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RESEARCH ARTICLE

EFFECT OF HEAD COVERING ON PHOTOTHERAPY INDUCED HYPOCALCEMIA IN JAUNDICED NEONATES WITH GESTATIONAL AGE MORE THAN 35 WEEKS

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ABSTRACT

Background: Phototherapy is a commonly used treatment for neonatal hyperbilirubinemia. Hypocalcemia is a known adverse effect of phototherapy. We conducted this study to measure the efficacy and safety of head covering in prevention of phototherapy-induced hypocalcemia.
Material and Methods: A total 210 newborns of >35week gestation with neonatal jaundice were included in the study. They were randomized into two equal groups- group A underwent phototherapy without any head cover while the heads of newborns in group B was covered with a cap. In both the groups, ionized serum calcium was measured at the start of phototherapy and at 48 hours.
Results: The mean decline in ionized serum calcium in group A was 0.63mg/dl while in group B it was 0.34mg/dl. The incidence of hypocalcemia in the group A without head covering was 27.6 % (29 cases) while in group B with head cover was 10.5 % (11 cases).
Conclusion: Phototherapy can cause hypocalcemia in a significant proportion of newborns. Monitoring of serum calcium during phototherapy is desirable to detect hypocalcemia. Use of a head cover during phototherapy appears to be a safe and effective intervention for prevention of phototherapy-induced hypocalcemia.

INTRODUCTION

Hyperbilirubinemia is a common and in most cases benign problem in neonates. It is the most common abnormal physical finding in the first week of life and is observed in approximately 60% of term neonates and 80% of preterm neonates (Kliegman *et al*., 2016).Bilirubin encephalopathy is a devastating brain injury, which can cause permanent neurodevelopmental handicaps (Maayan-Metzger *et al*., 2001). Fortunately, a non-invasive and easily available treatment, neonatal phototherapy is effective in degrading unconjugated bilirubin. Phototherapy decreases the serum bilirubin level by transforming bilirubin into water-soluble isomers that can be eliminated without conjugation in the liver (Stokowski, 2006). However, phototherapy may itself result in the development of some complications. Among these are loose stools, erythematous macular rash, overheating, dehydration, damage to DNA, retinal injury, hypocalcemia and a benign condition called bronze baby syndrome in cholestasis (Cloherty JP *et al*, 2012). Neonatal Hypocalcemia is defined as total serum calcium of less than 7 mg/dl or ionized calcium less than 4 mg/dl (Cloherty *et al*., 2012). It usually manifests as increased extensor tone, clonus, hyperreflexia apnea, seizures, jitteriness and stridor (laryngospasm) (Oden *et al*., 2000).

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It was found that only a few hypocalcemic neonates present clinically, and in almost all hypocalcemic neonates serum level of calcium return to normal, after 24 hrs of ending phototherapy (Oden, 2010). The association between phototherapy and hyocalcemia was first noticed by Romagnoli *et al* (Romagnoli C *et al*, 1979). There are few other studies which state that phototherapy leads to hypocalcemia (Sethi *et al*., 1993). It has been hypothesized that phototherapy inhibits pineal secretion of melatonin, which blocks the effect of cortisol on bone calcium. Therefore, cortisol increases bone uptake of calcium and induces hypocalcemia. Phototherapy leads to inhibition of pineal gland via transcranial illumination, resulting in a decline in melatonin level and, as a result, hypocalcemia develops (Hakanson *et al*., 1981). Other causes suggested for this hypocalcemia include a decreased secretion of parathormone and a higher urinary excretion of calcium in the phototherapy group (Hooman *et al*., 2005). There is some evidence that the use of a stockinet cap to cover the head prevents phototherapy-induced hypocalcemia (Whaley L *et al*, 2004). This study was conducted to determine whether the head covering during phototherapy is an appropriate and safe method for preventing phototherapy-induced hypocalcaemia in neonates.

MATERIALS AND METHODS

The present study was conducted in department of pediatrics, Mata Chanan Devi Hospital, Janakpuri, New Delhi over a period from January 2016 to December 2016.

The study was planned to measure the primary outcome of phototherapy induced hypocalcemia with 80% power and an error of less than 5%. The sample size thus calculated using the following formula: $n = 2(Z\alpha+Z1-\beta)^2 (\sigma)^2/(\Delta^2)$was 98 per group. Considering an attrition rate of 5%, 105 neonates were enrolled in each group. Only healthy neonates with a gestational age of >35 weeks with unconjugated hyperbilirubinemia were included. The neonates who developed jaundice within 24 hours of birth, neonates with Rh or ABO incompatibilities, hypothyroidism, sepsis, G6PD deficiency or birth asphyxia were excluded. The newborns were divided into two equal groups by using Computer generated randomization in blocks of 4. In the Group A there were 105 neonate underwent phototherapy without any caps for covering their head while in group B there were another 105 infants with caps that covered their heads during phototherapy. For neonates in both the groups phototherapy was started on the basis of cut off values of total serum bilirubin from American Academy of Pediatrics guideline charts. A conventional phototherapy equipment, containing four blue light fluorescent lamps with wavelengths of 410–470 nm,was placed at a distance of 30–40 cm from the skin surface of neonates. The irradiance during phototherapy was measured and maintained consistently between the two groups.

The demographic and clinical variables were recorded on a predesigned proforma. It included birth weight, sex, gestational age, duration of phototherapy, age in hours at the start of phototherapy, maternal blood group and Rh status, baby's blood group and Rh status and family history of jaundice. Total serum bilirubin was measured at the start of phototherapy, at 24 hours, 48 hours and then at the end of phototherapy. Serum ionized calcium level was measured at the start of phototherapy and after completion of 48 hours of phototherapy. Ionized calcium level of < 4 mg/dL is considered to be hypocalcemia (Abrams *et al*., 2012)

OBSERVATIONS AND RESULTS

In group A out of 105 neonates, 52 (49.5 %) were male and 53 (50.5 %) were females, and in group B 54 (51.4 %) were male and 51 (48.6 %) were females. The mean gestational age for group A and group B was 268.6 days (38.4weeks) and 272.2 days (38.9 weeks) respectively. The mean birth weight for group A was 2880.8 g and for group B was 2902.8 g. The differences in both gestational age and birth weight were not statistically significant.

The mean age of newborns at the time of start of phototherapy in group A was 119.13 hours and in group B was 118.14 hours. The mean total serum bilirubin at the start of phototherapy was 20.51 mg/dl in group A and 20.69 mg/dl in group B. There was no significant difference between the two groups with respect to total serum bilirubin levels at the start of phototherapy. The mean serum ionic calcium of both groups at the start of phototherapy and at 48 hour is shown in Table 1 The mean decline in serum calcium in group A was 0.63 mg/dl and in group B was 0.34 mg/dl. This difference was statistically significant (p value<0.001) by using unpaired t-test (table 2). The incidence of hypocalcemia defined as a serum ionic calcium of less than 4 mg/dl, was 27.6% (29 cases) in the group A without head cover and it was 10.5% (11 cases) in group B with the head cover (p=0.0025)(Fig 1). In the group A without head cover, out of a total of 29 cases of hypocalcemia 7 newborns (24.1%) developed symptomatic hypocalcemia. The major symptom in 5 of them was jitteriness while the other 2 had hypocalcemic seizure. In group B out of 11 cases of hypocalcemia, 3 developed jitteriness but none had seizure. The mean duration of phototherapy in group A was 1.83 hours less than that in group B. In study group A 2 newborns developed hyperthermia while in group B 5 babies had hyperthermia. Septic screen was negative in all newborns with hyperthermia from both the groups.

DISCUSSION

The current study was done to measure the effect of head covering in prevention of phototherapy induced hypocalcemia in neonates with gestational age >35 weeks. The base line characteristics including gestational age, age at start of phototherapy, birth weight, sex, serum bilirubin at the start of phototherapy were similar between the two study groups. The mean decline in ionized serum calcium in group A was 0.63 mg/dl while in group B it was 0.34mg/dl. The difference was statistically significant. The association between phototherapy and hyocalcemia was first reported in preterm neonates by Romagnoli *et al* (Romagnoli *et al*., 1979). In another study done by Sethi, Saili, and Dutta has found that ninety per cent preterm neonates and seventy-five per cent term neonates developed hypocalcemia after being subjected to phototherapy (Sethi *et al*., 1993). In our study the incidence of hypocalcemia in the group A without head covering was 27.6 % while in group B with head cover was 10.5 %. The difference when analysed with Fisher's exact test resulted in a p value of 0.0025 indicating a statistically significant result.

Table 1. Mean serum ionic calcium at 0 hrs and 48 hrs in Group A and Group B (mg/dl)

	Mean serum ionic calcium at 0 hrs of PT	Mean serum ionic calcium at 48 hrs of PT	Mean difference	S.D	p value
Group A (without cap)	4.72	4.09	0.63	0.42	0.001
Group B (with cap)	4.67	4.33	0.34	0.26	0.001

Table 2. Comparison of mean decline in serum ionic calcium between Group A and Group B

	Mean difference (mg/dl)	S.D	p value
Group A (Serum ionic Ca^{+2} at 0 hr of PT – Serum ionic Ca^{+2} at 48 hr of PT)	0.63	0.42	<0.001
Group B (Serum ionic Ca^{+2} at 0 hr of PT – Serum ionic Ca^{+2} at 48 hr of PT)	0.34	0.26	

Similar results have been obtained in many previous studies also. Bahbah MH *et al* conducted a study on "Effect of phototherapy on serum calcium level in neonatal jaundice" and reported that 26% of the neonates developed hypocalcemia (Bahbah MH *et al*, 2015). Ezzeldin *et al*. in their study "The effect of hat on phototherapy-induced hypocalcemia in jaundiced full-term neonates" at Cairo University, Giza, Egypt found that significant decrease in the incidence of neonates with hypocalcemia in Group with hat 9.7% as compared to 24.2% in Group without hat (Ezzeldin *et al*., 2015). Another study done by Jain BK *et al*, on "Phototherapy induced hypocalcemia" at department of pediatrics, Dayanand Medical College, Ludhiana, have found that 55% of preterm neonates and 30% of fullterm neonates with hyperbilirubinemia developed hypocalcemia after 48 hours of phototherapy (Jain BK *et al* 1998). In (2008) Ehsanipour F *et al* conducted a study titled "The Effect of Hat on Phototherapy-Induced Hypocalcemia in Icteric Newborns". There was a statistically significant difference between the prevalence of hypocalcemia in group A neonates who received phototherapy without hat (77.77%) and group B neonates who received phototherapy with hat (22.22%) (p= <0.001) (Ehsanipour *et al*., 2008). The mean duration of phototherapy administered in group A was 49.03 hours while in group B was 50.86 hours. The duration of phototherapy required in the group B was longer by 1.83 hours. Though this result was statistically significant with a p value of 0.0026, the absolute value of 1.83 hours does not seem to be very relevant clinically. The longer time for phototherapy required in the group B might be because the hat covered a significant surface area (8 – 10 %) of body thus reducing the effect of phototherapy.

Thus the present study is in agreement with many previous studies suggesting that phototherapy is a significant causative factor for hypocalcemia in icteric newborns and head covering by using an appropriate hat seems to reduce the incidence of this hypocalcemia significantly.

Conclusion

Treatment of hyperbilirubinemia in newborns with phototherapy can cause hypocalcemia in a significant proportion of newborns. Monitoring of serum calcium in newborns during phototherapy is important to detect hypocalcemia. Use of a head cover during phototherapy appears to be a safe and effective intervention for prevention of phototherapy induced hypocalcemia. Head covering during phototherapy can increase the duration of phototherapy required for the treatment of hyperbilirubinemia. However this needs to be confirmed by further studies. Phototherapy in general and especially if using a head cover can increase the risk of hyperthermia. Therefore all newborns undergoing phototherapy with or without head cover should be closely monitored for body temperature.

Conflict of interest: There was no conflict of interest.

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Protective head covering may prevent phototherapy-induced hypocalcemia in icteric newborns younger than 35 weeks' gestational age. [85] Concentrations of certain amino acids in total parenteral nutrition solutions subjected to phototherapy may deteriorate; thus, shield total parenteral nutrition solutions from light as much as possible. Regular maintenance of the equipment is required because accidents have been reported, including burns resulting from a failure to replace UV filters. Phototherapy is the use of visible light to treat severe jaundice in the neonatal period. Approximately 60% of term babies and 85% preterm babies will develop clinically apparent jaundice, which classically becomes visible on day 3, peaks days 5-7 and resolves by 14 days of age in a term infant and by 21 days in the preterm infant. Treatment with phototherapy is implemented in order to prevent the neurotoxic effects of high serum unconjugated bilirubin. Phototherapy is a safe, effective method for decreasing or preventing the rise of serum unconjugated bilirubin levels and reduces the need for Hypocalcemia is a known adverse effect of phototherapy. We conducted this study to measure the efficacy and safety of head covering in prevention of phototherapy-induced hypocalcemia. Material and Methods: A total 210 newborns of >35week gestation with neonatal jaundice were included in the study. They were randomized into two equal groups- group A underwent phototherapy without any head cover while the heads of newborns in group B was covered with a cap. In both the groups, ionized serum calcium was measured at the start of phototherapy and at 48 hours. Results: The mean decline in ionized