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Research Article

Anatomical Transverse Helical CT Study of The Postprostate Part of The Rabbit Urethra

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ABSTRACT

Background/Aim: The male urethra in domestic mammals is composed of pelvic and penile part. The pelvic part consists of preprostate and prostate part.The aim of the study was to present data for helical CT visualization of the rabbit postprostate urethra.

Material and Method: Ten mature clinically healthy male New Zealand white rabbits were studied. The animals were anesthetized. The bone landmarks at the helical CT study were identified. The peroral and parenteral contrast agents were administered. A whole body multi-slice helical computed tomography scanner was used.

Result and Conclusion: CT scan of the pelvis in the transverse plane through the third, fourth sacral and first coccygeal vertebra, body of ischiadic and ischiadic symphysis visualized the following: urethral hypoattenuated lumen was dorsal to the pelvic symphysis; the urethral lumen's shape was ovoid with regular contours and flattened dorsoventral; the urethral wall was relatively hyperattenuated, compared to the close soft tissues, except the rectal finding. The study creates a detail picture for the postprostate urethra that shows the method's benefits.

Keywords: Anatomy, Helical CT, Rabbit, Urethra.

Tavşanda urethra'nın postprostatik bölümünün bilgisayarlı tomografik anatomisi

ÖZET

Özbilgi/Amaç: Erkek hayvanlarda urethra, pars pelvina ve pars penina olmak üzere iki bölümde incelenir. Pars pelvina ise pars preprostatica ve pars prostatica urethra olma üzere ikiye ayrılır. Bu çalışmanın amacı tavşanlarda postprostatik urethra'nın bilgisayarlı tomografik görüntülerinin sunulmasıdır.

Materyal ve Metot: Bu çalışmada 10 adet sağlıklı erkek Yeni zellanda tavşanı kullanıldı. Hayvanlar anesteziye alındı. Tomografik görüntülerde kemik bölgeleri belirlendi. Oral ve parenteral yolla kontrast madde verildi. Çok kesitli helikal bilgisayarlı tomografi ile tüm vücut tarandı.

Bulgular ve Sonuç: Pelvis bölgesinin üçüncü ve dördüncü sacral vertebra ve birinci caudal vertebra hizasından geçen transversal tomografik kesitlerinde, öncelikle corpus osssis ischii ve symphysis ischiadica belirlendi. Bunu takiben sypmhisis'in dorsalinde düşük yoğunlukta urethra lumeni belirlendi. Lumenin şekli, kenarları belirgin dorsoventral yönlü düzleşen ovoid olarak belirlendi, Urethra duvarı daha çevresindeki yumuşak dokulara göre daha yüksek yoğunlukta görülüyordu. Bu çalışmada kullanılan metot ile postprotatik urethra detaylı bir şekilde görüntülenebilmiştir..

Anahtar kelimeler: Anatomi, Helikal BT, Tavşan, Urethra.

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Introduction

The male urethra in domestic mammals is divided into pelvic and penile part. The pelvic part consists of preprostate and prostate part that reaches and ends with urethral isthmus (Nomina Anatomica Veterinaria, 2012).

On the posterior wall of the man prostate urethra is located verumontanum. The membranous portion is the narrowest segment of the urethra which is two times shorter than prostatic and passes through the urethral sphincter of the urogenital diaphragm.

The morphology of the human urethra has been investigated to determination of normal and pathological urethral findings by using CT (Kawashima et al., 2004; Rockall and Vinnicombe, 2007).

The urethral anatomy in the dog and rabbit is investigated using imaging modalities. It is reported that these animals are suitable animal models to study the urethral sphincter (Stolzenburg et al., 2006; Skaff et al., 2012).

The contemporary devices have a potential to obtain CT slices with a thickness less than 1mm and to scan rapidly large areas. In children and newborns is necessary to apply anesthesia in order to avoid the occurrence of artifacts. CT provides a high dimensional resolution of the anatomic image (Hiorns, 2011; Stamatova-Yovcheva et al., 2012).

CT visualization of post traumatic morphologic changes in the human pelvic urethra is carried out following double contrasting of the studied organs (orally and parenterally). Axial CT scans with a thickness of 10 mm and helical CT slices with a thickness of 3 mm are obtained. Prostate urethra is not visualized by axial CT, by this modality are defined only the outlines of prostate finding. Between prostate and pelvic symphysis is found periprostatic fat depot (Ali et al., 2003).

Axial CT study of the rabbit pelvic urethra is carried out (Kajbafzadeh et al., 2005). Urethral finding is visualized between transversal planes through 2nd sacral vertebra and 1st coccygeal vertebra (dorsally), middle of the pelvic symphysis (ventrally) and the body of ischiadic bone (laterally). Urethra is relatively hyppoattenuated compared to the rectal wall (Dimitrov et al., 2009).

The pelvic part of urethra of the tomcat is studied by axial computed tomography (CT). Transverse image of the urethral finding was obtained from among 2nd to 3rd sacral vertebra (dorsally) middle of the pelvic symphysis (ventrally) and body of the ischiadic bone close to acetabulum (laterally). Urethral wall is visualized as a hypoattenuated finding compared to the rectal (Dimitrov and Toneva, 2006).

The anatomical features of urogenital system of the rabbit were studied using CT in order to the successful catheterization procedure of the urinary bladder (Uthamanthil et al., 2013).

The mouse is used as a biological model to study hypospadias in the man (Baskin et al., 2001).

CT features of the urinary tract and particularly urethra are investigated in healthy male calves (Braun et al., 2014).

The morphology of occurring in man valvular formations in the pelvic and penile urethra is investigated radiologically (Kajbafzadeh et al., 2005; Doumanian, 2010).

The aim of study was to present the data for helical CT visualization of the rabbit postprostate urethra. Thus our results of the study may be practical both investigation of rabbit urethra and to create disease model for human.

Materials and Methods

Objects

Ten mature clinically healthy rabbits 12 months of age, from the New Zealand white rabbit breed with weight between 2.8 kg and 3.2 kg were studied.

Anesthetic protocol

The animals were treated (IM) with Ketaminol® 10 solution (Intervet) (Ketamine hydrochloride 100 mg/ml and Benzethonium chloride 0.1 mg/ml) of 0.5 ml/kg (6).

Anatomical protocol

The bone landmarks at the helical CT study were the following: body of ischium (laterally), pelvic symphysis (ventrally), sacral and initial coccygeal vertebrae (dorsally) (Dimitrov and Toneva, 2006; Dimitrov et al., 2009) (figure 1[A], figure 1[B]).

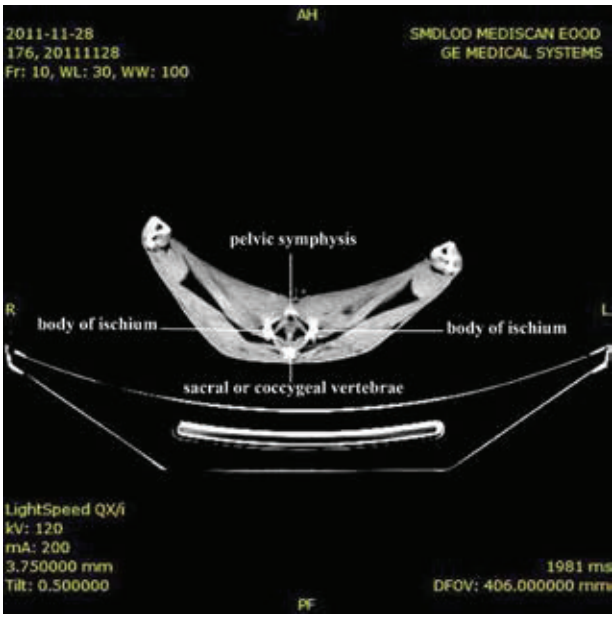

Figure 1A. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvic urethra. R – right, L – left. (ventrodorsal recumbency) (positive image).

Figure 1B. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvic urethra. R – right, L – left. (ventrodorsal

recumbency) (negative image)

Imaging protocol

The studied animals were positioned in ventrodorsal (supine) recumbency, as in four of them contrast was not applied. Used contrast media were Optiray 350 (nonionic low osmolar contrast medium) (Healtcare Ltd. UK) and Urografin 76% 20 ml (Schering LTD. Germany) (a water-soluble iodinated contrast medium). The parenteral contrast media was firstly applied intravenously via cephalic vein at a dose of 3 ml/kg and immediately after the CT study was performed. The second contrast material was orally administrated (per os) as 1.52 % water solution (30 ml/kg m) three hours before the study. Before administration of the contrast medium the animals were fasted for 4 hours. Their intake of water was not restricted (Dimitrov, 2013; Stamatova-Yovcheva et al., 2013).

Imaging techniques apparatus

It was used a whole body multi-slice helical computed tomography scanner (Light Speed QX/I GE, General Electric USA). Computed tomography study was carried out at the following protocol: electric current's intensity – 200 mA; anode tension – 120 kV; scanning time – 0.8; 1 maximum to 2 seconds; rotational speed – 360 degrees in 0.8, 1, 2, 3 and 4 seconds; slice thickness of the pelvis and accessory sex glands – 3.75 mm; pitch (to define a position) – 6; converting filter – standard; tilt (gentry) +/- 30 degrees; exposure time – 1981 sec; zoom – 6.97; level – 35; window (W) – 350; high resolution – 512; SFOV – 50; MTF 10 in lp/cm (Modulation Transfer Function) – 13.6. The films were obtained by Printing device – Drystar AXYS – model AGFA, with size (film's size) DT 2B 14/17 inches. The image connectivity and transfer was made by DICOM (DICOM (Digital Imaging and Communications in Medicine) service classes provided by CT console (SCP and SCU). The obtained images were presented in positive and negative aspect, in order to use analytical approach for their interpretation (Dimitrov, 2013).

Ethical protocol

The study was approved by the institutional committee (Trakia University, Faculty of Veterinary Medicine, Stara Zagora, Bulgaria) of animal care (Approval № 51/29. 09. 2012). The experiments were made in strict compliance with European Council Decision 1999/575/EO от 23. 03. 1998 concerning concluded European convention by the Committee for the protection of vertebrate animals, used for experimental and other scientific purposes and the Animal protection's law in Republic of Bulgaria (Section IV - Experiments with animals, art. 26, 27 and 28, received on 24th January 2008 and published in Government Gazette, № 13, 2008).

Results

Helical contrast anatomical presenting of the membranous urethra (postprostate part) of the rabbit pelvic urethra was related to the hyper contrast of the rectal lumen image and the relative hypo contrast of the urethral lumen. CT scan of the pelvis in the transverse plane through the third sacral vertebra (dorsal) body of ischiadic bone - close to articular acetabulum (lateral) and ischiadic symphysis in the transition between its pubic and ischiadic parts (ventral) visualized the following imaging anatomical soft tissue findings (figure 2^{A} and figure 2^{B}): Urethral hypoattenuated lumen was dorsal to the pelvic symphysis, as between them was the pubic adipose depot, which was negative tissue characteristic. The urethral lumen's shape was ovoid with regular contours and flattened dorsoventral. The urethral wall was relatively hyperattenuated, compared to the close soft tissues, except the rectal finding. Rectum was visualized as a finding with relatively higher contrast (density) compared to the close soft tissue structures and was ventral to the vertebra's body. Due to its regular filling with contrast medium, its borders were regularly outlined and marked by the adjacent structures. The rectal lumen and wall were not visualized as separate findings. Between rectal and urethral walls was a soft tissue finding with intermediate contrast, whose attenuation was higher than that of the urethral wall and lower that the rectal.

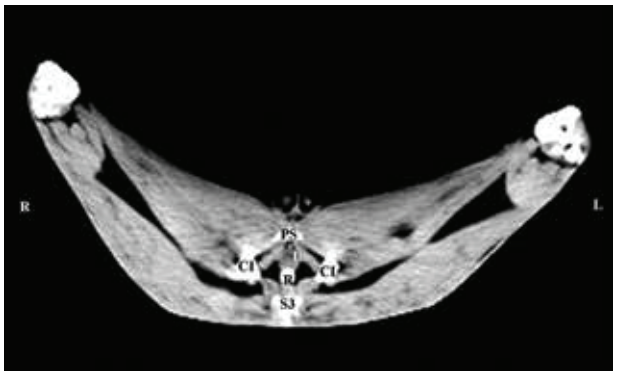

Figure 2A. Helical anatomic contrasted computed tomography image of the rabbit pelvis through the third sacral vertebrae (S3): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (positive image). ,

Figure 2B. Helical anatomic contrasted computed tomography image of the rabbit pelvis through the third sacral vertebrae (S3): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (negative image).

At the helical precontrast anatomical study of the postprostate part of the pelvic urethra the rectal finding was also with relatively hyperattenuated image, compared to the adjacent soft tissues, including urethra (figure 3A and figure 3B) but at the same time with hyper contrast image, compared to the rectal finding at contrast presenting (figure 2^{A} and figure 2^{B}). The helical CT scan of the pelvis in the transverse plane through the fourth sacral veretebra (dorsal), body of the ischiadic bone (lateral) and the ischiadic part of the pelvic symphysis (ventral) imaged the following imaging anatomical findings (figure 3^{A} and figure 3^{B}): Urethra was dorsal to the pelvic symphysis and pubic adipose depot and showed hypoattenuated (hypo contrast) lumen and relatively hyperattenuated (hyper contrast) wall. The urethral lumen's shape was regular ovoid, contoured and dorsoventral flattened. Rectum was ventral to the vertebra body, as the rectal lumen and wall were visualized as separate structures. The rectal wall was hypoattenuated, compared to the rectal lumen. Between rectal and urethral finding was visualized the location of a soft tissue structure with intermediate attenuation, which was hyperdense to the urethral wall and hypodense to the rectal.

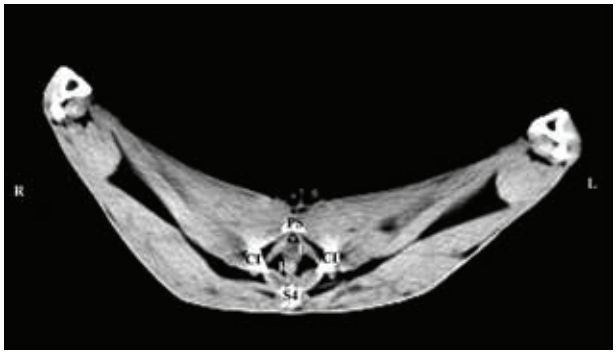

Figure 3A. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvis through the fourth sacral vertebrae (S4): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (positive image).

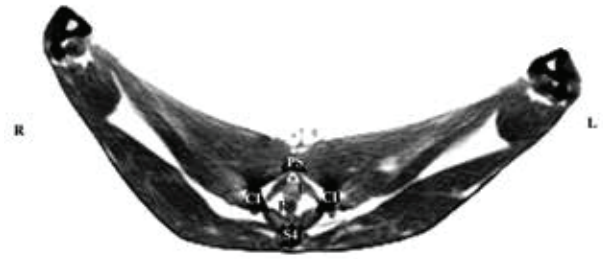

Figure 3B. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvis through the fourth sacral vertebrae (S4): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (negative image).

At the contrast helical anatomical scanning of the pelvis at the transversal plane through the first coccygeal vertebra (dorsal) body of ischiadic bone (lateral) and ischiadic part of symphysis (ventral) were found the following structures (figure 4^{A} and figure 4^{B}): The urethral finding's caudal segment showed again difference in the attenuation of the lumen and wall. Urethral lumen was hypodense (hypocontrast), compared to the urethral wall. Urethra was with dorsoventral flattened irregular ovoid shape and with irregularly outlined boundaries. The rectal finding was with irregular contours, with relatively hyperattenuated wall and hypoattenuated lumen. The rectal wall and lumen were relatively hypocontrasted (figure 4^{A} and figure 4^{B}) compared to the same, observed in the previous precontrast CT scan (figure 3^{A} and figure 3^{B}). In the space, located between the rectal and urethral walls, compared to the prior scan levels, was not found a single soft tissue structure with intermediate density.

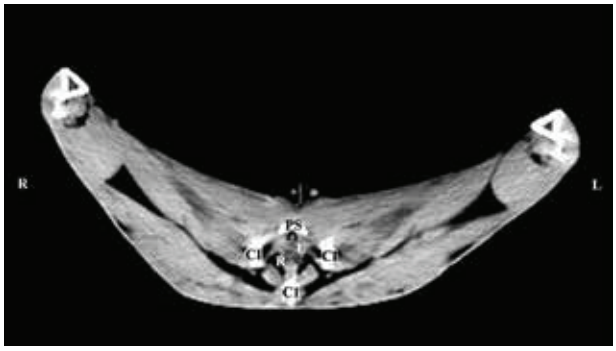

Figure 4A. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvis through the first coccygeal vertebrae (C1): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (positive image).

Figure 4B. Helical anatomic pre-contrasted computed tomography image of the rabbit pelvis through the first coccygeal vertebrae (C1): CI – body (corpus) of ischium, U - pelvic urethra, R – rectum, PS – pelvic symphysis, * - adipose depot. R – right, L – left. (ventrodorsal recumbency) (negative image)

Discussion

The results from the helical CT study correspond to the available data (Ali et al., 2003) where is applied axial and helical CT presenting of the features of human pelvic urethra in relation to post traumatic morphological alterations. Similar to some studies (Ali et al., 2003) a double contrasting (peroral and parenteral) was applied to obtain the helical CT slices with thickness of 3.75 mm in this study.

Like to the found by Ali et al. (2003) for the man, in the rabbit is obtained a definitive image of the investigate part of the pelvic urethra, which is accompanied by periurethral (pubic) negative contrasted adipose depot.

In order to avoid artefacts and improve the scans' quality general anesthesia was applied to rabbits for the helical CT study. It is confirmed that CT provides a high spatial resolution of the anatomical image (Hiorns 2011).

Prostate part of the rabbit prostate complex, consisting of prostate, paraprostate and proprostate is closely related to the urethra and localized caudal to bulbourethral glands (Vsquez and del Sol, 2002). Thus the dorsal surface of the membranous urethra is covered by prostate, which reaches to the bulbourethral glands. That is confirmed by performed helical CT scans at the level of the third and fourth sacral vertebra. It was found that soft tissue finding between urethral and rectal walls is an argument for prostate glandular tissue between these two tubular structures.

In the present study similar to some researches (Kawashima et al., 2004; Rockal and Vinnicombe, 2007) the normal imaging features of the presented urethral part have been studied, with the aim to define in details some of its imaging anatomical features. In comparison to other domestic mammals (Kawashima et al., 2004; Rockal and Vinnicombe, 2007) in the rabbit the behind prostate urethra is directly related to the prostate glands, so it was not found typical for the other species free dorsal surface of the membranous part in the study.

Compared to the axial CT data for the urethra in bull, tomcat and rabbit (Dimitrov and Toneva, 2006; Dimitrov et al., 2009; Braun et al., 2014) the obtained helical CT anatomical image of the rabbit membranous urethra is precisely detailed. In the present study was achieved a high definitive image of the membranous urethra and are proved data for its normal imaging alive morphology. In correspondence to the above mentioned

authors, the topography of the membranous urethra has been demonstrated. Additionally have been presented data for its accompanying structures (dorsal situated prostate part of the rabbit prostate complex).

The obtained results for helical CT urethral morphology in the rabbit correspond to the studies for the urogenital CT imaging anatomical characteristics in the rabbit, in relation to the successful catheterization of the urinary bladder. These results could serve successfully for diagnosis of obstructive uropathies in this animal species (Uthamanthil et al., 2013).

In correspondence to data of some authors (Baskin et al., 2001) who use mouse as biological model when investigate the human urethral lesions, it could suppose that the rabbit is a suitable animal model to investigate these anomalies in the man (Doumanian, 2010; Kajbafzdeh et al., 2005).

By the researched data we could present a hypothesis that the rabbit is a suitable biological model for CT investigation of many urethral structures, similar to the found for the urethral sphincter in the rabbit and dog (Stolzenburg et al., 2006; Skaff et al., 2012).

The present study creates a detail picture for the postprostate (membranous) part of the rabbit urethra that shows the method's benefits, compared to the axial CT presenting of this organ and proves the anatomical and clinical application of these results.

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