PREDICTING THE PARTURITION DATE IN YORKSHIRE TERRIER AND GOLDEN RETRIEVER BITCHES USING ULTRASONOGRAPHIC FETOMETRY

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Abstract

The aim of this study was to evaluate the suitability of the ultrasonographic fetometry involving inner chorionic cavity diameter (ICC) and biparietal diameter (BP) measurements for predicting the parturition date in two dog breeds: the Yorkshire Terrier and Golden Retriever. Additionally, the authors studied whether developing specific mathematical formulas for predicting parturition dates in the breeds was justified. In the group of Yorkshire Terrier bitches, 12 ICC measurements and 14 BP measurements were taken. In the Golden Retrievers the ICC was measured 8 times and BP – 10 times. The obtained values were substituted into Luvoni–Grioni formulas, taking into account the body mass before pregnancy. Due to the lack of earlier studies on dogs with a body mass over 25 kg, the parturition date for the Golden Retrievers was calculated using formulas for medium–sized dogs (body mass 10–25 kg). In the case of the Yorkshire Terriers, formulas for dogs smaller than 10 kg were used. The method proved to be highly useful in predicting the accuracy of the parturition date in both breeds. Prediction accuracy in the Golden Retrievers reached 80% to 100%, depending on the type of measurement used, and precision levels. In the Yorkshire Terriers, the accuracy reached 57%–93%. Comparing the effectiveness of the parturition date prediction in the two breeds, no statistically significant differences were found. Regression lines based on the authors' own fetometric measurements were highly convergent with the lines defined by the Luvoni–Grioni formulas. The only statistically significant difference was found in BP measurements in the Golden Retrievers; this suggests that the commonly used Luvoni–Grioni formula should be modified when applied to large dog breeds.

Key words: bitch, parturition date, ultrasonography, fetometry.

One of the latest applications of ultrasonography in veterinary obstetrics is the control of embryo and foetus development in dogs (8, 18). The gestation period in this species is relatively short, and, moreover, is often subject to pathological processes (5, 8, 17). One of the most important clinical problems is the varied duration of pregnancy (57-72 d), which makes it impossible to plan obstetric and neonatal care (4, 9, 13). In bitches, the varied duration of the gestation is due to the biological nature of the fertilisation stage and it is not possible to calculate the parturition date based on the date of mating. The parturition date may be predicted with greater accuracy using cytological and hormonal methods; however, their disadvantages include: high cost, labour-intensiveness, and limitation of the testing period to the mating period only. The disadvantages render these methods unsuitable for general practical use (9, 12, 14, 17).

Therefore, over the last few years, there have been several attempts to adapt fetometry in veterinary practice as it is used in human medicine (3, 6, 10, 16, 21, 24). The method consists of periodical ultrasonographic measurements of certain foetal structures, assuming their linear and proportional development. The application of appropriate mathematical formulas provides the basis for establishing the parturition date (6, 12, 13, 20). Recently, measurements of the foetal inner chorionic cavity (ICC) and biparietal diameter (BP) became common, and the authors underline their great practical value (1, 10, 13-15, 19, 22). This allows the possibility to predict parturition dates in bitches at different gestation stages. However, studies of this method conducted so far must be regarded as preliminary, and one of the factors that prevent its full application is the presence of big differences depending on breed, individual animal, and its body mass. In particular, there have been so far only few observations of large and giant dog breeds (4, 7, 11, 16).

The objective of this study was to evaluate the suitability of the ultrasonographic fetometry method involving ICC and BP measurements for determining the parturition date in two dog breeds: one with a small body mass – the Yorkshire Terrier, and one with a large body mass – the Golden Retriever. Additionally, the authors studied whether developing specific
mathematical formulas for predicting the parturition dates in the two breeds was justified.

Material and Methods

Material. Studies were conducted on 19 pregnant bitches of two breeds: the Yorkshire Terrier (n=10) with an average body mass 3.4 ±0.4 kg and the Golden Retriever (n=9) weighing on average 31 ±1.8 kg. The dogs were subjected to routine pregnancy control with clinical and ultrasonographic methods; the animals of each breed were also subjected to fetometric examinations to measure the ampulas and craniums.

Fetometry. The inner chorionic cavity diameter (ICC) was measured 40-25 d before parturition as an average of two perpendicular measurements of the inner chorionic cavity diameter. Each time at least one foetus from two different uterine horns was measured (1). The biparietal diameter (BP) was established between 25-0 d before parturition after obtaining an appropriate foetus image by measuring the distance between the parietal bones. Each time at least two foetuses from two opposite uterine horns were evaluated (1). Examinations were conducted using the Pie Medical 260 Corvus scanner with a convex transducer 5.0–7.5 MHz. During examinations, the bitches were standing or lying down, and their underbellies were shaved and covered with ultrasonography gel. In the group of Yorkshire Terrier bitches, 26 measurements were taken, including 12 ICC measurements and 14 BP measurements. In the Golden Retrievers, the ICC was measured 8 times and BP – 10 times. Obtained values in millimetres were substituted into Luvoni–Grioni formulas (13), taking into account the body mass of the bitches before pregnancy. Due to the lack of earlier studies on dogs with a body mass over 25 kg, the parturition date for the Golden Retrievers was calculated using formulas for medium-sized dogs (body mass 10–25 kg). In the case of the Yorkshire Terriers, formulas for dogs smaller than 10 kg were used. The used formulas were as follows:

- Weight group (0.10) kg
  - ICC: dd = (mm – 74.68)/1.75
  - BP: dd = (mm – 24.5)/0.6

- Weight group (10.25) kg
  - ICC: dd = (mm – 84.66)/1.86
  - BP: dd = (mm – 31.19)/0.8

The calculated value (dd) was the number of days until parturition counting from the day of measurement. The correctness of the predicted parturition date was evaluated in the breed groups (percentage of animals) by comparison with the actual date; two accuracy levels were taken into account: ±1 d and ±2 d.

Information about the parturition date, its course, litter size, and foetal sex ratio was obtained from the owners. In statistical analyses, only data of pregnancies with the correct number of pups were used. Following Beccaglia and Luvoni (1) average litter sizes for both breeds were assumed; for the Yorkshire Terrier - two-six pups, and for the Golden Retriever five–nine pups. An accurate Fisher test applied to both breeds independently was used to check whether there were significant differences between the accuracy of the parturition date predicted by means of ICC and the accuracy of the parturition date predicted by means of BP. Moreover, statistical points of the regression line obtained in the authors’ research, showing the relationship between the number of days until parturition and ICC or BP diameters, was compared with the line in Luvoni–Grioni formulas for small and medium dog breeds. The calculations were performed using Statistica software.

Results

The results of accuracy of the prediction parturition date based on ICC and BP measurements in both dog breeds are presented in Tables 1 and 2. In the Yorkshire Terrier bitches at accuracy level ±1 d, better results were obtained using ICC measurements (66.67%), while at accuracy level ±2 d, more correctness was achieved using BP (92.86%). However, the statistical calculations did not show significant differences in the parturition date prediction results between ICC and BP methods, both at ±1 d and ±2 d accuracy levels (P>0.05), (Table 1).

In the Golden Retriever bitches, the precision of parturition date prediction was much higher and reached 80%–100%. At both accuracy levels, ICC gave better results (100%) than BP (80%-90%). However, these differences were statistically insignificant (P>0.05), (Table 2).

On the basis of the measurements, the authors developed the following formulas for both dog breeds taking into the account the factors (ICC and BP):

Yorkshire Terrier
ICC: dd = (mm – 74.68)/1.75
BP: dd = (mm – 24.5)/0.6

Golden Retriever
ICC: dd = (mm – 84.66)/1.86
BP: dd = (mm – 31.19)/0.8

Table 1
The accuracy of prediction the parturition day (%) based on ICC and BP using Luvoni-Gioni formulas in Yorkshire Terrier bitches

<table>
<thead>
<tr>
<th>Precision in days</th>
<th>ICC</th>
<th>BP</th>
<th>ICC – BP exact Fischer probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>± 1</td>
<td>8/12</td>
<td>66.67</td>
<td>8/14</td>
</tr>
<tr>
<td>± 2</td>
<td>10/12</td>
<td>83.33</td>
<td>13/14</td>
</tr>
</tbody>
</table>
Table 2
The accuracy of prediction the parturition day (%) based on ICC and BP using Luvoni-Grioni formulas in Golden Retriever bitches

<table>
<thead>
<tr>
<th>Precision in days</th>
<th>ICC</th>
<th>BP</th>
<th>ICC – BP exact Fischer probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 1</td>
<td>9/9 100.00</td>
<td>8/10 80.00</td>
<td>0.2632</td>
</tr>
<tr>
<td>± 2</td>
<td>9/9 100.00</td>
<td>9/10 90.00</td>
<td>0.5263</td>
</tr>
</tbody>
</table>

Fig. 1. Relationship between ICC and number of days until parturition established by means of regression analysis compared with Luvoni-Grioni formula for Yorkshire Terriers.

Fig. 2. Relationship between BP and number of days until parturition established by means of regression analysis compared with Luvoni-Grioni formula for Yorkshire Terriers.

Fig. 3. Relationship between ICC and number of days until parturition established by means of regression analysis compared with Luvoni-Grioni formula for Golden Retrievers.

Fig. 4. Relationship between BP and number of days until parturition established by means of regression analysis compared with Luvoni-Grioni formula for Golden Retrievers.

A comparison of the regression lines obtained following the authors’ ICC and BP measurements with the ones in Luvoni–Grioni formulas (13) in both dog breeds are presented (Figs 1–4).

For the Yorkshire Terriers, no statistically significant differences were found between the regression line based on experimental data and a respective line established by the Luvoni–Grioni formula, taking into account ICC and BP. (Figs 1 and 2).

For the Golden Retrievers, no statistically significant differences were found between the two lines for the ICC parameter; however, a highly statistically significant difference (P<0.01) was found between the
authors’ regression line and the Luvoni–Grioni line for the BP parameter.

Discussion

Fetometry used to predict the parturition date and to determine the pregnancy stage is a fairly new technique used in veterinary medicine; it is also a new research field (8, 10, 15, 23). In humans, calculation formulas used in foetal biometry take into account the mother’s height and body mass, ethnic group, and child’s sex (13, 15). Studies conducted so far on dogs have taken into account only the body mass (1, 2, 6, 7, 10, 13, 16, 21, 23, 24); there is no information about the influence of dog breed, affinity to local animal populations, litter size, and sex ratio on the results of this method. Therefore, in this paper the authors decided to study the possibility of using fetometric measurements in two popular dog breeds with extremely different body masses. ICC and BP measurements were used, because earlier studies showed these parameters to be the most practical ones (6, 10, 13). Other measurements of foetal structures and organs used in veterinary medicine, such as body diameter (BD), crown-rump length (CRL), embryonic vesicle diameter (EVD), head diameter (HD), and diencephalo-telencephalic diameter (DPTV) proved to be less useful in clinical practice (6, 7, 10, 13, 21, 23, 24). One should underline that the authors studied pregnant Golden Retriever bitches because no calculation formulas were published so far for this dog breed. In the literature, one may find only calculation formulas for bitches with a small and medium body mass (12, 13, 20, 21). This is the reason why the authors used the Luvoni–Grioni (13) formula for medium body mass bitches as the starting point in this paper.

The authors’ accuracy results for the prediction parturition date confirmed in general the usefulness of the method in both dog breeds and are not significantly different from other authors’ results (10, 11, 13, 14, 21). One should underline the high accuracy of the parturition date prediction of 80%–100% in the Golden Retriever bitches, depending on the measurement used and accuracy level. It should also be stressed that the use of ICC measurement provided a higher percentage of accurate predictions; however, the difference was not statistically significant. According to authors’ opinion, it is better to perform the measurements of Golden Retriever in the 2nd trimester, rather than in the 3rd one. This opinion, in reference to other dog breeds and weight groups, was also expressed by Yeager (24) and Son et al. (21). The reason for this phenomenon may be different foetus growth and development dynamics in individual animals in the final trimester, which distorts the results obtained by means of BP.

As it has been mentioned earlier, there are no publications on the use of fetometry in large and giant dog breeds. Only Kutzler (10) and Lopate (12) have confirmed its effectiveness at a level of 65%–86%; however, they did not publish the calculation formula they used. The authors also proposed a modification consisting of deducting 2 d from the parturition date predicted using their formula. This is because gestation in large dog breeds is generally known to be shorter than in small dog breeds (9, 10, 12, 21).

The authors of this paper found the 57%–93% accuracy of the prediction parturition date, depending on the assumed accuracy level and used measurement, to be surprisingly lower in Yorkshire Terriers. One should add that the Luvoni–Grioni formula appropriate for this weight group was used. This indicates a considerable individual variation of the measurement results in this breed, which is clearly visible in Fig. 1 as evidenced by the large scatter of individual measurement results. This may be also caused by technical problems with measuring relatively small foetuses and the related phenomenon of reproducing error. Another interesting observation is that in Yorkshire Terriers, the ICC parameter measurement is more precise than the BP at ±1 d accuracy; however, at an assumed accuracy of ±2 d, the measurement of the distance between parietal bones proved to be more precise. A similar relationship is not reported in any available publication. This result may be related to the anatomical and developmental features of this breed’s population. However, in order to confirm these conclusions it is necessary to conduct more experiments on a larger group of animals. One should also mention that similar relationships were not found in the Golden Retrievers.

Independently of the percentage of accuracy obtained in this study, the parturition date predictions in both breeds are at a satisfactory level from the clinical point of view. It is because prediction of the parturition date even at an accuracy of 1–2 d allows for appropriate medical assistance to be provided, in cases of natural birth as well as in severe cases requiring surgical assistance (1, 13–15, 20, 21).

The fetometric measurements obtained in this study were also used to compare the authors’ regression lines with the lines defined by the Luvoni–Grioni formulas (13). The lines were considerably similar for both dog breeds and parameters, which proves that they are correct and may be applicable to dogs without breed-specific formulas. Only in the Golden Retriever bitches the BP parameter showed a statistically significant difference. This suggests that the generally used Luvoni–Grioni formula (13, 14) should be modified when applied to large dog breeds. It should be remembered that it was developed for medium body sized dogs. Other authors (10, 12) mention major difficulties in establishing parturition dates in large and giant dog breeds and postulate the creation of appropriate fetometric formulas for these breeds. This also shows that further wide-ranging population studies must be conducted to investigate this problem in animal groups defined by body mass, breed, or affinity with local populations. The authors of this paper realise that their observations, even though conducted on a group of animals ensuring statistical correctness, included a relatively small amount of animal material. It seems, however, that on the basis of the ICC and BP measurements, in the case of both breeds, one may
Correctly evaluate the gestation development stage and predict the parturition date with a precision satisfactory for clinicians. This problem requires, nonetheless, further population studies and constant modification of the formulas that are used. Similar overall suggestions were included in the works of Kim (7), Kutzler (10), and Lenard (11) concerning other dog groups and breeds.

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References