COMPARATIVE 2D AND 3D ULTRASONOGRAPHIC IMAGING OF DEVELOPMENTAL CHANGES OF URINARY BLADDER IN DOGS

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Received 25-6-2015 ***Accepted 25-8-2015***

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ABSTRACT

The present study was undertaken in six apparently healthy pups of mixed mongrel breed from the same litter irrespective of their sex. Normal ultrasonographic images of development of urinary bladder were obtained by 2D and 3D ultrasonography. First scanning was done on the 15th day of age and at 15 days interval till the two month of age and then at the interval of one month till eight month of age.The wall thickness, diameter, length and circumference of urinary bladder were measured. There was linear increase observed in the bladder parameters with age. The change in parameters was also dependent on the fullness of the urinary bladder. At 15th day the urinary bladder appeared as a small anechoic structure with indistinct wall. With advancement of age the size and capacity of urinary bladder increases. The circumference of the bladder was found maximum at 240th day of age.

KEY WORDS : Ultrasonography, Hypoechoic, Hyperechoic, Anechoic.

INTRODUCTION

Urinary bladder is ideally suited for sonographic examination because of its superficial position and its fluid content so that little attenuation of sound beam occurs (Barr, 1990). Different ultrasonographic images of urinary bladder in dogs and goats have been recorded by 2D ultrasonography (Satish *et al*., 2012). Also the measurements of normal renal parameters in dogs by 2D ultrasonography have been done (Singh *et al*., 2010). But there is no record of 3D ultrasonographic imaging of urinary bladder in dogs. Therefore present study is undertaken to obtain and compare the normal 2D and 3D ultrasonographic images of developmental changes of urinary bladder in dogs.

MATERIALS AND METHODS

The present study was undertaken in six apparently healthy pups of mixed mongrel breed from the same litter irrespective of their sex. These pups were completely weaned from their mother at 15 days of age and kept in the similar managemental and dietry condition. 1st scanning was done at 15th day of age. Subsequently scanning was done at 30th, 45th, 60th days and 3rd, 4th, 5th, 6th, 7th and 8th month of age. The pups were kept off feed for 12 hours prior to ultrasonography to allow clearance of the solid content from GI tract. The pups were provided ad-lib fluid just before scanning to get a better acoustic window for scanning. Scanning area was shaved properly and enough gel was applied over the site and the surface of transducer to get a better image. The ultrasound machine used for this study was 3D ultrasound machine (Nemio-XG: Toshiba, Japan) having 4D volumetric probe. The statistical analysis of data was done by one-way-analysis of variance and Duncan's multiple range tests was used to compare the means.

RESULTS AND DISCUSSION

The urinary bladder was scanned in both the transverse plane and longitudinal plane. In this study the various parameters of urinary bladder measured were wall thickness, diameter, length and circumference. The bladder appeared pear shaped in the longitudinal plane and had a round form in the transverse plane as also reported by Voros *et al*., (1995). Measurements were taken from the recorded image using electronic callipers. The maximum bladder length and circumference were measured in sagittal section. The maximum diameter was measured in transverse section. The wall thickness can be measured in any of the plane.

In present study the urinary bladder wall thickness was found to increase with age. The mean value of wall thickness was 2.61±0.15 mm at 15th day of age and 5.47±0.30 mm at 8th month of age (Table.1). The wall thickness was found to be increased due to development of urinary bladder with age.

Table 1: Ultrasonographic measurements of parameters of urinary bladder with the advancement of age

Age (Days) / Parameters	15	30	45	60	90	120	150	180	210	240
Wall thickness (mm)	2.61^{b} ± 0.15	2.78^{b} ± 0.19	2.98^{b} ± 0.10	3.22^{b} ± 0.20	3.35^{b} ± 0.28	3.82^{b} ± 0.11	5.13^{a} ± 0.57	5.20^{a} ± 0.29	5.24^{a} ± 0.18	5.47^{a} ± 0.30
Diameter (mm)	16.83^{d} ± 1.15	19.20^{cd} ± 0.53	19.93^{cd} ± 0.74	23.40^{c} ± 0.87	30.85^{b} ± 0.70	31.43^{b} ± 3.47	32.58^{b} ± 1.26	33.86^{ab} ± 1.07	34.38^{ab} ± 2.24	38.07^{a} ± 2.29
Length (mm)	36.13^{d} ± 3.09	39.25^{cd} ± 2.32	39.73^{cd} ± 1.94	40.98^{cd} ± 1.82	43.82^{bcd} ± 1.15	48.18^{bc} ± 1.31	52.22^{ab} ± 4.52	53.15^{ab} ± 8.08	59.37^{a} ± 5.54	59.72^{a} ± 2.32
Circumference (mm)	46.93^{g} ± 1.28	88.45^{f} ± 3.45	114.67^{e} ± 3.25	126.43^{de} ± 3.09	129.61^{de} ± 1.75	140.95^{cd} ± 12.91	154.22^{bc} ± 5.32	157.35^{bc} ± 10.46	172.62^{b} ± 5.07	201.88^{a} ± 14.95

Note : Different superscripts are significantly different within group (P<0.5). n=6

At 15th day of age in 2-D ultrasonogram (Fig.1A) the lumen of bladder appeared as a small anechoic area. The shape of bladder appeared as a little spheroid. In 3-D ultrasonogram (Fig.1B) of the urinary bladder the anechoic shadow of urine was visible and more distinct as compared to 2-D ultrasonogram. At 30th day of age in 2-D ultrasonogram (Fig.2A) the lumen appeared as an anechoic area larger than previous stage. In 3-D ultrasonogram (Fig.2B) the various regions of bladder vertex, body and neck were visualized clearly. The course of urethra at the bladder neck was also seen. The bladder appeared more echogenic at the vertex. A 45th day of age in 2D ultrasonogram (Fig.3A) the bladder was more developed than the previous stage. It was larger spheroid in shape at this stage. A large anechoic lumen and a hyperechoic wall were visualized. In 3-D ultrasonogram (Fig.3B) the lumen appeared as large anechoic area. At 60th day of age in 2-D ultrasonogram (Fig.4A) the bladder appeared of ellipsoid shape. The lumen appeared larger than the previous stage. The acoustic enhancement was also seen as a hyperechoic area below the ventral wall of bladder. The 3-D ultrasonogram (Fig.4B) was also similar to previous stage. The course of urethra at the bladder

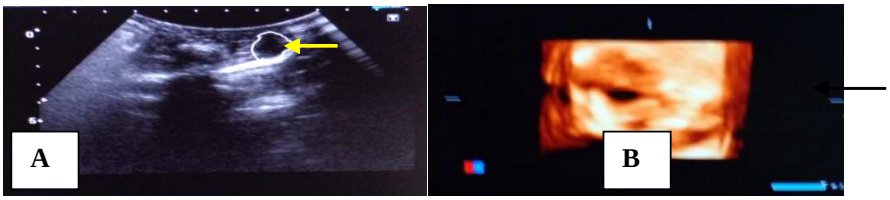

Fig.1: Urinary bladder at 15th day of age. (A)In 2D sonogram,spheroid shaped urinary bladder with small anechoic lumen (yellow arrow). (B) In 3Dsonogram the lumen of the urinary bladder is clearly visualized (black arrow).

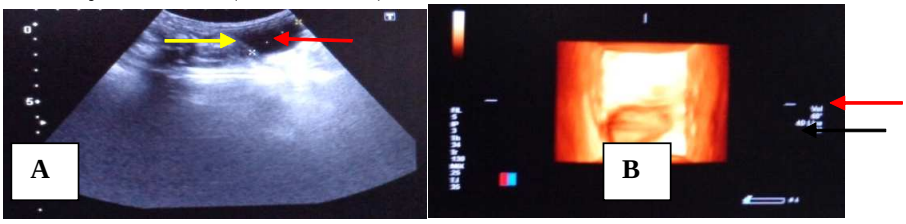

Fig.2: Urinary bladder at 30th day of age. (A) In 2-D sonogram anechoic urinary bladder lumen (red arrow) and less distinct bladder wall (yellow arrow) is present. (B) In 3-D sonogram the lumen is clearly visualized (black arrow). The course of urethra at the bladder neck is also clearly visible (red arrow).

Fig.3: Urinary bladder at 45th day of age. (A) In 2D sonogram anechoic lumen (black arrow) and hyperechoic bladder wall (red arrow) are clearly visible. (B) In 3D sonogram the lumen of bladder (black arrow) is clearly visualized.

Fig.4: Urinary bladder at 60th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and hyperechoic bladder wall (yellow arrow) are visible clearly. (B) In 3D sonogram bladder lumen (red arrow) is visualized clearly.

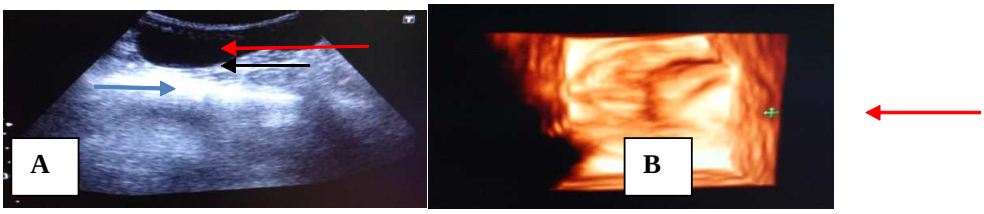

Fig.5: Urinary bladder at 90th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and clearly distinct hyperechoic bladder wall (black arrow) are visible. Strong acoustic enhancement is presented distal to the urinary bladder (blue arrow). (B) In 3D sonogrambladder lumen (red arrow) is visualized clearly.

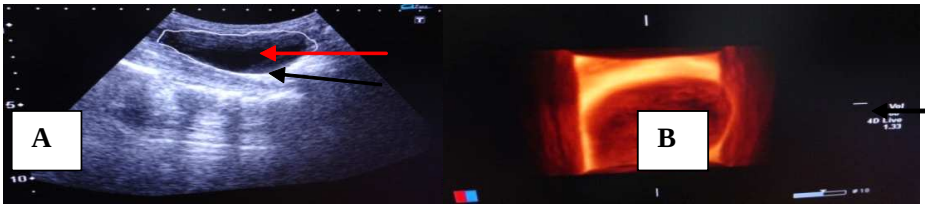

Fig.6: Urinary bladder at 120th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and less distinct hyperechoic bladder wall (black arrow) are visible. (B) In 3D sonogram bladder lumen (black arrow) is visualized clearly.

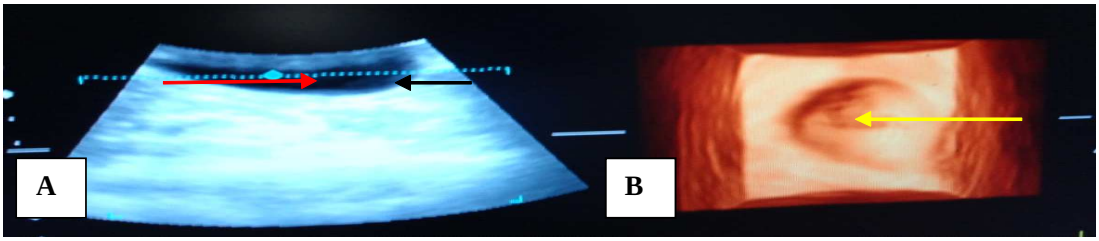

Fig.7: Urinary bladder at 150th day of age. (A) In 2-D sonogram anechoic lumen (red arrow) and less distinct hyperechoic bladder wall (black arrow) are visible. (B) In 3-D sonogram bladder lumen (yellow arrow) is visualized clearly.

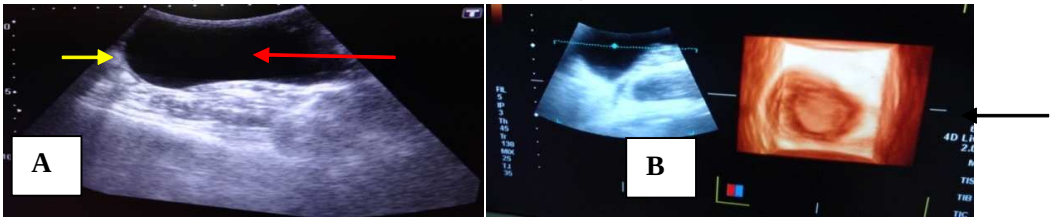

Fig.8: Urinary bladder at 180th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and clearly distinct hyperechoic bladder wall (yellow arrow) are visible. (B) In 3D sonogram bladder lumen (black arrow) is visualized clearly.

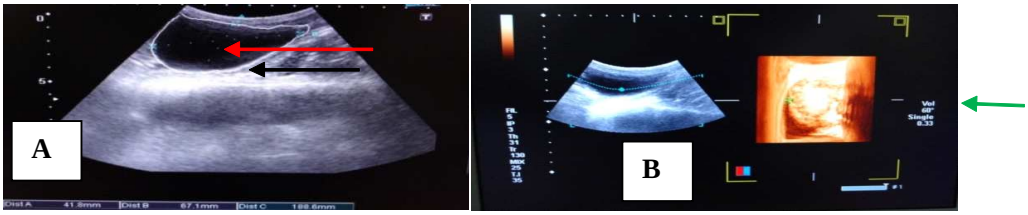

Fig.9: Urinary bladder at 210th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and clearly distinct hyperechoic bladder wall (black arrow) are visible. (B) In 3D sonogram Bladder lumen (green arrow) is visualized clearly.

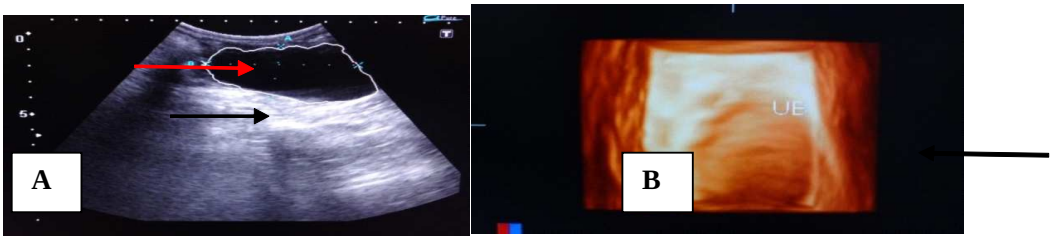

Fig.10: Urinary bladder at 240th day of age. (A) In 2D sonogram anechoic lumen (red arrow) and strong acoustic enhancement distal to the urinary bladder (black arrow) are visible. (B) In 3D sonogram bladder lumen (black arrow) is visualized clearly.

neck was seen more clearly. At 90th day of age in 2-D ultrasonogram (Fig.5A) the urinary bladder appeared as a large anechoic lumen surrounded by a hyperechoic wall. The wall of the urinary bladder was found to be more distinct than the previous stage. Acoustic enhancement distal to the bladder wall was also more prominent. In 3-D ultrasonogram (Fig.5B) the wall of urinary bladder was less clear than 2-D ultrasonogram. The anechoic lumen was visualized clearly. At 120th day in 2-D ultrasonogram (Fig.6A) the urinary bladder appeared with smaller anechoic lumen and thick wall. The size of the urinary bladder appeared small and the wall was not distinct from the surrounding tissue. In 3-D ultrasonogram (Fig.6B) also the lumen appeared as anechoic area and the wall was more distinct than 2-D ultrasonogram. At 150th day of age in both 2-D and 3D ultrasonogram (Fig.7A and B) the urinary bladder appeared similar to the previous stage with small change in parameters. The wall thickness was found to be increased. The 3-D ultrasonogram was also similar to previous stage. At 180th day of age in 2-D ultrasonogram (Fig.8A) the urinary bladder appeared fully developed at this stage. It appeared as a large anechoic lumen surrounded by a hyperechoic wall. The wall was clearly distinct from surrounding tissue. In 3-D ultrasonogram (Fig.8B) the shape of the bladder was spheroid. The wall of the urinary bladder was more distinct than 2-D ultrasonogram. At both 210th and 240th day of age, the 2-D ultrasonogram (Fig.9 and 10) of urinary bladder appeared similar to that of previous stage. The wall of urinary bladder was clearly demarcated. The 3-D ultrasonogram of the urinary bladder was also similar to previous stage. The bladder wall was less distinct than 2-D ultrasonogram.

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