# Duration of pregnancy is shorter in Cavalier King Charles spaniels

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## Abstract

Duration of pregnancy was evaluated in 17 Cavalier King Charles spaniel bitches, based on timing of LH surge (progesterone concentrations between 2.0 and 3.0 ng/ml, with continued rise in subsequent 48 hours) and compared to 17 bitches of other breeds. Duration of pregnancy was shorter ($p < 0.05$) in Cavalier King Charles spaniel bitches compared to others (mean ± SD, 62.8 ± 2.0 days [range; 60 - 66 days] versus 64.5 ± 1.4 days [range; 62 - 68 days]). This observation has clinical implications for pregnancy management of this breed, including recommendations for scheduling a timed caesarean section and approaches to managing late-term complications.

**Keywords:** Cavalier King Charles spaniel, duration of pregnancy, parturition

## Introduction

Exact prediction of duration of pregnancy has important clinical implications for management of canine pregnancy. Correct prediction can aid clients and veterinarians in the decision-making process surrounding periparturient interventions, thereby avoiding dystocia and improving neonatal survival. Perinatal mortality is relatively higher in dogs compared to other species.[1-4] Perinatal mortality, defined as the sum of stillborn puppies and puppies that died by day 7 after parturition, was 24.6%, whereas mortality from 8 days to 8 weeks in the same group was only 1%.[4] Respiratory distress following dystocia and septicemia are 2 common causes of perinatal mortality.[5] This is especially important in bitches with high-risk pregnancies, including those with a singleton pregnancy, history of pyometra, abortion, embryonic reabsorption, insufficient luteal phase, or dystocia.[6] In ideal circumstances, parturition or caesarean section (c-section) would be performed after final fetal lung and organ maturation, but before fetal/neonatal distress occurs due to dystocia. In cases of high-risk pregnancy, elective c-section is frequently planned to occur shortly before predicted parturition. Determination of duration of pregnancy and accurate estimation of date of parturition are critical to develop a treatment plan. Due to difficulty and variability of assessing accurately during pregnancy, prediction of parturition date is frequently based on events during breeding.[7] When measured from first of multiple matings, duration of pregnancy, can vary anywhere from 57 to 72 days attributed to long canine behavioral estrus and prolonged survival of canine semen within the reproductive tract.[8] Duration of pregnancy can also be measured from the first day of a diestrual vaginal smear (56 - 58 days), from the estimated day of ovulation (62 - 64 days), or from the day of LH surge or estimated LH surge (64 - 66 days).[7-12] Use of this latter method for prediction of parturition date is well-characterized in literature, with multiple studies demonstrating a high degree of accuracy and repeatability both when LH is measured directly and when LH surge is identified indirectly as the period of early progesterone ($P_4$) rise.[10-12] However, while this method works well for "dogs in general", several studies have demonstrated evidence for breed specific duration of pregnancy.[9,14-16] Cavalier King Charles spaniel (CKCS), a toy breed ranking as the 19th most popular dog breed by the American Kennel Club, is anecdotally reported by CKCS breeders to consistently whelp earlier than their predicted parturition date, based on a duration of pregnancy of 65 days from LH surge. This was supported by a previous study that specifically included CKCS.[9] In that population of 25 dogs, parturition was noted on average on day 61 ± 1.5 after estimated ovulation. These findings are clinically significant, because animals with a shorter natural duration of pregnancy would experience increased risk of dystocia prior to a traditionally timed c-section compared to another animal. We therefore aimed to confirm the clinical impressions of CKCS owners and the findings reported from European lines of dogs in our clinical population. To accomplish this, we retrospectively analyzed breeding management and parturition data from 2 facilities in central North Carolina. We hypothesized that this population of CKCS would have a significantly shorter duration of pregnancy than bitches of other breeds.

**Materials and methods**

Selection of CKCS litters

        Records from 2 facilities (a small animal private practice and a university theriogenology service) in central North Carolina were reviewed to identify client owned litters of CKCS to be included in this retrospective case series. Litters were included if data were available on preinsemination $P_4$ concentrations and parturition date. Litters were excluded, if no live puppies were produced from the pregnancy, if puppies were delivered via scheduled c-section, or if medical intervention took place before delivery of first pup but were not excluded for undergoing emergency c-section if bitch delivered 1 or more pups prior to surgery. A total of 17 litters from 10 bitches were included in the case series.

Selection of nonCKCS litters

        Records from both facilities were reviewed to identify 17 litters of breeds other than CKCS to be included in the control group. Same criteria as described for CKCS were used to include or exclude nonCKCS litters. Cases were selected for inclusion randomly and stratified based on the bitch's weight, in 10 kg increments. Litters were randomly selected for inclusion in the study from these categories. No more than 2 litters were selected from any 1 weight group, and only 1 litter per breed was included in the control group. Duration of pregnancy of the litters was not calculated prior to their selection for inclusion in the study. Breeds included in the study were Lucas terrier, Tibetan terrier, French bulldog, English springer spaniel, Border collie, Airedale terrier, Nova Scotia duck tolling retriever, Labrador retriever, Polish lowland sheepdog, German shorthaired pointer, Briard, black and tan Coonhound, German shepherd dog, Gordon setter, Doberman pinscher, Rottweiler, and Great Dane.

Calculation of duration of pregnancy

        Duration of pregnancy was defined as the number of days between estimated LH surge and delivery of the first puppy. Day of LH surge was defined as the day when $P_4$ was between 2.0 and 3.0 ng/ml, with a continued rise recorded in subsequent 48 hours. Per cycle, 2 - 7 blood samples ($3.76 \pm 1.1$) were collected in untreated glass red top tubes for $P_4$ assay, based on patient presentation and clinician preference. Samples were analyzed at 2 clinical diagnostic laboratories (Antech Diagnostics [Fountain Valley, CA] and North Carolina State University Clinical Pathology Laboratory). At both locations, $P_4$ was determined using chemiluminescence assays.

Data analyses

        Data were evaluated for normalcy with a Shapiro-Wilk test and two-sample Student's t-tests were subsequently used to compare between groups, attending clinician and laboratory performing the $P_4$ assays. Linear regression was performed to characterize the relationship between duration of pregnancy and bodyweight (nonCKCS) and the relationship between duration of pregnancy and litter size in CKCS. All statistical analyses were performed with Statistix 10 (Statistix 10, Tallahassee, FL).

**Results**

        Mean ($\pm$ SD) serum $P_4$ concentration at first presentation was $1.2 \pm 1.1$ ng/ml and at final presentation was $9.9 \pm 4.6$ ng/ml. There were no differences between groups.

        Average duration of pregnancy for the CKCS group, $62.8 \pm 2.0$ days with a range of 60 - 66 days (Figure 1) was shorter ($p < 0.05$) compared to the average duration of pregnancy for the nonCKCS group ($64.5 \pm 1.4$ days with a range of 62 - 68 days; Figure 2).

        Linear regression analysis revealed no relationship between body weight and duration of pregnancy in the control group ($R^2 = 0.02$, range 14.8 - 125 pounds). Data on litter size were not available for all animals. Data were not available for nonCKCS animals and available only for 11 CKCS litters. For litters with reported pregnancy outcomes (11 of 17 CKCS litters), there was no relationship between litter size and pregnancy length ($R^2 = 0.06$, median number of puppies 5, range 1 - 7).

**Figure 1.** Mean duration of pregnancy (62.8 ± 2.0 days) in 17 litters (range; 1-7 pups) from 10 CKCS bitches
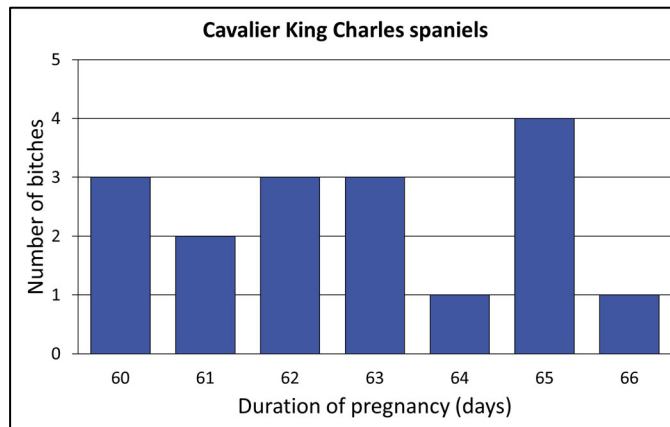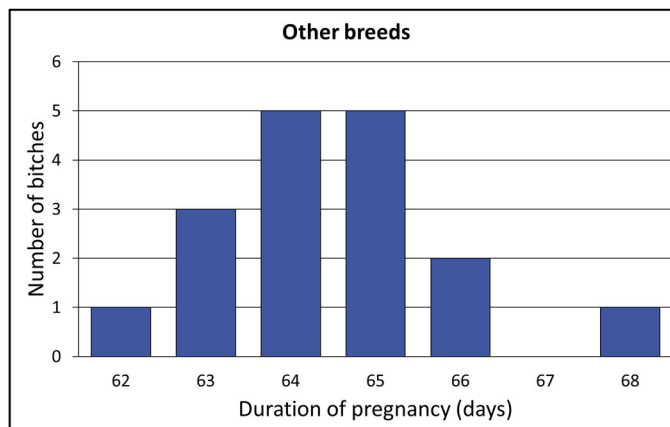


**Figure 2.** Mean duration of pregnancy (64.5 ± 1.4 days) in 17 nonCKCS litters



**Discussion**

Accurate prediction of duration of pregnancy in bitches enables better periparturient decisions, including decision to perform a c-section.[7] In evaluating data from breed clubs in UK, the rate of c-sections in CKCS was determined to be 13.1%,[18] a moderate rate as compared to other breeds evaluated. C-sections may be performed as an emergency procedure after onset of stage II of labor, or may be performed as a timed elective procedure in singleton pregnancy, historic dystocia or inability of the owner to reliably detect and supervise parturition. In such cases, timing of c-section (after final lung and organ maturation is complete, but prior to onset of fetal distress or mortality) is vital to short- and long-term survival of puppies. Traditionally, timed c-sections are performed on days 63 - 65 of pregnancy (61 - 63 days postovulation). However, this time-range may not be ideal for CKCS. In the present study, average duration of pregnancy in CKCS was 2 days shorter than bitches of various other breeds, suggesting that, in this breed, initiation of prepartum monitoring protocols and timed c-section should be advanced to days 59 - 60 and 61 - 63 after the LH surge, respectively.

Physiological relationship between LH surge and parturition date was used to define the duration of pregnancy in beagle dogs as 65 ± 0.1 days from LH surge.[8] Subsequent work from numerous laboratories determined the average duration of pregnancy for numerous breeds based on LH surge, preovulatory rise in $P_4$, estimated ovulation dates, and breeding dates (Table 1). Comparison of preovulatory $P_4$ rise among Golden retrievers, German shepherd dogs, and Labrador retrievers revealed that German shepherd dogs were 3 times more likely, and Golden retrievers 4 times more likely, to have a

longer duration of pregnancy compared to Labrador retrievers.[15] This study also compared duration of pregnancy as determined by cytologic diestrus in hounds to that of Labrador retrievers, and reported that hounds were 8 times more likely to have a longer pregnancy. In another study, duration of pregnancy, defined as the period from mating to parturition, was determined in 113 dogs of 6 breeds (31 Dobermans, 31 Labrador retrievers, 14 German shepherd dogs, 13 Bernese mountain dogs,12 golden retrievers, and 12 West Highland white terriers). Breeding was scheduled immediately if $P_4$ exceeded 7.9 ng/ml (25 nmol/l), within 24 hours if $P_4$ was 5.0 - 7.9 ng/ml (16 - 25 nmol/l), and within 24 - 48 hours if $P_4$ was 4.1 - 5.0 ng/ml (13 - 16 nmol/l).[14] Duration of pregnancy of West Highland white terriers was determined to be significantly longer than that of German shepherds, Labrador retrievers, and Dobermans that did not differ significantly from each other.[14] Recently, data on 1203 inseminations representing 1146 individual bitches of 84 different breeds were evaluated.[16] Of these breeds, only Greyhounds had significantly different (longer) duration pregnancy (Table 1) that was measured from preovulatory rise in $P_4 > 2$ ng/ml.

To date, only 1 study specifically investigated duration of pregnancy in CKCS. In that study, data from 162 pregnancies in 151 bitches of 53 breeds were used to identify factors influencing duration of pregnancy.[9] Duration of pregnancy was defined as the interval between ovulation and parturition, and ovulation was defined as the day when plasma concentrations of $P_4$ reached 6 ng/ml and subsequently rose the following day. This study included 25 CKCS and duration of pregnancy in CKCS was $61 \pm 1.5$ days from estimated day of ovulation. In the present study, duration of pregnancy was $62.8 \pm 2.0$ days when calculated from LH surge, similar to the above study that used ovulation as day 1 of pregnancy.

Comparisons between studies was difficult, since varying determinants were applied to determine onset of pregnancy using varying hormonal assay methods. Whereas there was no difference between RIA and chemiluminescence assay,[11] interassay variability between laboratories is well-known and can complicate interpretation of research and clinical data. In this retrospective analysis, our clinical estimation of LH surge was used to define day 0. There were no differences in duration of pregnancy between clinicians or between laboratories that performed the $P_4$ assays. A shorter duration of pregnancy of Cavalier King Charles spaniels in these 2 practices was confirmed in comparison to other clinical cases and also by an earlier study.[9] A specific cause for shortened duration of pregnancy in CKCS was not elucidated in this retrospective study, nor in prior studies from other groups. In addition to breed, other factors that were characterized and compared to duration of pregnancy in this study included nonpregnant body weight of bitch and litter size. However, linear regression analysis revealed no relationship between body weight or litter size and duration of pregnancy in the present study.[9,19] These findings were consistent with several other large studies that demonstrated no effect of either litter size or body weight on pregnancy length.[14,16]

Irrespective of whether the differences are genetic or have an alternate underlying cause, clinical consequences of differences in pregnancy length are considerable. Clinicians facing a high-risk pregnancy, elective c-section or potential dystocia must weigh the effects of medical intervention on both maternal and fetal health. Data from this study suggested that medical therapy to prolong pregnancy may have to be terminated earlier in this breed than others and that surgical removal of puppies from an at-risk pregnancy may be achieved with good neonatal outcomes earlier than in some other breeds. In this breed, bitches may experience life-threatening dystocia prior to elective c-sections that are routinely scheduled

**Table 1.** Breed-specific studies on duration of pregnancy

| Breed | Duration of pregnancy (days) | Factor used to define the beginning of pregnancy | Reference |
|---|---|---|---|
| Beagle | $65.1 \pm 0.1$ | LH surge, measured directly by RIA | Concannon, et al: 1983 |
| Cavalier King Charles spaniel | $61 \pm 1.5$ | Ovulation, defined as occurring when $P_4 = 6$ ng/ml | Mir, et al: 2011 |
| Doberman | $61.4 \pm 1.0$ | Date of breeding was timed by determination of $P_4$ concentrations | Okkens, et al: 2001 |
| German shepherd dog | $60.4 \pm 1.7$ | Date of breeding was timed by determination of $P_4$ concentrations | Okkens, et al: 2001 |
| | $63.6 \pm 2.1$ | Preovulatory rise in $P_4$ to estimate LH surge | Eilts, et al: 2005 |
| | $63.2 \pm 1.8$ | Ovulation, defined as occurring when $P_4 = 6$ ng/ml | Mir, et al: 2011 |
| Golden retriever | $64.7 \pm 1.5$ | Preovulatory rise in $P_4$ to estimate LH surge | Eilts, et al: 2005 |
| | $64.3 \pm 1.3$ | Ovulation, defined as occurring when $P_4 = 6$ ng/ml | Mir, et al: 2011 |
| Hound | $66.0 \pm 2.8$ | 8 days prior to onset of cytologic diestrus day 1 | Eilts, et al: 2005 |
| Labrador retriever | $60.9 \pm 1.5$ | Date of breeding was timed by determination of $P_4$ concentrations | Okkens, et al: 2001 |
| | $62.9 \pm 1.3$ | Preovulatory rise in $P_4$ to determine LH | Eilts, et al: 2005 |
| West Highland white terrier | $62.8 \pm 1.2$ | Date of breeding was timed by determination of $P_4$ concentrations | Okkens, et al: 2001 |
| Greyhound | $68.0 \pm 1.5$ | LH surge, estimated by rise in $P_4 > 2$ ng/ml | Hollinshead, Hanlon: 2017 |
| Rottweiler | $65.6 \pm 1.6$ | Ovulation, defined as $P_4 = 6$ ng/ml | Mir, et al: 2011 |

for 63 or 64 days after LH surge, whereas CKCS bitches that present with signs of "premature labor" at 59 or 60 days of pregnancy may in fact deliver fully mature viable puppies with no evidence of disease. Recognition of the variability in duration of pregnancy in this and other breeds, along with adjunctive diagnostic tools to estimate fetal maturity, can help clinical decision-making and improve outcomes in cases of complications of pregnancy in CKCS.

## Conclusion

Duration of pregnancy in CKCS bitches was $62.8 \pm 2.0$ days from estimated LH surge. Parturition dates several days earlier than otherwise expected can be a normal finding in this breed and should be considered when determining the best option for periparturient interventions. Consideration of breed related differences in duration of pregnancy may be critical to improving neonatal survival in CKCS by reducing inherent biases in clinicians hesitant to attempt c-section too early and encouraging timely diagnostic and treatment interventions in both normal and compromised pregnancies in this breed.

## Conflict of interest

None to declare.

## Funding

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