EFFECT OF PHOTOTHERAPY ON SERUM CALCIUM LEVELS IN NEONATAL JAUNDICE IN FULL TERM NEONATES

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Abstract

Introduction: The most prevalent anomalous physical finding during the first week of life is neonatal hyperbilirubinemia (NNH). It is estimated that more than two thirds of newborn babies have acquired clinical jaundice. It was also discovered that in the unconjugated hyperbilirubinemia of most neonates represents a common or exaggerated physiological syndrome. The physical immaturity of infants to handle increased production of bilirubin is referred to as Jaundice. This becomes potentially neurotoxic if severe unconjugated hyperbilirubinemia is left untreated. One of the routine strategies for treating hyperbilirubinemia is known as phototherapy. However it is not a harmless interference. This can produce negative results, such as dehydration, temperature volatility, blood flow redistribution, genotoxicity, rashes on the skin, loose skin, stools, damage to retinas, hypocalcemia and bronze baby syndrome. One of the lesser known but which has a potential adverse effect of phototherapy is hypocalcemia. A total serum calcium concentration of < 7 mg / dl or ionised calcium concentration < 4 mg / dl (< 1 mol / L) is classified as neonatal hypocalcemia. Hypocalcemia increases the permeability of cells to sodium ions and increases the excitability of cell membranes.

Material & Methods: 60 full term neonates were included in present cross sectional study who was admitted to Neonatal Intensive Care Unit (NICU). Full term neonates who completed 37 weeks of gestation with unconjugated hyperbilirubinemia who require phototherapy. Under the normal protocol, traditional phototherapy equipment containing four blue light fluorescent lamps with wavelengths of 410-470 nm was mounted at a distance of 25-35 cm from the skin surface of neonates with entirely covered eyes and genitals. At $15\mu\text{W} / \text{cm}^2 / \text{nm}$ at the level of the infant's skin, the irradiance during phototherapy was assessed and maintained consistently.

Results: Among 60 neonates included in this study there were 27 (45%) male whereas 33 (55%) female neonates. In present study the mean levels of serum calcium before phototherapy was 9.21 with standard deviation of 0.83 while the serum calcium levels after phototherapy were 8.36 with standard deviation of 0.78. There was a statistically significant difference between serum mean calcium levels before and after phototherapy ($p=0.001$).

Conclusion: A major issue is phototherapy induced hypocalcemia. Before beginning and during phototherapy for neonatal jaundice and close monitoring of neonates for signs of hypocalcemia, careful calcium status calculation should be carried out.. After phototherapy, there is a substantial reduction in the amount of serum calcium, but the risk of hypocalcemia in stable full-term neonates is minimal.

Introduction

The most prevalent anomalous physical finding during the first week of life is neonatal hyperbilirubinemia (NNH). It is estimated that more than two thirds of newborn babies have acquired clinical jaundice. It was also discovered that in the unconjugated hyperbilirubinemia of most neonates represents a common or exaggerated physiological syndrome¹. Neonatal jaundice in newborns is a typical and benign problem. Jaundice is found in Around 60% of term neonates and 80% of preterm neonates are observed to suffer from jaundice during the first week of life². Most of the cases does not require any intervention but in about 5% to 10% cases who have significant hyperbilirubinemia, the use of phototherapy becomes necessary. The physical immaturity of infants to handle

increased production of bilirubin is referred to as Jaundice. This becomes potentially neurotoxic if severe unconjugated hyperbilirubinemia is left untreated³.

One of the routine strategies for treating hyperbilirubinemia is known as phototherapy. However it is not a harmless interference. This can produce negative results, such as dehydration, temperature volatility, blood flow redistribution, genotoxicity, rashes on the skin, loose skin, stools, damage to retinas, hypocalcemia and bronze baby syndrome. This causes bilirubin to be photooxidized into water soluble or less lipophilic, colourless form of bilirubin, which is excreted through bile, faeces, and urine.

It is understood that elevated levels of unconjugated bilirubin induce encephalopathy of bilirubin and then kernicterus, with devastating, permanent handicaps in

neurodevelopment. Phototherapy or an exchange transfusion may treat hyperbilirubinemia. In order to alter unconjugated bilirubin in the skin, phototherapy utilises blue wavelengths of light. In neonates with hyperbilirubinemia, phototherapy has a detrimental effect on certain segments of the oxidant and antioxidant defence system and exposes them to lethal oxidative stress⁴.

One of the lesser known but which has a potential adverse effect of phototherapy is hypocalcemia. A total serum calcium concentration of $< 7 \text{ mg / dl}$ or ionised calcium concentration $< 4 \text{ mg / dl}$ ($< 1 \text{ mol / L}$) is classified as neonatal hypocalcemia. Ionized calcium, including blood coagulation, neuromuscular excitability, integrity and function of the cell membrane, and cellular enzymatic and secretory behaviour, is essential for many biochemical processes. Hypocalcemia increases the permeability of cells to sodium ions and increases the excitability of cell membranes⁵. This present study is undertaken with an objective to study the serum calcium levels in neonates with hyperbilirubinemia undergoing phototherapy.

Material & Methods:

The present cross-sectional study was conducted at Department of Pediatrics, Venkateshwara Institute of Medical Sciences, Gajraula, U.P. India.. 60 full term neonates were included in present study who was admitted to Neonatal Intensive Care Unit (NICU). Informed consent of parents/guardians have been obtained for all cases undertaken for this study. Complete maternal history has been recorded for any risk factors like diabetes, hypertension, anemia, epilepsy, rash, oligohydramnios or any drug intake during pregnancy other than iron or folic acid supplementation. All neonates were examined physically. The demographic details were noted including their weight, gestational age, gender, mode of delivery, blood group and Rh status. Anthropometric details were also noted. A total serum calcium concentration of $< 7 \text{ mg / dl}$ is classified as neonatal hypocalcemia

Inclusion criteria: Full term neonates who completed 37 weeks of gestation with unconjugated hyperbilirubinemia who require phototherapy.

Exclusion criteria: Mother with history of anticonvulsant, perinatal asphyxia with Apgar < 4 at 1 minute of birth, diabetic mother, sepsis, birth with apparent major congenital anomalies, onset of jaundice within 24 hours of birth, having hypocalcemia prior to start of phototherapy.

Under the normal protocol, traditional phototherapy equipment containing four blue light fluorescent lamps with wavelengths of 410-470 nm was mounted at a

distance of 25-35 cm from the skin surface of neonates with entirely covered eyes and genitals. At $15 \mu\text{W / cm}^2$ /nm at the level of the infant's skin, the irradiance during phototherapy was assessed and maintained consistently.

Data was entered in Microsoft Excel 2013 and analyzed using SPSS software version 20. Descriptive statistics were expressed as number and percentage for qualitative data. Studebnts paired t-test has been applied for continuous quantitative data.

Results:

Table 1: Demographic characteristics

Gender	Number	%
Male	27	45%
Female	33	55%
Total	60	100%

Among 60 neonates included in this study there were 27 (45%) male whereas 33 (55%) female neonates.

Table 2: Type of delivery

Type of delivery	Number	%
Normal vaginal delivery	36	60%
Lower segment caesarean section	24	40%
Total	60	100%

It was observed that there were 36 (60%) normal delivery while 24 (40%) lower segment caesarean section.

Table 3: Comparison of serum calcium levels

	Before phototherapy	After phototherapy	P - value
Total serum calcium (mg/dl)	9.21 ± 0.83	8.36 ± 0.78	0.001

It was found that the mean serum calcium levels were significantly lower after undergoing phototherapy.

Discussion:

A common problem is hyperbilirubinemia or jaundice, and it is sometimes considered benign in babies. Jaundice can be seen at birth or at any time during childhood. Hence, if non-conjugation hyperbilirubinemia is not treated early, bilirubin crosses the blood-brain barrier and exerts its neurotoxic impact. Drug treatment, blood alteration and phototherapy are part of his treatment⁶. Phototherapy is generally recognised as a reasonably effective and reliable procedure. As defined by Cremer et al in 1953, for the treatment of neonatal hyperbilirubinemia, there are far less studies showing the adverse effects of phototherapy⁷. Hypocalcaemia, whose exact cause is still unclear, is one adverse effect of phototherapy. After phototherapy, it can be due to a drop in the amount of melatonin or a rise in intestinal prystaltysm and deficiency in its absorption⁸. Inhibition

of the pineal gland by transcranial illumination has been documented as a hypocalcemic effect mechanism of phototherapy, resulting in a decrease in melatonin secretion that blocks the effect of cortisol on bone calcium. Cortisol has a hypocalcemic direct effect which improves calcium bone absorption which causes hypocalcemia⁹. Calcium, magnesium and vitamin D are essential elements in the body and the reduction of serum calcium and magnesium in the blood may be caused by phototherapy. Decreases in calcium and magnesium, on the other hand, may lead to some symptoms, such as apnea, muscle tick convulsion, and decreases in vitamin D absorption, due to a decrease in calcium absorption. Therefore, some blood level fluctuations trigger irreparable consequences and can also impair the absorption of other components¹⁰.

In present study the mean levels of serum calcium before phototherapy was 9.21 with standard deviation of 0.83 while the serum calcium levels after phototherapy were 8.36 with standard deviation of 0.78. There was a statistically significant difference between serum mean calcium levels before and after phototherapy ($p=0.001$). The mean serum calcium levels before phototherapy in a study by Goyal S et al were 9.14 ± 0.78 mg / dl and decreased to $(8.53 \pm 0.77$ mg / dl) after treatment with phototherapy. The discrepancy between serum calcium levels before and after phototherapy has been found to be statistically significant ($p<0.001$). This work was in agreement with our findings¹¹. There was a substantial decrease in calcium levels after phototherapy in a study by Yadav RK et al, but the difference between our study and their study was that they measured ionised calcium levels instead of serum calcium levels as in ours¹². Another study done by Barak M et. al reported that calcium levels were 9.43, 9.16, 8.88, and 8.35 mg / dl at baseline, 24, 48, and 72 hours after phototherapy, respectively, and this drop in calcium levels was statistically significant ($P=0.001$)¹³. In a study conducted by Behjati et al. the mean calcium level was found to be 8.96 and 8.6 before and 72 hours after phototherapy and the reduction in the amount of calcium after phototherapy was statistically important ($P=0.005$)¹⁴. The mean value of serum calcium prior to phototherapy in the current study was 9.27 ± 0.73 and the mean value of calcium after phototherapy was 8.88 ± 0.70 . On the basis of the t-test (p value <0.001), this decrease in the mean serum calcium value was found to be statistically important in a study by Rozario CI et. al, while similar findings were shown in research conducted by Tehari et al^{15,16}.

Conclusion:

A major issue is phototherapy induced hypocalcemia. Before beginning and during phototherapy for neonatal jaundice and close monitoring of neonates for signs of hypocalcemia, careful calcium status calculation should be carried out.. After phototherapy, there is a substantial reduction in the amount of serum calcium, but the risk of hypocalcemia in stable full-term neonates is minimal.

References:

1. Singh M. Care of the Newborn. 7th edn. New Delhi: Sagar Publications; 2010:254-274.
2. Kliegman RM. Jaundice and Hyperbilirubinemia in the Newborn. In Behrman R, Nelson Text book of Pediatrics. 20th ed. Philadelphia:Elsevier;2015:871- 875.
3. Anthony J, Piazza, Stoll BJ. Jaundice and hyperbilirubinemia in newborn. In: Kliegman, Behrman, Jenson, Stanton (eds) Nelson Text book of pediatrics. 18th ed. Philadelphia:Saunders;2008:756-57.
4. Xiong T, Qu Y, Cambrier S, Mu D. The side effects of phototherapy for neonatal jaundice: What do we know? What should we do? Eur J Pediatr. 2011;170(10):1247-55.
5. Camilla R, Martin, Cloherty JP. Neonatal hyperbilirubinemia. In: John P. Cloherty, Eri C Eichenward, Ann R Stark(eds) Manual of neonatal care. 6th edition, Philadelphia:Lippincott Williams and Wilkins;2008:201.
6. Martin R, Fanaroff A, Walsh M. Disorders of Calcium, Phosphorus, and Magnesium in the Neonate. Neonatal-Perinatal Medicine. Elsevier; 2015. pp. 1461–1489.
7. Young Infants Clinical Signs Study Group. Clinical signs that predict severe illness in children under age 2 months: a multicentre study. Lancet. 2008;371(9607):135-42.
8. Alizadeh-Taheri P, Sajjadian N, Eivazzadeh B. Prevalence of Phototherapy Induced Hypocalcemia in Term Neonate. Iran J Pediatr Dec 2013; 23(6): 711-712.
9. Hakanson D, Penny R, Bergstrom WH. Calcemic responses to photic and pharmacologic manipulation of serum melatonin. Pediatr Res. 1987;22(4):414- 16.
10. Kliegman RM, Behrman RE, Jenson HB, Stanton BM. Nelson textbook of pediatrics e-book. Elsevier Health Sciences; 2007. Aug .
11. Yadav RK, Sethi RS, Sethi AS, Kumar L, Chaurasia OS. The Evaluation of Effect of Phototherapy on Serum Calcium Level. People's J Sci Res. 2012;5(2):1-4.
12. Yadav RK, Sethi RS, Sethi AS, Kumar L, Chaurasia OS. The Evaluation of Effect of Phototherapy on Serum Calcium Level. People's J Sci Res. 2012;5(2):1-4.
13. Barak M, Mirzarahimi M, Eghbali M, Amani F. The Effect of Phototherapy Duration on Serum Level of Total Calcium and 25-hydroxy vitamin D (25(OH) D) in Jaundiced Neonates. IJHRS. 2014; 3(4): 123-127
14. Behjati SH, Ghotbi H. Evaluation of efficacy and complication between three mode of phototherapy.Iranian Journal of Pediatrics 2006. 16(2):230-233.
15. Rozario CI, Pillai PS, Ranamol T. Effect of phototherapy on serum calcium level in term newborns. Int J Contemp Pediatr 2017;4:1975-9.
16. Alizadeh-Taheri P, Sajjadian N, Eivazzadeh B. Prevalence of phototherapy induced hypocalcemia in term neonate. Iran J Pediatr. 2013;23(6):710-11.