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BIOCHEMICAL AND PHYSIOLOGICAL CHANGES IN HANDBALL PLAYERS DURING A SPECIFIC HIGH INTENSITY TRAINING PROGRAM

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INTRODUCTION

At the high performance handball training level the smallest details observation of the specific activity is realised now by compare some of the values of pulse, lactic acid concentration, heart rate or other physiological parameters wich could show us the specific training area in wich our handball players are acting (1, 2, 32, 34).

A physiological and biochemical approach of the specific handball effort is necesary because high performance in team handball means much more than a perfect technique or a perfect colaboration between players during technical–tactical combinations in the official competitions (5, 7, 8).

A depper understanding of the biochemical processes wich are happened in the handball player body it could be a benefit for the future training structures conception, a corect evaluation of the individual resources for a handball player in critical moments of a competititon or specific training structures addaptation, according to the permanent player demandings (24, 25, 26, 28).

Dynamic changing values of the pCO_2 in relation with blood pH and LA blood concentration values is a much more significant marker than LA blood concentration itself for performance; relation between SBC and HCO_3^- indicates metabolic desorders wich take place during specific effort in handball, ABE values makes possible calculation of the LA blood concentration and shows the relation with other physiological parameters, others than VO_2max or breathing threshold as they are analized before (6, 11, 33) .

MATERIAL AND METHOD

Subjects:

Our research included 50 handball players (men) from 5 handball teams wich are acted in the first Romanian League and 50 handball players (women) from 5 handball teams from the same performance level.

Approximately 150-200 microlitre of blood were necessary from midle finger of each player for biochemical determinations using ABL 5 Blood Gase Analizer. The samples were kept in a special frozen kit between the moment of testing and proper analization at the "Lia Manoliu Sports Research Dpt. Center – Bucharest, " where took place all the measurements and interpretations.

The signification of acid-base parameters wich we have analised:

- pH sample – is measured by the pH electrode of the ABL 5, and indicates the acidity or alcalinity of the sample;
- pCO_2 (mmHg)– is measured by the pCO_2 electrode and is the carbon dioxide partial pressure (or tension) in a gas phase in equilibrium with the blood (3,4). High and low pCO_2 values of arterial blood indicate blood hypercapnia and hypocapnia, respectively;
- HCO_3^- sample (mmol/L) – is the concentration of hydrogen carbonate in the plasma of blood sample (also termed actual bicarbonate) and is calculated as stated in Eq.4;
- ABE (mmol/L) – Actual Base Excess, is the concentration of titrable base when the blood is titrated with a strong base or acid to a plasma pH of 7.40 at the pCO_2 of 5,33kPa (40 mmHg) and 37^o C at the actual oxygen saturation (4,5); positive values (base excess) indicate a relative deficit of noncarbonic acids and negative values (base deficit) indicate a relative excess of noncarbonic acids;
- SBE (mmol/L) – Standard Base Excess, is an "in vivo", expresion of a base excess. It refers to a model of the extracellular fluid (one part of blood is diluted by two parts of its own plasma) and is calculated using a standard value for the hemoglobin concentration of the total extracellular fluid (including blood) of 3mmol/L as stated in Eq. 6;
- SBC (mmol/L) – Standard Bicarbonate, is the concentration of hydrogen carbonate in the plasma from blood wich is equilibrated with a gas mixture with pCO_2 of 5,33kPa (40 mmHg) and pCO_2 > 13,33kPa (100 mmHg) at 37^o C(4,5) and calculated as stated in Eq. 7;
- LA blood concentration was calculated using the following formula :

  LA = [(0,5 – ABE) x 7,2] : 9,1 mmol/L;
- R – is the value of the relation between SBC and HCO_3^- (SBC / HCO_3^-), related to 1 values wich is the normal in repause condition. Any variation up and down indicate breathing or metabolic desorders determined by the effort intensity;

RESULTS AND DISCUSSIONS

Our research values are presented in Table1 and Table 2, for each 50 handball players men and women.

At the end of the experiment we found some statistical significant differencies between the beginning and the end of the training at some of our tested biochemical parameters values. Our values indicates an aerobic field of action pointed with some anaerobic periods of effort especially at the men players but at the same time women were caracterised by an aerobic effort even if the intensity of the effort during the training session were same as the competition (3, 9, 10). In our experimental conditions we don't have any alcalosis state, because pH has only decreased evolution (12, 13).

Even if the women teams has been caracterised by an metabolic acidosis (determined by the evolution of the pH and pCO_2) the same acidosis status is present in men teams (but the compensated one), where we have in plus an increased lactic acid concentration (LA) in addition to 20% decreased plasma bicarbonate concentration (HCO_3^-). The interpretation scale has take in considering Sigaard Anderson nomogram for determination of the acidosis or alcalosis players specific status (21, 22, 23).

According to our results we can apreciate that in men teams after training session pH, pCO_2 , HCO_3^-, ABE, SBE and SBC values are decrease, during the statisticaly significant incresed LA blood concentration. At the women teams are the same modifications but with different limits. The modifications induced by the intensive specific effort determine the following effects (14):

- respiratory acidosis;
- respiratory alcalosis;
- metabolic acidosis;
- metabolic alcalosis;

In our experimental conditions we found no alcalosis status after training, pH has only decrease tendency. On the other hand, the incresed values of the plasmatic pCO_2 (because of the hipoventilation) represent the main cause of the decreasing pH values and the respiratory acidosis appearence. The extracellular incresed pCO_2 values will be accompaniated by the incresing H_2CO_3 values (H_2CO_3 as a result of hydrated CO_2) wich will be dissociate in H^+ and $H_2CO_3^-$, but as the buffering capacity will be out of control the pH value will decrease faster.

The respiratory acidosis in one of the most comon cause of the basic – acid disorders. Even a few minutes hipoventilation could cause an acidosis status with pH values of 7,0. In this situations the plasma and spinal cord liquid chemoreceptors will apreciate the plasmatic pCO_2 and excess of the CO_2 it will be eliminate by the hiperventilation induced. If the pulmonary response is not present the kidney response will occure through the incresing secretions of H^+ inside the tubular liquid. Even with intervention of the kidney activity, the recovery of the normal pH values is not possible without any respiratory and circulatory support. Our experimentals data shows a plasmatic decresed pH and pCO_2 values because of the effort stimuli during the training session so we can say that a metabolic acidosis is instaled. According to that it is wellknown that the main cause of the metabolic acidosis is organic acids high accumulation. The (H_2CO_3 - HCO_3^-) buffer sistem it is exceeded by the organic acids H^+ releasing ions and so the pH values start to decrease.

In this experiment, post training LA has increased aproximately 4 times (from 1,67$\pm$ 0,244 mmol/L to 6,0 $\pm$ 0,407 mmol/L), plasmatic bicarbonates decresed 20% aproximately (from 22,12 $\pm$ 0,518 mmol/L to 17,48 $\pm$ 0,58 mmol/L) and 31,6 $\pm$ 0,838 mmHg pCO_2 post training values determine a compensated metabolic acidosis status, (normal rest values of pCO_2 it is 35 - 45 mmHg in men and 32 – 42 mmHg in women) (14, 27).

The LA concentrations could increase in this situation as a result of the stimulated Sympathetic Nervous System because of specifc effort characteristics induced by the hormonal activity. The specific activity of cathecolamines could be a cause of the incresed LA blood concentration (4, 15, 17, 18).

All of this data shows a different kinds of specific effort reactiveness in men and women teams, depending of the level of their own training capacity (19,20). Using the same training structures at the same intensity during training, it could be a benefit for the handball players, both men and women, only in case that the performance level is close enough, and the physiological, biochemical and even psychological profile of the handball players are included in aproximately same limits (16, 29, 30, 31).

CONCLUSIONS

The level of high performance training in handball could be appreciate in small details taking in considering evolution of this biochemical parameters values. According to that, we will point the followings:

- even if pH values are controled by buffering sistems, an untrained person could not perform any physical activity with 7,0 value of this parameter; our handball players as the others athletes could perform for a short period of time physical activity at 6,9 and even lower pH values;
- pCO_2 is an essential parameter because is very unstable during training conditions; in normal conditions the higher pCO_2 values are accompanied by lower values of pH; in untrained persons or not very well trained athletes the relation between this two parameters is different, lower values of pCO_2 are accompanied by the lower pH values; that s why is necessary to point that in high performance athletes, the lower pH values are not accompanied by incresed or decreased values of pCO_2 , the pCO_2 values has to be closed to the normal rest values; very important to mention, the smaller pCO_2 values difference between beginning and finishing training

program we have, the higher performance athletes capacity is possible;
- ABE parameter is necessary for LA blood concentration calculation; LA has to be analised according to pCO_2 values, because the same value of LA blood concentration has a different signification when it is accompanied by two different pCO_2 values (e.g. 22mmol/L , LA blood concentration with pCO_2 = 34 mmHg means that our athelete has a good shape and could perform a higher intens effort and if this 22mmol/L is accompanied by pCO_2 = 24 mmHg, means that our athlete it is completely exhausted with a very important body metabolic desorder; this difference of pCO_2 values could be translated as a 1000m altitude training place for this two athletes);
- The relation between SBC and HCO_3^- has an important signification because is the main metabolic desorder marker; if it is appreciate according with the other parameters values will tell us much more about the physiological and biochemical handball player profile;
- At the highest level of handball performance is good to know that ***acid-base concentration organic desorder produced by the blood concentration of H_2CO_3 has a respiratory origin*** and at the same time, when we found an ***acid-base concentration organic desorder produced by the blood concentration of HCO_3^- this has a metabolic origin.***

REZUMAT

Scopul cercetării de față a fost acela de sublinia în ce măsură stările psihice specifice competiției din jocul de handbal poate influența dinamica unor modificări fiziologice şi biochimice la nivelul handbaliştilor de performanță spre deosebire de antrenamentul specific. Studiul s-a concentrat asupra a 50 de handbalişti cu media de vârstă 23 ± 3,21 ani şi 50 de handbaliste cu media de vârstă 22 ± 2,23 ani. Particularitățile cercetării vor fi prezentate în detaliu în materialul de față. Indicatorii fiziologici testați au fost următorii: pH -ul sanguin, pCO2, (presiunea parțială a CO2 din sânge), pO2 (presiunea parțială a O2 din sânge), HCO3, (bicarbonatul plasmatic actual), BE, (excesul de baze actual), SBE (excesul de baze standard), SBC, (bicarbonatul plasmatic standard), LA (concentrația acidului lactic sanguin), R (coeficientul de dezordine metabolică, CH, (Coeficientul de anxietate - Hamilton). Datele obținute ne-au arătat că în timpul jocurilor oficiale indicatorii fiziologici studiați s-au modificat semnificativ mai puternic ($p< 0,05$) în condiții de anxietate crescută specifică jocurilor oficiale. Se pare că factorii de stress specifici competițiilor din jocul de handbal (atitudinea spectatorilor, prestația arbitrilor, acțiunea antrenorilor, momentele cu încărcătură psihică crescută din timpul jocului, evoluția coechipierilor, pretențiile sponsorilor, imaginea în fața prietenilor şi familiei etc) influențează dinamica valorilor unor indici fiziologici şi biochimici în afara limitelor pregătite în cadrul antrenamentelor specifice cu implicații directe asupra nivelului de performanță atins în jocurile respective.

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