

Comparison of Electrolyte Changes in Term Neonates before and after Phototherapy

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Abstract

Background: Jaundice or hyperbilirubinemia is one of the most common problems occurring in the neonatal period. Phototherapy plays a major role in its treatment. However, this treatment modality may itself result in complications which even contribute to the development of convulsions. Hence in this study changes in serum electrolytes are evaluated in term neonates receiving phototherapy for unconjugated hyperbilirubinemia. **Aim and objective:** To estimate and compare the serum electrolytes levels in term neonates with unconjugated hyperbilirubinemia before and after phototherapy. **Method:** After getting Ethical Committee approval informed, written consent, medical history were obtained from the neonate's mother, general examination, systemic examination was carried out for 30 full-term jaundiced neonates receiving phototherapy. Laboratory tests including total serum bilirubin by Diazo method, serum calcium level by Arsenazo III method and serum electrolytes by Ion selective electrodes analyser were performed before and after 48 hours of phototherapy. Blood samples taken from the newborn babies before the commencement of phototherapy was regarded as control group. Blood samples taken 48 hours following establishment of phototherapy was regarded as study group. **Results:** Statistical analysis was done using Paired t test. There was a significant decrease in serum bilirubin after 48 hours of phototherapy. This was accompanied by a significant decrease in serum calcium levels with a p value of 0.014 in eighteen neonates (60%). None of the neonates were clinically symptomatic. There was no alteration in the values of serum bicarbonate, chloride, sodium and potassium. **Conclusion:** This study shows a decrease in serum calcium levels in term infants exposed to phototherapy. Hence serum calcium, sodium, potassium, chloride, bicarbonate along with routine measurement of serum bilirubin should be monitored regularly for neonates receiving phototherapy to prevent the development of complications.

Keywords: Jaundice, phototherapy, serum bilirubin, serum calcium, serum electrolytes, term neonates, unconjugated hyperbilirubinemia,.

Introduction

Neonatal hyperbilirubinemia has been the most common physical finding during the first week of life. It affects nearly 80% preterm and 60% term neonates. Hyperbilirubinemia in neonate is due to liver's immature excretory pathway for bilirubin.

Jaundice looks as if to proceed in a course starting from head and ending in foot, as bilirubin levels rises. When the level increases to 15 mg/dL (258 μ mol/L) it

becomes apparent upto the level of umbilicus and when the level increases to 20 mg/dL (340 μ mol/L) it becomes apparent upto the feet. In the first week of living slightly additional than 50% of all neonates become apparently jaundiced.

Based on its reason and the degree of increase hyperbilirubinemia may be safe or dangerous. No matter what may be the bilirubin level few reasons of jaundice are very hazardous. Once the level is elevated enough hyperbilirubinemia of any cause is a concern. Depending on age level of prematurity and health position the threshold for concern changes.

Unconjugated hyperbilirubinemia is a normal physiological occurrence in most of the infants. High

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values of unconjugated bilirubin could proceed towards bilirubin encephalopathy and later kernicterus through overwhelming permanent neurological development problems⁸. Hence managing neonatal hyperbilirubinemia appropriately is of utmost importance.

Neonatal hyperbilirubinemia can be managed in three means which includes:

a. Mechanical removal of bilirubin by exchange transfusion b. Conversion of bilirubin into substances which can bypass the liver's system of conjugation and their excretion either through the bile or through the urine devoid of metabolism by phototherapy³ c. Hastening the usual metabolic pathways for clearance of bilirubin or inhibition of enterohepatic circulation for bilirubin by meddling with heme degradation and synthesis of bilirubin through the action of pharmacologic substances. Subsequent to publications of **Dr. Cremer's** in the *Lancet* during **1958** paediatricians in the United Kingdom started to employ phototherapy³.

Phototherapy plays a major role in prevention and management of hyperbilirubinemia. Phototherapy was suggested by the American Academy of Paediatrics¹. A practical consideration which deals through the treatment in the healthy newborn, born at term with hyperbilirubinemia was formed during 1994 October by **the Subcommittee on Hyperbilirubinemia and Provisional Committee for Quality Improvement of the American Academy of Pediatrics (AAP)**.

During month of July in **2004**, **the American Academy of Paediatrics** published protocols which would decrease beginning of avoidable circumstances². Ultimate value of phototherapy relies on the kind of light source used (i.e. dosage, spectral release curve, deepness of infiltration), the space amidst the light and the infant, the surface area to be treated, the etiology of the jaundice and also value of total serum bilirubin at phototherapy's onset.

Phototherapy transforms bilirubin into water soluble isomers which can be excreted without conjugation in the liver. The goals of phototherapy are to prevent the already elevated total serum bilirubin level from rising, to prevent the occurrence of encephalopathy or kernicterus and to prevent the total serum bilirubin from rising to a level that requires exchange transfusion. The foremost exhibited phototherapy's value has been diminishing the need for exchange transfusion. When

the total serum bilirubin reduces less than the level at which phototherapy was started phototherapy can be safely terminated in infants who were treated⁹.

As any treatment has its side effects, phototherapy also has its adverse effects like hyperthermia, feeding intolerance, loose stools, skin rashes, bronze baby syndrome, retinal changes, dehydration, hypocalcemia, redistribution of blood flow and genotoxicity.

Numerous investigations have been carried out to establish the safety of phototherapy in the management of neonatal hyperbilirubinemia. Hypocalcemia is one of the known adverse effects. Hypocalcemia is defined as total serum calcium level less than 8mg/dl in term and less than 7mg/dl in preterm babies.

90% of preterm and 75% of fullterm neonates develop hypocalcemia after being subjected to phototherapy. Hypocalcemia can cause serious complication like irritability, jitteriness, convulsion and apnea. Therefore this study is aimed to evaluate and compare phototherapy induced changes in serum electrolyte levels in term neonates with unconjugated hyperbilirubinemia.

Aim

To estimate and compare the serum electrolytes in term neonates before and after phototherapy.

Material and Methodology

Prospective study was conducted in the Department of Paediatrics, Government Theni Medical College Hospital, in association with the Physiology Department, Government Theni Medical College, Theni. Approval was obtained from the ethical committee of Government Theni Medical College, Theni. This study was performed on 30 full-term jaundiced neonates (15 males and 15 females) receiving phototherapy. A detailed antenatal, perinatal history and examination of the neonates was done.

Control group :

It consists of blood samples of the neonates in which serum bilirubin and calcium, potassium, chloride, bicarbonate, sodium were measured before the onset of phototherapy.

Study group :

It consists of blood samples of the neonates in which serum bilirubin and calcium, potassium, chloride, bicarbonate, sodium were measured after 48 hrs of phototherapy.

- **Inclusion criteria :**

1. Cephalohematoma
2. External bruising
3. Breast feeding jaundice
4. Breast milk jaundice
5. Physiological jaundice

- **Exclusion criteria :**

1. Neonatal asphyxia.
2. Preterm infants.
3. Infants of diabetic mothers.
4. Infants undergoing exchange transfusion.
5. Hemolytic anaemia / Rh /ABO incompatibility

6. Conjugated hyperbilirubinemia.

7. Sepsis.

8. Congenital malformations.

9. Respiratory distress.

Blood investigations:

The investigations include indirect bilirubin measured by Diazo method, Serum calcium measured by Arsenazo III method, serum electrolytes measured by Ion selective electrodes analyser .

Results and Observation

The serum electrolyte changes in term neonates receiving phototherapy for jaundice was analysed before and after phototherapy using **Paired t test**. By means of **SPSS (Statistical Package for Social Sciences) software version 16**, analysis of statistics was performed.

The **statistical significance** was drawn at '**p**' value < **0.05**.

Table – I : Analytical statistics of total serum bilirubin and serum calcium before and after Phototherapy

S No	Parameters	Before phototherapy (Mean ± Standard deviation)	After phototherapy (Mean ± Standard deviation)	p value
1.	Serum bilirubin (mg/dl)	14.04 ± 0.71	8.13 ± 0.40	0.001 Significant
2.	Serum calcium (mg/dl)	9.51 ± 0.29	8.38 ± 0.31	0.014 Significant

In the table above we compare the total serum bilirubin before and after phototherapy. It was found that the mean ± SD of total serum bilirubin before phototherapy was 14.04 ± 0.71 mg / dl and after phototherapy was 8.13 ± 0.40 mg / dl. The total serum bilirubin decreased significantly after phototherapy with a p value of 0.001.

The mean±SD of serum calcium before phototherapy was 9.51 ± 0.29 mg / dl and after phototherapy it was 8.38 ± 0.31 mg / dl. Levels of serum calcium decreased significantly after phototherapy when compared to values before phototherapy with p value 0.014.

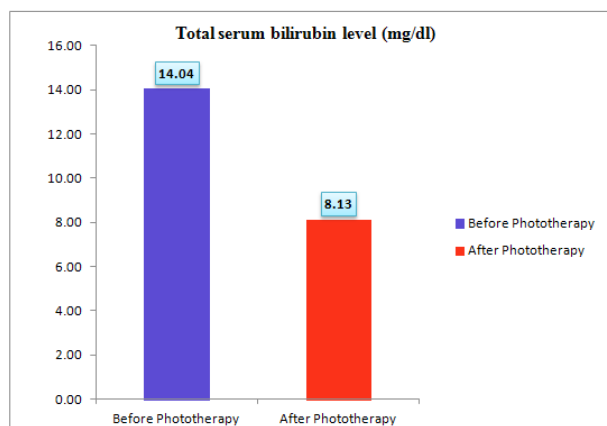


Figure-1 : The diagram above shows the decrease in total serum bilirubin after phototherapy

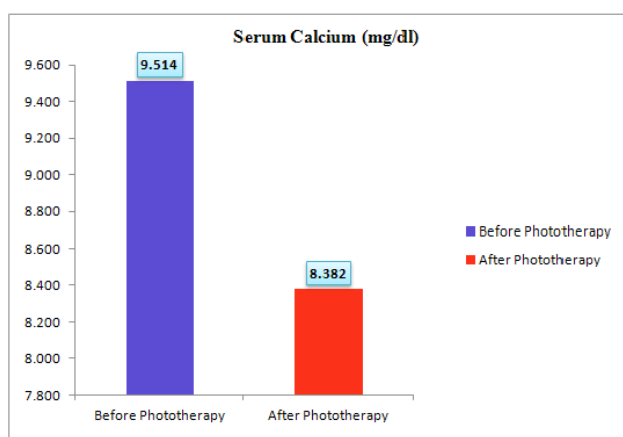


Figure – 2 : The diagram above shows the decrease in serum calcium after phototherapy

Discussion

The general atypical physical finding in the initial week of life is neonatal hyperbilirubinemia . Phototherapy has emerged as the most widely used form of treatment. In order to diminish the rigorosity of neonatal unconjugated hyperbilirubinemia this is the recent therapy of preference.

As any treatment has, phototherapy also has its side effects. Unlike other side effects a very few studies are currently available that depicts the adverse effects of phototherapy on serum electrolytes. A few studies in the recent past have stressed on the incidence of hypocalcemia following phototherapy. The differential effect of other electrolytes with phototherapy has not been studied by other workers except that for **Curtis MD et al (1989)**.

The plan of this study was intended to establish the serum electrolyte changes in neonates receiving

phototherapy for neonatal jaundice. In this present study we have estimated the serum electrolytes in 30 jaundiced term neonates before and after phototherapy. We compared the occurrence of phototherapy induced electrolyte changes in them. We excluded neonates having risk factors from this study.

Romagnoli et al in 1979 noticed the relationship in preterm newborns of phototherapy and hypocalcemia¹⁰. Likewise **Bergstrom and Hakanson** in 1981 experimented in newborn rat the same findings. **Odell and Gutcher** in 1983 suggested considerable reduction in levels of serum calcium in rats which were newborn subsequent to keeping them in fluorescent daylight.

Eghbalian et al (2008) in his study found that serum calcium levels declined considerably after neonates with hyperbilirubinemia treated with phototherapy. **Sethi et al** in 1990 proposed that after phototherapy 75% of term neonates begin to build up hypocalcaemia. In the same way **Medhat** in 2006 belonging to Cairo University suggested development of hypocalcaemia in 75% of term neonates after phototherapy.

Sourabh dutta (2001) in his study concluded that 75% of fullterm neonates with unconjugated hyperbilirubinemia developed hypocalcemia after phototherapy. A significant drop in level of calcium was observed after phototherapy among 66.6% of the term neonates which was noted by **Yadav RK and Rajesh KY** in 2011.

Taheri PA et al (2013) in his study found decrease in serum calcium level in 56% babies after 48 hours of phototherapy. **Arora S et al** (2014) in her study found hypocalcemia in 56% of term neonates after 48 hours of phototherapy.

In our study 60% of term neonates developed decrease in serum calcium levels 48 hours after phototherapy. Findings in the present study are in concurrence with the studies mentioned above.

In 1998 **Jain et al** in his study suggested among fullterm neonates with hyperbilirubinemia 30% developed hypocalcemia after 48 hours of phototherapy⁶. **Karamifar et al** (2002) in his study found that prevalence of hypocalcemia was 8.7% in fullterm neonates after 48 hours of phototherapy for hyperbilirubinemia

This study was conducted on 30 term neonates with jaundice managed with phototherapy. Serum bilirubin, potassium, chloride, bicarbonate, sodium and calcium were measured and compared before and after phototherapy. After 48 hours of phototherapy there was a **significant decrease** in serum calcium levels with **p value 0.014** in eighteen neonates (60%). None of the neonates were clinically symptomatic. There was no alteration in the values of serum bicarbonate, sodium, chloride and potassium .

Normal level of serum calcium is 9-11 mg per 100 ml. Calcium is an essential structural component of the skeleton and plays a key role in muscle contraction, blood coagulation, enzyme activity, neural excitability, secondary messengers, hormone release and membrane permeability.

In Hypocalcaemia cellular permeability to sodium ions increases and thereby increasing cell membrane excitability leading to the development of seizures, apnea, jitteriness, increased extensor tone, clonus, hyperreflexia and stridor .

Conclusion

The mechanism of hypocalcaemic effect of phototherapy was hypothesised by **Hunter and Hakinson in 2004** . There is inhibition of pineal gland secretion via transcranial illumination, resulting in decline of melatonin secretion. This blocks the effect of cortisol on bone calcium. Cortisol has a direct hypocalcaemic effect and increases bone uptake of calcium and induces hypocalcaemia⁵.

Kim (2001) in his study suggested that hypocalcaemia was caused due to a reduction in parathormone secretion in jaundiced neonates who were treated with phototherapy⁷.

In **Hooman's** study (2005) the significantly higher level of urinary calcium excretion was proposed to be the cause of hypocalcaemia in phototherapy treated jaundiced neonates⁴ .

Substantial reduction in the level serum calcium was seen in newborns with icterus which was induced by phototherapy were the observations of current study. There was no signs and symptoms suggestive of hypocalcaemia which may present like convulsions, cyanosis and apnea due to diminished calcium in the

neonates who received phototherapy.

Proper monitoring of electrolytes after phototherapy in the neonates can prevent dyselectrolytemia and its associated complications. In the newborns who were treated with phototherapy level of calcium need to be measured and should be treated accordingly. Significant decrease in calcium level was well evident in our study. Although the signs were not remarkable this decline may continue down to the threshold of hypocalcaemia development.

Hence we suggest assessment of serum calcium, sodium, potassium, chloride, bicarbonate along with routine measurement of serum bilirubin in neonates before and after phototherapy. Thus by regular monitoring and maintaining normal serum electrolyte levels we can avoid the development of neurological complications in icteric neonates receiving phototherapy.

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Conflict of Interest - Nil

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