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Validation of screening examinations of the ureteral orifices in dogs: Comparison of ultrasonography with dissection

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ABSTRACT

In dogs, ultrasonography is performed to locate the ureteral orifices in the urinary bladder, but reference values for their normal location using this technique are missing. In this study, the ureterovesical–vesicourethral and inter-ureterovesical distances were determined in 20 freshly euthanized medium size dogs by detecting artificially produced ureteral jets in color-flow Doppler ultrasonography at two different bladder volumes, and comparing them to manual measurements in the dissected bladder. All distances determined by ultrasonography were in agreement with values found by dissection ($P \geq 0.100$). With increasing bladder volume only the left ureterovesical–vesicourethral distance changed ($P = 0.041$). The right ureteral opening was more cranial than the left in 16 dogs. The inter-ureterovesical distances differed by gender ($P = 0.016$), but spay/neuter status had no influence ($P \geq 0.847$). In conclusion, ultrasonography is a reliable modality for screening ureteral orifices in medium size dogs and agrees with anatomical findings.

1. Introduction

Ectopic ureters (EU) are rare congenital malformations characterized by one or both ureteral orifices opening in a location other than the trigone of the urinary bladder (Owen, 1973a). The ureter normally passes through the layers of the dorsal bladder wall, and after a short intra-mucosal course, it opens into the bladder with a slit-shaped orifice, the Ostium ureteris. The two ureteral openings together with the internal urethral orifice form the Trigonum vesicae (Nickel et al., 2004). EU in dogs has previously been described as intravesicular or extravesicular, which refer to ureteral orifices within the urinary bladder elsewhere than the trigone or outside the bladder in the caudal urogenital tract, respectively (North et al., 2010). In clinical cases of canine EU, ureteral orifices were most commonly found in the urethra or in the bladder neck (Cannizzo et al., 2003; Reichler et al., 2012; Samii et al., 2004). EU in dogs is present as unilateral left or right side with equal frequency, or as bilateral (Cannizzo et al., 2003; Holt and Moore, 1995). Currently, EUs are categorized into intramural and extramural depending on their course, with the intramural form being more common (Cannizzo et al., 2003; Davidson and Westropp, 2014; Holt and Moore, 1995). Intramural EUs contact the dorsal bladder wall at the appropriate site, but instead of opening into the lumen after a short submucosal course, they tunnel further caudally within the bladder wall and terminate with an orifice in the bladder neck or in the urethra. Extramural EUs completely by-pass the bladder and convey urine directly to more caudal parts of the urogenital tract.

In dogs, single system ectopic ureters are predominant (Holt and Moore, 1995), while ureteral duplication with ectopia, which is the most common form in humans (Berroca et al., 2002) and in those cases commonly associated with a duplex kidney, is extremely rare in the dog (Newman and Landon, 2014). A prevalence of 0.016% has been reported for canine ureteral ectopia (Dean et al., 1988; Smith et al., 1981), but certain breeds are known to have a higher risk *e.g.*, the Siberian Husky, Newfoundland, West Highland White Terrier, Fox Terrier, Skye Terrier, Miniature and Toy Poodles, Labrador and Golden Retrievers (Hayes, 1984; Holt and Moore, 1995). In previous studies, two Swiss national breeds, the Entlebucher and Appenzeller Mountain Dogs, were over-represented (Bitterli, 2011; Reichler et al., 2012). Due to the increased frequency of EU in certain breeds and families, a genetic coherence is suspected. Recently, the hereditary basis of the condition was demonstrated in the Entlebucher Mountain Dog in a large multicenter study using complex segregation analysis, and the involvement of a major gene was suspected regarding the extravesicular EU phenotype (Fritsche et al., 2014).

In the past, ureteral ectopia was regarded as a condition predominantly affecting bitches (Hayes, 1984; Holt and Moore, 1995). Since then, EU is also increasingly described in males in the veterinary

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literature (Lamb and Gregory, 1998; Reichler et al., 2012). The most prevalent clinical symptom of EU is urinary incontinence (UI). In bitches, incontinence most often manifests itself already in puppyhood, while in some males UI may occur at a more advanced age (Holt and Moore, 1995; Reichler et al., 2012). The urethra in male dogs is longer and the closing pressure is usually high enough to maintain continence. In cases of ectopic ureteral openings located in the prostatic urethra, urine flow may be retrograde back into the bladder and the animal becomes incontinent only when urethral tone declines with age (Holt and Moore, 1995).

Several modalities are available for the diagnostic work-up of EU in dogs. Contrast radiography of the urinary tract including *intravenous excretory urography* (IVU) and *retrograde urography* (RU) is seldom used nowadays. IVU allows assessment of the size of the renal pelvis and the size and course of the ureters. However, in one study, a definite diagnosis of EU was obtained only in 70% of the cases when IVU was used alone (Samii et al., 2004). Dilution of the contrast medium given as an intravenous drip improves visibility of the ureters and prevents renal shut-down (Owen, 1973b). During RU, concentrated contrast medium is instilled directly into the caudal urethra and bladder, but retrograde filling of the ureters is unlikely unless they are abnormally dilated. Consequently, this modality catches only a fraction (47%) of affected ureters (Samii et al., 2004). In both methods, diagnostic specificity is restricted due to insufficient accumulation of the contrast medium and/or superimposition in the pelvic region (McLoughlin and Chew, 2000).

Ultrasonography is a non-invasive and commonly used method to assess the anatomical integrity of the urogenital tract. It allows accurate examination of the distal ureters and ureterovesical junctions, however, the proximal part of the ureters may be difficult to visualize except when abnormally dilated (*e.g.*, hydroureter) (Elliot and Grauer, 2007; Lamb and Gregory, 1994, 1998). The ureteral orifices are identified by urine jets entering the bladder (Lamb and Gregory, 1994). It is challenging to see them in gray-scale ultrasound images and therefore the color-flow Doppler mode is often used to enhance accuracy. Furthermore,

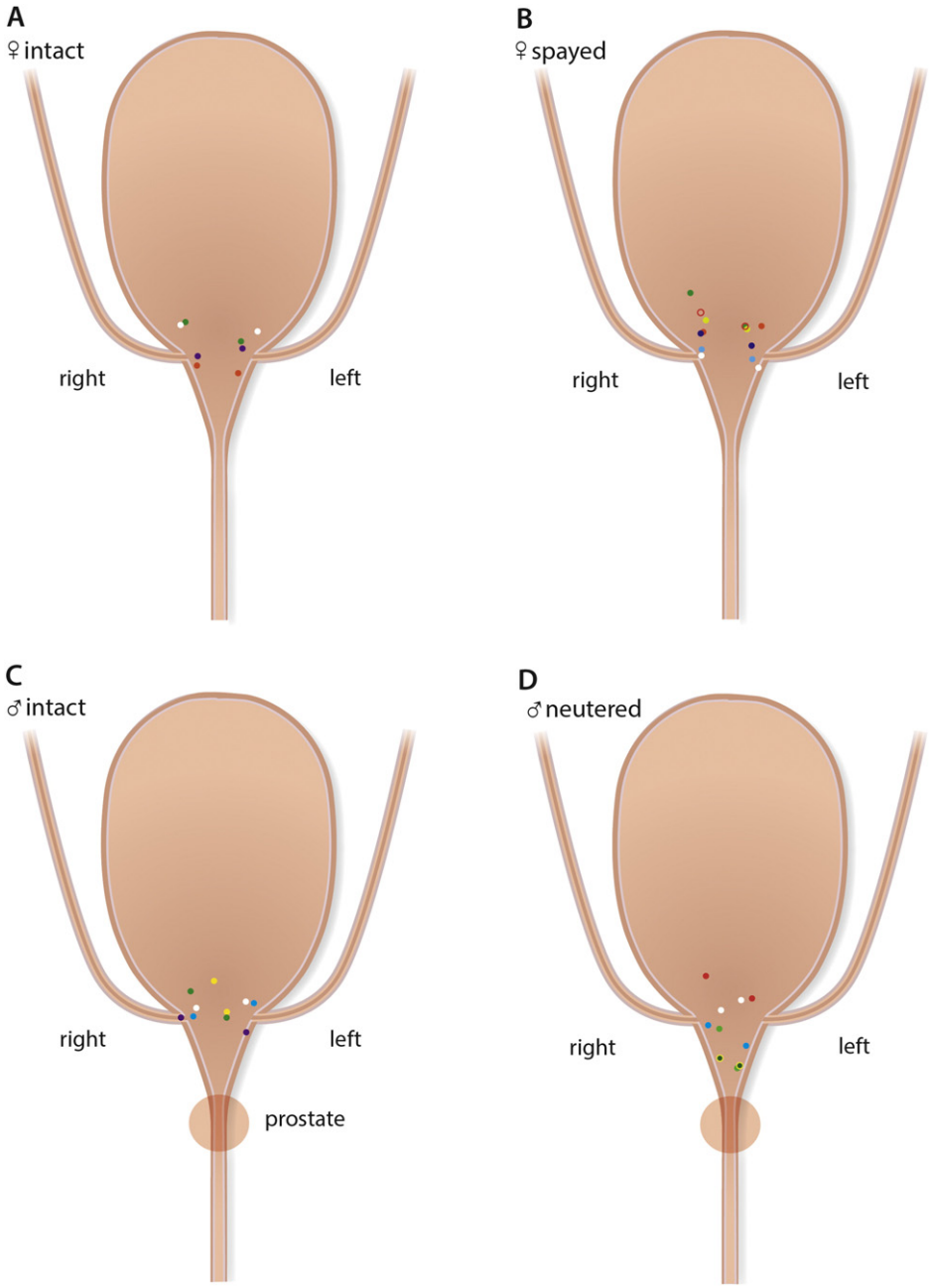

Fig. 1. A Foley catheter size 10 Fr placed in the urethra of a male neutered dog.