Comparison of Transabdominal and Transrectal Ultrasonography of the Prostate Gland in Dogs

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Abstract

Objective- To compare transabdominal (TA) and transrectal (TR) ultrasonography of the prostate gland.

Design- Experimental study.

Animals- 10 intact male dogs that required euthanasia for reasons other than prostatic disease.

Procedures- Prostatic length (L), width (W) and height (H) were measured in TA (L₁, W₁, and H₁) and TR (L₂ and H₂) ultrasonography. Prostatic volume was calculated using the formula for the volume of an ellipsoid (Vₑ₁ and Vₑ₂) or for a box (Vₚ₁ and Vₚ₂) in TA and TR procedures, respectively. The dogs were euthanized, the prostate gland removed, and actual prostate dimensions and volume were measured. Linear regression was used to compare prostatic dimensions and volume measured by ultrasonography to actual ones.

Results- In TR ultrasonography there was no damage to rectum, the time for evaluation of the prostate gland was faster and the resolution of prostatic images was better than other procedure. There was highly significant correlation between prostatic parameters and their actual dimension. Vₑ₁ and Vₑ₂ were greater and Vₚ₁ and Vₚ₂ were lesser than actual prostatic volume. In TR and TA methods the dimensions had significant correlation with real prostatic sizes, while had not significant statistical differences with real prostatic sizes.

Conclusions and Clinical Relevance - TR ultrasonography found to be a simple, quick and noninvasive method and TA ultrasonography also yields useful information about the prostate. Calculated prostatic volume doesn't estimated prostatic volume correctly and need to use equations produced by linear regression:

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V = 0.427 Vₑ₁ - 0.88 \quad V = 0.796 Vₑ₁ - 0.40
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V = 0.680 Vₑ₂ - 1.95 \quad V = 0.980 Vₑ₂ + 1.94
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Key Words- Transrectal ultrasonography, Prostate gland, Dog.

Introduction

The prostate gland is the major accessory gland in male dogs. A fluid which will transport and support the survival of sperm and which is delivered to the urethra during the terminal phase of ejaculation is produced by prostate gland.¹,²,³ Prostate disease is common problem in older sexually intact male dogs. The most common prostatic diseases are bacterial prostatitis, prostatic cyst, benign prostatic hyperplasia, prostatic adenocarcinoma and prostatic abscesses.¹,³ The main diagnostic techniques for prostatic diseases are history, physical and laboratory examinations, radiography, ultrasonography, computed tomography and magnetic resonance imaging.¹,²,³,⁵ The canine prostate remains the best model for assessing the effectiveness and complications of human studies.⁵,⁶ The canine prostate gland can be affected by several disease processes, which often have overlapping clinical signs, making it difficult to reach the correct diagnosis.¹,³ Accurate diagnosis of prostatic disease requires a thorough understanding of prostatic anatomy, as well as clinical signs associated with canine prostatic disease. Furthermore, knowing which diagnostic tests are indicated, and how to properly them, facilitates an efficient and accurate diagnostic process.¹,⁰,¹¹ Ultrasonography is a useful, safe and noninvasive technique to assess the canine prostate gland. It allows better identification of the prostatic parenchyma compared to radiographic or urethrocystographic procedures. It is an excellent means for guiding

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Ultrasoundography was used in the evaluation of prostate gland in dogs, via transabdominal and transrectal route. 15-23, 25 Dimensions of the prostate gland are used as a preoperative criterion for deciding on the best way for treatment. Therefore, it is quite important to accurately assess the dimensions. 13, 15, 24 Prostate volume is used in man to decide between possible treatment modalities and prostatic volume estimation by transrectal ultrasound is a common clinical procedure. Step section planimetry is assumed to be the most accurate method of prostate volume determination, but it is time consuming and requires cumbersome special equipment. 5, 9 Although Zoheil and Castellano (1995) compared prostatic ultrasonography by prepubic and transrectal technique in dogs, but in healthy young adult dogs, 24 it seems there is no document about comparison of transabdominal and transrectal ultrasonography for prostatic dimensions with actual size. The aims of this study were: to compare the transabdominal and transrectal ultrasonography of the prostate gland in dogs, to estimate the dimension, volume and weight of the prostate gland by transabdominal and transrectal ultrasonography and to derive a simple formula from actual and ultrasonographic prostate measurements for estimating prostate volume and weight.

Materials and Methods

The study was performed on 10 intact male dogs referred to our veterinary teaching hospital that required euthanasia for reasons other than prostatic disease. Their body weights ranged 16-23 kg and their ages between 2 to 4 years old.

Transabdominal and transrectal ultrasonography were performed using a 5 MHz linear array transducer (Veterinary Rectal probe, Piemedical 450 VET, Netherland). After complete preparations, each dog was placed in dorsal recumbency for transabdominal and in lateral and sternal recumbency for transrectal methods. Standard longitudinal and transverse sections (based on Atalan study 17, 1999) were obtained and prostatic length (L1), width (W1) and height (H1) were measured in cm in transabdominal technique. Length was defined as the maximum diameter of the gland along the urethral axis. Height was defined as the maximum dorsoventrally diameter of the prostate. Width Width was defined in transverse section in maximum diameter perpendicular to the axis of the H1. But in transrectal procedure only prostatic length (L2) and height (H2) were obtained for right and left prostatic lobes. Because of the equal measurements in both lobes only right lobe were documented. After measurement L1, W1 and H1 by transabdominal ultrasonography, prostatic volume was calculated using the formula for the volume of an ellipsoid, {\( V_{E1} = \frac{4}{3}\pi L_1 W_1 H_1 \)} or for the volume of a box, {\( V_{B1} = L_1 W_1 H_1 \)}. In transrectal procedure prostatic volume was also calculated by {\( V_{E2} = 0.524 \times L_2 \times W_2 \times H_2 \)} and {\( V_{B2} = L_2 \times W_2 \times H_2 \)}.

After the ultrasonographic evaluations the dogs were euthanized and the prostate gland was removed from cadaver, immediately. Connective tissues around the prostate gland were removed and weighed with a digital scale in grams. The actual prostate length (L), width (W) and height (H) were measured using a mechanical caliper graduated in mm. The actual prostate volume \((V_A)\) was determined through water displacement in a graduated cylindrical containing in cm\(^3\). Prostatic volume was also calculated using the formula for the volume of an ellipsoid \(V_E = 0.524 \times L \times W \times H \) and for the volume of a box \(V_B = L \times W \times H \). Specific gravity of the prostate glands was determined by dividing prostatic weight in grams by prostatic volume in cm\(^3\). In necropsy rectum, colon, prostate gland and urinary bladder were controlled for any gross pathologic changes.

All statistical analyses were performed using SPSS 16 software. Linear regression was used to compare prostatic dimension and volume measured by ultrasonography to actual prostate L, W, H and \(V_A\). Correlation coefficient method was used to compare prostatic dimension measured by ultrasonography to actual sizes. The relationships between age or bodyweight and prostatic dimensions, volume and weight were tested by means of correlation analyses, in all entire dogs. Results were considered significant when P > 0.05.

Results

In physical and ultrasonographic examinations and after necropsy there were no signs of prostatic diseases. In transrectal ultrasonography there was no damage to rectum and the time for evaluation of the prostate gland was faster than transabdominal ones. Also the resolution of prostatic images in transrectal method was better than other procedure. Lateral recumbency was better than sternal recumbency for transrectal examination. After transrectal ultrasonography there were not any signs of mucosal damages and hemorrhage. Rectal perforation had not observed in necropsy.

Mean±SD of the dimensions of the prostate gland measured by transabdominal and transrectal ultrasonography and prostatic actual measurements are summarized in table 1. Measurements obtained from transabdominal and transrectal ultrasonography were greater than actual prostatic dimensions. But measurements obtained from transrectal method were closer to actual prostatic dimensions than transabdominal ultrasonography. In transrectal ultrasonography only length and height could be measured due to type of transducer that was used. There was highly significant correlation between prostatic parameters calculated from transabdominal (L1, W1 and H1) and transrectal (L2 and H2) ultrasonography and their actual dimension (P < 0.001). The measurements
were highly accurate in both methods and had not significant statistical differences with real prostatic sizes (p<0.001). The mean ± SD of V_E1 and V_B1 measured by transabdominal ultrasonography were 16.68±8.7 and 31.85±9.3 cm³, respectively. Based on table 1, V_B1, V_E1, and V_B2 were greater than actual prostatic volume while, V_E2 and V_E12 were lesser than actual prostatic volume. All of the prostate weights were greater than their volume. Actual prostatic volume and weight were 12.5±6.72 cm³ and 12.82±6.8 grams, respectively. The mean±SD of specific gravity of prostate gland was 1.026±0.016 and there was highly significant correlation between actual weight and volume (P ≤ 0.001). Also there were significant correlation between body weight (P ≤0.05) and age (P ≤ 0.001) of dogs to their actual prostatic volume. Based on linear regression the equations comparing actual prostatic dimensions (L, W and H) to transabdominal ultrasonographic ones (L1, W1 and H1) are: 

$$L = 1.06 L_{1} – 0.99; \quad (R_{2}^{2} = 0.93).$$
$$W = 0.99 W_{1} – 0.4; \quad (R_{2}^{2} = 0.87).$$
$$H = 1.06 H_{1} – 0.62; \quad (R_{2}^{2} = 0.82).$$

Based on linear regression the equations comparing actual prostatic volume to calculated volume (V_B1 and V_E1) by transabdominal ultrasonography are:

$$V = 0.427 V_{B1} – 0.88; \quad (R_{2}^{2} = 0.95).$$
$$V = 0.796 V_{E1} – 0.40; \quad (R_{2}^{2} = 0.94).$$

Based on linear regression the equations comparing actual prostatic volume to calculated volume by transrectal ultrasonography are:

$$V = 0.680 V_{B2} – 1.95; \quad (R_{2}^{2} = 0.89).$$
$$V = 0.980 V_{E2} + 1.94; \quad (R_{2}^{2} = 0.91).$$

Also the equations comparing actual prostatic weight (W) to calculated weight are:

$$W = 0.434 V_{B1} – 0.747; \quad (R_{2}^{2} = 0.96).$$
$$W = 0.81 V_{E1} – 0.265; \quad (R_{2}^{2} = 0.95).$$

| Table 1. Comparisons between prostatic dimensions (mean ± SD) in present study and others 15, 21, 25. |
|---|---|---|---|---|
| Present study transabdominal method | Length (cm) | Width (cm) | Height (cm) | Volume, Box(cm³) | Volume, Ellipsoid (cm³) |
| Present study transrectal method | 3.35±0.4 | 3.42±0.53 | 2.78±0.5 | 31.85±9.3 | 16.68±8.7 |
| Present study actual size | 3.01±0.32 | undetermined | 2.30±0.32 | *20.83±7.1 | *10.92±6.5 |
| Ruel et al. (1998)25 | 2.5±0.45 | 2.92±0.52 | 2.27±0.36 | 16.75±6.23 | 8.68±5.72 |
| Atalan et al. (1999)16Ω | 2.9 | 2.5 | 2.3 | 12.3 | - |
| Kamolpatana et al. (2000)22 | 3.15±0.83 | 3.15±0.9 | 2.83±0.6 | 32.0±22.6 | 16.7±11.77 |

*Volume was calculated with length instead of width, which could not measured by linear transducer in transrectal ultrasonography. Ω SD was not published in Atalan et al. (1999) study16. |

Discussion

This study was successfully performed on 10 intact male young adult dogs by transabdominal and transrectal ultrasonography. Ultrasound has become increasingly popular in the measurement of prostate size in men, via transabdominal, transrectal, perineal or transurethral routes.8, 9 In dogs, transabdominal and transrectal ultrasound have been used for the assessment of prostate size. To the best of our knowledge there is no study to compare prostatic dimensions and volume measured by transabdominal and transrectal ultrasonography and to compare each one to actual prostatic size. Based on our findings transabdominal method took more time than other procedure. It could be due to clipping hair from caudoventral abdomen and require of a full bladder. The higher resolution of images of the prostate gland obtained with transrectal ultrasonography. In this method there was not any adverse reaction like bleeding, tenesmus or mucosal damages. A comparative study was done by Zoheil and Castellano (1995) in ten dogs with signs of prostatic disease in order to evaluate the usefulness of the prepubic and transrectal ultrasonography. They found both techniques were adequate to identify the prostate gland and prostatic urethra but transrectal ultrasound found 5 occurrences of parenchymal echogenicity changes whereas the prepubic technique found only 2.24 The normal (actual) size of the canine prostate is said to be 2.5 to 3.0 cm in diameter (Allen and others 1991).26
Christensen (1979) found that the size in two- to five-year-old 25-lb dogs varied from ovoid, 1.7 cm in length by 2.6 cm in width by 0.8 cm in height, to spheroid, 2 cm in diameter. These measurements are comparable with the results in the present study. The mean ±SD of prostatic measurements using ultrasonography in present study and others in centimeters were summarized in table 1. There are differences between prostatic dimensions in our study and others. The differences between this study and previous studies can be explained by variations due to breed differences, animal size, age, body weight, inter observer’s variability and numbers of dogs were used in the study. Cartee and Rowles (1983), in eight normal dogs was highly significant. While in Kamolpatana et al (2000) 18.9 ± 15.1 cm³ respectively. The mean ±SD of prostatic measurements using ultrasonography, Atalan et al used 154 healthy adult (1-14 years) dogs with body weight 4.5 to 65 Kg. Ruel et al used 100 healthy adult (0.75 to 14 years) dogs with 2 to 50 Kg weight that 14% of them had prostatic cysts and Kamolpatana used 12 intact adult (less than 5 years old) male dogs with 11 to 30.8 Kg. Despite of similarity of the age and weight of the dogs in Kamolpatana’s report to ours but they measured prostatic dimension on cadavers.

Based on the table 1 prostatic dimensions in transabdominal method in this study was slightly greater and in transrectal method was smaller than other studies. In transrectal method transducer could be positioned in close proximity to the prostate gland so that prostatic dimensions were closer to actual dimension than the other one method.

The mean ±SD prostatic volume determined by transabdominal ultrasonography and calculated using formulas of V₁ and V₂ were 16.68±8.7 and 31.85±9.29 cm³ respectively. While in Kamolpatana et al (2000) study, V₁ and V₂ of prostate gland were 16.77 ± 11.77 and 32 ± 22.6 cm³ respectively. Prostatic volume using formula of V₁ in Ruel et al (1998) research was 18.9 ± 15.1 cm³. The normal size, volume and weight of the canine prostate gland are said to vary depending on age, breed and bodyweight (Barsanti and Finco 1979). It varies in shape from almost spherical to bilobed or pear-shaped so that it seems it would be difficult to use formula of a box or an ellipsoid to calculate prostatic volume.

It must be mentioned that there was highly significant correlation between prostatic volume calculated by ultrasonography and water displacement in present study like Kamolpatana’s study. The formula for measurement of prostatic volume by ultrasonography determined in this study is different from later study, Furthermore Kamolpatana’s study was performed on dead dogs, before necropsy. Based on our findings calculated prostatic volume, (V₁, V₁, V₁ and V₁) overestimate prostatic volume. Otherwise V₁ and V₁ underestimate prostatic volume. So, due to these facts calculated prostatic volume must be corrected with equations produced by linear regression. L₁ and W₁ in transabdominal ultrasonography and L and W in actual prostatic measurement were very close to each other in our study. So that we used L₁ instead of W₁ to calculate V₁ and V₁ which could not measured in transrectal ultrasonography.

Numeric prostatic weight in grams is similar to volume in cubic centimeters so that specific gravity is near to one. The prostatic specific gravity in this study was comparable to Kamolpatana et al in the dog (1 ± 0.05) and Vilman et al study (1.05 to 1.06) in human. In conclusion, transrectal ultrasonography found to be a simple, quick and noninvasive method for evaluating the prostate in the dog and transabdominal ultrasonography also yields useful information about the prostate and is the modality commonly used in veterinary practice. Calculated prostatic volume by formula of a box or an ellipsoid do not estimated prostatic volume correctly and need to correct with equations produced by linear regression.

Acknowledgments

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References


مقایسه اولتراسونوگرافی سطح شکمی و داخل رکتومی غده پروستات سگها

چکیده

 مقایسه اولتراسونوگرافی سطح شکمی و داخل رکتومی غده پروستات سگها

هدف - مقایسه اولتراسونوگرافی سطح شکمی و داخل رکتومی غده پروستات سگها

طرح - مطالعه تجربی

حیوانات - ده قلاده سگ که در داخل پروستات از یک گرفت روده‌ای داشته‌اند.

روش کار - در پروستات از یک حرکت اولتراپلیژن و یک حرکت درون‌پیوسته در داخل رکتومی غده پروستات استفاده شده است.

نتایج - در روش اولتراسونوگرافی داخل رکتومی، بیشتر از پروستات سریع‌تر و تغییرات بیشتری در پروستات از وضعیت به‌خودی بروز می‌دهد.

واکنش‌ها - نتایج نشان دادند که اولتراپلیژن داخل رکتومی غده پروستات افزایش خاصی نمی‌دهد.

کلید واژه‌ها - اولتراپلیژن، داخل رکتومی، غده پروستات، سگ

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V = 0.427 V_{B1} - 0.88, \quad V = 0.796 V_{E1} - 0.40, \quad V = 0.980 V_{E2} + 1.94.
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