SCREENING FOR LEAD POISONING IN URBAN SCHOOL CHILDREN OF SOUTHERN INDIA USING CAPILLARY AND VENOUS BLOOD SAMPLES

Herman S D'Souza, Geraldine Menezes and Venkatesh T

*Department of Biochemistry and Biophysics,
St. John's Medical College,
St. John's National Academy of Health Sciences,
Koramangala, Bangalore - 560 034, Karnataka, India*

ABSTRACT

Our study aimed at comparing lead and zinc protoporphyrin (ZPP) levels in capillary and venous blood samples in a small population and to employ an easier method of sample collection for a major screening program in school children in major Indian cities. An awareness program on lead and its effects was conducted in two different schools. A total of thirty urban school children from South India, with an age group between 4 - 12 years consented for dual blood sampling and reported for the study. Venous and capillary blood samples were obtained simultaneously. Blood lead and zinc protoporphyrin (ZPP) levels were estimated using ESA Lead Analyzer and Haematofluorometer respectively. A significant correlation between capillary and venous ZPP ($r = 0.98$) and lead ($r = 0.99$) was observed. Rank sum test showed that there is no statistically significant difference between capillary and venous ZPP ($P = 0.891$) and lead ($P = 0.672$) values. This pilot study recommends that screening for lead may be done using capillary blood samples since significant correlation is observed between capillary and venous blood measurements. Obtaining samples using this mode is a non-invasive, less expensive, quick and easy method in children. Appropriately performed capillary sampling may be considered as an acceptable alternative to venipuncture for screening of blood for lead poisoning both in children and adults.

KEY WORDS:

Anodic Stripping Voltammetry, ZPP, Haematofluorometer.

INTRODUCTION

Lead, the most versatile and commonly available metal has emerged as a major health hazard with the detection of alarming levels of lead among the Indian population particularly in children (1-6). The Center for Disease Control and Prevention (CDC) recommended in October 1991, the priority groups for screening which involved children mainly between 6 to 72 months. They also recommended that ZPP is not sensitive enough to identify lead poisoning at lower blood lead levels, that is between 10-25 $\mu\text{g/dl}$ and misses many children with blood lead $\leq 25 \mu\text{g/dl}$ (7). Hence the

measurement of Zinc Protoporphyrin (ZPP), which has been shown to be insensitive with lower levels of exposure, should be replaced by the direct measurement of blood lead as the screening test of choice (8). The major problem in implementing a screening program for children has been obtaining blood samples (9). Lead levels can be analyzed using capillary blood samples as well as venous samples. Obtaining capillary samples is more feasible at many screening sites. Of concern is the fact that lead levels measured in capillary samples may not reflect true blood lead levels because of lead contaminated fingertips (10). Alternatively venous blood samples can be used for screening. Collection of venous blood samples poses a lot of difficulty, as children are frightened to see the needles and syringes, difficulty in getting veins to collect blood, and if it is a mass-screening

Author for correspondence :

DR. T. VENKATESH M.Sc. PhD, FACBI, FINASS.
Professor at above address. Telephone (080) 2065058
Fax: (080) 5520777 E-mail: venky_tv@hotmail.com

program, the sampling procedure is time consuming. It is also difficult to obtain venous sample collections in some clinical settings (11).

We took up this study in young children, primarily to correlate blood lead levels in capillary blood samples and simultaneously drawn venous blood samples. This was a pilot study to arrive at the difference in blood lead levels in both types of sampling methods since we had to carry out screening for a larger population of children for lead poisoning in major Indian cities. Our aim was also to see the differences in ZPP levels in both types of sampling since increased ZPP levels is a good indicator of chronic lead exposure (12).

MATERIALS AND METHODS

An awareness program was conducted by us on lead, in schools, for school authorities, teachers and parents. Parents who consented to their children participating in lead screening were informed about dual blood sampling. Patient consent forms were given only to those who agreed for dual blood sampling followed by patient information forms comprising of patient demographics, parent occupation, family size, annual income, residential location, food and play habits and mode of reaching school. 30 school children aged between 4 to 12 years belonging to two different schools were selected for the study. Our lead-screening program included analysis of blood lead as well as ZPP levels. Children participating in the screening program were asked to wash their hands thoroughly with soap and water and dry them with a clean, low-lint towel. The finger to be punctured was checked for any visible infection or wound and was wiped using a spirit swab and allowed to dry. All blood samples were obtained from the children by skilled personnel. For capillary blood sample collection, the fingertip was punctured using disposable lancets. The first drop of blood was discarded followed by transferring the second drop onto a cover slip, taking precautions to see that the fingertip did not touch the cover slip. ZPP was estimated immediately by front face fluorometry using Haematofluorometer (13). 100 µl sample was collected in a 100 µl capacity capillary tube, from the same fingertip and added immediately to Metexchange Reagent (supplied by ESA Inc., USA) for the estimation of lead. Subsequent to capillary blood sampling, venous blood sampling was carried out. The site chosen for venous sample collection was thoroughly

cleaned using spirit swab, allowed to dry and blood was drawn using a syringe. A drop of blood was transferred to a cover slip and ZPP was measured immediately. 100µl of the sample was dispensed into Metexchange reagent as mentioned above. Lead estimations of both capillary and venous samples were carried out after 24 hours by Anodic stripping voltammetry (ASV) using ESA Lead Analyzer (14). Metexchange reagent, other accessories and 3010B Lead Analyzer were supplied by ESA Inc., MA, U.S.A. and AVIV Haematofluorometer from AVIV Biomedical, Inc., (Lakewood, NJ) by "The George Foundation," a non-government organization.

Statistical analysis carried out, included comparing the study population for age and sex, calculating mean capillary and venous blood lead, mean capillary and venous blood ZPP levels, correlation coefficient and standard deviation of differences. *P* value was calculated using Mann-Whitney Rank Sum Test.

RESULTS AND DISCUSSION

30 school children with mean age 8.3 (4 - 12 yrs) participated in the study. 26.7% (n=8) of them were males and 73.3% (n=22) were females. Four children had a difference of 12-16 µg/dl in ZPP levels, three children had a difference of 2.9, 4.5 and 16.6 µg/dl in lead levels between capillary and venous samples and hence were eliminated from the study. This would have been due to a technical or analytical error. The analysis could not be repeated due to the non-availability of the sample. With the elimination of four ZPP values from the total 30 values, the remaining 26 capillary ZPP values showed a significant correlation ($r=0.98$) with corresponding venous blood ZPP measurements. Rank Sum Test showed that there is no statistically significant difference ($P=0.891$) between venous and capillary blood ZPP measurements. Similarly with the elimination of three lead values from the total 30 values, the remaining 27 capillary blood lead values showed a significant correlation ($r=0.99$) with corresponding venous blood lead measurements. Rank Sum Test showed no statistically significant difference ($P=0.672$) between venous and capillary blood lead measurements (Table 1).

Our study showed excellent correlation of capillary blood lead and ZPP values with corresponding venous blood lead and ZPP values.

We strongly recommend capillary blood sampling for both lead and ZPP estimations. The added advantage is that, it is noninvasive, less expensive and is more acceptable especially in children. Appropriately performed capillary sampling may be an acceptable alternative to venipuncture for screening children as well as adults for lead poisoning. Based on its ease of performance, capillary sampling may be preferred for mass screening programs. However, if the lead values obtained are very high, and if the patient needs to be subjected for chelation therapy, a confirmatory recheck of blood lead levels with another capillary sample or a venous sample may be necessary.

Even though this study was taken up as a pilot study, the lead levels seen in some children were alarmingly high. Patient information forms revealed that some of them belonged to poor economic background, others had their parents working in lead based industries or had their

houses located near the highway and a few had unusual sources for lead exposure. Our study clearly shows lead poisoning in children in an urban set up. Looking for and finding lead toxicity in a community may be calling attention to a health problem that previously may not have been a concern to the local health care providers. There is a need to provide education about lead toxicity at different levels of the health care system. This study has also highlighted the important role of public health in identifying the sources of lead exposure for a community and in developing appropriate educational materials and for implementing basic control measures.

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Table 1.
ZPP ($\mu\text{g/dl}$) and Lead ($\mu\text{g/dl}$) levels in capillary and venous blood samples.

	ZPP	Lead
n	26	27
Capillary blood - mean $\pm$ SD	41.31 $\pm$ 11.26	14.19 $\pm$ 10.86
Venous blood - mean $\pm$ SD	41.23 $\pm$ 12.49	13.61 $\pm$ 10.55
Correlation Coefficient (r)	0.98	0.99
P value	0.891	0.672

REFERENCES

1. Lalit, B.Y., Ramachandran, T.V. and Rajan, S. (1980) Lead-210 content of food samples in India. *Radiation and Environmental Biophysics* 18(1), 13-17.
2. Khandekar, R.N., Raghunath, R. and Mishra, U.C. (1987) Levels of lead, cadmium, zinc and copper in the blood of an urban population. *The Science of the total environment*. 66, 185-191.
3. Potula, V. and Hu, H. (1996) Occupational and lifestyle determinants of blood lead levels among men in Chennai, India. *International Journal of Occupational and environmental health*. 2(1), 1-4.
4. Keen, R.W., Deacon, A.C., Delves, H.T., Moreton, J.A. and Frost, P.G. (1994) Indian herbal remedies for diabetes as a cause of lead poisoning. *Postgrad. Med.J.* 70, 113-114.
5. Srikanth, R., Ramana, D. and Rao, V. (1995) Role of rice and cereal products in dietary cadmium and lead intake among different socio-economic groups in south India. *Food additives and contamination*. 12(5), 695-701.

6. Shenoi,R.P., Khandekar,R.N., Jayakar,A.V. and Raghunath,R. (1991) Sources of lead exposure in urban slum school children. *Indian Pediatrics*. 28,1021-1027.
7. CDC (Centers for Disease Control). (1991) Preventing lead poisoning in young children: A statement by the centers for Disease Control-October 1991. CDC, U.S.Department of Health and Human Services Publication. Atlanta, GA.
8. McElvine,M.D., Orbach,H.G., Binder,S., Blanksma,L.A., Maes,E.F. and Krieg,R.M. (1991) Evaluation of the erythrocyte protoporphyrin test as a screen for elevated blood lead levels. *J.Pediatr.* 119, 548-550.
9. Edwards,K.S. and Forsyth,B.W.C.(1989) Lead screening at pediatric teaching programs. *Am.J.Dis.Child.* 143,1455-1457.
10. DeSilva,P.E. and Donnan,M.B. (1980) Blood lead levels in Victorian children. *Med.J. Aust.* 1, 93-96.
11. Lyngbye,T., Jorgensen,P.J., Granjean,P. and Hansen,O.N. (1990) Validity and interpretation of blood lead levels: a study of Danish school children. *Scan.J. Clin.Lab.Invest.*50,441-449.
12. Carl,A.B. and Edward,R.A. (1999), *Tietz Textbook of Clinical Chemistry*. 3rd edn. W.B. Saunders, U.S.A. p 1033.
13. Blumberg,W.E., Eisinger,J., Lamola,A.A. and Zuckerman,D.M. (1977) The Haematofluorometer. *Clin. Chem.* 23,270-274.
14. Roda,S.M., Greenland,R.D., Bornschein,R.L. and Hammond,P.B. (1988) Anodic Stripping Voltammetry procedure modified for improved accuracy of blood lead analysis. *Clin.Chem.*34,563-567.