Comparative Ultrasonographic Characterization of the Pelvis in Clinically Normal Horses and Donkeys.

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ABSTRACT
This study was conducted to provides detailed comparative ultrasonographic description of the pelvis in clinically normal horses and donkeys. It was carried out on 48 mature animals (30 horse and 18 donkey). Evaluation of pelvis was performed using transcutaneous and transrectal techniques. The following structures were examined; tubera sacralia (shape and distance between them and distance between each of them and first sacral spinous process), ilial wing, tuber coxae, ilial body, hip joint, tuber ischii, third trochanter, appearance and measurements of dorsal and lateral parts of dorsal sacroiliac ligament and thoracolumbar fascia, ischiatic table, obturator foramen and its contents, pubis, medial aspect of acetabulum and ilial body, sacroiliac joint and ventral aspect of sacrum. For each evaluated structure, the obtained results were compared between horses and donkeys. A high correspondence was found between pelvises of horses and donkeys concerning their ultrasonographic appearance and measurements except, for cross sectional area of both dorsal part of the dorsal sacroiliac ligament-thoracolumbar fascia combination and the sacroiliac joint width which showed significant difference between them.

Keywords: Donkey, Horse, Pelvic Ultrasonography, Transcutaneous, Transrectal

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INTRODUCTION

Affections of the pelvis are common in equine species. It constitutes one of the major causes of hind limb lameness, that greatly affect the animal performance and may leads to its culling (Almanza, & Whitcomb, 2003; Pilsworth, 2003; Bertoni et al, 2013). The complex anatomic structure of the pelvis coupled with animal body size makes diagnosis of its injuries presents a challenge to equine practitioner (Haussler et al, 1999; Tomlinson, et al, 2001; Pilsworth, 2003; Verheyen & Wood, 2004; Engeli et al, 2006; Whitcomb, 2012; Head, 2014).

Pelvic evaluation is carried out by different techniques including; X-ray, computed tomography (CT), magnetic resonance imaging (MRI) and nuclear scintigraphy. Each one of them has its own advantages and disadvantages (Hogan, et al, 1995; Tomlinson et al, 2001; Barrett, et al, 2006; Butler, et al 2008; Dewé et al, 2008; Powell, 2011; Head, 2014, Shields et al, 2015). X-rays, CT and MRI gives excellent details about pelvic osseous structures. On the other hand, it gives little information about soft tissues. The high cost of their equipment and the danger of fracture displacement accompanied with casting of the animal for examination limits its wide use in most of equine hospitals (Geissbühler et al, 1998; Dyson & Murray, 2003; Barrett, et al, 2006; Trump et al, 2011 Whitcomb, et al, 2011). Nuclear Scintigraphy was used for diagnosis of pelvic affections related to sacroiliac region (Dyson et al, 2003a&b), ischial tuberosity and third trochanter (Geissbühler et al, 1998; Davenport-Goodall & Ross 2004; Shields et al 2015). Nuclear Scintigraphy is more sensitive than other diagnostic tools. As well as, the animal is examined while maintained in standing position thus it can be kept from the risk associated with general anesthesia. Nuclear Scintigraphy has many disadvantages in terms of; it is nonspecific diagnostic tool gives little information about the nature of the pathological process. In addition, the quality of the obtained image is greatly affected by pelvic muscle mass, animal motion and the absorption effect of the urinary bladder. Moreover, its Equipments is highly expensive, thus it is not suitable for all veterinary hospitals (Erichsen & Berger, 2001; Davenport -Goodall, & Ross, 2004; Butler et al, 2008). Ultrasonography is recently used for pelvic examination (Walker, et al 2012; Whitcomb, 2012). It can give diagnostic information about the bone surfaces, pelvic joints and soft tissue. It does not require general anesthesia and the animal is examined while maintained in standing position, thus eliminates the danger associated with animal casting (Tomlinson, et al, 2003; Dewé et al, 2008; Brenner & Whitcomb, 2009; Bertoni et al, 2013; Head, 2014; Shields et
al, 2015). Moreover, ultrasonography constitutes a rapid, non-invasive and less expensive method for diagnosis of the pelvic injury (Pilsworth, 2011; Powell, 2011).

Several reports have described normal and abnormal ultrasonographic appearance of the horse’s pelvis (Tomlinson, et al, 2001; Kersten & Edinger, 2004; Engeli, et al, 2006; Walker, et al, 2012; Whitcomb, 2012). According to our knowledge, there is no available data concerning the normal ultrasonographic characterization of the donkey’s pelvis although its wide distribution all over the world. The purpose of this study is to provide detailed comparative ultrasonographic description of the pelvis in clinically normal horses and donkeys, paving to use the obtained data as a guide for future pelvic examination studies. We assume that there is no big differences in ultrasonographic picture between horse and donkey.

**MATERIALS And METHODS:**

The present study was carried out at the hospital of Surgery, Anesthesiology and Radiology Department, Faculty of Veterinary Medicine, University of Sadat City, Egypt. The study protocol followed the guidelines of the faculty for the use and care of animals. The study was carried out on 48 mature clinically normal male animals of native breed (30 horses and 18 donkeys). The animals have no any previous history of hind limb lameness or back pain. The mean age of the horses was 19.5 years (range, 13 to 25 years old) and mean body weight 420 Kg (range, 350 to 500 Kg). The mean age of the donkeys was 8 years (range, 7 to 10 years) and mean body weight 197 Kg (range, 150 to 250 Kg). The animals were owned by the institution. They were used for teaching purposes and scheduled for euthanasia. In all cases, the reason for euthanasia was unrelated to pathology affecting the pelvis. The pelvis of 6 animal (3 horses and 3 donkeys) were dissected to judge ultrasonographic findings. All animals were inspected while standing squarely behind on a flat surface in order to assess the symmetry of the pelvis and the hind quarter musculature. The animals were examined while moving on soft and hard ground followed by flexion test of the proximal hind limb. External and rectal palpation of pelvic components was performed for detection of any of abnormalities and/or response to pain. The animals included in the study were free from any detectable lameness when moving in hand on hard surface, and on the lung on both hard and soft surfaces. The response to proximal limb flexion test of the hind limb was negative. All animals with asymmetry between both sides of the pelvis were not included in the study.
Animals were controlled in a stanchion sedated by intravenous administration of Xylazine hydrochloride (Xylaject®: 2% sol. ADWIA Co., Egypt) at dose of 1.1 mg/kg B.W./IV. followed by induction of caudal posterior epidural analgesia using 2% lidocaine hydrochloride (Debucaïne® 2% El-Nasr Pharm. Chemicals co. for Al-Debeiky Pharm. Egypt) at dose of 0.35 mg/kg B.W. Animal preparation included hair clipping and cleansing the skin overlaying the pelvis using ethyl alcohol followed by spreading the acoustic gel.

Ultrasonographic examination was performed using ultrasound unit (Esaote mylab one-507, Italy) equipped with 6.6 to 18 MHz micro-convex, linear array tendon and rectal linear probes. For complete pelvic evaluation both transcutaneous and transrectal ultrasonographic examination was carried out on the same bases as described by Walker et al, (2012), Head, (2014) and Whitcomb & Vaughan (2015). The examined structures, probe type, recorded parameter, recommended frequency and depth were listed in table 1&2. The highest-frequency that penetrated the area of interest was used to achieve the best-quality images.

**STATISTICAL ANALYSES:**

For each measured structure, mean, standard error (SE) and range of values were calculated. The differences in values between the right half of the pelvises of all examined were analyzed using a nonpaired t test. The same test was repeated to analyze the differences in values between the left half of the pelvises of all examined animals were analyzed by the same manner. Paired t test was used to compare the difference in values between the right and the left side of each specie. For all tests, significance was set at P<0.05.

1. **RESULTS**

The pelvises of both donkeys and horses showed the same ultrasonographic appearance during both transcutaneous and transrectal examination. In transcutaneous examination both tubera sacralia were imaged as hyperechoic convex arches with some irregularity at its surface. They are separated from each other by hypoechoic zone. Each one of them covered with thin echogenic layer constitutes dorsal part of the dorsal sacroiliac ligament and thoracolumbar fascia (Fig. 1A&B). The spinous process of the first sacral vertebra was imaged as hyperechoic small area midway between tubera sacralia. The shadow artifact created by it masked observation of the sacral vertebral bodies (Fig.1 A). The mean distance between both tubera sacralia as well as the distance between each of them and most dorsal point of first sacral spinous process were listed in (Table, 3).
Table 1: Showing the examined structures during transcutaneous examination, recorded parameter, used probe type, recommended frequency and depth.

<table>
<thead>
<tr>
<th>Examined structure</th>
<th>Probe type</th>
<th>Scanning frequency MHz</th>
<th>Scanning depth cm</th>
<th>Recorded parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubera sacralia</td>
<td>Microconvex</td>
<td>10</td>
<td>5-6</td>
<td>• Shape. • Depth from skin surface, distance between them at the most dorsal point and the distance between the medial aspect of each of them and the most dorsal part of first sacral spinous process,</td>
</tr>
<tr>
<td>Ilial wing</td>
<td>Microconvex</td>
<td>6.6</td>
<td>8-12</td>
<td>• Shape.</td>
</tr>
<tr>
<td>Lateral part of the dorsal sacroiliac ligament</td>
<td>Microconvex</td>
<td>8-10</td>
<td>4-8</td>
<td>• Shape • Thickness. • Attachment to the lateral sacral crest.</td>
</tr>
<tr>
<td>Dorsal part of the dorsal sacroiliac ligament-thoracolumbar fascia combination</td>
<td>Linear array tendon</td>
<td>8-14</td>
<td>4-6</td>
<td>• Echogenicity and linear fiber pattern. • Cross sectional area and thickness</td>
</tr>
<tr>
<td>Tuber coxae</td>
<td>Microconvex</td>
<td>10</td>
<td>5-8</td>
<td>• shape • Ventral muscle attachment</td>
</tr>
<tr>
<td>Ilial body</td>
<td>Microconvex</td>
<td>6.6</td>
<td>8-12</td>
<td>• Shape</td>
</tr>
<tr>
<td>Tuber ischii</td>
<td>Microconvex</td>
<td>6.6-10</td>
<td>5-10</td>
<td>• Shape.</td>
</tr>
<tr>
<td>Third trochanter</td>
<td>Microconvex</td>
<td>6.6-8</td>
<td>8-12</td>
<td>• Shape</td>
</tr>
<tr>
<td>Hip joint</td>
<td>Microconvex</td>
<td>6.6</td>
<td>5-10</td>
<td>• Joint space • femoral head and acetabulum</td>
</tr>
<tr>
<td>Pelvic muscles</td>
<td>Microconvex</td>
<td>6.6-10</td>
<td>4-12</td>
<td>• appearance</td>
</tr>
</tbody>
</table>
Table 2: Showing the examined structures during transrectal examination, recorded parameter, used probe type, recommended frequency and depth.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Probe Type</th>
<th>Frequency</th>
<th>Depth</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis symphysis</td>
<td>Microconvex</td>
<td>10</td>
<td>4-7</td>
<td>Appearance</td>
</tr>
<tr>
<td>Ischiatic table</td>
<td>Linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape</td>
</tr>
<tr>
<td>Medial aspect of the acetabulum</td>
<td>Linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape</td>
</tr>
<tr>
<td>Ilial body</td>
<td>Linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape</td>
</tr>
<tr>
<td>Ventral aspect of the sacrum</td>
<td>Linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape</td>
</tr>
<tr>
<td>Obturator foramen (OF) and its contents</td>
<td>Microconvex and linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape, Contents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(blood vessels and nerve)</td>
</tr>
<tr>
<td>Sacroiliac joint</td>
<td>Linear</td>
<td>10</td>
<td>4-7</td>
<td>Shape and width</td>
</tr>
</tbody>
</table>

The dorsal part of the dorsal sacroiliac ligament and the thoracolumbar fascia appeared in transverse scan as S-shape homogenous echogenic structure extended laterally to cover the proximal part of tuber sacrale and fused medially with the counterpart opposite side at the level of the dorsal spinous processes of the sacral vertebrae. In all examined donkeys and 20 of all examined horses, thoracolumbar fascia fused medially to the dorsal potion of the dorsal sacroiliac ligament (Fig.1 B) and fused dorsally in the rest (10 horses) of the examined horses (Fig.1 C). In longitudinal scan, the dorsal portion of the dorsal sacroiliac ligament and the thoracolumbar fascia appeared as two homogenous echogenic layers. At the cranial border of tuber sacrale, they were separated from each other by anechoic zone and completely fused together at the level of the most dorsal point of tuber sacrale without clear separating border (Fig.1 D). The mean thickness and cross-sectional area of the dorsal potion of the dorsal sacroiliac ligament-thoracolumbar fascia combination in both horses and donkeys was listed in (Table, 3).
Fig. 1

A. Transverse ultrasonographic image of the dorsal sacroiliac region of 7 years old donkey; showing both tuber sacrale (TS) and most dorsal point of first sacral spinous process (S1). D, dorsal; V, ventral.

B. Transverse ultrasonographic image of the dorsal sacroiliac region of 10 years old donkey showing; both tuber sacrale (TS), the dorsal part of the dorsal sacroiliac ligament (D-DSIL) fused medially with thoracolumbar fascia (TLF).

C. Transverse ultrasonographic image at the level of the most portion point of tuber sacral (TS) in 17 years old stallion; showing both dorsal part of the dorsal sacroiliac ligament (D-DSIL) and thoracolumbar fascia (TLF) fused dorsally. LAT, lateral; MED, medial.

D. Compound longitudinal ultrasonographic image at the level of tuber sacral (TS) of 9 years old donkey showing; the dorsal part of the dorsal sacroiliac ligament (D-DSIL) completely fused with thoracolumbar fascia (TLF) at the most dorsal point of TS. CR, cranial; CD, caudal.

The lateral portion of the dorsal sacroiliac ligament appeared as a slightly irregular hyperechoic line extending ventrolateral at an angle with the vertical axis. At its ventrolateral end, it attached to smooth hyperechoic linear structure constitutes the lateral sacral crest (Fig. 2 A). The mean thickness of the lateral portion of the dorsal sacroiliac ligament in both horses and donkeys was listed in (Table, 3).

Ilial wing was imaged as smooth continuous concave hyperechoic arch extended laterally from tuber sacrale to tuber coxae and covered with homogenous hypoechoic gluteal muscles mass (Fig.
2B). A gap like fracture was imaged during examination of the med ilial wing region (Fig.2C). Tuber coxae appeared as slightly convex hyperechoic arch with slight irregular surface (Fig.2D). The ilial body appeared as concave hyperechoic line extending caudoventrally from tuber coxae till the acetabulum (Fig. 3A).

Fig. 2:
A. Transverse ultrasonographic image of 10 years old donkey; showing the lateral portion of the dorsal sacroiliac ligament (L-DSIL) attached to the lateral sacral crest (LSC) and the sacral spinous process (SSP). LAT, lateral, MED, medial, D dorsal, V, ventral.
B. Compound longitudinal ultrasonographic image of the right ilial wing (IW) in a 7 years old donkey. The ilial wing appeared as hyperechoic concave arch extending from tuber sacral (TS) medially to tuber coxae (TC) laterally and covered with homogenous echogenic gluteal muscle mass. LAT, lateral, MED, medial.
C. Longitudinal ultrasonographic image of the med-ilial wing (IW) region in a 20 years old stallion showing; gap like fracture artifact (circle) at the level of the gluteal muscle tendon (GM) insertion. LAT, lateral, MED, medial, D dorsal, V, ventral.
D. Longitudinal ultrasonographic image of the right tuber coxae (TC) of 9 years old donkey. LAT, lateral, MED, medial, CR, cranial, CD caudal.

The hip joint was located at the caudal end of the ilial body where its surface diverges from concave to be convex. The cranial part of the hip joint was imaged as thin anechoic line bounded laterally and medially by two echogenic lines, the acetabulum femoral head respectively (Fig. 3A). The greater trochanter of the femur was imaged at the caudo-lateral portion of the femoral
head as a hyperechoic convex arch (Fig. 3B). The imaging of the caudal portion of the hip joint was difficult. The tuber ischii appeared in transverse scan as a smooth slightly convex hyperechoic curvilinear structure directed dorsoventrally which is covered caudally by two homogenous hypoechoic mass with echogenic linear fiber pattern constitutes semimembranosus and semitendinosus muscles (Fig. 3C). In longitudinal scan, it appeared as smooth nearly straight hyperechoic line (Fig. 3D). The third trochanter appeared in transverse scan as inverted hyperechoic U-shape arch attached cranially to the femur. The tendon of insertion of the superficial gluteal muscle attached to its apex and appeared ultrasonographically as straight echogenic thick line directed cranially (Fig. 4A). In longitudinal scan, the third trochanter appeared as smooth hyper echoic curvilinear structure (Fig. 4B).

Fig. 3:

A. Compound longitudinal ultrasonographic image of the right ilial body and hip joint in 10 years old donkey. TC; tuber coxae, IB; ilial body, HJ, hip joint, FH, femoral head, AC, acetabulum, GT, greater trochanter. LAT, lateral, MED, medial, CR, cranial, CD caudal
B. Transverse ultrasonographic image of the left greater trochanter (GT) of 10 years old donkey. The probe was positioned in a dorso-lateral (D-LAT) to Ventro-medial (V-MED) direction.
C. Transverse ultrasonographic image of left tuber ischii (TI) of 8 years old donkey. The probe was located caudo-ventral to TI and directed slightly craniodorsally. Tuber ischii
(TI) covered with two echogenic muscle layers constitute semimembranosus (SMM) and semitendinosus (STM) muscles. CD, caudal, CR, cranial, D, dorsal, V, ventral.

D. Longitudinal ultrasonographic image of tuber ischii (TI) of the same animal in figure 3C. MED, medial, LAT, lateral, CR, cranial, CD, caudal.

![Image: Longitudinal ultrasonographic image of tuber ischii (TI) of the same animal in figure 3C.](image)

**Fig. 4:**

A. Transverse ultrasonographic image of the third trochanter (3rd T) in 7 years old donkey. It attached medially to femoral shaft (F SH) and cranially to the tendon of insertion of superficial gluteal muscle (T SGM). MED, medial, LAT, lateral, CR, cranial, CD, caudal.

B. Longitudinal ultrasonographic image of third trochanter (3rd T) of the same animal in figure 4B.

The Pelvic symphysis was imaged during transrectal examination as a small echogenic area separating between two hyperechoic slightly concave lines constituting ischiatic table. It showed a great width at the most caudal portion of the pelvic floor (Fig. 5A) and completely disappeared at the anterior third (Fig.5B). During longitudinal scan, the ischiatic table appeared as smooth hyperechoic slightly concave arch (Fig. 5C). The obturator foramen appeared as an area of mixed echogenicity pounded caudally and cranially by two hyperechoic convex arches constitutes ischiatic and pubic rims respectively (Fig. 5D). The Obturator blood vessels could be easily identified as two anechoic circular structures with well-defined echogenic borders while, the obturator nerve appeared as echogenic structure located distal to the obturator blood vessels (Fig. 5D & 6A). The pubis and the pubic prim appeared as a smooth hyperechoic curvilinear structure with bony prominent at its cranial end (Fig. 5D). The Medial aspect of the acetabulum appeared as smooth convex hyperechoic arch continuous with medial aspect of ilial body. The ilial body appeared as smooth hyperechoic slightly irregular linear structure extended craniodorsally (Fig. 6B). The sacroiliac joint appeared as narrow anechoic band bounded ventrally and dorsally by
two hyperechoic slightly convex arches constitute the first sacral transverse process and the ilial wing respectively. The iliolumbar artery could be easily detected as hypoechoic circular structure at the lateral portion of the sacroiliac joint (Fig. 6C). The mean width of the sacroiliac joint in both horses and donkeys was listed in (Table, 3). The ventral aspect of the sacrum appeared as slightly convex hyperechoic arch interspersed with hypoechoic to echogenic half circle pit like depressions located at equal distances constitutes the ventral sacral foramina (Fig. 6D). Each foramen formed of central core of mixed echogenicity and bounded by a hyperechoic bony rim.

**Fig. 5**

A. Transvers ultrasonographic image of the caudal part of the pelvic floor in a 25 years old stallion showing pelvic symphysis (PS) which, appeared as small echogenic area separating between two hyperechoic lines constitutes ischiatic tables (IT). D, dorsal, V, ventral.

B. Transvers ultrasonographic image of the anterior third of the pelvic floor of the same animal in figure 5A. Note, the pelvic symphysis (PS) completely disappeared by fusion of both ischiatic tables (IT). D, dorsal, V, ventral.

C. Longitudinal ultrasonographic image of ischiatic table (IT) of the same animal in figure 5A. It appears as hyperechoic slightly convex arch extends cranially till obturator foramen (OF). D, dorsal, V, ventral.

D. Compound longitudinal ultrasonographic image of the same animal in in figure 5A showing; the obturator foramen (OF), pubis (P) and pubic prim (PP). the OF contains the obturator blood vessel (BL V) and nerve (N). D, dorsal, V, ventral.
Fig. 6:  
A. Transverse ultrasonographic image of the obturator foramen (OF) of the same animal in Figure. 5D, showing the contents of the obturator foramen including blood vessels (BL. V) and nerve (N)  
B. Compound Longitudinal ultrasonographic image of the medial aspect of the acetabulum (AC) and ilial body (IB) in a 9 years old donkey. MED, medial, LAT, lateral, CR, cranial, CA, caudal  
C. Ultrasonographic image of left sacroiliac joint (SIJ) in 8 years old donkey. It pounded ventrally by the transverse process of the first sacral vertebra (1st STP) and dorsally by ilial wing (IW). The iliolumbar artery (ILA) could be located at the ventrolateral portion of the SIJ. V, ventral, D, dorsal  
D. Longitudinal ultrasonographic image of the ventral aspect of the sacrum (VS) of 15 years old stallion. it contains hypoechoic to echogenic half circle pit like depressions constitutes the ventral sacral foramina (VSF). V, ventral, D, dorsal
Table 3: Showing The mean and standard error (SE) of the recorded pelvic measurements:

<table>
<thead>
<tr>
<th>Measured item</th>
<th>Horse Mean ± SE</th>
<th>Donkey Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>The distances between both tubera sacralia (cm)</td>
<td>2.96 ± 0.13 a</td>
<td>2.92 ± 0.07 a</td>
</tr>
<tr>
<td>The distance between tuber sacral and skin surface (cm)</td>
<td>1.04 ± 0.05 a</td>
<td>1.08 ± 0.05 a</td>
</tr>
<tr>
<td>The distance between tuber sacrale and first sacral spinous process (cm)</td>
<td>1.70 ± 0.1 a</td>
<td>1.76 ± 0.1 a</td>
</tr>
<tr>
<td>The thickness of dorsal portion of the dorsal sacroiliac ligament- thoracolumbar fascia combination (mm)</td>
<td>4.1 ± 0.2 a</td>
<td>4.05 ± 0.2 a</td>
</tr>
<tr>
<td>Cross sectional area of both the dorsal sacroiliac ligament- thoracolumbar fascia combination (cm²)</td>
<td>1.4 ± 0.07 a</td>
<td>1.4 ± 0.06 a</td>
</tr>
<tr>
<td>Thickness of the lateral portion of dorsal sacroiliac ligament (mm)</td>
<td>1.6 ± 0.09 a</td>
<td>1.7 ± 0.1 a</td>
</tr>
<tr>
<td>Width of the sacroiliac joint (mm)</td>
<td>4.2 ± 0.1 a</td>
<td>4.2 ± 0.1 a</td>
</tr>
</tbody>
</table>

Values with the same superscript litters have no significant difference, while values with different superscript litters have significant difference.

2. DISCUSSION
In equine, hind limb lameness caused by pelvic affections (bone fractures and/or ligament damage) is far more common than previously thought (Walker, et al 2012; Whitcomb, 2012). Ultrasound
was used for pelvic examination in recent years. It is accessible to most of equine practitioners. It is also, safer and can provide a rapid and accurate diagnosis (Whitcomb, 2012; Head, 2014). Several reports have paid attention to ultrasonographic evaluation of the pelvis in both clinically normal and affected horses and ponies (Tomlinson, et al, 2001; Kersten & Edinger, 2004; Engeli et al, 2006; Whitcomb, 2012; Walker, et al, 2012 and Head, 2014). According to our knowledge, this may be the first report concerned with ultrasonographic evaluation of the pelvis in clinically normal donkeys.

Efficient planning is very important to save time and effort during pelvic examination (Kofler, 2009; Walker et al., 2012; Head, 2014; and Whitcomb & Vaughan 2015). For complete evaluation of the pelvis, both transcutaneous and transrectal techniques should be performed. This can be achieved safely by efficient animal restraint (Walker et al, 2012). In this study, all animals were restrained in a stanchion under the effect of xylazine tranquilization and caudal posterior epidural analgesia using lidocaine HCL 2%. Caudal posterior epidural analgesia is very important for safe transrectal examination. It reduced animal straining as well as the chance of rectal tearing. From the technical and economical point of view, this technique was superior to previously mention by Walker et al., (2012), whom sprayed large amount (50 ml) of lidocaine intra-rectal to facilitate transrectal examination.

According to this study, a high similarity was found between horses’ and donkeys’ pelvises concerning ultrasonographic appearance of its structures. Our findings in that respect were found in accordance with previously published data (Tomlinson, et al, 2001; Pilsworth, 2003; Kersten & Edinger, 2004; Walker et al, 2012; Whitcomb, 2012; Head, 2014). The examined bone surfaces appeared hyperechoic linear, convex or concave structures with smooth or slightly irregular surfaces. In both horses and donkeys, tuber sacral, tuber coxae, and tuber ischii appeared as slightly convex hyperechoic arches (Pilsworth, 2003; Kersten & Edinger, 2004 and Whitcomb, 2012 Head, 2014). Tuber sacrale showed slight irregularity at its surface (Tomlinson, et al., 2001 and Engeli, et al, 2006). Such findings shouldn’t be misdiagnosed with pathological changes of tuber sacrale and requires careful monitoring and examination of the contralateral side to rule out these changes (Tomlinson et al, 2003).

In our study, we imaged the proximal part of first sacral spinous process as small hyperechoic area located med way between both tubera sacralia. The distance between each tuber sacrale and first sacral spinous process showed no significant difference between horses and donkeys and
between right and left sides. The Ilial wing and body appeared in both horses and donkeys as contentious hyperechoic concave arches. These results found in accordance with previous reports (Pilsworth, 2003; Head, 2014). In our study, we imaged a gap like fracture during ultrasonographic examination of ilial wing med-region. Such finding was excluded after dissection studies. This artifact may be a result of scattering of ultrasound beam at the surface of the accessory gluteal muscle tendon that, inserted at med-ilial wing. Such finding shouldn't be misdiagnosed with fracture. It can be overcome by careful evaluation and proper probe orientation during examination (Whitcomb, 2012).

Affections of pelvic ligaments and tendons constitute the most common back soft tissues affections in horse (Haussler, et al. 1999). Their evaluation in terms of echogenicity and measurements, should be performed carefully during pelvic examination. The thoracolumbar fascia showed two different configurations relative to the dorsal portion of the dorsal sacroiliac ligament. The predominate one of them was viewed in two thirds of the examined horses and all examined donkeys, in which the thoracolumbar fascia fused to the medial aspect of the dorsal portion of the dorsal sacroiliac ligament. The less frequently encountered configuration was viewed in one third of the examined horses. In which the thoracolumbar fascia fused dorsally to the dorsal portion of the dorsal sacroiliac ligament. These results found in accordance with previously published data by (Engeli et al, 2006). Due to difficulty in ultrasonographic differentiation between dorsal portion of the dorsal sacroiliac ligament and thoracolumbar fascia at the point of their fusion (most dorsal point of tuber sacrale), the thickness and cross-sectional area of the entire fused portion were evaluated and compared with the opposite side. According to this study, the thickness of the fused portion of the dorsal part of the dorsal sacroiliac ligament-thoracolumbar fascia combination showed no significant difference between both horses and donkeys while, the cross-sectional area of both structures showed significant difference between them. In our opinion, this variation in measurement between horses and donkeys may be attributed to the configuration by which the thoracolumbar fascia attached to the dorsal portion of the dorsal sacroiliac ligament (in horses two configurations were detected while in donkeys only one configuration was detected). Evaluation of lateral portion of the dorsal sacroiliac ligament at its attachment to the lateral sacral crest is very important because of its inflammation or rupture may cause acute hind limb lameness (Haussler, et al. 1999).
The deep location and excessive musculature surrounding the hip joint, make its localization and examination difficult. It can be easily located at the caudoventral end of the ilial body at the point of its surface divergence from concave to be convex. Our results concerning the appearance of the hip joint in both horses and donkeys in accordance with previously published data (Walker, et al., 2012; Whitcomb & Vaughan, 2015). Transcutaneous ultrasonographic evaluation of the hip joint may be limited to abnormalities involving cranial head of the femur and acetabulum. This may be attributed to the deep location of the femoral head within the acetabulum and the presence of the greater trochanter which prevent complete evaluation of the femoral head and caudal portion of the hip joint (Hogan et al, 1995; Dyson & Murray, 2003). For complete evaluation of the hip joint, transrectal examination of the obturator foramen and the medial aspect of the acetabulum are required especially when acetabular fracture and/or femoral head luxation are suspected (Brenner & Whitcomb, 2009). Although third trochanter is not a part of the bony pelvis, its evaluation is very important and constitute a part of pelvic evaluation. Because of its fracture or fragmentation constitute one of the main causes of sudden hind limb lameness (Whitcomb, 2012; Head, 2014; Shields et al, 2015).

For complete pelvic evaluation, beside transcutaneous examination a fully and sequential transrectal examination should be performed. Following the anatomical landmarks is important to locate different pelvic structures (Head, 2014). Whatever the age of the examined animal, pelvic symphysis could be easily identified at the posterior two thirds of the pelvic floor and completely disappeared at the anterior third (Walker, et al, 2012 and Whitcomb, 2012). Such findings shouldn't be misdiagnosed with ischiatic table gap fracture. From the obstetrical point of view, evaluation of the medial aspect of the ilial body and the sacrum are of clinical importance. Their fracture may collapse and distort the internal pelvic dimensions, which, may affect the animal reproductive performance and predispose to dystocia (Whitcomb, 2012; Gundelach et al., 2013).

Regardless of the difference in their body weight and size; horses and donkeys showed no significant difference in their pelvic measurements evaluated in this study, except for cross sectional area of both dorsal portion of the dorsal sacroiliac ligament- thoracolumbar fascia combination and the width of the sacroiliac joint. Careful evaluation of different pelvic measurements is very important to detect the cause of pelvic asymmetry. According to (Gillis, 1999), evaluation of tubera sacralia depth from skin surface is helpful in diagnose of sacroiliac
joint subluxation. While, Kersten & Edinger, (2004) disagreed with this opinion. They referred left to right asymmetry in that respect to soft tissue lesion only, and diagnosis of sacroiliac joint subluxation is not possible depending upon this measurement alone. They added that, diagnoses of sacroiliac joint subluxation by transcutaneous approach, requires measuring and comparing the distance from right and left tuber sacrale to the most dorsal part of first sacral spinous process although, in their study they couldn’t image it. In another study, the authors relied on the importance of measuring the distance between tubera sacralia and skin surface in evaluation of both soft and hard tissue related asymmetry (Engeli et al, 2006). In authors’ opinion, depending upon one measurement to detect the cause of right to left pelvic asymmetry may be not helpful. It requires careful evaluation and combining between more than one measurement. i.e. Transcutaneous approach for evaluation of sacroiliac joint abnormalities is not sufficient to give complete idea about joint status, due to its deep location and bony structures surrounding it (Tomlinson et al, 2001; Kersten & Edinger, 2004; Engeli & Haussler, 2012). For complete evaluation of sacroiliac joint, a combination between transcutaneous and transrectal examination is required. In transcutaneous examination, the depth of tuber sacralia from skin surface and the distance between each tuber sacrale and first sacral spinous process should be evaluated. While in transrectal examination, the width of the joint space should be evaluated. Presence of asymmetry in measurement between both sides may be attributed to luxation or subluxation of the sacroiliac joint.

Conclusion.

Ultrasonography is an efficient, safe and inexpensive readily available diagnostic tool for evaluation of bony and soft structures of the pelvis under field condition where other tools are not available. Donkey's pelvis has the same ultrasonographic appearance of the horse with no significance difference between them in their measurements, except for both cross sectional area of dorsal portion of the dorsal sacroiliac ligament – thoracolumbar fascia combination and the width of the sacroiliac joint. Concerning the ultrasonographic appearance of the pelvis, the obtained results are highly suggestive that, manuscripts concerned with ultrasonographic examination of the horse’s pelvis can be used as a guide for donkey’s pelvic evaluation.

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**REFERENCES**


DOI: 10.2746/042516406776866435


DOI: 10.2460/javma.243.2.261


DOI: 10.1111/j.1740-8261.2009. 01560.x


DOI: 10.2460/javma.2004.224.88


DOI: 10.2746/042516403776148219

DOI: 10.2746/042516403776148219

DOI: 10.1111/j.2042-3292.2011.00313.x

DOI: 10.1111/j.1740-8261.2006.00159.x

DOI: 10.1111/j.1740-8261.2001.tb00921.x

DOI: 10.1111/j.1740-8261.1998.tb01654.x


DOI:10.3390/ani3030951


DOI: 10.2746/0425164044864480

DOI: 10.1016/j.cvfa.2009.07.011


DOI: 10.1111/vru.12262.

DOI: 10.2460/ajvr.2001.62.1768

DOI: 10.2746/042516403775467540


