Evaluation of the effect of birth type on the blood gas and Apgar scores of Aleppo goat newborn kids

Research Article

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ABSTRACT

This study was conducted to investigate the effect of eutocia and dystocia on the blood gas and Apgar scores of Aleppo goat kids. A total of 40 kids were examined, separated into 2 groups according to the type of birth. Group 1 (n=20) consisted of kids born as a result of eutocia, and the Group 2 (n=20) included kids born as a result of dystocia. The Apgar scores (appearance, pulse, grimace, attitude, respiration) were evaluated at 0, 5, and 15 minutes postpartum in the kids in both study groups, and blood samples were taken from blood gas injectors and blood gas profiles (pH, pCO_2, pO_2, HCO_3) were obtained. The data obtained were analyzed with the Mann-Whitney U-test and Friedman post-hoc Bonferroni tests. Spearman correlation coefficients were calculated to determine the relationships between measurements. A statistically significant difference was observed between the groups in the 0, 5, and 15-min Apgar scores and in the blood gas measurements of pH, pO_2, pCO_2, and HCO_3 at 0, 5, and 15 minutes ($p<0.05$). A significant time-dependent difference in Apgar score value was noted in both groups ($p<0.05$). There was a significant time-dependent difference in pH, pCO_2, pO_2, and HCO_3 values in both groups ($p<0.05$). In Group 1, a significant correlation was determined between Apgar and pCO_2 and HCO_3 values ($p<0.05$). In Group 2, a significant correlation was recorded between Apgar and HCO_3 values ($r=-0.464$; $p<0.05$). As a result, a significant difference was observed between the mode of delivery and the blood gases evaluated and Apgar scores. It was concluded that the evaluation of Apgar score and blood gases together would be more successful in neonatal interventions.

Keywords: Kid, dystocia, blood gases, Apgar

INTRODUCTION

The neonatal period is a critical period for the adaptation of newborn lives to the extrauterine environment (Piccione et al., 2007). This period is significantly affected by the pregnancy process, the mode of delivery and the quality of postpartum care (Türkoğlu et al., 2014). The adaptation processes of thermoregulation, cardiovascular, respiratory, metabolic and homeostatic mechanisms are completed during this period (Dwyer, 2008). Newborn lives are sensitive to adverse environmental conditions and perinatal diseases, and their metabolic status is highly variable (Piccione et al, 2007). During this period, numerous changes occur in different systems and organs, including respiratory function and acid-base balance (Camargo et al, 2012). Newborns may die due to trauma and prolonged hypoxia during delivery (Feitosa et al, 2012). Intrapartum hypoxia is of great importance in terms of newborn losses due to dystocia (Scott, 2006).

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The Apgar scoring system was developed in human medicine to guide the clinical care of neonatal life immediately after birth. The Apgar scoring system was designed by Virginia Apgar, a human obstetric anesthesiologist, to monitor the effects of maternal anesthesiology on the newborn infant (Apgar, 1953). This method is widely and effectively used worldwide in the evaluation of newborns (Kredatusova et al., 2011). Adaptation of the original method to veterinary medicine was developed with great success (Vassalo et al., 2014). The Apgar score of lambs, modified by Born (1981), showed clinical signs of neonatal health and vitality conditions in a minimally invasive manner without impairing the mother-offspring relationship. The Apgar score was evaluated in 5 categories: Appearance, pulse, grimace, attitude, and respiration. Each parameter is scored with 0, 1, or 2 points, and the total of these is evaluated as 7-10 points indicating a healthy newborn, 4-6 points as moderate, and 0-3 points as severe depression (Apgar, 1953; Nelson ve Ellenberg, 1981). Total Apgar scores, which are used as a basis for resuscitation intervention, have been found to increase survival rates, and lower Apgar scores have been associated with higher mortality in the offspring (Vassalo et al., 2015; Veronesi et al., 2009). Although Apgar scoring has been used for approximately 50 years, it is a subjective method for reasons such as prematurity, congenital anomalies, gestational age, medication or anesthesia type applied to the mother, and the person who made the scoring (Gilstrap et al., 1989). Therefore, umbilical cord blood gas values have been accepted as a more reliable method of showing fetal oxygenation and acid-base status (Thorpe et al., 1989).

The aim of this study was to reveal the effect of birth type on venous blood gases and Apgar scores in Aleppo goat kids. Furthermore, as there is no information in literature about blood gases and Apgar score evaluations related to the mode of birth in kids, it was thought that this study could contribute to the literature in this context. Thus, it is aimed to obtain healthier kids with and less loss of newborns.

MATERIAL and METHOD

Animal selection and experimental protocol

The study material consisted of 40 kids that were born on a private farm in the Eyyübiye District of Şanlıurfa. The offspring were selected by a random sampling method of Aleppo goats aged 3-5 years, who had one birth and were under the same feeding and management conditions. The goats used in the study had eutocia in the anamnesis taken, no postpartum problems, and only singleton animals were included in the study in order to objectively evaluate the parameters considered. The study was conducted between September and April. The kids were separated into 2 groups according to the birth types. Group 1 (n=20) consisted of kids born through eutocia (normal birth, natural birth without any complications), and Group 2 (n=20) included kids born through dystocia (difficult birth, difficulty or abnormal course of delivery). Dystocia was defined as the total time to delivery exceeding 90 minutes or when the fetal membranes ruptured and there was no progression for 30 minutes.

Blood gas and Apgar score evaluation

Venous blood gas levels (pH, pCO_2, pO_2, HCO_3) were determined from blood samples withdrawn into blood gas injectors from the kids in both study groups at 0, 5, and 15 minutes postpartum. The venous blood gas (pH, pCO_2, pO_2, HCO_3) measurements were performed using an Epoc® Blood Analysis System device Apgar score evaluations were made with reference to the Apgar score assessments by Flora et al. (2020). Appearance was numerically determined as cyanotic, pale, or pink. Pulse and respiration were measured indirectly through the ear set with a pulse oximeter (Vzn medical finger-type oxygen measuring device). Grimace was evaluated by gently tickling the nasal mucosal surface of the kids. Attitude was determined according to the reaction of the kids with stimulation to the pelvis region.

Statistical analysis

Statistical analysis of the data was performed with the *Statistical Package for the Social Sciences* (SPSS for Windows; version 25.0) software. In calculating the sample size of the study, Power was determined by taking at least 80% and Type-1 error of 5% for each variable. The conformity of the variables to normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). As the measurements did not show normal distribution, non-parametric tests were applied. Descriptive statistics for continuous variables in the study were expressed as mean, standard deviation, minimum, and maximum values. The Mann-Whitney-U test was applied to compare the measurements according to the type of delivery. The Friedman test was applied to compare the measurements according to time, separately in the groups. The post-hoc Bonferroni multiple comparison test was applied to determine the difference over time following the Friedman test. Spearman correlation coefficients were calculated to determine the relationships between measurements. A value of $p<0.05$ was considered statistically significant.

RESULTS

The mean values of the study groups are presented in Table 1 and Figure 1. A statistically significant difference was observed between the groups in the Apgar score at 0, 5, and 15 minutes and in the blood gas measurements of pH, pO_2, pCO_2, and HCO_3 at 0, 5, and 15 minutes ($p<0.05$). In the evaluation of the Apgar score at 0, 5 and 15 minutes between the groups, and the pH, pO_2 and HCO_3 blood gas measurements at 0, 5, and 15 minutes, the values of the eutocia group were found to be higher than those of the dystocia group ($p<0.05$), and the pCO_2 measurement was higher in the dystocia group than in the eutocia group ($p<0.05$). A statistically significant difference was observed in Apgar score value according to time in both groups ($p<0.05$). In Group 1, the Apgar score at 0 minutes was lower than at the other times ($p<0.05$). The 5 and 15-min Apgar scores were similar ($p>0.05$). A statistically significant difference was observed in the time-dependent Apgar score evaluations in Group 2 ($p<0.05$). All Apgar scores were found to be different from each other, as the Apgar score increased as time progressed. A statistically significant difference was observed in both groups in terms of pH value according to time ($p<0.05$). In Group 1 and Group 2, pH values were different from each other at all measurement times ($p<0.05$). The pH value increased in both groups as time progressed. A statistically significant time-dependent difference was observed in terms of PCO_2 value in both groups ($p<0.05$). In Group 1 and Group 2, pCO_2 values were different from each other at all measurement times ($p<0.05$). In both groups, the pCO_2 value decreased as time progressed. A statistically significant time-dependent difference was observed in terms of pO_2 value in both groups ($p<0.05$). In Group 1 and Group 2, pO_2 values were different from each other at all measurement times ($p<0.05$). In Group 1, the pO_2 value decreased as time progressed. In Group 2, the pO_2 value first increased and then decreased as time progressed. There was a statistically significant time-dependent difference in HCO_3 value in both groups ($p<0.05$). HCO_3 values were found to be different from each other in all measurement times in Group 1 and Group 2 ($p<0.05$). In Group 1, the HCO_3 value decreased as time progressed. In Group 2, the

HCO_3 value first increased and then decreased as time progressed.

The results of the correlation analyses between the Apgar scores and blood gas values measured in Group 1 are given in Table 2. A statistically significant correlation was found between Apgar-0 and pCO_2-5 values ($p<0.05$). This relationship was 45.8% negative, and it was determined that the Apgar-0 score decreased as pCO_2-5 increased. A statistically significant correlation was found between Apgar-5 and pCO_2-5 values ($p<0.05$). It was observed that this relationship was 47.6% negative, and as pCO_2-5 increased, the Apgar-5 score decreased. A statistically significant correlation was found between Apgar-0 and HCO_3-15 values ($p<0.05$). It was observed that this relationship was 46.0% positive, and as HCO_3-15 increased, the Apgar-0 score also increased. A statistically significant correlation was found between Apgar-5 and HCO_3-15 values ($p<0.05$). This relationship was 55.6% positive, and as HCO_3-15 increased, the Apgar-5 score increased. The results of the correlation analyses between the Apgar scores and blood gas values measured in Group 2 are given in Table 3. A statistically significant correlation was found only between Apgar-0 and HCO_3-5 values ($p<0.05$). This relationship was negative at 46.4%, and as HCO_3-5 increased, the Apgar-0 score decreased.

Table 1. Average values of the study groups

	Group 1				Group 2				*p.
	Mean	SEM	Min.	Max.	Mean	SEM	Min.	Max.	
Apgar-0	7,45[b]	1,64	5,00	10,00	6,10[c]	1,89	4,00	10,00	0,021
Apgar-5	8,45[a]	1,50	5,00	10,00	7,05[b]	1,70	5,00	10,00	0,009
Apgar-15	8,95[a]	1,10	7,00	10,00	7,60[a]	1,60	5,00	10,00	0,004
****p**	0,001				0,001				
pH-0	7,32[c]	0,01	7,30	7,34	7,30c	0,01	7,28	7,31	0,001
pH-5	7,35[b]	0,01	7,34	7,36	7,32[b]	0,01	7,31	7,33	0,001
pH-15	7,39[a]	0,01	7,38	7,40	7,36[a]	0,01	7,35	7,37	0,001
****p**	0,001				0,001				
pCO_2-0	56,73[a]	0,13	56,51	56,91	59,39[a]	0,33	59,01	59,96	0,001
pCO_2-5	52,57[b]	0,28	52,12	52,98	56,40[b]	0,29	56,02	56,98	0,001
pCO_2-15	47,46[c]	0,30	47,02	47,98	51,48[c]	0,25	51,03	51,97	0,001
****p**	0,001				0,001				
pO_2-0	22,39[a]	0,33	22,01	22,92	17,33[b]	0,26	17,01	17,91	0,001
pO_2-5	20,46[b]	0,26	20,07	20,97	18,39[a]	0,19	18,05	18,69	0,001
pO_2-15	17,45[c]	0,23	17,02	17,89	14,50[c]	0,27	14,02	14,89	0,001
****p**	0,001				0,001				
HCO_3-0	31,43[a]	0,29	31,02	31,92	28,41[b]	0,25	28,09	28,81	0,001
HCO_3-5	30,64[b]	0,26	30,12	30,98	29,56[a]	0,23	29,12	29,97	0,001
HCO_3-15	28,46[c]	0,28	28,01	28,94	27,59[c]	0,29	27,04	27,97	0,001
****p**	0,001				0,001				

* Significance levels according to Mann-Whitney-U test results→
** Significance levels according to Friedman test results↓
a,b,c: Shows time-to-time differences according to Bonferroni Post Hoc multiple comparison test↓

Table 2. Correlation analyses between the Apgar score and blood gases measured in Group 1

		Apgar-0	Apgar-5	Apgar-15
pH-0	r	0,050	0,089	0,155
pH-5	r	0,227	0,038	0,174
pH-15	r	0,386	0,334	0,360
pCO_2-0	r	0,077	0,227	0,142
pCO_2-5	r	-0,458*	-0,476*	-0,371
pCO_2-15	r	0,329	0,290	0,125
pO_2-0	r	-0,152	-0,034	0,346
pO_2-5	r	0,267	0,368	0,300
pO_2-15	r	0,188	0,198	0,366
HCO_3-0	r	0,129	0,041	0,066
HCO_3-5	r	0,080	0,216	-0,002
HCO_3-15	r	0,460*	0,556*	0,431

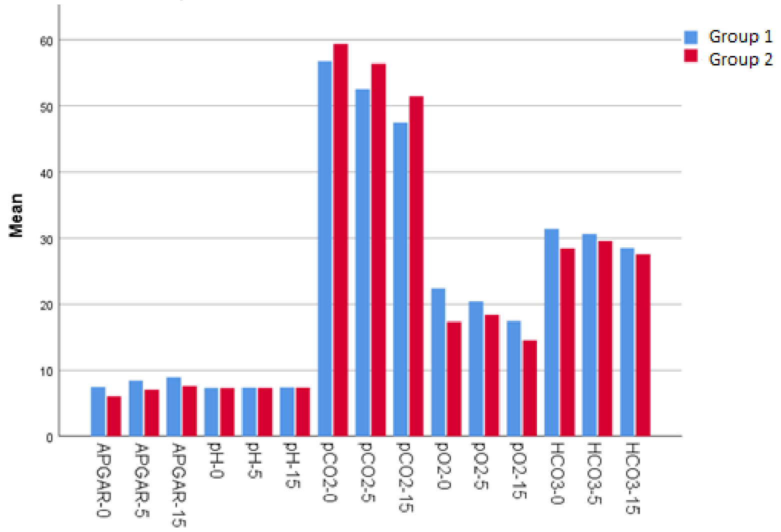
*p<0.05; **p<0.01 r: Spearman correlation coefficients

Table 3. Correlation analyses between Apgar score and blood gases measured in Group 2

		Apgar-0	Apgar-5	Apgar-15
pH-0	r	-0,344	-0,140	-0,093
pH-5	r	0,090	0,177	0,263
pH-15	r	0,283	0,111	0,313
pCO_2-0	r	0,099	-0,113	-0,089
pCO_2-5	r	-0,065	0,063	0,036
pCO_2-15	r	-0,169	-0,106	-0,107
pO_2-0	r	-0,076	0,020	0,057
pO_2-5	r	0,144	0,037	-0,052
pO_2-15	r	0,103	0,364	0,388
HCO_3-0	r	-0,031	0,096	0,195
HCO_3-5	r	-0,464*	-0,422	-0,409
HCO_3-15	r	-0,029	-0,055	-0,095

*p<0.05; **p<0.01 r: Spearman correlation coefficients

Figure 1. Average values of the study groups



DISCUSSION

The Apgar scoring system, which is applied as an evaluation criterion for the reduction of newborn losses, has been adapted and studied on pigs (De Roth ve Downie, 1976; Randall, 1971), horses (Vaala et al., 2002), calves (Vaala et al., 2002), dogs (Veronesi et al., 2009), donkeys (Bonelli et al., 2020), and sheep (Dutra ve Banchero, 2011), but to the best of our knowledge, no studies have been conducted on kids. In the previous animal studies, only Apgar score evaluation was made, and evaluation was not performed together with fetal blood gas values. The aim of the present study was to reveal the effect of delivery method on venous blood gases and Apgar scores. It was also aimedto evaluate the parameters subjectively evaluated with the Apgar score and venous blood gases and to determine whether there is any relationship between these.

In Apgar scoring, respiration has been measured by counting breaths/minutes for horses (Vaala et al., 2002) and donkeys (Bonelli et al., 2020). In dogs, two parameters have been defined: newborn cries (no cry, subtle cry, cry) and respiratory rate (<6 to >15 breaths/minutes) after birth (Veronesi et al., 2009). The Apgar scoring system for lambs is qualitatively evaluated as good, regular (score = 2), slow, irregular (score = 1), and absent (score = 0) respiration, since newborn lambs do not sound like human infants, and breath/min monitoring using a stethoscope or monitoring the chest rise and fall has the potential for interobserver error (Dutra ve Banchero, 2011). In a recent study, respiration was determined quantitatively using oxygen saturation (SpO_2) as detected by pulse oximetry (Flora et al., 2020). Apgar scoring was 67% ± 15% in normal lambs, based on previous studies showing 48 ± 6% SpO_2 in abnormal lambs (Norton et al., 1998). Respiration for Apgar scoring in the current study was evaluated using pulse oximetry, similar to Flora et al. (2020), as <45% (score = 0), 45-65% (score = 1), and >65% (score = 2). The pulse oximeter is a small, inexpensive instrument that is easy to use in field conditions. The respiratory evaluations at 0 and 5 minutes in Apgar scoring in Group 1 in this study were seen to be in agreement with the findings of Flora et al. (2020). In addition, respiration was found to be lower in Group 2 in Apgar scoring at 0, 5, and 15 minutes. This was thought to be related to dystocia caused by the hypoxia that developed as a result of the long-term stay of the kids in the birth canal. It has been reported that the mucous appearance for Apgar scoring is associated with cardiovascular and respiratory distress in newborn foals, puppies, and lambs and is a strong indicator of the need for urgent intervention (Flora et al., 2020; Vaala et al., 2002; Veronesi et al., 2009). In the present study, the appearance for the Apgar scoring was classified according to appearance color as cyanotic (score = 0), pale (score = 1), and pink (score = 2). The evaluations at 0 and 5 minutes of Apgar scoring in Group 1 were found to be in agreement with those of Flora et al (2020). The appearance in Apgar scoring at 0, 5, and 15 minutes was lower in Group 2, which was attributed to problems in the respiratory or cardiovascular system as a result of dystocia. It has been reported that lambs born with weakness or that respond poorly to stimuli may miss forming a strong sheep-lamb bond in the first hour of life, increasing neonatal mortality (Dwyer et al., 2016). In the present study, grimace for Apgar scoring was evaluated with a method similar to that used for foals, donkeys and sheep (Bonelli et al., 2020; Dutra ve Banchero, 2011; Vaala et al., 2002) by measuring the response to nasal stimulation with signs such as sneezing, coughing, moving the ears, or shaking the head. In the present study, grimace evaluations at 0 and 5 minutes in Apgar scoring in Group 1 were consistent with those of Flora et al. (2020). The grimace evaluation was found to be lower in

Group 2 in Apgar scoring at 0, 5, and 15 minutes, which was thought to be due to the fact that the kids born as a result of dystocia could not clean the respiratory tract by themselves as a result of the disruption in the respiratory system. Attitude for the Apgar scoring was modified based on lambs' responses to maternal attention (specifically, rump stimulation). In previous studies, attitude has been measured by the ability to maintain sternal reclining in foals (Vaala et al., 2002) and donkeys (Bonelli et al., 2020), and by the strength of spontaneous movement in bitches (Veronesi et al., 2009). The attitude assessment used in the present study was similar to the methods used in other species, with no response to stimuli (score=0), moving without trying to stand up (score=1), and trying to stand (score=2). In the attitude in Apgar scoring in Group 1, the evaluations at 0 and 5 minutes were seen to be in agreement with Flora et al. (2020). The attitude value in Apgar scores at 0, 5 and 15 minutes was found to be lower in Group 2, which was thought to be due to the fact that mothers with dystocia did not take care of their offspring as a result of fatigue. Pulse was used to assess neonatal viability in the current study, similar to previous studies of horses (Vaala et al., 2002), dogs (Veronesi et al., 2009), donkeys (Bonelli et al., 2020), and sheep (Dutra ve Banchero, 2011). The data available in the literature for small ruminant newborn heart rates vary significantly between (mean ± standard deviation) 92 ± 42 and 151 ± 47 (Koether et al., 2016; Vannucchi et al., 2012). In Group 1 in the current study, 45% had a pulse score of 2 (>175 beats/min) and 55% had a pulse score of 1 (100-175 beats/minute) at minute 0. At 5 minutes, 65% had a pulse score of 2 (>175 beats/minute) and 35% had a pulse score of 1 (100-175 beats/minute). At 15 minutes, 75% had a pulse score of 2 (>175 beats/minute) and 25% had a pulse score of 1 (100-175 beats/minute). The evaluations of heart rate in Apgar scoring in Group 1 at 0 and 5 minutes were seen to be in agreement with the literature data (Vannucchi et al., 2012; Flora et al., 2020). In addition, heart rate was found to be higher in Group 1, which was attributed to the fact that the kids did not show any respiratory and cardiovascular system problems in eutocia. In the current study, the total Apgar scores tended to increase in both groups during the first 15 minutes after birth. This finding is supported by the increase in mean Apgar scores in human infants from 6.2 to 7.4 at 5 to 60 minutes after birth (Batista et al., 2014) and by the total Apgar score in piglets increasing from 7 to 9 over time (De Roth ve Downie, 1976). This was thought to be due to intrapartum hypoxia as a result of prolonged stay in the birth canal, which initially caused low Apgar scores and could be improved by the newborn's adaptation to extrauterine life.

Postnatally increased pCO_2 has been reported in newborn lambs (Vannucchi et al., 2012). In the current study, pCO_2 levels were found to be high in both groups and were higher in Group 2. The reason for this was thought to be due to hypoxia due to the prolonged stay in the birth canal due to dystocia. It has been stated that the low pO_2 value in newborns may be due to the decrease in oxygen exchange between the alveoli and pulmonary capillaries in the placenta during delivery (Vannucchi et al., 2012). Uterine contractions that occur during labor cause compression of the uterine artery and umbilical cord, resulting in a major reduction in placental and umbilical blood flow (Siristatidis et al., 2003). In the present study, pO_2 levels were found to be low in both groups, and the pO_2 level was measured lower in Group 2 than in Group 1. It has been reported that postnatal hypercapnia and respiratory acidosis are seen in newborn lambs (Vannucchi et al., 2012). In the current study, lower pH and higher pCO_2 were determined in Group 2, and it was determined that the newborn kids had respiratory acidosis. Dystocia is often associated with prolonged hypoxia and acidosis (Lester et al., 2009). Neonatal pulmonary changes due to dystocia cause progressive hypoxemia and hypercapnia (Bleul et al., 2007). The level of hypoxia and acidosis may vary depending on the onset of spontaneous breathing and the time it takes for the mother to completely leave the fetal bloodstream (Reece, 2004). It has been reported that there is no significant difference in pH, pCO_2, pO_2 and HCO_3 levels at 0 and 24 hours in calves with dystocia compared to calves with eutocia (Feitosa et al., 2012). In another study, it was found that foals and lambs born as a result of dystocia had low pH and HCO_3 levels, and the improvements in blood gases were similar on the 1st day, according to those results, it was reported that in foals born as a result of dystocia there were negative effects on blood gases (Aydoğdu et al., 2018; Kimura et al., 2017). In the present study, the blood gas values of pH and HCO_3 were found to be low in the group with dystocia, and the difference was determined to be statistically significant, consistent with the literature. In addition, in the eutocia group, a positive correlation was determined between the total Apgar score and HCO_3-15 values at 0 and 5 minutes, and it was noted that the Apgar score increased as HCO_3 increased. Similarly, in the dystocia group there was observed to be a negative correlation between the 0-minute total Apgar score and the 5th minute HCO_3 values, with a decrease in the total Apgar score as HCO_3 increased.

CONCLUSION

In conclusion, the results of this study demonstrated that in kids with dystocia there were negative effects on the total Apgar score and blood gases. It was also concluded that the qualitative evaluation of the Apgar score together with the quantitative blood gas measurements will provide more information in terms of intervention in newborns, serious problems can be prevented, and negative effects can be minimized with early interventions. As there was a significant correlation in the Apgar scoring of HCO_3 from blood gas measurements, it was deduced that it should be supported by more comprehensive studies.

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