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Intravenous urographic study of urinary system in canine using non-ionic and ionic contrast agent

Abstract

The present study was conducted to compare the imaging quality of non-ionic (iohexol) and ionic (sodium and meglumine diatrizoate) contrast agents for intravenous urography in dogs. Twelve clinically healthy adult dogs were randomly divided into two groups I and II, consisting six dogs of either sex in each. Two relevant radiographic exposures i.e. ventro-dorsal and right lateral views were obtained in survey following intravenous urography to evaluate the effectiveness of imaging quality using both non-ionic and ionic contrast agents @ 1100 mg I/kg body weight respectively under general anaesthesia. The radiographic examination of the contrast agent in both groups was assessed immediately after their administration and then at 5, 15, 30 minutes interval by taking ventro-dorsal/ lateral radiograph of abdomen. The obtained urograms were evaluated on the basis of nephrogram, pyelogram and cystogram phases. Nephrogram phase showed good visualization (2+) in animals group I as compared to group II which was slightly visualized (1+). The nephrogram phase persisted for a period of 15 minutes inventro-dorsal radiograph in group I whereas; it was clearly visible upto 5 minute duration in group II. The pyelogram phase was visible upto 5 to 15 minutes time interval in both the groups. Cystogram phase showed good visualization between 15 to 30 minute interval in both the groups. It was concluded that intravenous urography using non-ionic low osmolar iohexol at dose rate of 1100 mg I/kg produced better image quality as compared to ionic high osmolar sodium and meglumine diatrizoate following administration of same dose rate.

Keywords: cystogram, canine, iohexol, ionic contrast agent, intravenous urography, nephrogram non-ionic contrast agent, pyelogram, sodium and meglumine diatrizoate

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Introduction

Urinary tract infections and mainly urolithiasis are the most routine urological complications encountered in canines which are clinically characterized by haematuria, dysuria or stranguria[1] and are difficult to diagnose with plain radiography which is considered to be first investigative tool after clinical examination. Due to minimum differential contrast between abdominal and pelvic organs, it limits the diagnostic precision which can be overcome using contrast agents which specifically further enhance visualization and provide additional information regarding the functional status of the urinary system.

Intravenous urography is an improved radiographic contrast procedure used to enhance visualization of the renal parenchyma, pelvis, ureter as well as urinary bladder[2] which are viewed by obtaining a timed series of imaging of abdomen and pelvis after administering intravenous positive contrast media i.e. water soluble iodinated contrast agent. In intravenous urography, the contrast agent is injected into the convenient vein and a series of radiographs are taken. Iodinated contrast agents are ionic high osmolar (sodium and meglumine diatrizoate; sodium and meglumine iothalamate) and non-ionic low osmolar (iohexol and iopamidol) contrast agents. Both these agent are same except that non-ionic do not dissociate in solution and therefore, has less osmotic pressure. Since, the information on the comparison between non-ionic and ionic contrast agents for intravenous urography in dogs is scanty, therefore, the present study was conducted for comparing the imaging quality of non-ionic (iohexol) and ionic (sodium and meglumine diatrizoate) contrast agents for intravenous urography in dogs.

Materials and methods

The present study was conducted during April 2020 to September 2020 on 12 apparently healthy adult dogs presented for routine health checkup and vaccination to the Department of Veterinary Surgery and Radiology and Teaching Veterinary Clinical Complex, College of Veterinary Science & A.H. Anjora, Durg (C.G.) India. Twelve dogs were randomly divided into two groups I and II, consisting 6 animals of either sex in each. The animals of group I underwent intravenous urography with non-ionic low osmolar agent (Iohexol) @ 1100mg I/ kg body weight while animals of group II received ionic high osmolar agent (sodium and meglumine diatrizoate) @ 1100mg I/kg body weight. The contrast agent in both groups was diluted with an equal amount of 5% dextrose saline solution and infused intravenously over a period of 10-15 minutes under general anaesthesia without abdominal compression. For intravenous urography study, the dogs were kept off feed for 12 hours before the commencement of the radiography. Free access to water was allowed before the start of study. Laxative, Bisacodyl (Dulcolax®) 2ml was given to each dog of both the groups, a day before the study. Prior to administration of contrast agents, chlorpheniramine maleate @ 1mg/kg body wt. intramuscularly was administered to animals of group I and group II. In both groups, intravenous urography was done under general anaesthesia using atropine sulphate @ 0.04mg/kg body wt., xylazine hydrochloride @ 1mg/kg body wt. and ketamine hydrochloride @ 15mg/kg body wt. administered intramuscularly followed by maintenance with xylazine and ketamine (1:2) intravenously. Before administration of contrast agents two abdominal survey radiographs (ventro-dorsal and right lateral) were taken. The animal was restraint in dorsal recumbency on X-ray table and cephalic vein of animal was catheterized using 20 gauge butterfly needle for administration of contrast agent which was held in place with adhesive tape. Contrast agents (ionic and non-ionic) @ 1100mg Iodine/kg body wt.was diluted with an equal amount of 5% dextrose saline solution and infused intravenously overa period of 10-15 minutes without abdominal compression. Care was taken that the dose did not exceeded 35gm of iodine as reported by Kealy et al.[3] After administration of contrast agents ventro-dorsal/lateral radiograph were taken immediately after infusion and

then at 5, 15, 30 minutes intervals.[4] The radiograph Machine of 100 mA was used for exposure with CR system (FUJI COMPUTED RADIOGRAPHY) with factors 12mA, 55kV and 100cm FFD. The visibility of the radiographs obtained in both groups were assessed and compared immediately after infusion of contrast agents and also at 5, 15, and 30 minutes intervals. Intravenous urograms were evaluated in three phases: nephrogram, pyelogram and cystogram which indicated sequential phases of contrast medium passing physiologically through the urinary system. Intravenous urogram obtained after infusion of contrast agents were graded usingscale : 0-absence of visibility, 1+- slight visibility, 2+- good visibility, 3+- especially good visibility as given by Velesova and Ledecky.[5]

Results and discussion

Intravenous urography refers to contrast radiographic examination of the kidneys, ureter and urinary bladder using positive contrast medium such as water soluble iodine based contrast agents that are excreted through urine. Intravenous injection of these agents outlines whole urinary tract. Besides being an important diagnostic aid for detecting abnormalities pertaining to urinary tract and the technique also serves as rough index for kidney function. Before administration of the contrast agents two abdominal survey radiographs (ventro-dorsal and right lateral) were obtained and subsequently at different time intervals for the study and evaluation of urinary system. Injection of non-ionic and ionic iodinated contrast agent results in overall increased opacity of all tissues of urinary system. Untoward reactions after injection are negligible although occasional vomiting occurs after rapid injections. Kealy et al.[3] documented that dose of contrast agent should not exceed 35g of iodine. In the present study, the dose of non-ionic (iohexol) and ionic (sodium diatrizoate) contrast agents used was @ 1100mg iodine/kg of body weight administered slow intravenously over a period of 10-15 minutes after diluting with an equal amount of 5% dextrose normal saline (DNS) as also reported by Kealy et al.[3] without abdominal compression. Similarly, Balasubramanian et al.[6] opined that 1000mg/kg of iohexol was suitable for intravenous pyelography in cases where compression cannot be applied whereas Johnson et al.[7] recommended 800 mg dose and Kealy[8] adopted 850 mg/kg and 1200 mg/kg dose for rapid bolus injection and drip infusion respectively. Ganesh[9] and Mahawar et al.[10] conducted intravenous urography in dogs using both ionic and non-ionic contrast agent at dose rate of 1000mg I/kg and 800mg of iodine/kg body weight respectively. Rashid et al.[11] used sodium diatrizoate @ 800mg iodine/kg body for intravenous pyelography in dogs. Gowtham[12] conducted excretory urography in canine using iohexol @ 800mg I/kg. To its contrary, Ajadi et al.[13] concluded that increasing the dosage of urografin above 800mg/kg in cats does not provide additional beneficial effects on the nephrograms produced. Intravenous urography in the present study using non-ionic low osmolar (iohexol) and ionic high osmolar (sodium diatrizoate) contrastagents @ 1100mg iodine/kg of body weight respectively was found to be useful for defining anatomic structures and qualitative assessment of renal functions in canines.

In the present study, intravenous urography was performed using atropine sulphate, xylazine and ketamine anaesthetic combination. Similarly, some workers have also performed excretory urography/ intravenous urography under general anaesthesia.[9,14,10] However, Sharma et al.[2] and Gowtham[12] performed excretory urography in canine without general anaethesia by physical restraining method. The different intervals and number of radiographs to be exposed depend upon the information neededas per the study, and there are several specific published protocols for the post injection film sequences.[15,3] In the present study, following administration of contrast agents ventro-dorsal/lateral radiographs were taken immediately and at 5, 15 and 30 minutes intervals. Similarly, Parrah et al.[14] made radiographic film exposures at 1, 5, 10, 15, 20, and 40 minutes after contrast agent administration. Mahawar et al.[10] obtained radiograph at 0, 5, 10, 15 and 20 minutes interval after complete injection of contrast agents in dogs. Borazjouni et al.[16] performed positive contrast cystography using urografin 76% and took ventro-dorsal abdominal radiographs immediately and at 5, 20 and 40 minutes after injection in female sheep. In another study, Sharma et al.[2] took only ventro-dorsal radiographs at 0 hr, at 10 seconds and following with 5, 15 and 30 minutes after administration of both ionic and non-contrast agents in dogs. Gowtham[12] obtained ventro-dorsal and right lateral radiograph of the urinary system immediately after infusion of iohexol and at 5, 15, 30 and 45 minutes post infusion of contrast agents in dogs.

Two abdominal survey radiographs of dogs i.e. ventro-dorsal and right lateral radiograph were taken before administration of contrast agents to evaluate the suitability of contrast radiography for determination of the size, shape and position of the urinary organs. Faint impression of left kidney was visible in right lateral radiograph and both kidneys were clearly visible in ventro-dorsal radiograph in both the groups (Figure 1). The accumulation of radiolucent gas was noted in the different parts of gastrointestinal tract in the survey radiograph in both the groups. Survey radiograph provided very little details of the urinary organs or tract as a result of reduced subject contrast. Ventro-dorsal view provided better detail than right lateral view for visualization of kidneys and ureters without any superimposition of images. After administration of contrast agents, urogram was obtained immediately (0 minute) and then at 5, 15 and 30 minutes interval as reported by Velesova and Ledecky.[5] The image quality of non-ionic low osmolar (iohexol) and ionic high osmolar (sodium and meglumine diatrizoate) contrast agents for intravenous urography in dogs at different time intervals are shown in Table-1, Figure 2 and Figure 3.

Table 1 Intravenous urographic evaluation of urinary system using non-ionic (iohexol) (Group I) and ionic (sodium and meglumine diatrizoate) (Group II) contrast agents at different time intervals (Velesova and Ledecky, 2005)

Time intervals	Group I (Non-ionic-iohexol)			Group II (Ionic-sodium and meglumine diatrizoate)		
	Nephrogram	Pyelogram	Cystogram	Nephrogram	Pyelogram	Cystogram
Immediately after infusion	2+	0	1+	1+	0	0
5 minutes	2+	2+	2+	1+	1+	2+
15 minutes	1+	2+	3+	0	1+	2+
30 minutes	0	0	3+	0	0	3+

0-absence of visibility; 1+- slight visibility of contrast agent in the urinary organs; 2+- good visibility of contrast agent; 3+- especially good visibility of contrast agent

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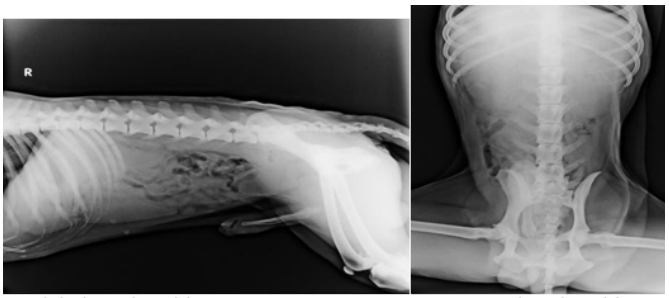
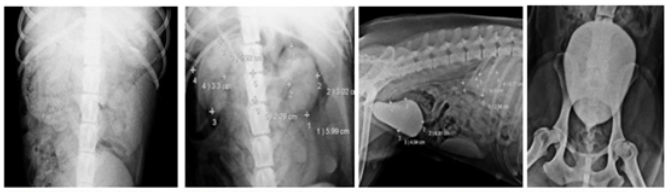


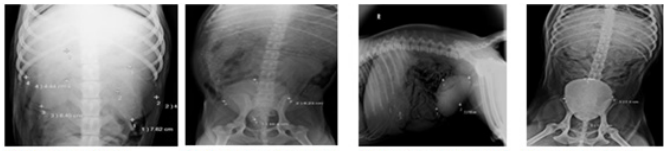
A. Right lateral position B. Ventro-dorsal position

Figure 1 Survey radiographic image of urinary system in a clinically healthy dog.



A. Nephrogram phase immediately | B. Nephrogram phase at 5 minute interval | C. Pyelogram phase at 15 minute interval | D. Cystogram phase at 30 minute interval

Figure 2 Urogram showing image quality and sequential phases of intravenous urography after administration of non-ionic contrast agent (iohexol) in Group I dogs.



Nephrogram phase immediately | Nephrogram phase at 5 minute interval | Pyelogram phase at 15 minute interval | Cystogram phase at 30 minute interval

Figure 3 Urogram showing image quality and sequential phases of intravenous urography after administration of ionic contrast agent (Sodium and meglumine diatrizoate) in Group II dogs.

Intravenous urography was evaluated in three phases i.e. nephrogram, pyelogram and cystogram which indicated sequential phases of contrast medium passing or eliminating physiologically through the urinary system.[4] These phases were clearly visible in dogs of group I as compared to group II. The earliest appearance of contrast agents in both the groups was seen immediately after infusion of contrast agents. The nephrogram phase was seen as the opacification of the functional renal parenchyma. This phase was distinctly recorded after 5 minutes of administration of contrast agent. In the pyelogram phase, there was opacification of the renal pelvis, pelvic recesses and ureters. This phase was observed at 15 minute interval wherethe fading of the renal parenchyma and pooling of contrast agents at renal pelvis, pelvic recesses and ureters was evident. The cystogram phase was characterised by the opacification of urinary bladder. The intensity of opacification in nephrographic and pyelographic phases along with the fading away patterns of contrast agents provided a qualitative assessment of renal function.

Nephrogram phase

In the present study, nephrogram phase was visualized in ventro-dorsal and right lateral radiograph taken immediately after infusion of contrast agents in both groups. This phase was visualized good (2+) in group I as compared to group II which was slightly visualized (1+). The nephrogram phase persisted for 15 minute duration in ventro-dorsal radiograph in animals of group I whereas, it was visible for short duration of 5 minute in group II. Present study revealed that nephrogram phase was visualized good in radiographs taken immediately and at 5 minutes interval in group I and slightly visualized in group II. The good nephrogram phase observed withiohexol might be due to lower volume of iohexol distribution as compared to other contrast agent. This findings are in accordance with Sharma et al.[2] where this phase was distinctly recorded after 5 minutes of administration of the contrast agents (Iohexol and Sodium and Meglumine Diatrizoate). On the other hand, Rashid et al.[11] documented excellent nephrograms obtained at 10 minute post injection interval with sodium diatrizoate @ 800mg iodine/kg body weight in mongrel dogs. Whereas, Gowtham,[12] reported that nephrographic phase was best visualized in ventro-dorsal and right lateral radiograph taken immediately and at 5 minutes after administration of Iohexol @ 800mgI/Kg infusion in both male and female dogs. In the present study, proper evaluation of the right kidney was not possible as compared to left kidney in the ventro-dorsal view due to accumulation and superimposition of the radiolucent intestinal gas in most of the dogs in both the groups. Mahawar et al.[10] and Gowtham[12] have also reported that the right kidney could not be visualized as good as the left in terms of radiopacity.

Pyelogram phase

The pyelogram phase was visualized good (2+) from 5 to 15 minutes interval in group I while in group II it was visualized slightly (1+) during same time interval. This phase was well visualized in ventro-dorsal rather than right lateral radiographs. Following contrast agent administration, ureters were visible good at 5 and 15 minutes interval in the dogs of group I whereas the ureters were slightly visible at 5 and 15 minutes interval in all the dogs of group II except in 1 dog. The best visualization of ureters was seen in animals of group I at 5 minute interval. Mahawar et al.[10] reported fairly to moderate good pyelogram at 15 minutes and adequately good to excellent radiographs at 20 minutes of study duration. To its contrary, Sharma et al.[2] reported that pyelogram phase was accurately revealed at 15 minute following administration of contrast agents where there was fading of renal parenchyma resultingin pooling of contrast agents at renal pelvis and diverticula. Gowtham[12] observed that pyelographic phase was clearly visible during 30 to 45 minutes interval after administration of iohexol @ 800mgI/Kg in both male and female dogs. This phase was well visualized in ventro- dorsal rather than right lateral radiograph. Velesova and Ledecky[5] reported especially good visibility of the ureters at 5 minutes interval in ventro-dorsal radiographs when iohexol wasused at the dose of 500mg I/kg body weight in dogs. In the present study, good visualization of ureters was evident at 5 to 15 minutes interval in ventro-dorsal view in group I where iohexol @ 1100mg I /kg body weight was used in dogs and there was slight visualization of ureters at 5 to15 minutes interval in ventro-dorsal view in all the dogs of group II when Sodium and Meglumine Diatrizoate @ 1100mg I/kg body weight was used. These observations are in accordance with Sharma et al.[2] who reported visibility of ureters in drainage phase at approximately 15 minutes following contrast administration. Contrary to present study, Rashid et al.[11] found excellent pyelogram at 15 minute post-injection of sodium diatrizoate @ 800mg iodine/kg body weight in mongrel dogs. Size of ureters were not uniform throughout their length and it was measured where the maximum luminal diameters was present. On a comparative basis, the intravenous pyelogram obtained in present study showed slightly better image details with non-ionic low osmolar contrast agent (iohexol @ 1100mg I//kg) as compared to ionic high osmolar contrast agent (sodium and meglumine diatrizoate @ 1100mg I/kg).

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Cystogram phase

The cystogram phase was visualized from 5 to 30 minutes interval in both the groups. The visualization of the urinary bladder varied with the time elapsed. Slight (1+) to good visibility (2+) of urinary bladder was observed up to 5 minutes interval in group I whereas absence of visibility (0) to good visibility (2+) of urinary bladder was observed in group II. Especially good visibility (3+) of urinary bladder was observed from 15 to 30 minute interval in all dogs of group I. Good visibility (2+) to especially good visibility (3+) of urinary bladder varied between 15 to 30 minutes interval in all dogs of group II. In the present study, cystogram phase was visualized good at 15 to 30 minutes interval in both the group**.** Mahawar et al.[10] reported that the cystograms obtained were poor at 5 minutes, fair at 10 minutes, fair to moderately good at 15 minutes and fair to adequately good at 20 minutes time interval. Rashid et al.[11] obtained excellent cystograms from 30 to 60 minutes post-injection of sodium diatrizoate @ 800 mg iodine/kg body weight in mongrel dogs. Similarly, Gowtham[12] reported excellent visualization of urinary bladder from 15 to 45 minutes interval in both view in all dogs using iohexol @ 800mg I/Kg. Towards the end of intravenous urogram, the contrast agent accumulated within urinary bladder and mixed contrast laden urine provided excellent visualization of urinary bladder at 15 minutes after contrast administration. The complete process for for performing intravenous urogram usually took 20 to 30 minutes. In the present study, intravenous urography in both groups was found useful for defining anatomic structures and qualitative assessment of renal functions. However, while comparing the image quality in both the groups, non-ionic low osmolar iohexol group produced better image quality than that of ionichigh osmolar sodium and meglumine diatrizoate in terms of renal density, detail and contrast. Nephrogram phase was visualized good (2+) in group I as compared to group II which was visualized slightly (1+). The nephrogram phase persisted for 15 and 5 minute interval during ventro-dorsal radiograph in group I and II respectively. The pyelogram phase was visible at 5 to 15 minutes time interval in both the groups. Cystogram phase was visualized good at 15 to 30 minute interval in both the groups**.** The above findings are in concurrence with Ganesh[9] who reported that iohexol at 1000 mg/kg produces excellent quality of nephrograms and pyelograms than those produced by sodium diatrizoate at same dose rate.[17]

Conclusion

From the above study, it could be concluded that intravenous urography using non-ionic low osmolar contrast agents (iohexol) @ 1100mgI/kg produced better image quality when compared to ionic high osmolar contrast agents (sodium and meglumine diatrizoate) at same dose rate in terms of renal density, detail and contrast.

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Conflicts of interest

Author declares there is no conflict of interest in publishing the article.

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