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RADIOGRAPHIC PELVIMETRY IN RELATION TO DYSTOCIA IN BULLDOGS

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ABSTRACT

Dystocia is a common complication of parturition in the breed of English Bulldogs, where most females are not able to have a natural parturition and many litters are delivered by caesarean section. The aim of this study was to evaluate the diameter of the pelvis of 11 females of English Bulldogs through radiographic pelvimetry and do proper measurements to observe if there are any correlations between a narrow pelvic canal and dystocia detected in the breed. The external parameters were also assessed to look for any differences between weight, height, and length in relation to the dystocia in the breed. The mean weight of the dogs with natural parturition was 21.25 ± 0.91 kg, whereas the females which had undergone caesarean section was 25.16 ± 1.44 kg (P = 0.0004). A P-value shows strong evidence for the hypothesis of this study as a possible factor of dystocia of the breed. The values of height and length in the category of dams which had undergone natural parturition were in cm 44.8 ± 2.48 (length) and 36.1 ± 0.98 (height). In the category of dogs which had undergone caesarean section, the parameters were in cm 45.4 ± 2.60 and 36.0 ± 1.58, respectively. The P-value for length were 0.72 for length and P-value for height were 0.83. Difference between the diameter of the pelvis in the two groups of English Bulldog females was P = 0.12, so there is no significant evidence. However, it could be significant for a possible future study with a higher number of animals for measuring pelvic diameter.

Key words: bitch; caesarean section; dystocia; parturition; radiographic pelvimetry

INTRODUCTION

English Bulldogs have a high incidence of dystocia, a complication of parturition where the dam has difficulty in passing the foetus through the pelvic canal [16]. It is commonly presumed that the English Bulldog is predisposed to dystocia due to foetal-pelvic disproportion caused by a small, narrow pelvic canal and deep position of the pregnant uterus in combination with large foetal head and shoulders [2]. This has led to a higher prevalence of emergency caesareans sections in veterinary clinics.

The literature in the field of dystocia of brachycephalic breeds are limited, with only a few articles having been written about the subject. Few articles have been written about other breeds with similar difficulties, however none to date have compared the pelvic diameter of natural whelping females, versus a category of females that had undergone dystocia in the English Bulldogs.

The causes of dystocia in English Bulldog are not completely determined, but there are several reasons why brachycephalic dogs like the English Bulldog might have an increased risk of dystocia and puppy mortality. Brachycephalic dogs are typically susceptible to obstructive dystocia because of the foetal head size or the dam's narrow pelvic canal. Bulldogs, in addition, are specifically reported to have slack abdominal musculature that inhibits positioning of the foetus in the pelvic inlet [11]. Further, the reproduction problems are seen as many dams cannot give birth naturally. It is pointed out in multiple causes, the gene pool of the breed is limited and with limited number of individuals there is often used same male for multiple females. The size of the foetal heads and shoulders can also be a complicating factor, together with a narrow and light pelvic diameter of the dam will give negative expectations [12].

Radiographic pelvimetry is a method performed through radiography, where the capacity and the diameters of the pelvis are measured. It is a valuable method for morphometric evaluation of the pelvis in dogs. However, it permits only two-dimensional evaluation of the pelvis and has a limited accuracy, based on distortion of the pelvis due to its angle relative to the detector. Pelvimetry has been found to be a useful technique for assessing the pelvic diameter and the correlation to dystocia in dogs. To the author's knowledge, radiographic pelvimetry has mainly been used retrospectively in dogs and cats to look for correlations between dystocia and the measurements of the pelvis [9, 10]. It is not known if there have been any scientific studies in comparable pelvic assessments to observe differences in the pelvic diameter in English Bulldogs.

Computed tomography (CT) is a new way of assessing the pelvis of dogs. It is a high-resolution method, which enables a three-dimensional evaluation of the pelvis. In the latest study, computed tomographic pelvimetry was used to study the pelvis of English Bulldogs compared to other non-brachycephalic breeds [2].

MATERIALS AND METHODS

In this study, there were included 11 females, aging 2 to 7 years, recruited from the population of English Bulldogs by the arrangement of the Norwegian Bulldog Club to undergo a radiographic examination of the pelvis. External parameters (height, length, and weight) were measured. The study was performed with the informed consent of the owners and the physical experiment was completed in the small animal veterinary clinic "Vetsentrum" in Norway. The dogs were divided into two groups: bitches which had given birth *per via naturales* (n=6) and bitches which had given birth to puppies by caesarean section (n = 5).

The reproduction history of the females was collected orally through an interview on the day of the experiment. Height, weight, length of the dog are external parameters that were measured. A clinical examination was also done to assess the overall health of the dog before sedation and the radiographical examination.

The dogs followed the identical medical procedure based on their weight to acquire correct doses. The radiographs were taken with sedation and anaesthesia to get the optimal accuracy of the radiographs and to limit the movement of the dog during the radiography. All premedications and anaesthesia solutions were given through intravenous catheter taken on both front legs in the cephalic vein. Sedation used for the study were 0.01 $mg.kg^{-1}$ dexmedetomidine hydrochloride (Dexdomitor Vet, 0.1 $mg.kg^{-1}$, ORION PHARMA, Corporation Espoo, Finland) and methadone hydrochloride (Synthadon Vet 10 $mg.kg^{-1}$, Le Vet Beheer BV, Netherlands) with dose 0.2 $mg.kg^{-1}$ before injectable anaesthesia. For the injectable anaesthesia was used propofol (Propolipid 10 $mg.kg^{-1}$, Fresensius Kabi Ab, Finland) intravenous injection with a dose 10 $mg.kg^{-1}$ for induction of anaesthesia. For optimal breathing for the dog, an endotracheal tube where applied, with lidocaine 1 $mg.kg^{-1}$ (Xylocain 100 mg/spray, Aspen Pharma Trading Ltd., Ireland) in the larynx before application. The total intravenous anaesthesia (TIVA) Syringe Pump SK-500I with propofol (Propolipid, Fresensius Kabi, Finland) 10 $mg.kg^{-1}$ were used for maintaining anaesthesia through the radiography, where it was set on 22.5 ml perhour. Fluids were given through the whole procedure, 5 $ml.kg^{-1}.hour^{-1}$ IV Sodium chloride (Natriumklorid, Fresensius Kabi 9 $mg.ml^{-1}$, Finland) through an infusion pump from KruTech VIP 2000 (KRUUSE, Denmark). An injection of atipamezolhydrochloride (Antisedan vet, Orion, Finland) were given intramuscularly 15 minutes after the radiographic the examination as done, with a dose of 5 $mg.kg^{-1}$. This procedure was replicated identically for the next 10 dogs in the radiographic procedure with different doses depending on the weight of the dams examined.

The X-ray apparatus that was used in all experiments during this diploma thesis were GER Int. (Cuy, France). The program used for the X-ray apparatus is Vet-Tech 300HF.

The focus-film distance is the distance between the centre of the anode of the X-ray tube and the film in the cassette and were 73 cm for all the dogs. The computer imaging software for reading, displaying and measurements of the X-ray images is Vet-Exam plus 9.6.0. Cassette reader and cassette is from CR43VET. The collimator used in this experiment was a Ralco, model R302/A. Kilovoltage (kV) used in all the dogs were 76, while milliampere per second was 13.5. Slight adjustments could be made on kV depending on the size of the dogs to get optimal radiographs.

The radiographs were taken in left lateral and dorsal recumbency [3]. In dorsal recumbency, the radiographs were obtained in ventrodorsal projection, and the dog was placed in a flexed ventrodorsal (frog-legged) position, and the central beam was focused on the midline between the *trochanter major* on the two femurs [9]. This projection is typically preferred in sedated animals, especially those that dislike extension of the hindlimbs due to the pain in the hip [8]. The lateral (LL) view would be obtained initially before ventrodorsal (VD) view, and the animal was placed in lateral recumbency with the legs in a natural position on the table. To prevent rotation in axial skeleton of the pelvis, padding should be placed between the femurs, and the femurs should be parallel to each other. The radiographic beam was centred on the hip joints where the trochanter major was used as landmarks [8].

After radiography, the radiographs of the pelvis were measured directly with a digital ruler in the radiography program and the measurements were done as follows: *conjugata vera* (CV) = distance between *promontorium* (cranial end of *sacrum*) and *pecten ossis pubis* (cranial end of *symphysis*), *conjugata diagonalis* (CD) = distance between *promontorium* and caudal end of *symphysis*, *diameter verticalis* (DV) = vertical distance between *pecten ossis pubis* and *sacrum* orthogonal to the *symphysis pelvis*, and *diameter transversa* (DT) = the horizontal distance between *corpus ossis ilii* (Fig. 1, 2) [3, 9].

In the study by Johansen [9] there were used fewer measurements to assess the pelvic proportions. Johansen stated: "To make sure that the horizontal distance was found when measuring DT a line was drawn between two distinct bony landmarks on the pelvis, namely the two lateral *tuber ischiadica*. The distance DT was measured parallel to the green line." (Fig. 2) [9].

The area of the pelvic inlet was determined by using the formula $\pi \times CV/2 \times DT/2$ [9, 17] with the measurements seen in the Figure 1 and 2.

Statistical analysis

Statistical tests were performed using Microsoft Excel with Anova: Single Factor data analysis with T-test. A P-value of < 0.05 was considered significant. Mean and Standard Error (SE) were calculated using Microsoft Excel.

Ethical approval

We confirm that the owners of patients in this study approved the medical process. The study was conducted according to the regulations of the local Institutional Animal Care and Use Committee.

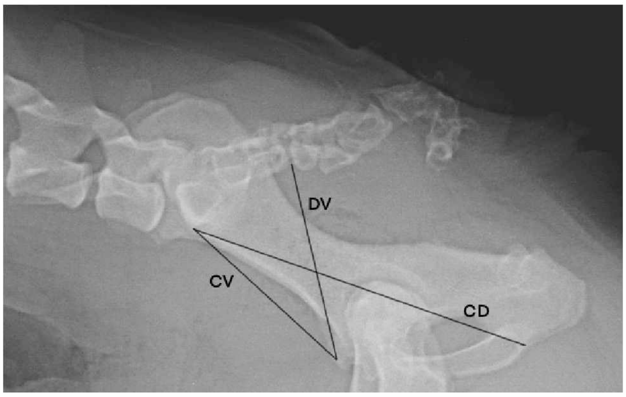

Fig. 1. Measurements on the lateral radiographs: CV = *conjugata vera;* DV = *diameter verticalis*; CD = *conjugata diagonalis*
Source: Self-made figure.

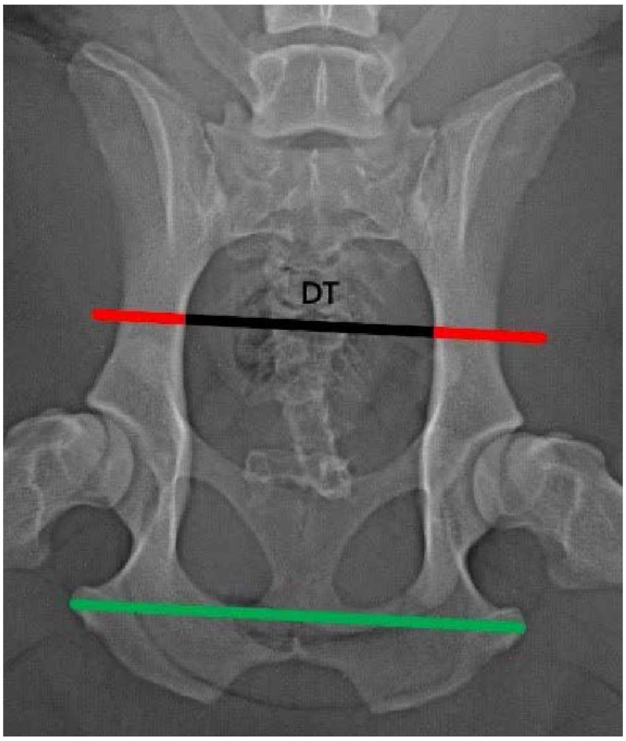

Fig. 2. Measurements on the ventrodorsal radiographs: DT = *Diameter transversa*
Source: Self-made figure.

RESULTS

The results are divided into two central components: the external parameter component where the external measurements of the female dogs in this project are listed, and the radiographic pelvimetry component where the internal measurements of the pelvic canal of the female dogs are listed.

To get an idea of the size of the female English Bulldogs, all dogs were weighted and measured to acquire external parameters of the dams. The two groups of the dogs were compared by length, height and weight with P-values. The results are seen in Table 1.

Table 1. The mean number with Standard Error (SE) of external measurements of naturally birthing dams and dams that has given birth through caesarean section and a comparison by P-value.

Measurement	Natural birth (n = 6) Mean + SE	Caesarean section (n = 5) Mean + SE	P – value
Length (cm)	44.8 ± 2.48	45.4 ± 2.60	0.721
Height (cm)	36.1 ± 0.98	36.0 ± 1.58	0.8350
Weight (kg)	21.25 ± 0.91	25.16 ± 1.44	0.0004

n – number of dogs

Pelvic diameter was measured and assessed through radiography and the results with comparisons of the two groups of dams are found in Table 2. All dams contributing to the radiographic study is included, both females that had a natural birth and the females that gave birth through caesarean section. The pelvic measures were compared of the two groups of females.

Table 2. Comparison of pelvic measurements of bitches that had given birth naturally and bitches that had given birth through caesarean section by means of P-values, mean and SE

Measurement	Natural birth (n = 6) Mean + SE	Caesarean section (n = 5) Mean + SE	P-value
CV (cm)	6.50 ± 0.3	6.48 ± 0.3	0.8937
DV (cm)	6.32 ± 0.3	6.15 ± 0.3	0.4291
CD (cm)	10.23 ± 0.4	10.15 ± 0.56	0.8068
DT (cm)	5.05 ± 1.15	5.31 ± 0.21	0.6240
CV/DT	1.46 ± 0.48	1.22 ± 0.08	0.2991
Area of pelvic inlet (cm)	28.29	27.01	0.1202

CV = Conjugata vera; DV = Diameter verticalis; CD = conjugata diagonalis; DT = Diameter transversa. CV/DT = relation between the vertical and horizontal diameter of the pelvic inlet. Calculated with the formula $\pi \times CV/2 \times DT/2$ to get the results of the area of pelvic inlet; n = number of dogs.

DISCUSSION

The purpose of this study was to use the external measurements of all the females of the study and look if there is any correlation between the height, weight or length to dystocia and narrow pelvis diameter. The values of height and length in the category of dams which had undergone parturition *per via naturales* were in cm 44.8 ± 2.48 (length) and 36.1 ± 0.98 (height). In the category of dogs which had undergone caesarean section, the parameters were in cm 45.4 ± 2.60 and 36.0 ± 1.58, respectively. The values show that there were only minor differences in height and length. The P-value for length was 0.721 for length and P-value for height was 0.835. In the thesis of Johansen [9], it was seen a significant difference in height of the dams and the correlation with caesarean section, where the dams had generally shorter height than the dams which had given birth naturally. In this study with the two categories of dogs, there was not seen any significant difference between the height and the length.

The mean weight and SE of the dogs with natural parturition was 21.25 ± 0.91 kg, whereas the females which had undergone caesarean section was 25.16 ± 1.44 kg. This resulted in a P-value of 0.0004 which shows strong evidence for the hypothesis of the study. This strongly indicates evidence for weight as an important factor of dystocia in females of English Bulldogs in this study. As a comparison, one female that undergone caesarean section with nearly the same height and length parameters as one with natural parturition is 1.6 kg heavier. The heaviest of the dogs in this study was 27.4 kg, whereas the heaviest in the group of natural parturition was 22.5 kg. These two dogs where in the same height and the length difference was 5 cm. In Johansen's thesis [9] there was not seen any correlation between the weight of the dams and the higher number of caesarean sections. In the article by Eneroth et al. [3] however, it was found that bodyweight, height and withers had some influence on the outcome of the parturition in Scottish terriers.

Obesity is defined as a disease in which excessive body fat has accumulated to such an extent, that the health of an animal may be adversely affected [6]. The cause of obesity is either excessive dietary intake or inadequate energy utilization, which results in positive energy balance [5]. Canine patients are typically seen as clinically obese when their body weight is at least 15 % above ideal weight of the breed. Since obesity is known to intensify and predispose to many different serious diseases and medical conditions, it is an important disease to follow and control [7]. In reproduction, obesity is associated with multiple reproductive disorders. Infertility, ovulation dysfunction, foetal growth disorders and abortion is observed in some cases in clinical practice. Obese animals possess a higher risk of dystocia due to accumulation of fatty tissues around the pelvic cavity reducing the elasticity of the pelvic ligaments which is a must for parturition [14]. In other veterinary articles dystocia is marked as a possible consequence of obesity in dogs and cats [6, 7]. It is essential that only animals that are in optimal body condition should be bred. Overfeeding pregnant animals is commonly seen in veterinary practice, where many owners believe that high amounts of energy are required from the very beginning of pregnancy. This will result in fat deposition which will make the females more prone to have dystocia. Weight of the dams should therefore be monitored throughout the pregnancy and the weight should not exceed 25–30 % of the pre-breeding weight. [4].

Diagnostic imaging as computed tomography (CT) or radiography is essential for management of canine dystocia. Radiography is especially essential for determining foetal number, foetal misplacement and foetal-maternal incompatibility [15]. English Bulldogs are a brachycephalic breed and it is discussed that the breed's large head in relation to a narrow pelvis is the main reason for obstructive dystocia. Recent CT studies of bulldogs showed an overall narrower pelvis and a pelvic canal and a narrower pelvic outlet, which gives a higher risk of dystocia in the breed [2]. The study by Dobak et al. [2] demonstrates that English bulldogs generally have a significantly smaller pelvis and pelvic diameter when compared to non-brachycephalic breeds of the same weight range. In the thesis of Johansen [9] it was also indicated that the pelvic canal was significantly shorter and lower in the dams suffering from dystocia compared to natural whelping dams in Scottish Terriers [3]. Johansen [9] and Eneroth et al. [3] did not observe any significant difference in *diameter transversa* in the two groups of dams in their studies, which is also the incidence in this study. That can indicate that the main problem with the pelvis of the Scottish Terriers is dorsoventral flattening of the pelvic inlet. In this study, there is not significant evidence to presume similar conformity, but it could be a possible description of the possible obstructive dystocia in the breed.

Contrary to expectations, this study did not find a significant difference between the diameter of the pelvis and the two groups of English Bulldog females. The P-value was 0.12, which showed no true evidence for the hypothesis of a narrower pelvic canal of the females giving birth through caesarean section. However, it could be significant for a possible future study with a higher number of animals for measuring pelvic diameter.

Johansen's thesis [9] of radiographic pelvimetry of Scottish Terriers states that vertical diameters of the bitches that had given birth naturally were significantly longer than for bitches that had given birth solely by caesarean section. They also observed that the pelvic canal was significantly shorter and lower in the dams suffering from dystocia compared to dams that were naturally giving birth. However, there are differences in the breed of Scottish terriers and English Bulldogs, hence it is difficult to see the value of this resource. In an article written by Celimli et al. [1], cats with dystocia had a significantly smaller pelvic dimension than cats which had a normal parturition. Dobak et al. [2] also reveals that English bulldogs generally has a significantly smaller pelvis and pelvic diameter when compared to non-brachycephalic breeds of the same weight range. This is a very important factor for this study, because the results show low significance between the two groups of dams. Essentially, the theory of Dobak et al. [2] points out the fact that the English Bulldogs' pelvic canal is smaller in general, hence the difference between the two groups can be minimal and there is a possibility of other factors making the difference in the problems of giving birth naturally, together with the main issue of a narrow pelvic canal.

There are some delimitations in this thesis. There are 11 dogs in the scientific study which limits the P-value of the scientific study. In this way, it would be useful to use this study as a preliminary study for a larger study where more subjects are used and more radiographic pelvimetry measurements are evaluated to get a larger picture of the dystocia in English Bulldogs.

CONCLUSIONS

The result of this study showed that the females which had undergone caesarean section and the females that had given birth *per via naturales* had only minor differences in height and length. The mean weight comparison for the two groups resulted in a P-value of 0.0004 which strongly indicates evidence for weight as an important factor of dystocia in females of English Bulldogs.

Contrary to expectations, this study did not find a significant difference between the diameter of the pelvis and the two groups of English Bulldog females. The P-value was 0.12, which is high and shows no true evidence for the hypothesis of a narrower pelvic canal of the females giving birth through caesarean section. However, it could be significant for a possible future study with a higher number of animals for measuring pelvic diameter. One can assume that if this had been a larger study with more research animals, the P-value would possibly been lower, and the number would been significant. This hypothesis cannot be concluded in this study.

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CONFLICT OF INTEREST

We declare that all listed authors are without a Conflict of Interest.

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