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THE EFFECTS OF USING HAT ON PHOTOTHERAPY-INDUCED HYPOCALCEMIA IN PRETERM ICTERIC INFANTS

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ABSTRACT

The most common method for reducing serum bilirubin level in the term infants is phototherapy and this method will cause some complications such as hypocalcemia. The present study aimed to investigate the effects of covering the head on phototherapy-induced hypocalcemia in preterm icteric infants in Vali-e Asr (AS) Hospital in 2015.
Material and Methods: This study was performed as randomized, double-blind clinical trial study. 60 preterm infants receiving phototherapy in Vali-e Asr (AS) Hospital in 2015 were randomly selected and assigned into two experimental (n=30) and control (n=30) groups. The infants of control group were routinely received phototherapy and the infants of experimental group were received phototherapy after wearing a hat which covers the infant's oxy-pot. Calcium and serum bilirubin were checked upon admission, 48 hours after starting phototherapy and 24 hours after cessation of phototherapy. The data was analyzed using SPSS software and t-test at significance level 0f 0.05.
Results: 48 hours after starting phototherapy, the mean level of calcium in the experimental group was higher compared to the control group and 24 hours after cessation of phototherapy, the mean level of calcium in the control group was higher compared to the experimental group because of intravenous calcium intake ($p<0.05$). In other words, 48 hours after starting phototherapy, the incidence of hypocalcemia in infants receiving phototherapy after wearing a hat was significantly less compared to the infants receiving phototherapy routinely. Conclusion: in the present study, covering the baby's head with a hat can prevent phototherapy-induced hypocalcemia as well as calcium intake required to treat it.

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Introduction

One of the disorders that some infants suffer from it and in recent decades, it has been spread quickly, is neonatal jaundice [1]. The causes of jaundice in newborns are increased production of indirect hyperbilirubinemia and liver failure in removing them from the plasma and as its result, the level of indirect bilirubin rises in the blood and over the time, it affects different body systems including the brain and causes bilirubin encephalopathy [2]. If severe neonatal hyperbilirubinemia is not treated early, it is highly neurotoxic and will cause kernicterus, mental retardation and death [3]. Today, conventional phototherapy devices with white, blue, blue-green lamps, fluorescents and halogens have been manufactured to treat jaundice [4, 5, 6]. In many studies the effects of phototherapy on calcium levels in preterm and full-term infants have been shown [7, 8]. Hypocalcemia in babies is associated with many complications including irritability, restlessness, tetany, weakness, tingling, laryngeal spasm, lethargy, poor feeding, vomiting, apnea, poor performance cardiovascular, convulsions, muscle cramps, physical disability and mental retardation [9].

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Materials and Method

This study was performed as randomized, double-blind clinical trial study. 60 preterm infants with a diagnosis of icterus, gestational age less than 37 weeks and the weight less than 2500g admitted in NICU ward of Vali-e Asr (AS) Hospital in Birjand in 2015 were selected by convenience sampling method. Inclusion criteria were: gestational age less than 37 weeks, birth weight less than 2500 g, being healthy on physical examination, mothers' tendencies to participate in the study. If the infant was affected by following items, he/she was excluded from the study: asphyxia, respiratory distress, sepsis, hemolytic anemia, congenital abnormalities, hypocalcemia before phototherapy, systemic infections, blood disorders, positive Coombs test, Apgar score was below 7, infants with parenteral nutrition, the babies were under blood transfusions and infants of mothers who affected by diabetes, thyroid disorders, high blood pressure and those who used anti-seizure drug.

After taking a permission from the authorities of the hospital and referring to NICU ward, the infants were selected according to inclusion criteria and after getting informed consent from their parents, they were studied. Age, weight, gender and bilirubin level were recorded in information form. They were assigned into two experimental (n=30) and control (n=30) groups. The infants of control group were routinely received phototherapy and the infants of experimental group were received phototherapy after wearing a white knitted hat which covers the infant's oxy-pot. In both experimental and control groups, in order to prevent possible damage to the gonads and the cornea of the eye, genital area and eyes were covered. Calcium and serum bilirubin were checked upon admission, 48 hours after starting phototherapy and 24 hours after cessation of phototherapy. Calcium and serum bilirubin of infants' blood samples were measured using Prestige24 Human 200 kit and photometry method.

Blood samples were gathered only in the morning and preferably by a research assistant. Blood samples were collected as clot and approximately 2 hours after feeding and pouring them in petri dishes containing oxalate, citrate and edta was refused due to complex formation of these materials with calcium. In order to prevent damage to blood cells and false increase in calcium level, the samples were poured in petri dishes very slowly. The maximum time for blood storage was one hour and in order to avoid false increase in calcium levels, the samples were immediately sent to a laboratory and examined there by a technician. The calcium level less than or equal to 7.5 mg / dl was considered as hypocalcemia [7]. All the infants were placed under phototherapy with blue light with a wavelength of 470-410 nm and at a distance of 40-30 cm from the body surface using eight-40watt lamp phototherapy device. The data was analyzed using SPSS software and t-test at significance level 0f 0.05.

Results

The results of the present study showed that before intervention, there are no significant differences between the experimental and control groups in gestational age, age at the time of phototherapy, weight, duration of phototherapy, the mean levels of bilirubin and calcium (Table 1).

Table 1. The Demographic characteristics of newborns with hyperbilirubinemia in the intervention and control groups before intervention

Demographic characteristics	Control group		Experimental group		p-value
	Mean	Standard deviation	Mean	Standard deviation	
gestational age (weeks)	30.83	2.93	30.86	3.14	0.97
age at the time of phototherapy (days)	3	0.52	3.53	3.34	0.39
Weight (g)	1525	444.66	1485.5	429.39	0.73
Duration of phototherapy (day)	3.7	2.03	3.1	0.40	0.12
Mean bilirubin level	10.67	1.75	11.27	2.93	0.34
Mean calcium level	7.83	1.25	7.87	1.19	0.891

The results of t-test presented in (Table 2) show that 48 hours after starting the phototherapy, there is a statistical significant difference between the two control and experimental groups and calcium level of the control group reduced compared to the time of before treatment. 24 hours after cessation of phototherapy, there is a statistical significant difference between the two control and experimental groups due to intravenous calcium intake in the control group. Since calcium level became normal in the both groups, there is no need to calcium injection and treatment is stopped.

Table 2. The Comparison of the mean calcium levels before intervention, 48 hours after starting the phototherapy and 24 hours after cessation of phototherapy in the both control and experimental groups

Variable	Experimental	Control	p-value
	mean±standard deviation	mean±standard deviation	
Before intervention	7.87±1.19	7.83±1.25	0.89
48 hours after starting the phototherapy	8.95±1.12	7.04±1.29	>0.001
24 hours after cessation of phototherapy	8.94±0.99	9.62±1.29	0.03

The results of t-test presented in (Table 3) show that 48 hours after starting the phototherapy, there is no statistical significant difference between the two control and experimental groups in calcium level and total dosage of calcium intake and frequency of infants receiving calcium in the control group were greater compared to the experimental group.

Table 3. The Comparison of the mean dosage of calcium intake in the both control and experimental groups 48 hours after starting the phototherapy

	Calcium					
Group	Frequency	Percentage of frequency	Total dosage	Mean	Standard deviation	p-value
Control	16	53.3	58.90	3.68	1.57	0.279
Experimental	2	6	10	5	1.41	

The results of chi-square test presented in (Table 4) show that according to descriptive statistics, 48 hours after starting the phototherapy, there is statistical significant difference between the two control and experimental groups in frequency and incidence of hypocalcemia (p=0.000).

Table 4. The comparison of the frequency and percentage of calcium in the both control and experimental groups 48 hours after starting the phototherapy

Calcium amount	Experimental		Control		p-value
	N	Percentage	N	Percentage	0.001
Calcium value≥7.5	27	90%	12	40%	
Calcium value<7.5	3	10%	18	60%	
Total	30	100%	30	100%	

The results of chi-square test presented in (Table 5) show that according to descriptive statistics, 24 hours after cessation of the phototherapy, there is no statistical significant difference between the two control and experimental groups in frequency and incidence of hypocalcemia (p=0.554).

Table 5. The comparison of the frequency and percentage of calcium in the both control and experimental groups 24 hours after cessation of the phototherapy

Calcium amount	Experimental		Control		p-value
	N	Percentage	N	Percentage	0.554
Calcium value≥7.5	30	100%	29	96.6%	
Calcium value<7.5	0	0%	1	3.3%	
Total	30	100%	30	100%	

Discussion and Conclusion

60 infants with hyperbilirubinemia were studied in the present study, average indirect bilirubin levels in experimental and control groups were 11.27±2.93 and 10.54±1.92 mg/dl, respectively, so no significant difference was observed between them (p=0.26). 48 hours after starting the phototherapy, average calcium levels in experimental and control groups were 8.95±1.12 and 4.7±1.29 mg/dl, respectively, so, 48 hours after starting the phototherapy average calcium level in experimental group was significantly higher compared to the control group (p<0.001). Kargar et al. (2011) have conducted a study on 72 infants with similar criteria such as demographic data and laboratory information. Average indirect bilirubin levels in experimental and control groups were 14.66±2.69 and 13.5±2.32 mg/dl, respectively and this reflects the similarity in the average level of bilirubin before the intervention. In their study, the calcium levels in experimental and control groups were reported 8.93±0.98 and 8.81±1.7 mg/dl, respectively, so, no significant difference was observed between them before intervention. Also, 48 hours after starting the phototherapy, average calcium levels in experimental and control groups were 9.1±1.16 and 8.13±1.35 mg/dl, respectively, so, the calcium level in the control group decreased and there was significant difference between the two groups (p=0.001). In a study by Ehsanipour et al. (2006), Average calcium levels in experimental and control groups were reported 8.41 and 8.36 mg/dl, respectively and no significant difference was observed between them before intervention [10]. The results of their study were not consistent with the results of the present study in demographic data and laboratory information because the studied population was preterm. In their study, 48 hours after starting the phototherapy, average calcium levels in experimental and control groups were 8.34 and 7.81 mg/dl, respectively, so, they concluded that 48 hours after starting the phototherapy, average calcium level in control group significantly decreased (p=0.001).

The results of the present study showed that 24 hours after cessation of the phototherapy, average calcium levels in experimental and control groups were 8.94 and 6.92 mg/dl, respectively, so, it can be concluded that 24 hours after cessation of the phototherapy, there was a statistical significant difference between the experimental and control groups (p=0.03). In fact, this indicates that not only the changed level of calcium in the control group was corrected after cessation of phototherapy but also, its level was higher compared to the experimental group due to intravenous calcium intake. In a study by Nezami Qeshmi et al. (2012), average calcium level was normal (9.80±0.61 mg/dl) after stopping phototherapy [11]. Also, in a study by Kargar et al. (2011), in the experimental group, calcium level after intervention was nearly same as that befor intervention and it was 8.89 mg/dl in control group. This shows that calcium level was corrected after stopping the phototherapy [2]. In a study by Ehsanipour et al., calcium level became normal after stopping the phototherapy [10]. In this study, after stopping the phototherapy, calcium level in the control group increased significantly (from 7.04 to 9.62 mg/dl) but in the experimental group (who used hats), it didn’t change significantly (from 8.95 to 8.94). The results of their study were consistent with the results of present study. Since in the present study, the population included preterm infants, the calcium levels in the both groups were lower compared to the results of their study.

In the studies on the effects of phototherapy on the calcium level by Kargar et al. (2011), Karamifar et al. (2002) and Ehsanipour et al. (2006), they reported that infants with hypocalcemia had no clinical symptoms of hypocalcemia and weren’t treated through calcium intake [2, 7,10]. In these studies, the infants were only under medical control and there was no need to calcium injection and the reason to this difference is that preterm infants are more sensitive and vulnerable compared to term infants. However, if hypocalcemia is observed in neonatal tests, it must be controlled even if no symptoms are observed and the treatment is started under medical order because if there is no symptoms, hypocalcemia may not be controlled and treated. If it is not treated, it can be cause of many neonatal problems and long-term complications such as mental retardation, academic failure and physical disability.

The results of the present study showed that the incidence of phototherapy-induced hypocalcemia in the experimental group was significantly less compared to the control group (p=0.000). The pathogenesis of phototherapy-induced hypocalcemia can be known as reduced melatonin in the pineal gland repression followed by inhibition of the corticosterone synthesis and increased calcium absorption by the bones [2, 7]. According to the results of the present study, covering the baby's head with a hat can prevent reduction in melatonin and as its result, phototherapy-induced hypocalcemia.

In a study by Nezami Gheshmi et al. (2012) reported that the probability of the incidence of hypocalcemia was 9%. The results showed that there was no significant in the two groups in the incidence of hypocalcemia (p=0.217) [11]. This result is not consistent with the result of the present study. This difference may be due to the number of lamps used in phototherapy. In a study by Karamifar et al. (2002), 22% of preterm infants and 8.7% of term infants were affected by phototherapy-induced hypocalcemia and their calcium levels became natural [7]. The results of mentioned studies are consistent with the results of the present study and in them, there is no difference between the two groups in the incidence hypocalcemia. In the present study on preterm infants, there is a significant difference between the two groups in the incidence of hypocalcemia. The use of a light-colored hat covering oxy-pot area can prevent phototherapy-induced hypocalcemia in the experimental group by preventing the light. The use of a hat covering oxy-pot area can prevent hypocalcemia and also, long-term complications such as mental retardation, physical disability and academic failure [12]. Although the reduction of calcium levels in newborns should be treated with calcium intake, there are complications such as bradycardia and dysrhythmia as the impacts of treatment and calcium injection causes complications such as necrosis and calcification of injection area [13]. According to the results of the present study, covering the head with hat can prevent the reduction of melatonin and as its result, hypocalcemia.

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