The change of blood Pb levels of basketball players after strenuous exercise

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Abstract

This study is related to the investigation of the Pb levels in blood of the 12 healthy University male basketball players before and after a strenuous training session by the use of square wave anodic stripping voltammetry. Although the results do not show acute lead intoxication it is obvious that blood lead levels show significant increase after training sessions. The average increase in blood lead levels is 297%. This increase is largely due to increased respiration rate during the training period.

INTRODUCTION

Heavy metal pollution is a serious health threatening environmental problem we face during normal flow of our lives. For instance the passage of blood Pb levels over 125 μg/dL causes deaths due to lead intoxication. Similarly blood lead levels of 100 μg/dL in adults and 80 μg/dL in children cause serious damage in brain and kidneys (ATSDR, 1992; 1997). It is also reported that lead levels of 30–40 μg/dL in blood effect the nervous system resulting neurological symptoms (ATSDR, 1997; EPA, 2006). It is known that elevated levels of lead in human blood have diversified adverse effects on human metabolism.

One of the major sources of lead in atmosphere is the exhaust fumes coming from cars (Sezgin *et al.* 2003; Gibson and Farmer, 1986.) Apart from that the combustion of fuels such as coal also makes great contribution to the emission of lead into the atmosphere. The main source of the bioaccumulation of lead in human body is food. However environmental factors also play an important role in this process. If we consider that the lead levels in playing grounds are well over 1000 ppm the children are much more prone to the bioaccumulation of this metal in their bodies (Hamamcý *et al.*·1997).

There are so many studies related to the determination of heavy metals such as lead by the use of spectrophotometric (Willis, 1999; Cida *et al.* 2001) and electrochemical (Locatelli and Torsi, 2003 Kaličanin *et al.* 2004) methods. Electrochemical methods with their very low detection limits are very suitable for heavy metal determination. The techniques such as anodic stripping polarography or voltammetry which contains preconcentration step may be suitable for the determination of heavy metals as low as 10^{-7} M by increasing the accumulation time. The detection limits of the stripping methods may be lowered by the use of square wave of differential pulse methods. Jyothi *et al.* (2003) reported the determination of Cd, Pb, Cu and Zn by the use of stripping techniques without any interference. The way of digestion of the sample is as important as the method employed. Generally the digestion of samples is carried out with the use

ORIGINAL ARTICLE

of micro wave apparatus in acidic solvents to eliminate any organic residue which may interfere with the analysis (Somer and Ünal, 2004; Nedeltcheva *et al.* 2005).

The sportsmen are also adversely effected by the amount of heavy metals present in atmosphere and training ground. This effect is aggravated in training time due to increased rate of metabolism. This study is related to the investigation of the Pb levels in blood of the 12 healthy university male basketball players before and after a strenuous training session using square wave anodic stripping voltammetry. The changes in blood levels are tabulated in Table 2. This procedure was repeated after six weeks training period. The players were subjected the same type of diet during this period. The results displayed that the Pb levels in blood was increased after the training session in spite of carefully controlled hygienic conditions of the playing court.

Table.1 The electrochemical analysis conditions of square wave stripping voltammetry.

Deposition potential	–1.250 V
Deposition time	150 s
Scan rate	2 mV
Amplitude	25 mV
Frequency	30 Hz
Rest time	15 s
Stirring rate	350 rpm

MATERIAL AND METHODS

Chemicals and Solutions

All the chemicals used in the digestion of samples, preparation of buffer solutions and standard additions were of analytical grade (suprapure quality). 10^{-2}, 10^{-3} and 10^{-4} M Pb, Cu and Zn solutions were prepared from the dilutions of 0.1M $Pb(NO_3)_2$, $Cu(NO_3)_2$ and $Zn(NO_3)_2$ (Merck) stock solutions. The blood samples taken from the players were digested with nitric acid (Riedel). All the solutions were prepared with de-ionized water.

Taking the samples

The blood samples were taken from the players before and after the training periods at the beginning and end of six week training period. The bloods of the participants were taken by the paramedics with the approval of the ethical committee using sterilized syringes. The samples had been kept in a refrigerator till they were used.

Digestion of the samples

The digestion procedure was carried out in microwave apparatus after taking1 mL of blood and adding 2.5 mL HNO_3 on it. The microwave were kept at 160 °C for five minutes, 190 °C, 100 °C and 80 °C ten minutes each. The totally digested samples were diluted to 10 mL with the addition of de-ionized water (16.8 MΩ).

Voltammetric procedure

The trace elements analyses of the samples were carried out by the use of square wave stripping voltammetry under the conditions given in Table 1. The electrochemical analysis were performed computer controlled CHI660B model potentiostat and BAS CGME hanging

Table 2. The Pb level in players' blood before the training session and after the training session.

Samples	Before the training session		After the training session		Statistics	
	Mean value (µg Pb/dL blood)	**Standard deviation**	**Mean value** (µg Pb/dL blood)	**Standard deviation**	**Difference**	**Percentage change**
Sample 1	1.04	0.194	7.56	0.68	6.52	627
Sample 2	17.18	5.067	10.67	2.23	–6.51	–38
Sample 3	1.49	0.328	7.53	3.52	6.04	406
Sample 4	1.43	0.071	15.27	2.78	13.84	968
Sample 5	5.41	0.528	5.91	0.84	0.49	9
Sample 6	1.12	0.107	4.17	0.96	3.05	273
Sample 7	5.85	0.743	11.57	1.75	5.72	98
Sample 8	2.86	0.050	17.31	2.60	14.45	505
Sample 9	4.48	0.478	10.41	0.70	5.93	132
Sample10	9.06	0.590	11.57	1.77	2.51	28
Sample11	6.83	0.271	15.63	1.45	8.80	129
Sample12	10.88	0.679	20.82	1.61	9.94	91

mercury drop electrode. The working electrode was 100μm capillary mercury electrode and the counter and reference electrodes were a Pt wire and Ag/AgCl (3 M NaCl) electrodes. The residual oxygen in the system was removed by purging Ar gas with spectrophotometric purity. The peak potential for Pb^{2+} was –0.47 V (Ag/AgCl) under the conditions stated in Table 1 (Figure 1).

Analytic procedure

0.5 mL of the samples which had been previously made up to 10 mL were taken into the cell and 2 mL acetic acid-acetate buffer was added to it. The solution was stirred for 2 minutes before the stripping process. The final voltammogram is given in Figure 1. The voltammograms obtained after three standard additions of 20 μL 10^{-4} M Pb solutions were superimposed upon each other. The resulting voltammogram was displayed in Figure 1. The increase in the Pb peak at –0.47 V was evaluated according to standard addition method. The procedure was repeated three times for each and the average value of the amount of Pb in each sample was computed. The blank study revealed that the amount of metal coming from nitric acid and de ionized water was negligible. That was why the amount of Pb found in the blank sample was subtracted from the amount obtained for the samples. The results are tabulated in Table 2 in μg Pb/dL blood together with standard deviations.

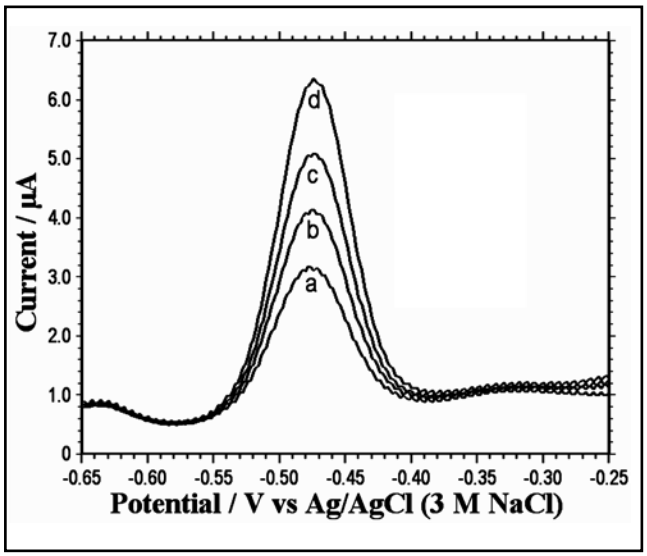

Figure 1. Anodic square wave voltammograms of Pb^{2+} peak located at –0.47 **a)** 0.5 mL sample +2 mL acetic acid-acetate buffer **b)** Addition of 20 μL 10^{-4} M Pb^{2+} **c)** Addition of 40 μL 10^{-4} M Pb^{2+} **d)** Addition of 60 μL 10^{-4} M Pb^{2+}.

RESULTS AND DISCUSSION

As seen from Table 2 except for those obtained for sample 2 all the results indicate significantly increased Pb^{2+} levels in blood after training sessions. This increase of 279% may be attributed increased contact of players with the basketball and atmosphere of the playing ground with increasing breathing rate. The atmospheric lead content of Ankara is given officially as 0.5 ppm by the General Directorate of Enviroment and Forestry.

If we take the fact that the players are at their adolescent ages into account we can expect that this level of lead accumulation may cause neurological complication in future. It was also reported that 10–15 μg/dL Pb in blood may cause neurobehavioral complications in children (WHO, 1996). Pb may cause anemia and other complications. Although clinical manifestations may occur at elevated concentrations its biological effects may be observed at much lower concentrations (Cope, 2004).

CONCLUSION

If we take the fact that 95% of lead in human body accumulates in bones (Cope, 2004), the significant increase in the lead levels of blood after the training session can be attributed to the environmental condition exposed during that period. Therefore the hygiene and cleanliness of the training grounds and materials are of great importance to obviate chronic lead intoxication in people doing sports. The training grounds have to be constructed outside the metropolitan regions away from the city atmosphere with heavy metal pollution. Although the results do not show acute lead intoxication it is obvious that blood lead levels showed a significant increase after training sessions. The average increase in blood lead levels is 297%. As seen in Table 3 the Pb level in blood increased from 5.69±4.99 (μg Pb/dL blood) to 11.54±4.96 (μg Pb/dL blood) after the training session. This difference is highly significant at $p<0.01$ significance level. This three folds increase is largely due to increased respiration rate during the training period. This is an issue which should be seriously addressed.

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Table 3. Statistical evaluation of the blood Pb levels

	Mean (μg Pb/dL blood)	SD	X1–X2	SD of Mean Differences	t-value	Percentage change
Before the training session (n=12)	5.69	4.99	–5.85	5.86	–3.447**	102.81
After the training session (n=12)	11.54	4.96				

**p<0.01

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