Monitoring of some metabolic parameters in Comisana lambs during the neonatal period

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SUMMARY

Introduction - The neonatal period represents a critical stage in development of physiological functions. During this phase morphological, physiological and behavioral changes take place in newborn animals to permit a successful adaptation to the extra-uterine environment. Moreover, newborn lambs have limited energy reserves and need a rapid access to colostrum to maintain homeothermy and survive. In addition to energy, colostrum provides proteins, including immunoglobulins, which ensure passive systemic immunity. Therefore, getting early access to the udder is essential for the neonate.

Aim - The purpose of this study was to monitor rectal temperature and the course of some metabolic parameters (serum total proteins, albumin, total cholesterol, triglycerides, creatinine and urea) of ten newborn lambs (Comisana breed) during the first 30 days of life in order to obtain useful information for neonatal care.

Material and methods - For each animal rectal temperature was recorded using a digital thermometer (HI92704, Hanna Instruments Bedfordshire, UK) with the probe being inserted to a depth of 9 cm. From all animals blood samples were collected by jugular venipuncture at the same hour (9:00) every 3 days for 30 days starting from birth. By means of an UV Spectrophotometer, the serum concentration of total proteins, albumin, total cholesterol, triglycerides, creatinine and urea were determined. One-way repeated measures analysis of variance (ANOVA), followed by Bonferroni’s Test, was used to determine statistically significant differences.

Results and discussion - Data analysis of variance showed a statistical effect of days of life on total proteins (P<0.0003), albumin, total cholesterol, triglycerides, creatinine and urea (P<0.0001) during the first 30 days of life, while no statistical significant effect of days of life on creatinine (P=0.09) and rectal temperature (P=0.06) is showed during the experimental period.

Conclusion - The results obtained in this study make a contribution to the knowledge of physiological and metabolic modification in lambs during the first 30 days of life and give useful information for the diagnosis and treatment of neonatal diseases.

KEY WORDS

Lambs; neonatal period; development; serum parameters.

INTRODUCTION

The ovine specie is one of the most economically important among ruminants in the livestock production, thus a better knowledge of its physiologic characteristics, in particular during the neonatal phase, is required. In fact, it is well known, that the most vulnerable period in the life of any animal is the period before and immediately after birth. Birth and the immediate postpartum period is a time of rapid development as the lamb undergoes a transition from uterine to independent postnatal life, accompanied by the onset of breathing and thermoregulation, shifts in cardiovascular patterns, and changes from placental nutrition to oral ingestion of nutrients. These involve a series of maturational processes in the fetal lamb before birth that must be coordinated with the birth process and behavioral responses after birth for a successful transition.

In precocious species, such as sheep, the role of neonate behavior in ensuring survival becomes increasingly important and may be at least as important as that of the mother1. The lamb is also an important source of sensory stimuli to the ewe to ensure that maternal behaviour continues to be expressed towards the lamb.

The physiological status at birth and the perinatal factors might predispose newborn animal to debility and death that is more relevant during the first days of life4,5. Factors affecting the risk for neonatal deaths have been evaluated in several studies. Birth difficulties, which may lead to injuries or weak lambs, are also an important risk factor. Feeding and breeding strategies directed towards increased litter size have resulted in increased number of triplet and higher order litters, which are associated with decreased lamb survival. Infections caused by various pathogens can be
an important cause of neonatal deaths in some flocks but are generally not of major importance. Specific hematological and serum biochemical reference ranges could help to promote the ability of clinicians to more accurately interpret clinical pathology data and diagnose neonatal disease. Moreover, a substantial proportion of neonatal disease or death could be prevent by good management techniques and by early intervention, diagnosis and treatment of situations that involve a high-risk for newborn, such as the non-early approach and suckling of lamb to the ewe. In fact, it is well shown that intake of colostrum shortly after birth is critical for lamb survival. Being born with limited energy reserves, lambs depend on colostrum as an essential source of nutrients. Starvation and hypothermia owing to insufficient colostrum intake are reported to be major causes of neonatal mortality. In fact, lambs that fail to suck successfully from their mothers rapidly deplete their body reserves and are at risk of hypothermia and starvation which may account for nearly half of all perinatal deaths. The composition of maternal colostrum also contributes to the available lipids for neonatal metabolism; ewe colostrum is relatively high in lipid compared to either human or sow colostrum. Moreover, another important function of colostrum is to transfer antibodies from the mother to the young before its own immunological protection becomes fully functional. For species having an epitheliochorial placental, such as sheep, the process of protein transfer, and in particular immunoglobulins, from the mother’s colostrum is of paramount importance to neonatal survival, since these compounds do not cross the placental barrier and thus newborn lambs are hypo-immunocompetent at birth and are characterized by a small store of energy for heat production and metabolism. Total proteins contribute profoundly to neonate immunity and growth, not only because of immunoglobulin content, but also because of other nutritional and physiological effects on the newborn. At birth, serum protein levels of most animals are quite low due to the minimal quantities of immunoglobulins and low albumin. Several studies demonstrated that parameters such as serum total proteins, albumin, electrolytes pattern and other biochemical parameters are involved in changes typical of the neonatal period, influenced also by the intake of the first colostrum. Given the importance of having physiological reference values as indicators of dynamic homeostatic processes taken place during neonatal period, the aim of this study was to monitor rectal temperature, and to evaluate the course of some metabolic parameters (serum total proteins, albumin, total cholesterol, triglycerides, creatinine and urea) in ten newborn Comisana lambs during the first month of life in order to make a contribution to the knowledge of the physiology of this ruminant species during the early period of extrauterine life and to obtain useful information for neonatal care.

MATERIAL AND METHODS

Ten clinically healthy female lambs (Comisana breed) were used in this study carried out in spring, in Sicily (Italy). The animal with a mean body weight at birth of 5.6 ± 0.7 kg, were feed only with colostrum and maternal milk and were kept in a sheltered pen. Lambs were allowed to suck ewes ad libitum. Their health status was evaluated daily based on behavior, rectal temperature, heart rate, respiratory profile, cough, nasal discharge, ocular discharge, appetite, fecal consistency and navel examination. During the experimental period, no abnormalities, such as fever, anorexia, depression, soft feces, or other condition that can alter the studied parameters, were observed.

Rectal temperature was recorded using a digital thermometer (HI92704, Hanna Instruments Bedfordshire, UK) with the probe being inserted to a depth of 9 cm. Body weight was measured by means of an electronic scale (Detecto Vet 400 Digital Vet Scale, Central Carolina Scale, North Carolina).

For each lamb blood samples were collected by jugular venipuncture using Vacutainer tubes without anticoagulant (Terumo Corporation, Japan) at the same hour (9:00) every 3 days for 30 days starting from birth. Blood samples were allowed to coat at room temperature (20°C) and centrifuged at 1,000 g 10 minutes to separate serum. Sera obtained were dispensed into plastic tubes and stored at -20°C until analyses. Sera, not lipemic neither hemolyzed because of possible interference with the biuret method, were analysed with commercially available kits by means of an automated analyzer UV Spectrophotometer (model Slim SEAC, Florence, Italy). The serum concentrations of the following blood parameters were measured: total proteins, albumin, total cholesterol, triglycerides, creatinine and urea.

All housing and care conformed to the standard recommended by the Guide for the Care and Use of Laboratory Animals and Directive 86/609 CEE.

STATISTICAL ANALYSIS

One-way repeated measures analysis of variance (ANOVA) and Bonferroni Test of a multiple comparisons were used to determine statistical differences between mean values of the studied parameters from the 1st to the 30th day of the observation period. P values < 0.05 were considered statistically significant.

Data were analyzed using the software STATISTICA 5.5 (Statsoft Inc., USA).

RESULTS

In Table 1 the mean values of blood parameters measured in ten newborn lambs during the first month of life are set out with the respective Standard Deviations (± SD). The rectal temperature measured during the first month of life ranged between 39.6 °C and 40.3 °C with an average value of 39.9 ± 0.2 °C. Figure 1 shows the mean values (± SD) of rectal temperature recorded during the experimental period.

One-way repeated measures analysis of variance (ANOVA) has revealed a significant statistical effect of days of life on total proteins (P<0.0003), albumin, total cholesterol, triglycerides (P<0.0001), and urea (P=0.0002) during the first 30 days of life (Figure 2), while no statistical significant effect of days of life on creatinine (P=0.09) and rectal temperature (P=0.06) are found during the monitoring.
The maintenance of homeothermy is a combination of the ability to generate endogenous heat and to reduce heat loss to the environment. It is known that the thermoregulatory capability of lambs is rather limited at birth and is dependent on glycogen reserves and the thickness of the adipose pancrēce. In this study the rectal temperature measured during the first month of life ranged between 39.6°C and 40.3°C, with no significant differences being recorded. The lack of lower temperature values at birth in lambs could be explained by the maturity at birth of this specie and the lack of significant differences of this parameter, confirms the performance in the newborn lamb regarding the thermal homeostasis mechanisms from first days of life. In fact, the efficiency of these thermal homeostatic mechanisms in the offspring is confirmed by the existence of a rhythmic pattern of body temperature that emerges within the first 10 days of life fully maturing during the first month of life.

**DISCUSSION**

As well shown in literature, the neonatal period demands extreme physiological, morphological, and behavioral changes to permit a successful adaptation to the extrauterine environment. The clinical follow-up of newborn lambs may allow for the early diagnosis of neonatal adaptation failure and the establishment of corrective procedures to avoid a lethal outcome, such as acid-base imbalance adjustment, and this latter is the main source of fatty acids. This could easily account for the almost immediate onset of the rise. Moreover, difference recorded for these parameters may reflect variations in suckling activity and amount of colostrum ingested, in fact the lambs of this study were allowed to suck ewes ad libitum. Has been observed that in monogastric animals the fat composition appears to be strictly dependent on the type of diet, and, in young ruminants is directly influenced by qualitative and quantitative characteristics of the fat contained in the milk. Another nitrogen metabolism's parameter evaluated in this study was urea. Urea concentration was a useful indicator of the status of protein metabolism and changes in urea concentrations were a reflection of changes in both dietary nitrogen and urea metabolism studied in ten newborn lambs during the first month of life.

Examining blood for their constituents is a good tool to monitor and evaluate health and nutritional status of animals. Our results, obtained during the first 4 weeks postpartum, showed a significant effect of days of life on total proteins, albumin, total cholesterol, triglycerides, creatinine and urea during the first month of life while no difference was found on creatinine and rectal temperature. According to other authors, that studied the course of these parameters in foals, calf, and kids, reflects the albumin’s medium half-life that ranges from 14 to 16 days in ruminants, after which period the liver is responsible for albumin synthesis. Total cholesterol and triglycerides showed a statistical changes with a similar trend during the monitoring. In particular these parameters after an increase within the first week, showed a gradual decrease until the third week, and then started to increase towards the end of the monitoring (from day 22 to day 28). Differences on total cholesterol and triglycerides, in particular increasing levels of these parameters during the first days of life, were to be expected. In fact, all animals were fed only with maternal milk and colostrum and this latter is the main source of fatty acids. This could easily account for the almost immediate onset of the rise. Moreover, difference recorded for these parameters may reflect variations in sucking activity and amount of colostrum ingested, in fact the lambs of this study were allowed to suck ewes ad libitum. Has been observed that in monogastric animals the fat composition appears to be strictly dependent on the type of diet, and, in young ruminants is directly influenced by qualitative and quantitative characteristics of the fat contained in the milk. Another nitrogen metabolism’s parameter evaluated in this study was urea. Urea concentration was a useful indicator of the status of protein metabolism and changes in urea concentrations were a reflection of changes in both dietary ni-

**Table 1** - Mean values (± Standard Deviations) of metabolic parameters (serum total proteins, albumin, total cholesterol, triglycerides, creatinine and urea) studied in ten newborn lambs during the first month of life.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Day 1</th>
<th>Day 4</th>
<th>Day 7</th>
<th>Day 10</th>
<th>Day 13</th>
<th>Day 16</th>
<th>Day 19</th>
<th>Day 22</th>
<th>Day 25</th>
<th>Day 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Proteins (g/dL)</td>
<td>6.21±0.34</td>
<td>6.40±0.45</td>
<td>6.66±0.45</td>
<td>6.28±0.32</td>
<td>6.39±0.34</td>
<td>6.71±0.47</td>
<td>6.36±0.31</td>
<td>6.68±0.48</td>
<td>6.35±0.29</td>
<td>6.62±0.39</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.55±0.33</td>
<td>3.84±0.57</td>
<td>3.26±0.24</td>
<td>2.99±0.27</td>
<td>2.84±0.30</td>
<td>2.79±0.24</td>
<td>2.90±0.23</td>
<td>3.06±0.22</td>
<td>3.00±0.25</td>
<td>3.14±0.28</td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>40.22±16.58</td>
<td>46.11±16.98</td>
<td>40.78±7.68</td>
<td>35.44±10.83</td>
<td>33.78±10.18</td>
<td>44.78±13.11</td>
<td>38.67±14.48</td>
<td>41.56±5.72</td>
<td>52.1±10.93</td>
<td>55.3±29.24</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.97±0.30</td>
<td>0.98±0.17</td>
<td>1.06±0.16</td>
<td>0.97±0.22</td>
<td>1.03±0.22</td>
<td>1.11±0.04</td>
<td>1.09±0.05</td>
<td>0.98±0.17</td>
<td>0.94±0.20</td>
<td>1.01±0.11</td>
</tr>
<tr>
<td>Urea (mg/dL)</td>
<td>30.63±11.28</td>
<td>40.23±9.42</td>
<td>34.81±2.92</td>
<td>32.80±5.97</td>
<td>32.14±5.66</td>
<td>32.36±3.54</td>
<td>30.34±3.43</td>
<td>30.88±6.13</td>
<td>30.62±4.95</td>
<td>30.36±7.77</td>
</tr>
</tbody>
</table>

![Figure 1](image-url) - Mean values (± Standard Deviation) of rectal temperature recorded in ten lambs during the first month of life.
Our results showed significant statistically difference of urea during the first month of life. The highest levels of this metabolite were recorded within the first week of life with the major peak at the fourth day. After this period urea levels showed a decrease until the end of monitoring. The reason why urea concentration was higher within the first week of life was probably due to the richer protein content of colostrum indicating increased protein utilization, while the decrease of urea after the first week could have been due to the conversion of colostrum to normal milk in the ewes.

CONCLUSION

In conclusion we can affirm that modifications of the studied parameters could be attributed to functional development of lambs in neonatal period, and in particular, accor-
ding to Massimini et al., 2006\textsuperscript{22}, indicate that intake of colostrum and passive transfer status was a significant source of variation in preweaning growth performance in dairy lambs. Moreover, the results obtained in this study makes a contribution to the knowledge on the metabolic changes in the lamb during the first month of life and providing useful information for monitoring those parameters whose homeostasis, still evolving, it should be interpreted dynamically as a function of the period of neonatal adaptation. Better knowledge of these parameters in lambs based on their physiologic status and diet is of great importance being used to aid the diagnosis and treatment of any neonatal diseases.

References