutic massage with sunflower oil will have better results than coconut oil.

Ethical issues

None to be declared.

Conflict of interest

The authors declare no conflict of interest in this study.

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