



Original Research

Renal Measures in Healthy Italian Trotter Foals and Correlation Between Renal and Biometric Measures: Preliminary Study



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ABSTRACT

The aim of this study was to evaluate ultrasonographic renal measures in healthy foals aged 1–6 weeks and to verify the correlation between biometric measures to ultrasonographic renal ones. A total of nine Italian trotter foals born in the same stud farm and underwent similar management conditions were enrolled. Inclusion criteria were normal gestation time, unassisted delivery, and normal physical examination at all evaluation times. Length and height of both kidneys were measured by ultrasound weekly from 1 to 6 weeks of life, along with the thoracic and the middle third of the metacarpal area circumferences. Data were expressed as mean and standard deviation, and distribution was evaluated. One-way analysis of variance (ANOVA) was applied to verify differences related to time. The Pearson correlation test was carried out to evaluate the linearity between time versus all the parameters measured. Student's *t* test was used to verify differences in ultrasound measures between right and left kidney at all recorded times. The Pearson test was applied to a mean-variance matrix to verify the correlation between each biometrical versus all renal measures. Significance level was set at $P < .05$. One-way ANOVA showed differences in biometric and renal measures related to time. Correlation test revealed a linear growth. Differences in ultrasound renal measures between right and left kidney were obtained. Correlation was found between biometrical parameters versus kidney measures. Renal measures and differences between left and right kidneys were in line with literature. Correlation test revealed a linear growth. Renal growth is correlated with age and biometric measures.

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Animal welfare/Ethical statement: The present in vivo experimental trial in a clinical setting was approved by the Institutional Animal Care and Use Committee of the University of Pisa (D.R. 23506/2015). The owner's written consent was obtained for all the foals included in this study.

Conflict of interest statement: The Authors' contribution to the manuscript is equally distributed and no conflict of interest exists.

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1. Introduction

Ultrasonography of the abdomen represents an important diagnostic tool in equine neonates, and it is performed routinely in many equine practices [1,2]. Due to the smaller size and the minimal adipose tissue, abdominal ultrasound is easier to perform in foals than in adult horses [3,4]. Ultrasonographic examinations have been employed for the diagnosis of urinary tract disorders in horses to evaluate size, shape, position, and echogenicity of the kidneys

[5]. Moreover, ultrasonography has been suggested for guiding percutaneous renal biopsy and represents the primary noninvasive diagnostic method for evaluating hematuria, renal failure, renal or perirenal masses, and pyelonephritis in the horse [6]. Normal renal parameters and ultrasonography techniques to detect kidneys are well documented in adult horses [7–12]. However, only few studies on the evaluation of ultrasonographic appearance and location of kidneys [1,13], as well as renal dimensions, are available in foals [3,4].

In particular, Hoffman et al [3] studied the correlation between the renal anatomic features performed on cadavers of foals and their sonographic appearance in images obtained using different planes. Aleman et al [4] reported the ultrasonographic characteristics, location, and variations of thoracic (TH) and abdominal organs, included kidneys, with relation to age and some biometrical measures. The authors provided a growth table for comparison with diseased foals.

The aims of the present study were (1) to evaluate ultrasonographic renal measures in healthy foals aged between 1 and 6 weeks and (2) to verify the correlation between some biometric measures to ultrasonographic renal ones.

2. Materials and Methods

2.1. Animals and Inclusion Criteria

The present observational study was approved by the Institutional Animal Care and Use Committee of the University of Pisa (D.R. 23506/2015). The owner's written consent was obtained for all the foals included in this study.

A total of nine Italian trotter foals were enrolled in the study. All the animals were born in the same stud farm and underwent similar management conditions. Five out of nine were fillies and four out of nine colts. The following inclusion criteria were set: (1) mares' physiological gestation time (>320 days) [14]; (2) controlled delivery by an operator plus no need of aids during birth; (3) normal clinical examination at all times of ultrasound evaluation (hear rate, respiratory rate, body temperature within physiological ranges, moisty mucous membrane and capillary refill time ≤ 2 seconds, no alterations of mental status, absence of particular behaviors, physiological defecation, urination and milk ingestion, no abnormalities at lymph node palpation) [15].

2.2. Animals Handling and Timing

All the foals were submitted to kidney ultrasound and biometric evaluations starting from day 7 (T7) and every 7 days (T14, T21, T28, T35), till 6 weeks (T42) of life. All the procedures were supported by three operators: one operator held the mare, one operator manually restrained the foal, and a third operator performed the biometric measurements and the ultrasound examination. All the procedures were performed in the same handling box, and no pharmacologic support was used. During the procedures, foals were always in the visual field of mares.

2.3. Biometric Measures

The biometric measures, obtained in the standing foal, were as follows: (1) TH circumference measured from the end of the withers around the thorax immediately caudal to the axillary region; (2) metacarpal area (MA) circumference measured at the middle third level. All measures were carried out using a flexible measuring tape for livestock and recorded in cm. Each measure was performed three times for reproducibility, and the average was used for statistical analysis. Biometric evaluations were always carried out before the ultrasonographic evaluation.

2.4. Kidney Ultrasound

Alcohol and ultrasound gel were applied to the unclipped hair coat to provide appropriate contact. The ultrasound examination was performed with each foal standing to avoid any change in position or overlapping from other organs, as proposed by others [3,4]. One of the authors performed all the ultrasound examinations using the scanning windows reported in the literature [3,4] and a portable ultrasound system (Mylab30, Esaote, Florence, Italy) equipped with a multifrequency convex probe (5–7.5 MHz). The ultrasound settings were changed as needed to optimize image quality.

The following measures were obtained: renal length (RL) defined as the longest cranio-caudal axis of the kidney (Fig. 1); renal height (RH) defined as the longest dorso-ventral axis of the kidney. Both measures were obtained using the sagittal plane until the image size was maximal and the renal pelvis could be seen clearly.

All the images were recorded as cineloops of 10 seconds each by the ultrasound machine software. Renal dimensions were measured on a still image by the same observer using electronic calipers associated with the ultrasound software (Mylab software, Esaote, Florence, Italy). Each measurement was performed three times for reproducibility, and the average was used for statistical analysis.



Fig. 1. Sagittal image of the left kidney (7-day-old filly foal). Scale (cm) on the right side and a gray scale bar located on the left side of the image. For details of probe placement see text. D1: renal length; D2: renal height. Cr, cranial; V, ventral.

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