COMPARATIVE STUDY OF PARAMETERS OF ACID-BASE BALANCE IN VENOUS AND ARTERIALIZED CAPILLARY BLOOD OF CALVES

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Abstract: Study was carried out on 16 clinically healthy calves at ages of 3-6 months. The parameters of acid-base balance (pH, pCO₂, pO₂, HCO₃, TCO₂, ABE, SBE, SBC, SAT, O₂ capacity) were measured simultaneously in venous and arterialized capillary blood. The results from the study revealed that the mean, minimum and maximum values of pH, pO₂, ABE, SAT and O₂ capacity were lower in the venous blood while those of pCO₂, HCO₃, and TCO₂ are higher that in the arterialized capillary blood. Wider differences were recorded in the values of the respiratory parameters of venous and arterialized capillary blood. The differences found in the value of the parameters of acid-base balance between both kinds of blood revealed the restricted informative significance of the venous blood. This calls for the use of arterialized capillary blood when it is necessary to assess the acid-base balance.

Key words: acid-base balance, calves, arterialized capillary blood

Introduction

During the 10-15 years of veterinary clinical practice in Bulgaria necessity for further investigation and more knowledge on acid-base balance and its breaches was established. We know that the changes in acid-base balance are the early manifestation or clinical signs of many diseases in domestic animals. Because of this, they are source of information for the early phase of the disease and they have an influence on the clinical signs and the development of the diseases and therapeutic effectiveness and the end of the disease (Brobst, 1983).

Knowing the reference values for every index in each of the domestic animals, facilitates us to do correct valuation and interpretation of the result. The literature date show evidences for the reference values in calves and this makes it difficult to do the interpretation. Same authors (Brobst, 1983; Singh, 2001; Nayto,
2002) think that with the exception of the respiratory components (pCO₂, pO₂) and the SAT, other components are not different in venous and arterIALIZED blood. Other authors (Bergman et al., 1983; Gemelli, 2003) think the opposite way about it – the venous blood is unsuitable for this analysis.

The limited overall research of acid-base balance and specifically for the calves, made it necessary for a research of this kind which purpose was to renew the reference values, redefine the information for the venous and arterialized capillary blood.

**Materials and Methods**

The research was carried out on 16 clinical healthy calves of the Holstein-Frisian breed, age between 3 to 6 months with an average physical body mass of 120-160 kg. For the determination of the parameters of acid-base balance (pH, pCO₂ - partial pressure of carbon dioxide, pO₂ – partial pressure of oxygen, ABE – actual base excess, HCO₃⁻ - actual bicarbonate, TCO₂ – total carbon dioxide, SBE – standard base excess, SBC – standard bicarbonate, SAT – oxygen saturation, and O₂ct –oxygen capacity) was used venous blood, taken from v. jugularis, and arterialized capillary blood, taken from the ear.

The blood samples were taken with the help of original glass capillary with heparin and were examined with an apparatus ABL-3, produced by Radiometer-Denmark. All the result were analysed by Anova.

**Results and Discussion**

The result of the average, minimal and maximal values of the index of acid-base balance are showed in Table 1.

**Table 1. Maximum, minimum and mean values of acid-base balance in venous and arterialized capillary blood of calves n = 16**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Arterialized capillary blood</th>
<th>Venous blood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X ± SX</td>
<td>min</td>
</tr>
<tr>
<td>pH</td>
<td>7.418 ± 0.017</td>
<td>7.351</td>
</tr>
<tr>
<td>pCO₂ kPa</td>
<td>5.81 ± 0.028</td>
<td>4.71</td>
</tr>
<tr>
<td>pO₂ kPa</td>
<td>8.71 ± 1.3</td>
<td>6.41</td>
</tr>
<tr>
<td>HCO₃⁻ mmol/l</td>
<td>24.4 ± 1.6</td>
<td>20.6</td>
</tr>
<tr>
<td>TCO₂ mmol/l</td>
<td>25.4 ± 1.8</td>
<td>21.1</td>
</tr>
<tr>
<td>ABE mmol/l</td>
<td>+1.80 ± 0.7</td>
<td>-2.1</td>
</tr>
<tr>
<td>SBE mmol/l</td>
<td>+2.0 ± 0.6</td>
<td>-2.0</td>
</tr>
<tr>
<td>SBC mmol/l</td>
<td>24.0 ± 1.1</td>
<td>20.3</td>
</tr>
<tr>
<td>SAT %</td>
<td>89.1 ± 4.0</td>
<td>79.1</td>
</tr>
<tr>
<td>O₂ct vol %</td>
<td>17.9 ± 2.8</td>
<td>14.1</td>
</tr>
</tbody>
</table>

* P < 0,05; ** P < 0,01; *** P < 0,001
The average values for pH in the venous blood are 0.040 lower than the ones of the arterialized capillary blood. Approximately 0.030 is the difference between the maximal and minimal pH indexes of the two kinds of blood. The average \((7.378 \pm 0.025)\) and the maximal \((7.411)\) indexes of pH in the venous blood are over taken with the minimal \((7.351)\) and the average \((7.418 \pm 0.017)\) pH indexes in the arterialized capillary blood.

The partial pressure of the pCO2 in the venous blood is 0.70-1.72 kPa higher than the one in the arterialized capillary blood. The biggest differences are found between the maximal indexes of the venous and arterialized capillary blood (1.72 kPa), the lowest are between their minimal indexes (0.70 kPa). In comparison with the pCO2, the partial pressure of the oxygen (pO2) in the venous is from 53 to 64 % lower compared to the arterialized capillary blood. Similar substantial differential rate are found for SAT and O2 vol.% were average minimal and maximal indexes for SAT in the venous blood are 44-57 %, for O2 vol.% are 48-63% lower than the ones of the arterialized capillary blood.

The average indexes of HCO3 and TCO2 in the venous blood are respectively with 2.7 and 3.5 mmol/l higher than the capillary ones. Differences are also found for the ABE, which average indexes in the venous blood are with 2.4 mmol/l lower than the capillary ones.

The analysis of the results for the average (X), minimal and maximal (max) values of the indexes of the acid-base balance of the venous and arterialized capillary blood show that the values of the pH, pO2, ABE, SAT and O2 vol.% in the venous blood are lower, and for pCO2, HCO3 and TCO2 are higher than the arterialized capillary blood. In the meantime the acquired results between the maximal and minimal values of pH, HCO3, TCO2 and ABE of the venous and capillary blood are narrower, and the ones for pCO2, pO2, and SAT are substantially wider. Sluijs et al. (1993) and Waizenhofer et al. (1998) discuss similar differences between the indexes of the venous and arterialized capillary blood of dogs and calves. According to these authors the values of the indexes of acid-base balance in the arterialized capillary blood are closer to the arterial rather than the venous blood.

The result acquired by us for the venous blood of calves are different that the ones of Nangia et al. (1982) and Sobti et al. (1995) who find higher indexes for pH and lower for pCO2, HCO3 and TCO2. The insufficient date for the these of arterialized capillary blood when use for an examination of blood analyses of calves does not allow to be done a better comparison of our results with the results of other authors. The values of pH, pO2 and HCO3 of the arterialized capillary blood found in our result are closer to the date found by Singh (2001) who used blood from a. carotis, rather than Nangia and Sobti who used venous blood.

Apart from the bigger differences of the established values for the respiratory indexes (pCO2, pO2) and SAT between arterialized and venous blood,
the values of the metabolitic component (HCO₃, ABE) of the acid-base balance and the blood pH of the both blood types overlap to a certain degree. For example, the average and minimal values of HCO₃ and TCO₂ in the venous blood overlap any with the average and maximal values of the arterialized capillary blood, the found borders for ABE of the venous (from -3.1 to +2.8 mmol/l) cover the whole values of the arterialized. This we can accept than the venous blood of calves can be used only for assessing pH and HCO₃. For the respiratory component (pCO₂, pO₂) and SAT the venous blood does not give a clear idea.

**Conclusion**

The overall assessment of the informative value of the venous blood shows that it is not suitable for the evaluation of acid-base balance. Because of this for the research arterialized capillary blood is used.

**Komparativno ispitivanje parametara ravnoteže kiselina-baza u venskoj i arterijskoj krvi u kapilarima goveda**

**Rezime**

Ispitivanje je urađeno na 16 grla klinički zdrave teladi u uzrastu od 3 do 6 meseci. Parametri ravnoteže kiselina-baza (pH, pCO₂, pO₂, HCO₃, TCO₂, ABE, SBE, SBC, SAT, O₂ kapacitet) su mereni istovremeno u venskoj i arterijskoj krvi u kapilarima.

Rezultati ispitivanja su pokazali da su srednje, minimalne i maksimalne vrednosti pH, pO₂, ABE, SAT i O₂ kapaciteta bile niže u venskoj krvi dok su vrednosti za pCO₂, HCO₃, i TCO₂ bile više od onih u arterijskoj krvi. Razlike su zabeležene i u vrednostima respiratornih parametara venske i arterijske kapilarne krvi.

Utvrđene razlike parametara kiselo-bazne ravnoteže obe vrste krvi su pokazale restriktivnu informativnu signifikantnost venske krvi. To zahteva korišćenje arterijske krvi u ispitivanjima kiselo-bazne ravnoteže.
References


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