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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Comparison between intraosseous and subcutaneous excretory urography in Persian squirrels

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Abstract

Thirteen hundred mg iodine/kg body weight was injected subcutaneously over shoulder area in ten clinically healthy adult Persian squirrels with no signs of urinary system disorder. Urographic examinations by the intraosseous route were performed in the same animals 7 days later. Lateral and ventrodorsal radiographs were taken every 2 minutes until the pyelogram was finished. Subcutaneous injection was successful to show pyelogram, uretrogram and cystogram but it was unsuccessful in showing a diagnostic nephrogram. Optimum visualization of the renal paranchyma, calices, ureters and the urinary bladder was between 41.00±11.60 and 219.00±8.00 minutes after injection. This long range of time may help clinician to make radiographs without having stress for losing critically best time for urograms. Intraosseous injection of iodixanol was successful to show nephrogram, pyelogram, uretrogram and cystogram clearly. The optimum opacity was between 1.54±0.76 and 5.60±1.1.67 minutes after injection. There were no abnormal clinical signs after one week of the experiments. Intraosseous urography could be an effective and reliable method for small animals.

Keywords: Persian squirrels; intraosseous; subcutaneous; excretory urography

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Introduction

Intravenous urography is the basic radiographic method for evaluating disorders of urinary system. Despite improvement in the techniques and equipments for obtaining venous access, it is not always possible to achieve a secure peripheral or central vein especially in small size animals. Small veins and abundant subcutaneous tissue make vascular access difficult or impossible, therefore, another methods of administration of contrast media is desired like intraosseous (Saglam et al., 2004), intramuscular (knotek et al., 2004) and subcutaneous routs (Cerny et al., 1967).

Excretory urography is used for morphologic and especially functional studies of the urinary tracts (Thrall, 2007). The contrast media is brought to the kidneys through circulating blood, filtered in the glomeruli and concentrated in the renal tubules. Then it is delivered to the pelvis, ureter and urinary bladder where it is seen as radio-opaque shadow on x-ray films. However, it is not always possible to achieve a secure intravenous line for intravenous urography. This is especially important for paediatric and small size patients known to have small vasculature, which could be more difficult to access at the time of vascular collapse associated with shock, soft tissue trauma, burns, cutaneous and subcutaneous oedema, vascular thrombosis, and anatomical variations. For these reasons, an alternative route of delivering contrast media to patients in such situations is desirable.

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The technique of intraosseous infusion is a life-saving emergency alternative when intravenous access is impossible or would be critically delayed (Voigt et al., 2012). The intraosseous infusion has numerous advantages over other techniques that provide vascular access during emergencies (Olaussen and Williams, 2012). It is a rapid and safe alternate route for fluid and certain drug administration in the young animals. Though a few contra-indications or restrictions exist, the success rate of the technique is very high, even when performed by paramedical personnel, and the rate of complications is very low (Jaimovich and Kecskes, 1991). Most appropriate sites of insertion are the proximal or distal segments of the tibia (Burgert et al., 2012) and the distal segment of the femur. The administration of fluids, electrolytes and drugs through the intraosseal route is similar to the venous route (Orgiler Uranga et al., 2001). Subcutaneous injection is an easy method for administration of contrast media which does not need experienced hands and specific instruments. Slow release of contrast media from subcutaneous injection site gives an ample time to clinician to take radiographs without having stress for losing critical best time for urograms.

Iodixanol is a nonionic dimeric contrast agent with a molecular weight of 1550.20 and iodine content of 49.1%. It is formulated to be isosmotic (290 mOsm/kg of water) with plasma by the addition of sodium and calcium chloride (Hill et al., 1994).

This study was conducted to compare the feasibility of subcutaneous and intraosseous injection of iodixanol in providing a suitable and diagnostic urogram in Persian squirrels.

Materials and Methods

This study was performed on clinically ten healthy adult Persian squirrels. All the squirrels were included in both intraosseous and subcutaneous studies. For each study, before administration of contrast media, the squirrels were fasted for 18 h. A dose of 20 mg/kg body weight dimethicone was given orally 2 h before starting the procedure. To facilitate handling the animals and to get high quality radiographs, the animals were sedated with a ketamine/diazepam combination. Plain lateral (L) and ventrodorsal (VD) radiographs were taken before administration of contrast media using a portable X-Ray tube and the mammography films and cassettes. Thirteen hundreds mg of iodine per kilogram body weight of iodixanol were injected subcutaneously over shoulder joint. Lateral and ventrodorsal radiographs were taken every 2 minutes until the pyelogram was finished. In order to ensure complete contrast medium removal from the blood, intraosseous studies were performed 7 days later on the same squirrels with the same parameters (contrast medium amount, same exposure factors and focus-film distance). Contrast medium was injected intraosseously over tibia. Lateral and ventrodorsal radiographs were taken every 2 min until the pyelogram was finished.

The statistical analysis was performed with SPSS (SPSS version 16.0 for windows, SPSS Inc). Means were compared using student t-test. P values less than 0.05 was considered as statistically significant. Urograms were visually evaluated for quality by two radiologists.

Results

In subcutaneous urography, opacification of the renal parenchyma (nephrogram) was seen only in two cases, starting at 13.00± 1.00 min, having the optimum opacity at 20.00±2.00 min and lasted until 230.00±4.00 min (Fig. 1).

With intraosseous injection of contrast media, nephrogram was seen in both L and VD views. In lateral views, starting nephrogram was seen at 0.42±0.89 min, having the optimum opacity at 1.54± 0.76 min, fading was at 8.24±1.19 min and duration was 8.34±1.62 min. These timings for VD views were 0.40±0.32, 1.15±1.09, 4.40±0.89 and 9.60±0.89 min (Table 1) (Fig. 2). Timing of nephrogram was significantly decreased in intraosseous injection compared with subcutaneous injection ($P<0.05$).

In subcutaneous urography, in lateral view, starting of pyelogram was at 31.50±7.21 min; optimum visualization was between 42.00±11.60 and 222.00±7.00 min. For VD view, pyelogram started at 42.36±12.68 min, optimum visualization was between 53.68±14.17 and 223.13±5.43 min (Fig. 1). No fading was detected for renal parenchyma up to 223.13±5.43 min. Fading started after 223.13±5.43 min and subcutaneous contrast media was completely faded in 240 min.

With intraosseous injection of contrast media, opacification of the renal pelvis, pelvic recesses, and ureters (pyelogram) was clearly seen in both in L and VD views (Fig. 2). In lateral views pyelogram started at 0.80±1.09; optimum visualization was at 5.20±1.78 min, and duration of the pyelogram was 20.80±1.78 min. These timings for VD view were 1.20±1.09, 5.60±1.67 and 17.60±8.76 min. With intraosseous injection of contrast media, ureters were not clearly seen in all VD views (Table 2). Timing of pyelogram was significantly decreased in intraosseous injection compared to subcutaneous injection ($P<0.05$). Urinary bladder was seen in both views and located at the level of fifth lumbar vertebrae.

Urinary bladder was extended up to the level of fifth lumbar vertebrae. The bladder wall was clearly determined from its surroundings with intraosseous injection of contrast media.

Table 1: Comparison between nephrogram in subcutaneous (I) and intraossous (II) injection in lateral and ventrodorsal views

Group	Phase	Number	Mean min.	SD min.	Minimum min.	Maximum min.	P value
Lateral view							
I	Starting of	2	13.00	1.00	12.00	14.00	0.039*
II	nephrogram	10	0.42	0.89	0.00	2.00	
I	Optimum of	2	20.00	2.00	18.00	22.00	0.027*
II	nephrogram	10	1.54	0.76	0.00	4.00	
I	Finishing of	2	230.00	4.00	226.00	234.00	0.011*
II	nephrogram	10	8.34	1.62	6.00	12.00	
Ventrodorsal view							
I	Starting of	2	13.00	1.00	12.00	14.00	0.034*
II	nephrogram	10	0.40	0.32	0.00	2.00	
I	Optimum of	2	20.00	2.00	18.00	22.00	0.036*
II	nephrogram	10	1.15	1.09	0.00	4.00	
I	Finishing of	2	230.00	4.00	226.00	234.00	0.011*
II	nephrogram	10	9.60	0.89	8.00	12.00	

*Values are statistically significant. (P<0.05)

Table 2: Comparison between pyelogram in subcutaneous (I) and intraossous (II) injection in lateral and ventrodorsal views

Group	Phase	Number	Mean min.	SD min.	Minimum min.	Maximum min.	P value
Lateral view							
I	Starting of	10	31.50	7.21	24.00	46.00	0.037*
II	pyelogram	10	0.80	1.09	0.00	4.00	
I	Optimum of	10	42.00	11.60	36.00	64.00	0.033*
II	pyelogram	10	5.20	1.78	4.00	8.00	
I	Finishing of	10	222.00	7.00	216.00	230.00	0.016*
II	pyelogram	10	20.80	1.78	16.00	22.00	
Ventrodorsal view							
I	Starting of	10	42.36	12.68	24.00	56.00	0.029*
II	pyelogram	10	1.20	1.09	0.00	4.00	
I	Optimum of	10	53.68	14.17	36.00	86.00	0.023*
II	pyelogram	10	5.60	1.67	4.00	8.00	
I	Finishing of	10	223.13	5.43	204.00	220.00	0.020*
II	pyelogram	10	17.60	8.76	14.00	26.00	

*Values are statistically significant. (P<0.05)

Table 3: Evaluation of intraosseous urogram and subcutaneous urogram in the best radiographs, +: Bad, ++: Good, +++: Better

	Nephrogram		Pyelogram		Cystogram	
	Intraosseous	Subcutaneous	Intraosseous	Subcutaneous	Intraosseous	Subcutaneous
1	++	+	++	++	+++	+++
2	+++	+	+++	++	+++	+++
3	+++	+	++	++	+++	+++
4	+++	+	++	+++	+++	+++
5	++	+	+++	++	+++	+++
6	+++	++	+++	++	+++	+++
7	+++	+	+++	++	+++	+++
8	+++	+	+++	++	+++	+++
9	+++	+	+++	+++	+++	+++
10	++	+	+++	++	+++	+++

Intraosseous and subcutaneous urograms are visually compared in the optimum time of each phase (Table 3). There were no abnormal clinical signs after one week in both experiments.

Discussion

Persian Squirrel (*Sciurus anumalus*) is a small rodent which lives in oak forest of the North West and

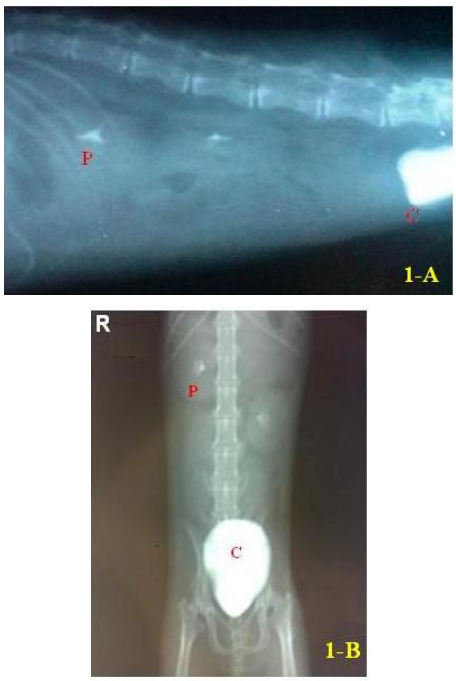

Fig. 1: Subcutaneous excretory urography. 1-A: Lateral view radiograph of pyelogram (P) and cystogram (C). **1-B:** Ventrodorsal view radiograph of pyelogram (P) and cystogram (C).

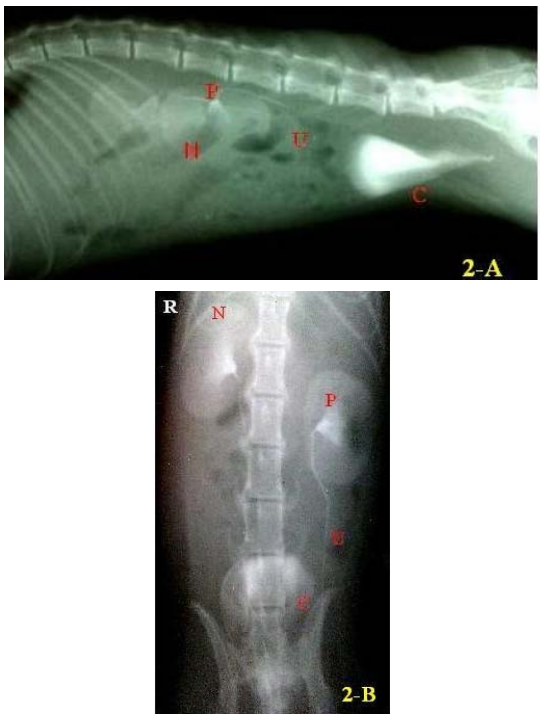

Fig. 2: Intraosseous excretory urography. 2-A: Lateral view radiograph of nephrogram (N), pyelogram (P), uretrogram (U) and cystogram (C). **2-B**: Ventrodorsal view radiograph of nephrogram (N), pyelogram (P), uretrogram (U) and cystogram (C)

West provinces of Iran (Firouz, 2000). Use of contrast media in exotic species is largely extrapolated from experiences in dogs and cats. Because of species differences in physiology and anatomic structure, caution should be exercised when utilizing these techniques in exotic animal medicine (Capello and Lennox, 2008). Drugs and fluids infused through the intraosseous space enter the central circulation as rapidly as through intravenous route (Orlowski et al., 1989). Preclinical study in dogs demonstrated active intraosseous blood circulation even during acidosis and hypoxemia (Brickman et al., 1996), also intraosseous infusion of fluids is useful in cases of shock, burns, mass casualties, and also for long term parenteral nutrition whenever peripheral veins cannot or should not be used. Behr (1994) described the tibia as a useful route for infusions in infants. Main advantages are ease, speed and firm placement. Comparison of tibial and humeral intraosseous use showed that both sites are suitable for this kind of infusion (Ong et al., 2009).

Urography is used by injection of contrast media via intravenous, intraosseous, intramuscular and subcutaneous in animals (Porzio et al., 2001; Knotek et al., 2004) and human (Cerny et al., 1967; Ngo et al., 2009). Intraosseous injection of iodinated contrast media in an abused child was performed previously (Geller and Crisci, 1999). Intravenous urography is the most practical procedure for making urography, but in very small size animals and neonates, it is difficult to find suitable veins for injection of iodine contrast materials (Porzio et al., 2001; Knuth et al., 2011). Intramuscular and subcutaneous injection for urography is reported in humans and also in small size animals where other routes for injection are not very easy so it seems that these routes are feasible in small size animals such as squirrel. Subcutaneous urography is reported in human many years ago (Cerny et al., 1967). Intraosseous urography has not been reported in squirrel at the present knowledge of authors. Like dog and cat, the right kidney in the squirrel is more cranial than the left. The most widely used quantification of normal kidney size in the dog and cat is renal length assessed on survey radiographs. But normal kidney size in the squirrel cannot be assessed on survey radiographs even by using mammography films and cassettes due to lack of abdominal and retroperitoneal fat and small size of the animal. The most accepted renal length is 2.5 to 3.5 times the length of the L2 vertebral body length in the dog, as visualized on the ventrodorsal view. This value in the cat is 2.4 to 3 times the length of the L2 vertebral body (Thrall, 2007). In this study, the normal renal size varies between 2.09 and 2.43 times the length of L2 vertebral body.

Subcutaneous injection of contrast media was unable to show diagnostic nephrogram as a distinct phase without pyelogram due to different factors like

slow releasing contrast media and unsuccessful emptying of large intestine (Kealy and McAllister, 2000).

In subcutaneous urography, pyelogram was shown in a good quality. Subcutaneous urography was capable to show pyelogram in a long range of time. Recommended times for complete assessment of the urinary system are 0, 2, 6, 12 min after intraossepus injection for lateral and ventrodorsal views in this study. Ventrodorsal views are preferred to lateral for assessment of kidneys, and lateral views are preferred for ureter and urinary bladder assessment. The pyelogram was more radio-opaque than the nephrogram as seen in the normally functioning kidney in the dog and cat. In conclusion, intraoseous injection of contrast media for excretory urography seems to be more diagnostic than subcutaneous injection in squirrels.

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