International Journal of Contemporary Pediatrics
Manohar S et al. Int J Contemp Pediatr. 2017 Mar;4(2):615-619
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20170719

Original Research Article

Vitamin D status in children with cerebral palsy

Sowjan Manohar*, Rajakumar Ponnandai Gangadaran

Department of Pediatrics, Shri Sathya Sai Medical College and Research Institute, Ammapettai, Thiruporur, Tamil Nadu, India

Received: 07 December 2016
Revised: 09 December 2016
Accepted: 04 January 2017

***Correspondence:**
Dr. Sowjan Manohar,
E-mail: sowjan86@gmail.com

ABSTRACT

Background: The aim of the study was to find the prevalence of vitamin D status - vitamin D deficiency and insufficiency in children with cerebral palsy and to compare them with normal children. To identify the risk factors associated with vitamin D deficiency in these children.
Methods: A prospective case control study was done in 200 children in Shri Sathya Sai Medical College and Research Institute, Ammapettai, Thiruporur, Tamil Nadu, India over a period of one year from December 2014 to December 2015 after obtaining approval from institutional ethical committee. Study group contained 100 children with cerebral palsy. 100 Age and sex matched children were taken as controls. Children included in the study were between 1 to 12 years. All children were subjected to the following investigations: serum calcium-total, serum phosphorus, serum alkaline phosphatase (SAP) levels. These were determined by an automated analyzer. The 25OH vitamin D levels were estimated by CLIA (chemi luminescence immunoassay) method.
Results: Vitamin D deficiency was observed in 32 (32%) and insufficiency in 61 (61%) of children with cerebral palsy in case group. Similarly, vitamin D status studied in control children was found that majority of them 49 (49%) was normal. While 38 (38%) were vitamin D insufficient, 13 (13%) showed deficient levels ($p < 0.0000001$).
Conclusions: The presence of feeding difficulties, poor sunlight exposure, poor nutritional status, and the use of antiepileptic drugs, type of CP and the functional grade of CP had statistically significant association with Vitamin D deficiency in these children.

Keywords: Antiepileptic drugs, Cerebral Palsy, Serum alkaline phosphatase, Vitamin D

INTRODUCTION

The cerebral palsy is one of the well-known common causes of childhood disability. The incidence of CP in developed world is 2-2.5/1000 live births.[1] Though the occurrence of vitamin D deficiency in cerebral palsy is well described, the epidemiological data are sparse in India.

Vitamin D is wrongly termed a vitamin as it can readily be synthesized in the skin. Vitamin D deficiency, known to occur in children with cerebral palsy is one such challenge and if left untreated can cause osteopenia and fractures. The reasons attributed are multifactorial. They include poor sunlight exposure due to their no ambulant nature, nutritional impairment due to feeding difficulties and use of long term anticonvulsants in these children. Months before rickets becomes manifest, latent vitamin D deficiency is seen. Reduced bone density as evidenced by bone densitometry and propensity to fractures with trivial injury sue to osteoporosis and extensive bone demineralization is common in children with cerebral palsy.[2] Vitamin D helps in mineralization of the bone matrix in growing bones.[3]

Trabecular bone and growth plate is affected. Rickets has been reported in children treated with AEDs.[4] Recurrent respiratory tract infections, growth failure, lethargy, irritability are seen associated with vitamin D deficiency.[5-8] Seizure disorder is very common in children with CP. 38% of children with cerebral palsy had epilepsy in a population based study.[9] Inappropriate dietary energy intake relative to nutrient needs is the prime cause of obesity and under nutrition in neurologically impaired children.[10,11] They are very much unable to communicate their hunger, food preferences, and satiety, leaving caretakers responsible for their dietary intake regulation.[12,13] Oro motor dysfunction is the most common cause in the pathogenesis of under-nutrition and it correlates with the severity of motor impairment.[14,15] Children may present with "inadequate lip closure, drooling, and persistent tongue thrust, resulting in food loss through spillage".[16] Gastroesophageal reflux, which affects seventy five percent of neurologically impaired children, and delayed gastric emptying, may result in a loss of nutrients because of frequent emesis.[17,18] Hence it was decided to study the prevalence of vitamin D deficiency in children with cerebral palsy and to possibly identify the potential variables associated with increased risk.

METHODS

A prospective case control study was done in 200 children in Shri Sathya sai medical college and research institute, Ammapettai, Thiruporur, Tamil Nadu, India over a period of one year from December 2014 to December 2015 after obtaining approval from institutional ethical committee. Study group contained 100 children with cerebral palsy. 100 age and sex matched children were taken as controls. Children included in the study were between 1 to 12 years. Informed consent was obtained, both cases and controls, from their parents or guardians. Children with cerebral palsy attending the paediatric outpatient department and in patient care of our hospital contributed as the subjects of this study.

Normal children were randomly selected as controls. Children already on calcium supplementation, with evidence of renal or liver disease, malabsorption syndromes and family history of metabolic bone disease were excluded from the study. A detailed history was obtained including age, sex, birth history including mode of delivery, gestational age, birth weight, presence of birth asphyxia, neonatal seizures, developmental delay, exposure to sunlight, ambulatory status, seizures, use of antiepileptic drug (AED) (single/multiple drug, duration of treatment, type of antiepileptic drug), history of constipation and feeding difficulties.

Complete physical examination of the child including anthropometry was performed with emphasis on evidence of fractures and dental changes. All children were subjected to the following investigations: serum calcium-total, serum phosphorus, serum alkaline phosphatase (SAP) levels. These were determined by an automated analyzer. The 25 OH vitamin D levels were estimated by CLIA (chemi luminescence immunoassay) method. Total calcium above 9 mg/dl was considered to be normal. Serum phosphorus in the range of 4-7 mg/dl was considered to be in the normal range. SAP below 400 IU/l was considered normal.

Vitamin D insufficiency is defined as serum 25-hydroxyvitamin D levels below 30 ng/mL. Vitamin D deficiency is defined as serum 25-hydroxyvitamin D levels below 10 ng/mL.[2] Vitamin D status in children with CP were analyzed with different variables including age, sex, sunlight exposure, feeding difficulty, AED use, type of AED, laboratory data and the statistical significance determined. The data analysis was computed using the SPSS v15 software and p value <0.05 was considered statistically significant. Based on the data, the possible risk factors for vitamin D deficiency were postulated.

RESULTS

A total of 100 children with cerebral palsy were subjects (cases) of the study. These children were analyzed with another 100 age and sex matched normal children (controls). Among cases 32 children were below 3 years, 25 between 3-6 years, 31 between 6 – 10 years and 12 were in more than 10 years age group. The mean age of cases was 5.9 years. Majority of them 62 were males and the rest 38 were females in case group. Nearly half of the cases were on AED for more than 3 years. While 16 children with CP were taking drugs for one to three years, 13 children with CP were taking drugs for less than one year. Only 22 children were on monotherapy whereas majority, 53 of them were on more than one drug. 25 children were not on AED.

Sodium valporate was the commonly used drug. The commonly observed co morbidities in cases with cerebral palsy were feeding difficulties (72%), dental changes (56%), constipation (28%) and fractures (13%) in that order. The other parameter implicated in vitamin D deficiency in children with cerebral palsy is the poor sunlight exposure in these children, mainly due to their non-ambulant nature. 32% of them had poor sunlight exposure. Total calcium, serum phosphorus and serum alkaline phosphatase was done in all children (both cases and controls). In the case group, 75 children had low total calcium and the rest 25 had normal total calcium. Low phosphorus was observed in 38 children. Serum alkaline phosphatase (SAP) was normal in 53 children whereas it was elevated in 47 children. The same was done for all the controls.

Serum calcium was low in 22 in this group and normal in 78. Serum phosphorus was normal in all children in the control group. In these children, alkaline phosphatase was normal in 81 and elevated in the rest 19. Vitamin D

deficiency was observed in 32 (32%) and insufficiency in 61 (61%) of children with cerebral palsy in case group. Similarly vitamin D status studied in control children was found that majority of them 49 (49%) was normal. While 38 (38%) were vitamin D insufficient, 13 (13%) showed deficient levels (p <0.0000001).

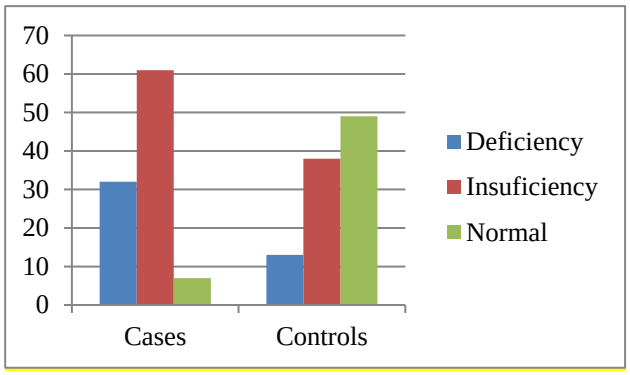

Figure 1: Vitamin D status.

DISCUSSION

Vitamin D deficiency is a common association in children with Cerebral Palsy due to known reasons like poor sunlight exposure, non-ambulatory nature, anticonvulsant use and feeding difficulties. In this study, we have tried to correlate the vitamin D status in children with cerebral palsy in relation to the nutritional status, anticonvulsant use, feeding difficulty, poor sunlight exposure, which have been implicated as possible causes for vitamin D deficiency in these children. It is a popular belief that rickets and vitamin D deficiency are not common in India, a tropical country, because of abundant sunlight exposure. But there is now increasing evidence that this statement is not correct. Vitamin D deficiency has been well documented among all age groups like neonates, toddlers, school children, pregnant women, and adult males and females residing in rural and urban India. There are studies from both north India and south India.[19-21] These studies clearly state the fact that approximately 75 to 85% of the groups studied have varying degrees of vitamin D deficiency or insufficiency (hypovitaminosis D). Also the latitude, solar zenith angle, ultraviolet radiation, amount of cloud cover, time duration of exposure to sunlight, body surface area exposed to sunlight is different among different parts of the world and also different in various areas of our own country and therefore comparisons between the different groups are not possible.

In our study, the prevalence of decreased vitamin D in cases was 93%. Whereas in control population of our study, prevalence of decreased vitamin D was 51%. The prevalence of vitamin D deficiency in study group was 32% and insufficiency was 61%. In the control group, vitamin D deficiency amounted to 13%, while insufficiency amounted to 38%. In both populations, insufficiency was found to be commoner than deficiency. There is a significant association between low vitamin D in CP children when compared to normal population. The prevalence of decreased vitamin D in our cases was 93 % which was statistically significant, while in the control group, decreased vitamin D levels amounted to 51%. This increased prevalence of decreased vitamin D levels in CP children is statistically significant and this is not an incidental occurrence but due to the multiple reasons like feeding and swallowing issues resulting in poor nutrition, lack of adequate intake of calcium rich food, lack of exposure to sunlight and added burden due to anti-epileptic medications. None of the controls showed any clinical signs of Vitamin D deficiency.

The prevalence of vitamin D deficiency in CP children by Hendersonn et al had a prevalence of deficiency of 19% while our study has a deficiency of 38%. Though the prevalence of vitamin D deficiency/insufficiency in normal population varies between 10% to 70% in various studies, it was 51% in our normal controls.[22] There have been no Indian studies to compare vitamin D levels and risk factor analysis in CP children and therefore mean vitamin D values cannot be compared with Indian population. Harinarayan et al conducted a study about vitamin D status in general population in Tirupathi.[19] As it is nearby our place of study and also enjoys the same amount of sunshine and cloud cover as our study place, the values of vitamin D and result analysis would be meaningful if compared with our population. The mean vitamin D levels of urban males in the above-mentioned study was 18.54 ng/ml while in females it was 28.35 ng/ml. Among rural population, mean was 29.24 ng/ml for men and 29.21 ng/ml for women. In our study, we have mean Vitamin D levels of 17.98 ng/ml. In our control population, we get a mean vitamin D value of 33.13 ng/ml. In a study by Marwaha et al in healthy school going children in North India, the mean vitamin D levels in low and high socioeconomic group were 10.4 and 13.7 ng/ml.[23] While all studies uniformly report higher prevalence of vitamin D deficiency in higher socio economic, urban and white collared population, this study gives a 42.3% prevalence of 25 (OH)D deficiency in lower socioeconomic group when compared to higher socioeconomic group which had a 27% prevalence. In the United States, a study done by Kumar J et al over four years in a large group of 6000 children reports that 9% of children were deficient and 61% were insufficient.[24] This study gives comparable results as the population as it was a large group and uniformly distributed to negate weather factors influencing vitamin D levels.

In our study, the control population had a 13% and 38% prevalence of deficiency and insufficiency. This is one study which used the cut off value for deficiency as <10 ng/ml as in our study while other studies have used higher cut off of 20 ng/ml to define deficient state. In our study, the mean vitamin D levels among case group were 17.98 while that of the control group was 33.13 ng/ml. In a population based study [9], 38% of children with CP had epilepsy but in our study 75 % had seizures. Our

hospital being a tertiary care centre, we had a higher prevalence of seizure disorder in CP in our study due to higher referral rates for refractory seizures. In our study, majority of children 24 (75%) were on anticonvulsant therapy and the commonly used anticonvulsant among them was sodium valporate constituting 68.5% of the total. 43.75% children were on phenytoin and 46.85% children were on phenobarbitone. But alteration of vitamin D status due to individual AEDs could not be analyzed as most patients were on polytherapy and co relation with vitamin D deficiency could not be obtained. The duration of AED intake has been found to be statistically significant in altering vitamin D levels. Longer the duration of intake, higher is the alteration. This has also been found to be the same as in earlier studies, which show alteration to low values and also decreased BMD with, chronic anti convulsant usage.[25,26] Reports of altered calcium, vitamin D, and bone metabolism associated with anticonvulsant medication use are numerous. Biochemical abnormalities have included decreased serum calcium, 25-hydroxycholecalciferol (calcidiol), and phosphorus, and elevated alkaline phosphatase (AP).[27,28] Although other investigators have found no association between anticonvulsant use and one or more of these variables.[29,30] In our study, Vitamin D deficiency has been significantly associated with low serum phosphorous levels. Probably the stage of vitamin D disease, though deficient, is in a compensated state due to increased parathormone levels or probably performing ionic calcium studies would reflect low calcium levels better.

CONCLUSION

The prevalence of vitamin D deficiency in children with CP was found to be 32% while insufficiency amounted to 61% and a total alteration in vitamin D status in CP children was 93%. The prevalence of vitamin D deficiency in age and sex matched controls was found to be 13% while insufficiency amounted to 38% and a total alteration in vitamin D status was 51%. The presence of feeding difficulties, poor sunlight exposure, poor nutritional status, and the use of antiepileptic drugs had statistically significant association with Vitamin D deficiency in these children. Periodic monitoring, early identification and appropriate calcium and vitamin D supplements may prevent complications like fractures, etc. Hypovitaminosis D is very common and represents latent stage of vitamin D deficiency. Appropriate treatment with vitamin D supplements and calcium is necessary for treatment of vitamin deficiency and replenishment of stores.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Rosen MG, Dickinson JC. The incidence of cerebral palsy. Am J Obstet Gynecol. 1992;167:417-23.
2. Fishman LN, Bousvaros A. Gastrointestinal issues in the child with cerebral palsy. Int Pedia Gastroenterol Nutrition. 1999;8:1-9.
3. Klein G. Nutritional rickets. In: Favus MJ, ed. Primer on the metabolic bone diseases and disorders of mineral metabolism. Philadelphia: Lippincott Williams and Wilkins. 1999:315-319.
4. Hahn T. Bone complications of anticonvulsants. Drugs. 1976;12:201-11.
5. Ladhani S, Srinivasan L, Buchanan C, Allgrove J. Presentation of vitamin D deficiency. Arch Dis Child. 2004;89(8):781-4.
6. Hatun S, Ozkan B, Orbak Z. Vitamin D deficiency in early infancy. J Nutr. 2005;135(2):279-82.
7. Najada AS, Habashneh MS, Khader M. The frequency of nutritional rickets among hospitalized infants and its relation to respiratory diseases. J Trop Pediatr. 2004;50(6):364-8.
8. Pawley NJ, Bishop N. Prenatal and infant predictors of bone health: the influence of vitamin D. Am J Clin Nutr. 2004;80(6):1748-51.
9. Lonstein JE, Beck K. Hip dislocation and subluxation in cerebral palsy. J Pediatr Orthop. 1986;6:521-6.
10. Sanders KD, Cox K, Cannon R. Growth response to enteral feeding by children with cerebral palsy. J Parenter Enteral Nutr. 1990;14:23-6.
11. Fried MD, Pencharz PB. Energy and nutrient intakes of children with spastic quadriplegia. J Pediatr. 1991;119:947-9.
12. Stallings VA, Zemel BS, Davies JC. Energy expenditure of children and adolescents with severe disabilities: a cerebral palsy model. Am J Clin Nutr. 1996;64:627-34.
13. Reilly S, Skuse D, Poblete X. Prevalence of feeding problems and oral motor dysfunction in children with cerebral palsy: a community survey. J Pediatr. 1996;129:877-82.
14. Sullivan PB, Juszczak E, Lambert BR. Impact of feeding problems on nutritional intake and growth. Dev Med Child Neurol. 2002;44:461-7.
15. Fung EB, Fang SL, Stallings VA. Feeding dysfunction is associated with poor growth and health status in children with cerebral palsy. J Am Diet Assoc. 2002;102:361-8.
16. Trier E, Thomas AG. Feeding the disabled child. Nutrition. 1998;14:801-5.
17. Ravelli AM, Milla PJ. Vomiting and gastroesophageal motor activity in children with disorders of the central nervous system. J Pediatr Gastroenterol Nutr. 1998;26:56-63.
18. Sondheimer JM, Morris BA. Gastroesophageal reflux among severely retarded children. J Pediatr. 1979;94:710-4.
19. Harinarayan CV, Ramalakshmi T, Prasad UV, Sudhakar D. Vitamin D status in Andhra Pradesh: a

population based study. Indian J Med Res. 2008;127:211-8.
20. Harinarayan CV, Ramalakshmi T, Prasad UV, Sudhakar D, Srinivasarao PV, Sarma KV, et al. High prevalence of low dietary calcium, high phytate consumption, and vitamin D deficiency in healthy south Indians. Am J Clin Nutr. 2007;85:1062-7.
21. Balasubramanian K, Rajeswari J, Gulab, Govil YC, Agarwal AK, Kumar A, et al. Varying role of vitamin D deficiency in the etiology of rickets in young children vs. adolescents in northern India. J Trop Pediatr. 2003;49(4):201-6.
22. Hendersonn AC. Vitamin D levels in non-institutionalized children with cerebral palsy. J Child Nerol. 1997;12(7):443-7.
23. Marwaha RK, Tandon N, Reddy DHK, Aggarwal R, Singh R, Sawhney RC, et al. Vitamin D and bone mineral density status of healthy school children in northern India. Am J Clin Nutr. 2005;82:477-82.
24. Kumar J, Mntner P, Kaskel FJ, Hailpern S, Michaed L. Prevalence and associations of 25 OH vitamin D deficiency in US children NHANES 2001-2004. Pediatrics. 2009;124:302-70.
25. Akín R, Okutan V, Sarící Ü, Altunbas A, Gokcay E. Evaluation of bone mineral density in children receiving antiepileptic drugs. Pediatr Neurol. 1998;19:129-31.
26. Pack AM, Olarte L, Morrell M. Bone mineral density in an outpatient population receiving enzyme inducing antiepileptic drugs. Epilepsy Behav. 2003;4:169-74.
27. Lifshitz F, Maclaren NK. Vitamin D-dependent rickets in institutionalized children receiving anticonvulsant therapy. A survey of 288 patients. J Pediatr. 1973;82:612-20.
28. Sato Y, Kondo I, Ishida S. Decreased bone mass and increased bone turnover with valproate therapy in adults with epilepsy. Neurology. 2001;57:445-9.
29. Fischer MH, Adkins WN, Liebl BH, Vancalcar SC, Marlett JA. Bone status in non-ambulant, epileptic, institutionalized youth. Clin Pediatr. l988;27:499-505.
30. Houhala AM, Korpela R, Koivikko M, Koskinen T, Koskinen M, Koivula T. Long-term anticonvulsant therapy and vitamin D metabolism in ambulatory pubertal children. Neuropediatrics. 1986;17:212-6.

Cite this article as: Manohar S, Gangadaran RP. Vitamin D status in children with cerebral palsy. Int J Contemp Pediatr 2017;4:615-9.