

## Puppy Apgar scores after vaginal delivery and caesarean section

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**ABSTRACT:** The aim of this study was to evaluate the vital signs of newborn puppies using the modified Apgar score after spontaneous delivery and caesarean section. The survival of puppies was monitored for up to 24 hours after birth. The experiment consisted of ten deliveries of bitches with dystocia terminated by caesarean section (C-section group) and ten bitches with spontaneous vaginal delivery (SVD group). Vital signs of neonates were evaluated using a modified method of the Apgar score 5, 10 and 15 min after birth. Five evaluation criteria (colour of mucous membranes, reflex irritability, motility, heart rate and respiration) were used with puppies classified into three scoring groups: “severe distress” (0–3 points), “moderate distress” (4–6 points) and “no distress” (7–10 points). In the SVD group, 57 puppies were evaluated; 98.2% of puppies were born alive, all survived their first 24 hours of life. At the time of birth, 1.8% of puppies were dead (1/57). The Apgar scores of all foetuses were in the “no distress” category. In the C-section group ( $n = 37$ ), 13.5% of puppies (5/37) were stillborn, two puppies (6.3%) died within 24 hours of delivery. The “no distress” group included 51.4% (19/37) of puppies, while 5.4% (2/37) of puppies were classified into “moderate distress” and 43.2% of puppies (16/37;  $P < 0.001$  at 5 min,  $P < 0.005$  at 10 min and  $P < 0.005$  at 15 min after delivery) were classified into “severe distress”. These results confirm the influence of type of delivery on the Apgar score immediately after parturition and on the short-term survival rate of puppies after parturition.

**Keywords:** dog; dystocia; eutocia; neonatal distress; periparturient mortality of puppies

The economic value of purebred dogs and their owners' emotional dependence on their four-legged companions is constantly growing; therefore, there are increasing efforts to improve the survival of newborn puppies (Veronesi et al. 2009).

The viability of puppies is largely influenced by the course of the delivery. Parturition is mostly a natural process, but there are also cases in which normal birth is difficult or impossible and as a result of abnormal prolongation of the first, and especially the second stage of labour, dystocia occurs (Oluwatoyin and Fayemi 2011). The term *dystocia* comes from Greek and is composed of two words: *dys* = difficult, painful, irregular or abnormal and *tokos* = birth (Feldman and Nelson 1996).

Although most puppies are born by spontaneous vaginal birth, in some breeds (brachycephalic and giant breeds) dystocia can be a relatively frequent occurrence (20–80%) (Bryden 2013). Approximately 16% of all bitches present with dystocia and more than 60% of them need an urgent caesarean section (C-section). An urgent C-section is considered to be a common practice in small animal surgery, and, thus, different anaesthesia protocols have been created for this purpose. All anaesthetics, including inhalant, pass through the placenta to the foetus and therefore cause neonatal depression (Doebeli et al. 2013).

The mortality of puppies may occur during the expulsion phase of parturition, during the first

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weeks of life or after weaning. The highest mortality rate is observed during birth, immediately after birth or a few days later. The most common cause of neonatal mortality is hypoxia and anoxia during dystocia.

Therefore, it is necessary to identify those newborn puppies which require emergency care immediately after birth. The modified Apgar score is a method of assessing the vital signs of newborn puppies; it determines their clinical status and has been adapted from human medicine (Apgar and James 1962).

Our hypothesis was that the type of delivery would affect the Apgar scores of canine neonates. We therefore evaluated and compared the vital signs of newborn puppies born after C-section and spontaneous vaginal delivery using the modified Apgar score. The aim was to determine the impact of the type of delivery on the survival rate in the period after parturition.

## MATERIAL AND METHODS

The study involved 94 puppies from 20 litters delivered by bitches of different breeds from two to eight years old. Nine bitches (45%) were large breeds (Labrador retriever, Bernese mountain dog, German shepherd, Belgian shepherd, Golden retriever, German boxer and a Rhodesian ridgeback), four (20%) were medium breeds (American cocker, Staffordshire terrier, Bavarian mountain hound and a crossbreed of medium size) and seven (35%) were small breeds (Yorkshire terrier, West highland white terrier, Chihuahua, Shih-Tzu and a French bulldog).

The puppies included in this study were delivered by spontaneous vaginal delivery (SVD group) or by emergency C-section (C-section group). The SVD group included only puppies born without any kind of assistance. When dystocia occurred, C-section was performed in each single case. Dystocia was recognised according to the criteria of Reichler and Michel (2009), and C-section was performed according to the criteria of Linde-Forsberg (2015). Briefly, in this study, fulfilment of the following criteria was used to diagnose dystocia: more than 68 days from day of last breeding; no signs of impending parturition; persistent abdominal straining for more than 30 min without delivery of a puppy; intermittent abdominal straining for

more than 4 h without delivery of a puppy; green vaginal discharge (placental separation); presence of a puppy stuck in the birth canal. Anaesthesia was induced by propofol (Norofol 10 mg/ml inj sus A.U.V., Norbrook, USA) administered at a dose of 4 mg/kg body weight *i.v.* and diazepam (Apaurin sol inj 5 mg/ml, Krka, Slovenia) at a dose of 0.3 mg/kg body weight *i.v.*, followed by isoflurane maintenance (Isoflurane Abbvie, AbbVie Inc., USA) and a butorphanol (Torbugesic Vet 10 mg/ml inj sol, Zoetis, Czech Republic) line block. C-section was performed by a midline incision of the abdomen from the pubis to the umbilicus and a dorsal incision on the uterine body to allow quick removal of the puppies. Immediately after removal of a foetus and its placenta, each puppy was transferred to a heat-controlled area and received first neonatal care. This consisted of a complete and careful cleaning of the upper airways, clamping of the umbilical cord, separation from its placenta and drying of the hair. After natural delivery (in the SVD group), or after first care for puppies born by C-section, each puppy was weighed and assessed for vital signs. The Apgar score was recorded 5, 10 and 15 min after delivery (for evaluating the effectiveness of resuscitation) and viability was rechecked 24 h after birth.

A modified Apgar test for puppies was formulated in accordance with the basic rules proposed by Virginia Apgar for babies. Five indices were chosen for scoring (according to the study by Veronesi et al. 2009), that were easily detectable without the use of sophisticated tools: colour of mucous membranes, reflex irritability, motility, heart rate and respiration. Each of these indices is rated from zero to two, and the sum of the total value of all variables determines the Apgar score, which ranges from zero to ten. The reference range for each index was adapted for use in dogs according to the physiology of the canine neonate (Veronesi et al. 2009).

The scores were used to identify three levels of neonatal distress. Scores lower than three are generally considered critical (“severe distress” group), those ranging from 4–6 indicate intermediate levels of distress (“moderate distress” group) and scores from 7–10 are considered to be normal (“no distress” group). A low score means that an individual requires immediate medical attention. All puppies with Apgar scores of 0–6 at birth were given resuscitation aimed at improving their chances of surviving. The treatment consisted mainly of stimulation

of breathing by rubbing the thorax, ventilation and/or oxygen mask administration (Veronesi et al. 2009).

**Statistical analysis.** For statistical analysis, we used the unpaired *t*-test and the chi-squared test. The results were evaluated using GraphPad Prism 1.6 (GraphPad Software Inc., USA).

## RESULTS

Of a total of 94 puppies, 57 were born spontaneously (SVD) and 37 puppies were born after C-section. The male-to-female ratio was 50.9 : 49.1% (29 : 28) in the SVD group and 62.2 : 37.8% (23 : 14) in the C-section group. In the SVD group, one puppy was born dead (1.8%), the remaining 56 puppies (98.2%) survived their first 24 h after delivery. In the C-section group, there were five stillborn puppies (13.5%). Two of the remaining 32 puppies from the C-section group (6.3%) that were born alive died within 24 h of delivery.

Nineteen puppies from the C-section group (19/37; 51.4%) were classified into the “no distress” group (a score from seven to 10), two puppies (2/37; 5.4%) had scores from four to six (“moderate distress” group) and 16 puppies (16/37; 43.2%) were classified into the “severe distress” group (a score from zero to three). The average values of the Apgar score (5, 10 and 15 min after birth) in puppies born by C-section from individual litters are shown in Table 1. There was no significant improvement of the Apgar score over the three times of measurement in litters of puppies from C-section group ( $P >$

0.005). Four puppies died in the C-section group of puppies with “severe distress” (score from zero to three) (4/16; 25%), whereas 12 others (12/16; 75%) improved quickly and were alive and viable up to 24 h after delivery. Both puppies (2/2; 100%) from the C-section group with Apgar scores from four to six (“moderate distress” group) survived their first 24 h after birth. Eighteen puppies (18/19; 94.7%) from the C-section group with the highest score (from seven to 10, “no distress” group) were viable 24 h after delivery. One puppy (1/19; 5.3%) from this group died after unsuccessful resuscitation.

Statistical analysis showed that the percentage of puppies that were dead at 24 h was significantly higher in the “severe distress” group compared with the “no distress” group ( $P < 0.001$ ).

In the SVD group, all live-born puppies (56; 100%) achieved a score from seven to 10 (“no distress” group); the average AS values at 5, 10 and 15 min after birth in puppies from individual litters are shown in Table 2.

Comparison of Apgar scores in puppies born by C-section and spontaneously by vaginal delivery revealed highly significant differences in values after 5 ( $P < 0.0001$ ), 10 ( $P < 0.005$ ) and 15 min after delivery ( $P < 0.005$ ) (Figure 1).

## DISCUSSION

Survival of the first puppy during dystocia is determined by the time from the beginning of its expulsion to the moment of its birth. In general, this interval lasts two, in some cases four hours (Reichler

Table 1. Apgar scores (AS) of puppies at 5 (AS 5), 10 (AS 10) and 15 (AS 15) min after delivery in the group of bitches undergoing emergency caesarean section

Litter No.	AS 5	AS 10	AS 15	Apgar score groups	Puppies (n)
1	0.5	0.8	1.8	0–3	4
2	2.0	2.0	3.0	0–3	1
3	7.3	8.0	8.7	7–10	3
4	7.5	8.0	8.8	7–10	8
5	9.0	10.0	10.0	7–10	2
6	7.5	7.5	8.0	7–10	6
7	0.0	0.7	1.3	0–3	3
8	1.8	2.0	3.2	0–3	5
9	0.3	0.7	1.3	0–3	3
10	4.0	5.0	6.5	4–6	2

Table 2. Apgar score (AS) of puppies at 5 (AS 5), 10 (AS 10) and 15 (AS 15) min after whelping in the group of bitches with spontaneous vaginal delivery

Litter No.	AS 5	AS 10	AS 15	Apgar score groups	Puppies (n)
1	9.7	9.8	9.8	7–10	6
2	10.0	10.0	10.0	7–10	3
3	10.0	10.0	10.0	7–10	4
4	10.0	10.0	10.0	7–10	5
5	9.8	9.8	9.8	7–10	8
6	9.2	9.2	9.6	7–10	5
7	7.8	7.9	8.1	7–10	7
8	10.0	10.0	10.0	7–10	6
9	9.6	9.6	9.6	7–10	7
10	10.0	10.0	10.0	7–10	5

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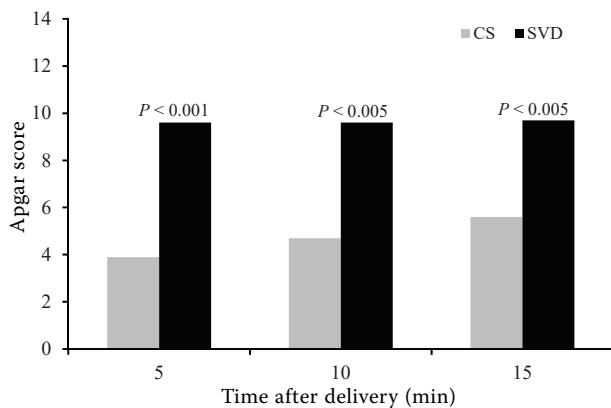


Figure 1. Comparison of Apgar scores (AS) in the group of bitches with spontaneous vaginal delivery (SVD) and those undergoing emergency caesarean section (CS) at 5, 10 and 15 min after delivery

and Michel 2009). Survival of the first puppy, but also the others, during spontaneous vaginal delivery is determined by the length of the puppy's expulsion through the birth canal, placental separation during labour and the total duration of labour. In this study, the time elapsed between the start of labour (dystocia) and its termination by emergency C-section depended on the owners deciding to come with the bitch to our clinic. Performance of emergency C-section itself started approximately 30 min after their arrival (after preparation of the patient/bitch). The survival of pups is also negatively correlated with the oxygen supply during dystocia because of early placental separation. Stagnation of the foetus/foetuses in the birth canal with reduced, or even discontinued oxygen saturation, leads to death during labour, so foetuses are born dead, or hypoxia causes reduction of the Apgar score.

Newborn puppy mortality for normal deliveries is 5.55%, significantly lower than that for dystocia deliveries, which is 33% (Moon et al. 2001). In cases of elective or emergency C-section, Moon et al. (2000) reported neonatal death rates of 6–11%.

In the group of bitches with spontaneous vaginal delivery, 98.2% of the puppies (56/57) were born alive and only one puppy was born dead (1.8%), which is well below the percentage of 13.9% (9/65) in the study by Veronesi et al. (2009) and 5.55% in the study by Moon et al. (2001).

In the group of bitches with dystocia terminated by emergency C-section, 86.5% (32/37) of the puppies were born alive and 13.5% of puppies (5/37) were born dead, compared to 21% (13/62) in the

study by Veronesi et al. (2009) and 19% in the study of CS delivery by Moon-Massat and Erb (2002).

Overall, six stillborn pups from a total of 94 (6.4%) were recorded. This finding is lower than the reported rate of 14% of dead puppies in the study by Veronesi et al. (2009). The percentage of live births (86.5%) in the CS group was very similar to the live-birth percentage (92%) of puppies born after C-section reported by Moon-Massat and Erb (2002). All live-born puppies from the SVD group (56/56, 100%) reached Apgar scores from seven to ten, placing them in the “no distress” group. In contrast, dystocia and its termination by C-section (C-section group) resulted in decreased Apgar score values in the puppies. In this group, 51.4% (19/37) of puppies were evaluated to have scores from seven to ten (“no distress” group), 5.4% (2/37) of puppies in the group scored from four to six (“moderate distress” group) and 43.2% (16/37) of puppies were classified into the “severe distress” group (score from zero to three). For comparison, in the study by Veronesi et al. (2009), 85.3% of puppies were classified into the “no distress” group (score from seven to 10), 10.4% into the “moderate distress” group (score from four to six) and 4.3% into the “severe distress” group (score from zero to three).

As well as the short-term effect of hypoxia/anoxia on the vital signs of foetuses, its longer-term negative impact (24 h after birth) was also evaluated, because puppies with lower Apgar scores have higher mortality probabilities in the period that follows the immediate post-labour phase.

In the C-section group, two puppies of the surviving 32 live-birth puppies (6.3%) died within 24 h of birth. All live-born puppies from the SVD group (56/57) survived their first 24 h after birth, so the total percentage of mortality of puppies from both groups within the first 24 h is 2.3% (2/88). This finding is lower than the 5.4% (9/166) of dead puppies within 24 h of birth reported in the study of Veronesi et al. (2009), and also lower than the rate of 11.8% (18/152) in the study by Munnich and Kuchenmeister (2014) but higher than the rate of 0.66% of puppies in the study by Batista et al. (2014). The overall survival rates at 24 h after birth ( $86/94 = 91.5\%$  overall;  $30/37 = 81.1\%$  in C-section group) were in agreement with the survival rate (94.6% overall; 87% in C-section group) reported by Veronesi et al. (2009).

Veronesi et al. (2009) claimed that the type of delivery does not influence the survival rate of

newborn puppies. In their study, six puppies (two from the “moderate distress” group, four from the “severe distress” group) died within 24 h of delivery, regardless of the type of delivery (two puppies were born spontaneously, four puppies were born by assisted whelping). All live-born puppies that were born by C-section survived their first 24 h after birth. Interestingly, in this study, both puppies that died within 24 h of birth were from the C-section group with Apgar scores from zero to three (“severe distress” group). There were significant differences among the Apgar scores between groups with different types of delivery. Although a good Apgar score did not guarantee newborn survival, puppies with higher scores had a survival advantage over those with lower scores.

Systematic evaluation of puppies allowed the timely detection of puppies with poor Apgar scores that might otherwise have been overlooked after birth. Twelve of 16 puppies (75%) with Apgar scores from zero to three (“severe distress” group) from the C-section group recovered completely and reached higher scores after rapid administration of first aid. Two puppies from the “moderate distress” group thrived after oxygen supplementation and resuscitation. This indicates that the prompt detection of less viable newborns, followed by successful resuscitation, could improve neonatal survival. Other puppies (from the “no distress” group) were sufficiently viable and, therefore, did not require medical treatment or resuscitation.

In conclusion, the results of this study show the reliability of routine Apgar scoring in evaluating the vital signs of newborn puppies and in determining short-term prognosis. Evaluation of puppy viability and early detection of foetal distress can allow the administration of foetal resuscitation and could contribute to reducing mortality at birth and shortly after it. Evaluation of the Apgar score does not require expensive equipment, and is a quick and straightforward method, that can save lives.

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