ANATOMICAL AND RADIOLOGICAL STUDY ON THE URINARY SYSTEM OF FOXES (ALPOX LAGAPUS

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ABSTRACT

Seven adult apparently healthy male foxes were used in this study. Radiological studies were occurred by intravenous pylography , retrograde urethrocystography and the radiographs were taken. For the anatomical studies, the foxes were thoroughly bled and injected with mixture of 10% formaline, 2% phenol and 1% glycerine. The different parts of the urinary tract were carefully dissected. The anatomical features of the kidneys and urinary tract were described including, shape, position, relations and dimensions. The obtained results were compared with the radiological results and discussed with that of the dog and cat. The results were showed great correlation between the anatomical and radiological results.

INTRODUCTION

Recently the foxes have great attention of many authors (**Abd El-Gawad and Youssef, 1994, Ahmed et al., 1990, Kamel and Zagloul, 1997, and Abu-Zaid et al.,1996**). This is owing to their great role in production of highly economic value hide and as a zoo animal as well as their role in the disease transmission. The goal of this study is the identification of both kidneys as to their size, shape, density and position. Outlining the renal pelvis, ureters and their point of entry into the bladder as well as the urethral length, diameter and position through the anatomical features, surface and topographical anatomy, intravenous pyelography, cystography and ascending positive contrast urethrocytography.

MATERIALS AND METHODS

Seven adult clinically healthy male foxes were used in this study. The average body weight ranging 4-6 kg. The healthy status of the animals were verified through clinical examination and survey abdominal radiography.

Radiological examinations:

All procedures of radiographic examination were made while the animal under the effect of xylazine hydrochloride (3 mg/kg BW.I/M) after **Kamel and Zagloul, (1997)**. Food withheld 12 hours, a warm soap and water enema was necessary preceding each study. Both lateral and ventrodorsal radiographs were performed. A low (69 kv) and high (10 m As) and minimum time (0.1 s) was used as exposure factors during radiographic study.

Intravenous pyelography :

Low volume rapid infusion technique by using urographin 67.6% (425 mg Iodine/kg). The calculated dose of the contrast material was rapidly infused interavenously in the cephalic vein after the fox was placed in dorsal recumbency on the cassette. Lateral and ventro-dorsal radiographs was exposed immediately and 5, 10, 15 and 30 minutes after injection. The study was terminated when the following criteria were met a) both kidneys had been identified and their size, shape, density and position evaluated., b) renal pelvis outlined, c) both ureters identified; d) the bladder was filled and examined (Ackerman, 1974). A compression band was placed over the bladder to aid in outlining the renal pelvis in two cases only.

Urethro cystography

Urethrocystography based on intravesical volumes recommended for cystography and urethrography in dogs and cats which vary from 6.6 - 11.1 ml/kg after Johnston et al. (1982). The calculated dose from the lower range 6 ml/kg of the diluted contrast media (urographin 67.6%) was infused through the urethra by male catheter and occlusion of the external urethral opining using artery forceps. Lateral and ventro-dorsal radiographs was exposed.

Interpreting the films :

The radiographic films were interpreted using the light box in a dark room. The size, shape, position, different relations of the kidneys were identified. Both renal pelvis, ureters course, their entry into the urinary bladder; bladder shape, size, and position in relation to the pelvie prim in empty and distended state were investigated. Bladder neck as well as the length, diameter and position of pelvic and penile urethra in both lateral and ventro-dorsal exposures were identified. Survey radiographs were kept for comparison to contrast radiographs.

Anatomical Study :

Under the effect of anesthesia (combination of ketamine hydrochloride 30mg/kg and xylazine hydrochloride 3 mg/kg) after **Kamel and Zagloul (1997)**, the animals were scarificed and thoroughly bled via the common carotid artery. Then,they were injected with a mixture of a 10% formaline, 2% phenol and 1% glycerin through the common carotid artery. Two days later, the animals were dissected for detailed description of position, shape, and surface anatomy of the kidneys and different part of the urinary tract. Colored gum milk latex was injected through the ureter for examination of the renal pelvis and pelvic recesses. The nomenclature used were that adopted with **Nomina Anatomica Veterinaria (1994)**, as it was possible.

RESULTS AND DISCUSSION

The kidneys of the fox are smooth bean-shaped retroperitoneal organs. Each has dorsal and ventral surfaces, cranial and caudal poles and straight medial and convex lateral borders which similar to that of the dog **(Evans, 1993)**. The left kidney in some specimens has three surfaces where the lateral border enlarged to form the lateral surface.

The right kidney is situated under the level of first 4 lumbar transverse processes as that of the cat **(Hudson and Hamilton, 1993)**. Its cranial pole is located under the transverse process of the first lumbar vertebra (Fig. 1 & 2) and medial to the lateral part of the last intercostal space (1.5 cm caudal to the uppermost part of the last rib). It is embedded in the renal fossa of the liver, which is formed by the renal depression of the right lateral lobe laterally and the caudate process of the caudate lobe medially with ventro-caudal relation to the right supra-renal gland. The caudal pole appears laterally between the dorsal abdominal wall and pancreas under the level of the fourth lumbar transverse process. **Smith (1999)** in the dog revealed that the right kidney was extended from vertebrae T12 or T13 to L2 or L3.

The left kidney is located under the transverse process of the 3rd, 4th, and 5th lumbar vertebrae. It is more mobile than the right one and can be slightly displaced cranially or caudally. **Evans and De-Lahunta (1996)** in the dog mentioned that, it was extended from the second to fourth lumbar transverse processes. However, **Hudson and Hamilton (1993)** in cat recorded its position from the second to fifth lumbar transverse processes. The cranial pole of the left kidney is located 4-5 cm caudal to the uppermost part of the last rib while the caudal one appears laterally between the jejunal coils and the dorsal abdominal wall (Fig. 3 & 4).

The average dimensions of the right and left kidneys are nearly similar, measuring about 5.5 cm length X 2 - 2.5 cm thickness X 2.5 - 3 cm width.

The right kidney of the fox is related dorsally to sublumbar muscles, laterally to the right lobe of the liver, diaphragm and lateral abdominal wall, ventrally to the caudate process of the liver, medially to the caudal vena cava and caudo-ventrally to the cecum. (Fig. 1 & 2). However, the left kidney is related laterally to the spleen and lateral abdominal wall, ventrally to the jejunal coils, descending colon and ascending duodenum and caudally to the supra-renal gland (Fig. 3 & 4). **Smith (1999)** in the dog mentioned similar results.

During intravenous pyelography, both kidneys outlined with contrast 5-10 minutes post injection. The size, shape and position were apparent. Ureters and pelvices were apparent on subsequent films (Fig. 9 & 10 & 11). The same results were obtained by **Ackerman (1974)** in the dogs.

The average kidney length has been reported (5.5 cm) to be 2.4 - 2.5 times the length of the second lumbar vertebra and 2.25 - 2.4 times the length of the fourth lumbar vertebra. **Osborne, et al. (1972)** reported that the average kidney length was 2.5 - 3.5 times the length of the second lumbar vertebra in the dog and 1.8 - 2.2 times the length of the fourth lumbar vertebra in the cat. Both kidneys have the same width of 3 cm. on radiographic examination.

On ventro-dorsal radiograph, the cranial pole of the right and left kidneys was situated 2 & 5 cm caudal to the dorsal end of the last rib respectively (Fig. 9). The results revealed a great correlation between radiographic and anatomical measurements. **Abu-Zaid, et al. (1990)** reported strong correlation between both sonographic and gross measurements of the renal parameters. While **Konde, et al. (1984)** reported that nephrosonogram measurements may be larger, smaller or equal to the actual gross measurements. The average ratio between the cortical and medullary tissue in the sagittal section of the both kidneys of the fox was 1:4 (Fig. 5) which coincided with the radiological results.

The proximal parts of both ureters were identified with both kidneys at 5-10 minutes post injection of the contrast media, originating from the indented hilus of the kidneys (Fig. 9 & 10 & 11). The distal segment of the ureters can not be identified on both ventrodorsal and lateral radiographs even after removal of the compression band. This is may due to its peristaltic movement which in a line with **Ackerman (1974)** in the dog. Radially distributed pelvic diverticula having smooth border were apparent 10 minutes post injection in most radiographs (Fig 9 & 10).

On gross anatomy, each ureters passes from the renal bilus medially caudal to the renal blood vessles, then courses caudally in retroperitoneal course ventral to the sublumbar muscles. Both ureters cross the ventral aspect of external iliac artery close to the pelvic inlet ventral to the seventh lumbar transverse process. Then, they continue caudo-ventrally in both sides of the descending colon crossing it to enter the urogenital fold lateral to the ductus deferens which loops

around it (Fig. 6 & 8). The ureter then crosses the dorsal surface of the ductus deferens, curves cranioventrally to continue obliquely in the trigone region of the urinary bladder. Similar results were obtained by **Dyce, et al. (1996)** and **Smith (1999)** in the dog .

The renal pelvis in the fox is elongated funnel-shaped structure occupies the much space of the renal sinus. It measures about 3 x 1.5 cm and projects between the renal pyramids by about 8 pelvic receesses. The renal crest projects into the middle of the pelvis (Fig. 5). Similar results were obtained in the dog **(Smith, 1999)** and cat **(Hudson and Hamilton, 1993)**. **Evans and De-Lahunta (1996)** in dogs recorded the presence of 5-6 pelvic diverticula.

The bladder is pear-shaped musclomembranous organ has more or less rounded apex, body and neck. It is completely abdominal in position, situated in the floor of the abdominal cavity just cranial to the pelvic inlet and ventral to the level of the last three lumbar transverse processes (Fig. 6 & 7 & 8) with ventral relation to the rectum and descending colon and caudal relation to the jejunal coils .

Results of urethrocystography revealed that the distended bladder is pear-shaped, smooth and uniform in outline. Bladder is totally intra-abdominal in distended or non-distended state. Bladder neck is blunt and located cranial to the pecten of the pubic bone (Fig. 12 & 13), which is coincided with the result obtained anatomically. Distended bladder displaces the small bowl cranially and dorsally.

Nickel et al. (1979) in the dog, **Crouch (1969), Johnston, et al. (1986) , Hudson and Hamilton (1993) and Dyce et al. (1996)** in the cat stated that the bladder was situated cranial to the pubis when empty or distended. **Miyabashi (2001)** stated similar results in human. However, **Park (1978), Khanna (1976), Jakson, et al. (1980), Mahaffey, et al. (1984), Evans (1993), Anderson and Anderson (1994) and Kealy and McKallister (2000)** have stated that the bladder in the dog is in part or totally intrapelvic when empty. The cranio-caudal dimension of the distended bladder is 5 cm while the dorsoventral dimension is 3 cm (Fig.14).

Three peritoneal folds are reflected from the bladder upon the pelvic and abdominal wall, one median leaves the ventral surface of the bladder to the ventral abdominal wall as far cranial as the umbilicus and two lateral folds attach to the dorsolateral part of the abdominal and pelvic wall. Similar results were recorded in the dog **(Evans and De-Lahunta, 1996)**. The craniocaudal and dorsoventral dimensions of the distended bladder is 5.2 & 2.8 cm respectively which is correlated with the results of the radiographic measurements.

Results of ascending urethrocytography and the gross anatomy revealed that the urethra in male fox is thin membranous tube extends from the neck of the urinary bladder to the external urethral orifice. Urethral length is ranged 18-21 cm. It divides into pelvic urethra with 6-7.5 cm

length and 3 mm diameter while the penile urethra range of 12-14 cm in length and 2 mm in diameter (Fig. 13 & 14).

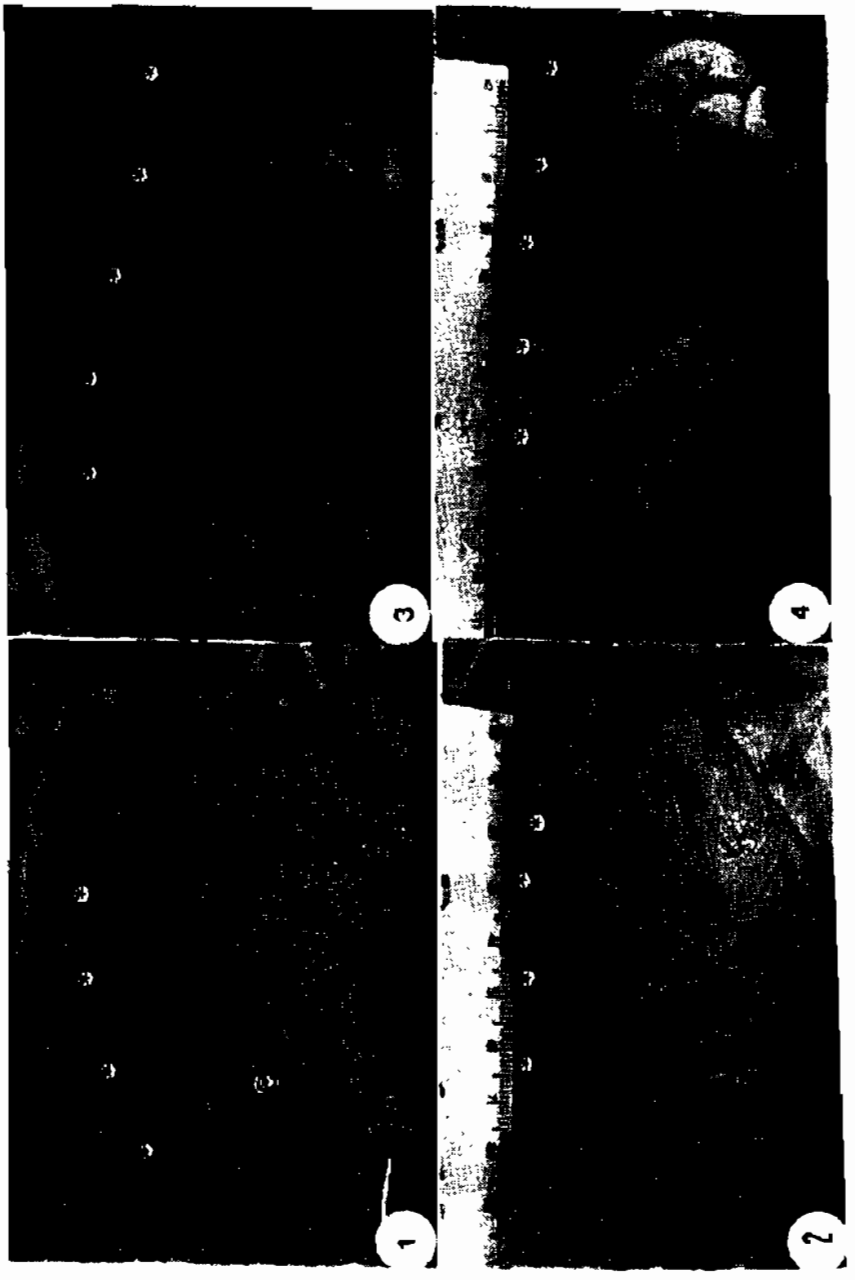

Fig. (1 & 2) : The different relations of the right kidney (K). Note lumbar vertebrae (*), right lateral lobe of the liver (L), Cecum (C), and pancreas (P).

Fig. (3 & 4) : The different relations of the left kidney (K). Note lumbar vertebrae (*), descending colon (D), jejunal coils (J), spleen (S) and stomach (m).

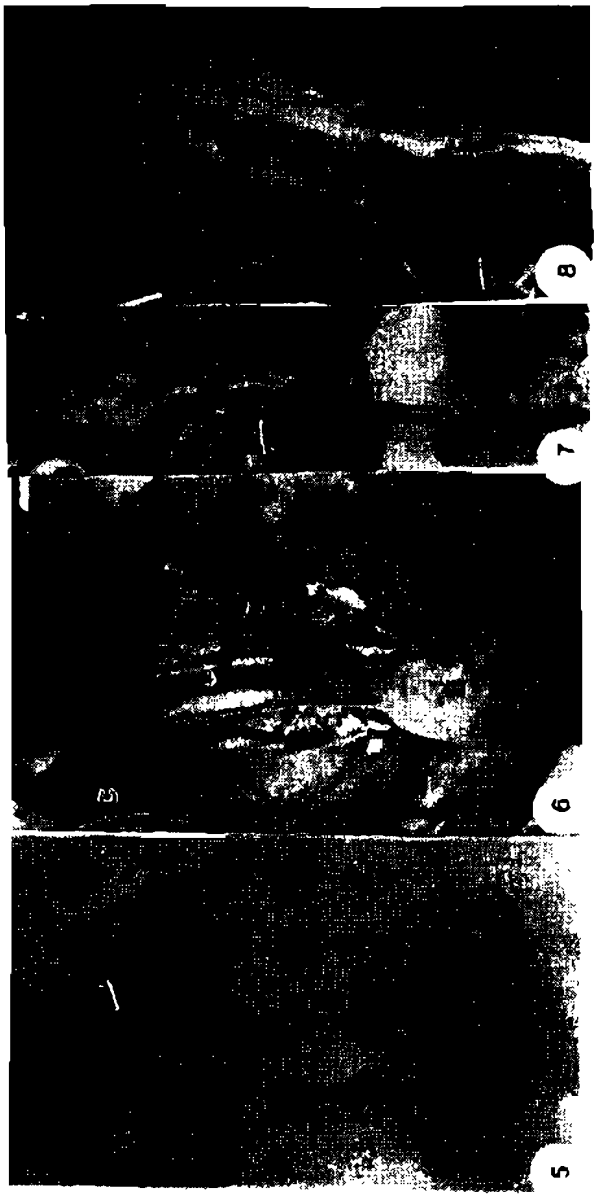

Fig. (5) : Sagittal section of the right kidney injected with colored gum milk latex showing renal pelvis (R) and recesses (arrows), renal cortex (X), renal pyramids (P) and ureter (u).

Fig. (6) : Photograph showing the kidneys (K), ureter (u), urinary bladder (B), descending colon (D), ductus deferens (d), round ligament of the bladder (r), caudate lobe of the liver (c), caudal vena cava (*) and abdominal aorta (a). (Note that the urinary bladder is pushed caudally and the left kidney is pushed cranially).

Fig. (7&8) : The intra-abdominal situation of the urinary bladder (B). Note pelvic urethra (P), descending colon (D), pubic symphysis (arrow), ureter (u), middle vesicoumbilical ligament (m) and ductus deferens (d).

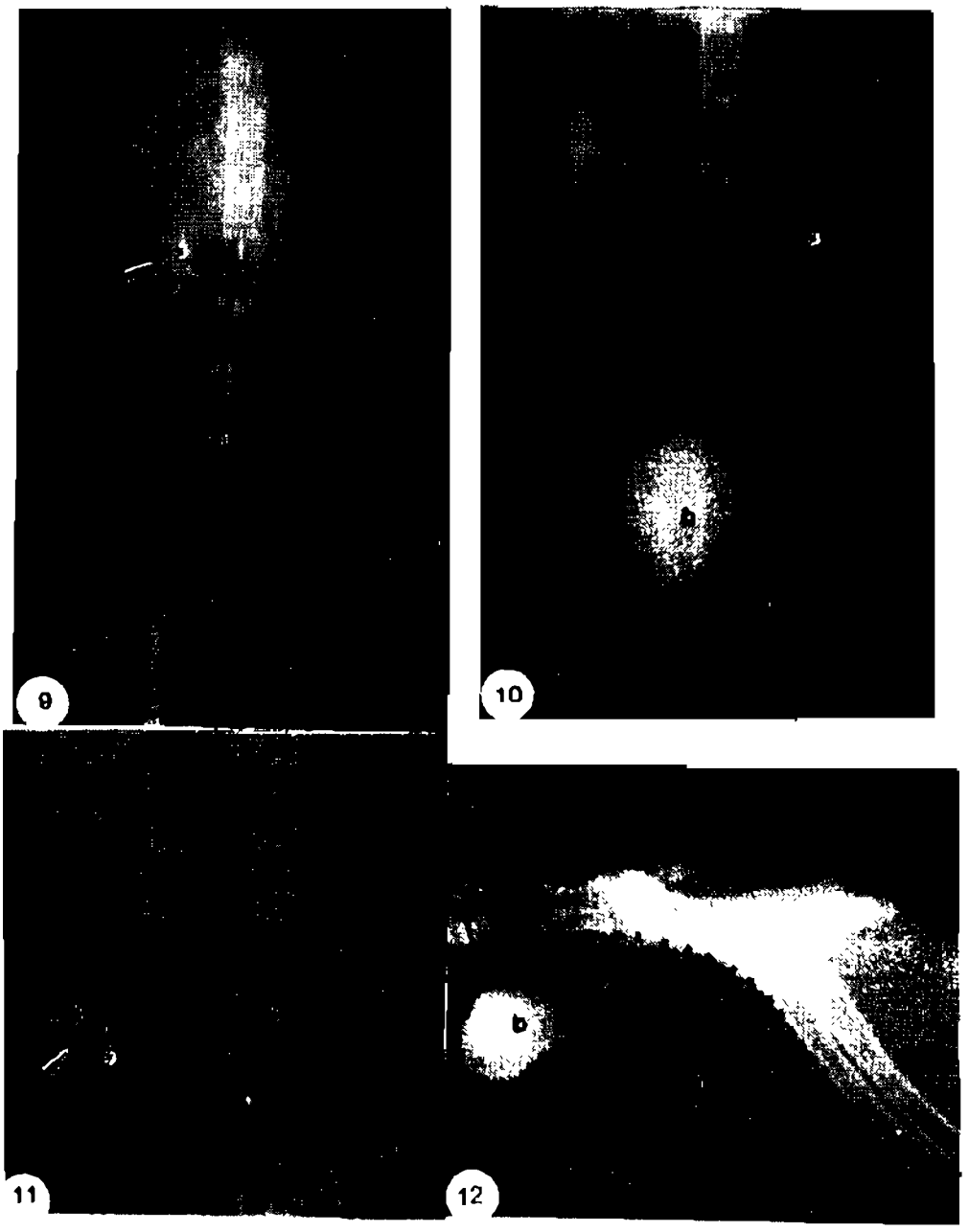

Fig. (9) : Ventrodorsal intravenous pyelography 5 minutes post injection showing right and left kidneys, renal pelvis (*), pelvic recesses (arrows) and first part of the ureter (u).

Fig. (10) : Ventrodorsal intravenous pyelography 30 minutes post injection showing the kidneys (K), ureter (u), renal pelvis (*) and urinary bladder (b).

Fig. (11) : Ventrodorsal renogram showing both kidneys, renal pelvis (*) and ureter (u).

Fig. (12) : Lateral urogram showing complete intra-abdominal position of non-distended urinary bladder (b).

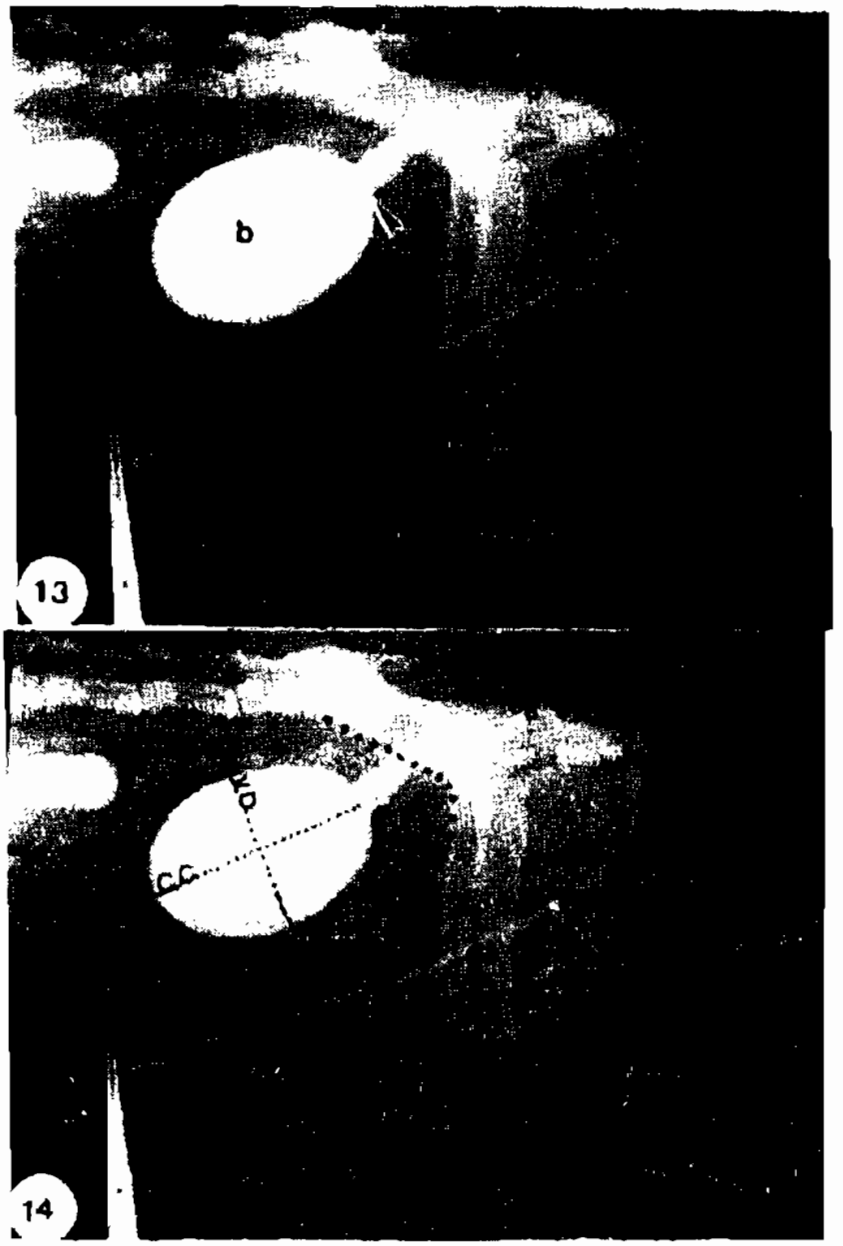

Fig. (13) : Lateral cystogram showing intra abdominal location of distended bladder (b), bluntedbladder neck (arrow), pelvic and penile urethra (P)

Fig. (14) : Lateral cystogram showing the craniocaudal (cc) ventrodorsal (VD) dimensions of the urinary bladder and pelvic and penile urethra (p).

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الملخص العربى

دراسة تشريحية وإشعاعية على الجهاز البولى فى الثعالب

المشتركون فى البحث

عادل زغلول و مصباح عبد الجواد

قسم الجراحة وقسم التشريح و الأجنة

كلية الطب البيطرى جامعة المنصورة

أجريت هذه الدراسة على سبعة من الثعالب الذكور البالغة تم تجميعها من منطقة الدلتا وتم التأكد من سلامتها بالفحص السريرى والأشعة السينية.

أجريت الدراسات الإشعاعية على الثعالب قبل استنزافها وذلك باستخدام أشعة الصبغة و الأشعة التصاعدية من خلال الحقن فى فتحة مجرى البول ثم أخذت صور الأشعة للأجزاء المختلفة للجهاز البولي.

أجريت الدراسات التشريحية على الثعالب بعد تخديرها واستنزافها وحقنها بمحلول ١٠٪ فورمالين، ٢٪ فينول، ١٪ جلسرين ثم تركت يومين وشرحت تشريحاً دقيقاً لدراسة الجهاز البولي.

تم استبيان التفاصيل التشريحية للأجزاء المختلفة للكلى والقناة البولية وقد أوضحت النتائج علاقة قوية بين نتائج الأشعة والنتائج التشريحية وقد تم تدوينها ومقارنتها بنفس النتائج في كل من الكلاب والقطط.