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Functional anatomy and ultrasound examination of the canine penis

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ABSTRACT

The aim of this study was to identify the functional–anatomical structures of the canine penis during and after erection to demonstrate the respective changes to provide a basis for further examinations of pathological conditions like priapism. Additionally, a gray-scale analysis was performed to quantify results from the ultrasound examination. In total, 80 dogs were examined. In group (Gr.) A, 44 intact or castrated dogs were examined, and in Gr. B, 36 dogs were examined during erection and after complete detumescence of the penis. The following parameters were assessed: (1) using physical measurements: length of the *Pars longa glandis* [*Plg*] and length of the *Bulbus glandis* [*Bg*]; and (2) using ultrasound: total penile diameter, width of the erectile tissue of the *Plg*, diameter of the *Corpus spongiosum* [*Cs*] including the penile bone and urethra, vertical diameter, circumference of the penis, cross-sectional area, and area of the *Cs* including the urethra. The mentioned parameters could be assessed in all dogs of Gr. A and Gr. B with the only exception being the urethra that could be visualized using ultrasound in some dogs only and predominantly in the erected penis (Gr. B). Concomitantly, the erectile tissue of the *Plg* and the *Cs* was more heterogenous and hypo- to anechoic during erection compared with dogs in Gr. A and Gr. B after detumescence. Comparing the results in Gr. B, the length of the *Plg* and the *Bg* were decreased approximately 40.6% and 38.0%, the total width of the penis 40.5%, the total width of the erectile tissue of the *Plg* 48.0%, and the width of the *Cs* 15.6% during detumescence compared with erection. Comparing the decrease in size at the different locations (*apex* penis, middle of *Plg*, middle of *Bg*) for vertical diameter, total circumference, and cross-section area, it was largest at the *Bg*. B-mode ultrasound is a suitable tool to investigate not only the morpho–functional structures of the resting canine penis, but also of the erected and detumescent penis, and to investigate the underlying changes during erection and detumenscence.

1. Introduction

Penile ultrasound including color or pulse-wave Doppler and gray-scale analysis is a valuable diagnostic tool in human medicine, especially in case of priapism (for review see [1]). A few studies reported the suitability of B-mode ultrasonography to identify physiological anatomical structures of the canine penis [2] or its use in case of priapism [3–5]; however, its use in canine andrology has not been established yet. The same is true for gray-scale analysis.

Gray-scale analysis is used for characterization of the ultrasonographic appearance of a tissue or an organ using computer-associated differentiation of 256 gray shades [6]. As the procedure is computerized it is considered an objective method and consequently superior to subjective evaluation of the echogenicity by the investigator. To our best knowledge, gray-scale analysis of the changes associated with erection in canine penis has not been described yet; but gray-scale analysis is considered a valuable tool,

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e.g., for assessment of reproductive functions such as spermatogenesis or epididymal function [6].

The aim of this study was to identify morpho–functional structures of the canine penis in intact and castrated dogs, and during erection and after detumescence to demonstrate the respective changes using ultrasound. Additionally, a gray-scale analysis was performed to quantify results.

2. Materials and methods

In a pretrial, optimum settings were identified for ultrasound examination and gray-scale analysis using the penises of four dogs obtained from the Institute for Pathology (dogs sent there for autopsy) and five living dogs.

The study consisted of two parts:

Part 1 (group A): intact and castrated male dogs were examined to compare presentability of physiological morpho–functional structures and to identify possible differences between intact and castrated dogs. In castrated dogs, age at castration was recorded.

Part 2 (group B): intact male dogs were examined during and after erection.

All animals were privately owned and housed; owners agreed to join the study voluntarily. No dog included in group B was included in group A; both groups were completely independent of each other.

2.1. Animal selection

In group A, 44 healthy adult male dogs (30 surgically neutered and 14 intact) of 19 different breeds were included. Surgically neutered dogs and intact dogs were similar in age and body weight (Table 1).

In group B, 36 healthy, adult, intact male dogs of 22 breeds were presented at the clinic for semen collection and examination for this study (Table 1).

2.2. Examinations performed in group A

2.2.1. Manual measurements

The penis was measured ensheated in the prepuce in the standing animal with the investigator standing on the left side. The following measurements were taken using a measuring tape: (1) length of the *Pars longa glandis* (*Plg*)—i.e., from the penile *apex* to the beginning of the *Bulbus glandis*; and (2) length of the *Bulbus glandis*.

2.2.2. B-mode ultrasound examination

A Zonare Z.one smartcart ultrasound machine (Physia GmbH, Neu-Isenburg, Germany) with a linear scanner (type L14-5w, mode “small parts”) with and without compounding was used (CH 12-MHz or 7-MHz). The setting CH 12-MHz included a combination of the tissue harmonic imaging technique and the frequence compounding technique by combining the sent frequency of 6 MHz with the harmonic wave of 12 MHz in addition. Results obtained were compared whether images with compounding (CH 12 MHz) or without (7 MHz) were more suitable for evaluation. The acoustic ultrasound gel (Sonogel GmbH, Bad Camberg, Germany) was prewarmed to 37 °C before use.

During examination the animal was standing on the table and the investigator was located on the left side. The penis was examined without protrusion out of the prepuce. After alcohol impregnation of the coat a sufficient amount of acoustic ultrasound gel was used to obtain good-quality images; the hair was not clipped. Only moderate pressure was exerted on the structures to avoid artifacts. Four ultrasound images were taken from every animal: (1) a longitudinal section (laterolateral) with the transducer located horizontally in the middle of the *Plg*; (2) a cross-section of the *Plg* at the penile *apex* with the transducer located vertically in the ventrodorsal direction; (3) a cross-section of the *Plg* in the middle between the penile *apex* and *Bulbus glandis* with the transducer located vertically in the ventrodorsal direction; and (4) a cross-section of the *Plg* at the *Bulbus glandis* (ventrodorsal direction).

The following parameters were assessed: total width (vertical diameter, measured from cross-sections) of the penis; width of the erectile tissue of the *Plg* (corresponding to the *Corpora cavernosa*); width of the *Corpus spongiosum* including penile bone and urethra and vertical diameter; circumference of the penis; and cross-sectional area of the penis. In the longitudinal section, the total width of the penis, lateral left and right width of the erectile tissue (including the Os penis), the lateral width of the *Corpus spongiosum* including the penile bone, and the lateral width of the erectile tissue were assessed.

2.2.3. Gray-scale analysis

Gray-scale analysis was performed as previously described using the portable ultrasound machine HS-1500 with a linear probe HLV-375M 7.5 MHz (Honda, Physia GmB, Neu-Isenburg, Germany) [6] because the gray-scale analysis software tool was not included in the Zonare Z.one smartcart ultrasound machine (described previously herein). Gray-scale analysis was performed on a freeze image defining two adjacent nonoverlapping regions of interest (ROI) of 0.25 cm^2 (within the erectile tissue of the glans penis next to the penile bone) within the standardized focus zone. The following settings were used: dynamic range = 75; range (mm) = 60, and y-correction = 1. Three different cross-sectional ventrodorsal areas were assessed: (1) *Plg* at the *apex* penis (ventrodorsal); (2) *Plg* in the middle between penile *apex* and *Bulbus glandis*; and (3) *Plg* in the middle of the *Bulbus glandis*. The following parameters were calculated using the software included: N-all, number of all data of ROI; N-most, data volume of the most common gray value; Nm/Na, part of data of the most common gray value from total data volume; Lmean, mean gray value, and SD.

2.3. Examinations performed in group B

Dogs were manually masturbated for semen collection [7]; penile length and width were measured and ultrasound examination (as described in 2.2.2. and 2.2.3.) was performed during ejaculation of the third fraction within intermittent stimulation. The probe was directly placed on