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Review Articles

THE USAGE OF PELVIMETRY TO PREDICT DYSTOCIA IN CATTLE

M.W.H. Hiew[1*] and P.D. Constable[2]

[1]*Faculty of Veterinary Medicine, Universiti Putra Malaysia, Serdang, Selangor, Malaysia*
[2] *College of Veterinary Medicine, University of Illinois at Urbana-Champaign, Illinois, USA*

SUMMARY

Pelvimetry is the measurement of the dimensions of the pelvis, measured internally or externally, and is typically conducted with the aid of a pelvimeter. Intrapelvic dimensions, namely the intrapelvic height and width, are used to calculate pelvic area which has a moderate to high degree of heritability. Pelvic area measurements are associated with calving difficulty and have been used by producers to select for heifers to be included in their breeding herd.

Keywords: Pelvimetry, Dystocia, Calving difficulty

INTRODUCTION

Pelvimetry is the "measurement of the capacity and diameter of the pelvis, either internally or externally or both, with hands or with a pelvimeter" (Blood *et al.,* 2007). In cattle, internal pelvimetry has been used to determine pelvic area and its association with calving difficulty (Rice and Wiltbank, 1972; Deutscher, 1991; Van Donkersgoed *et al.,* 1993; Coopman *et al.,* 2003).

Pelvimetry measurements are comprised of external and internal pelvimetry. External pelvimetry is done to correlate pelvic dimensions with measurements taken outside of the animal such as the distance between the two tuber ischii (pin width), the two tuber coxae (hip or hook width), the anterior surface of the ilial wing and the posterior surface of the ischium (rump length), ilial wing to hip joint, and iliac crest to ischial tuberosity (hook to pin length) (Craig, 1912; Bellows *et al*., 1971; Johnson *et al.,* 1988; Coopman *et al*., 2003). These distances were initially measured using straight pieces of wood and tape measure (Craig, 1912) and later on with sliding calipers (Bellows *et al*., 1971).

Pelvic area is commonly calculated by multiplying the pelvic height with the width which results in a rectangular area (Wiltbank and LeFever, 1961; Bellows *et al.,* 1971; Bellows *et al*., 1971; Rice and Wiltbank, 1972; Laster, 1974; Morrison *et al.,* 1986; Green *et al.,* 1988; Johnson *et al*., 1988; Kolkman *et al.,* 2009). Observations of the actual pelvic opening show that the opening resembles an ellipse more than a rectangle, and has been calculated as such whereby:

$$\text{Ellipsoidal area} = (\text{Width} + \text{Height})/2 \times \pi$$

(Ben David, 1960; Rice and Wiltbank, 1972; Morrison *et al.,* 1986).

When comparing these two methods to calculate pelvic area, the ellipsoidal equation provided an accurate representation of the actual pelvic opening area but had no advantage over the rectangular equation in predicting dystocia and was not different in ranking pelvic size (Rice and Wiltbank, 1972). The ellipsoidal equation also did not affect variance components but simply multiplied the area obtained from the rectangular equation by a constant of $\pi/4$ which made the average ellipsoidal area lesser by about 21% (Morrison *et al.,* 1986).

There has been mixed responses on the value of external pelvimetry as a predictor for internal pelvic dimensions with one group noting significant correlations ($P<0.001$) between the two (Murray *et al.,* 2002) while another found that withers height and heart girth were better predictors of internal pelvic dimensions than external pelvic dimensions (Kolkman *et al.,* 2012). In a seminal publication from 1875, internal pelvic height was reported to be 0.18 times the height of the animal at the withers and the pelvic width was 0.36 the distance of the external ilial angles (Saint-Cyr, 1875). This should be compared to a an equation developed in by Murray (2002) that fitted data to measured values:

$$\text{Pelvic area} = -122.2 + 23.2 \times (\text{Hook width}) + 24.3\ (\text{Hook to pin length}) - 0.3 \times \text{Hook width} \times \text{Hook to pin length}$$

Internal pelvic dimensions consist of the pelvic height which was measured on the midline between the pubic symphysis and midsacrum, and pelvic width which was measured at the widest point between the shafts of the ilia (Rice and Wiltbank, 1972)(Figure 1).

Heritability of intrapelvic dimensions

Pelvic area has moderate to high heritability, ranging from 0.36 to 0.61, which suggests that it responds to selection (Benyshek and Little, 1982; Morrison *et al.,* 1986; Nelsen *et al.,* 1986; Green *et al*., 1988).

**Corresponding author: Dr Mark Hiew Wen Han (M.W.H. Hiew); Phone No. : +603 8609 3933; Fax No.: +603 8609 1971; Email: mark@upm.edu.my*

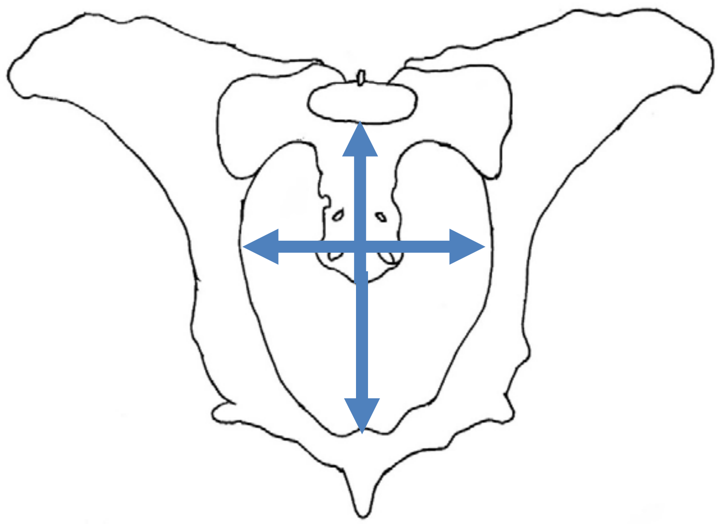

Figure 1. Measurements of intrapelvic height (midline between the pubic symphysis and midsacrum) and width (widest point between the shafts of ilia)

Both pelvic height and width have moderate to high heritability estimates with pelvic width having higher heritability values in most studies due to its more easily obtained measurements which leads to a higher repeatability (Benyshek and Little, 1982; Morrison *et al.,* 1986; Green *et al.*, 1988). A useful correlation to examine would be the association between pelvic areas of bulls and the expected progeny differences (EPD) for daughters' calving ease which might give an indication if pelvic area measurements would be a good selection criteria for bulls (Van Donkersgoed, 1992).

Pelvimetry and dystocia

Pelvic area has been seen as a reliable measurement influencing calving difficulty, as larger pelvic areas are associated with reduced calving difficulty (Bellows *et al.* 1971; Murray *et al.*, 1999) and is used to identify potential problem heifers with small pelvic sizes (Deutscher, 1991; Micke *et al*., 2010) that may be at risk for dystocia at calving. In heifers, pelvic measurements are taken at the time of breeding or when pregnancy diagnoses are done, while in multiparous cows they are taken during pregnancy examinations (Ko and Ruble, 1990). The average pelvic area grows at a rate of 0.27 cm^2 per day from yearling to 2 years of age and this fixed linear correction factor can be used to adjust the pelvic area of heifers to the standard 365 days of age (Smith, 2005), whereby:

365 day pelvic area =
Actual pelvic area (cm^2) + [0.27 x (365 – age in days)]

Many producers cull cattle with the lowest 10 to 15 % pelvic area as it is deemed that heifers with small pelvic areas as yearlings usually have smallest pelvic areas at calving (Deutscher, 1991). However, studies have shown that morphometic growth rates in cattle follow a curvilinear or logarithmic rather than a linear pattern, that extends past 24 months (Ragsdale, 1934; Guilbert and Gregory, 1952) and up to 6 years of age (Green *et al*., 1988; West, 1997), which makes it difficult to accurately predict the occurrence of dystocia when measurements are obtained as yearlings. Dystocia in 2 year old animals does not mean an unfavorable prognosis for calving ease in future births as pelvic dimensions change and the pelvic canal widens as they grow older (De Bruin, 1901). It has also been reported that high variations in pelvic growth rate and the correlation of the pelvic area at any time before parturition to that at parturition is low. Even measurements obtained a month prior to calving only had moderate correlation with the pelvic area at calving (Gaines, 1994). There is also a rapid increase in pelvic area just prior to calving due to dilation caused by hormonal changes such as estrogen and relaxin (Bagna *et al.,* 1991). Therefore, the clinical utility of using intrapelvic dimensions to predict dystocia is controversial as some studies deem it useful as a predictor (Deutscher, 1978; Johnson *et al*., 1988) while others find that it is not (Basarab *et al*., 1993, Van Donkersgoed *et al*., 1993).

A few alternative techniques of pelvimetry calculation have been proposed which include the measurements of ratio for Pelvic area:calf birth weight and Pelvic area:heifer body weight (Deutscher 1991, Basarab *et al.*, 1993). Also, a recent study ranked heifers based on their body weight adjusted pelvic area or lean body weight adjusted pelvic area using a regression coefficient (Holm *et al*., 2014). Additionally, there is also an equation to predict calving difficulty score using fetal hoof circumference at the coronary band, measured during Stage II of parturition, and pelvic dimensions (Ko and Ruble, 1990), whereby:

Predicted calving difficulty score =
[(Hoof circumference – Pelvic Height +3.5) +
(Hoof circumference – Pelvic Width + 3.5)] ÷ 2.

The scores were then interpreted as follows:
0.00 to 4.00 = will calve unassisted
4.01 to 5.50 = will require manual assistance
5.51 to 6.50 = will require mechanical assistance (call puller)
≥ 6.51 = will require cesarean section.

These techniques however had poor positive predictive values and sensitivities (Van Donkersgoed *et al.,* 1993) and were not useful diagnostic tools to predict dystocia (Basarab *et al.,* 1993).

Pelvimeter

Internal pelvic dimensions were first estimated with fingers via rectal or vaginal examination (Saint-Cyr, 1875; De Bruin, 1901) by spanning the thumb to the other fingers with the distance between these previously measured.

In the early 1960s, the use of instruments to measure internal pelvimetry was reported. Studies that showcased a self-designed hemostat-like compass that had two 26 cm length arms and a 15 cm graduated metal arc at the end (Ben David, 1960), and a pair of sliding calipers to measure pelvic area through the rectum (Wiltbank and LeFever, 1961) were undertaken. Another self-designed compass was also reported (Menissier *et al*., 1971) and this instrument differed from the compass by Ben David as it had one fixed and one movable arm.

In more recent times, the Rice pelvimeter (Lane Manufacturing, Denver, CO) (Figure 2), Krautmann-Litton bovine pelvic meter pelvimeter (Jorgensen Laboratories, Inc., Loveland, CO), and the Equibov pelvic clearance micrometer (Equibov, Ontario, Canada) have been more commonly used. These instruments are designed to be placed in the rectum of the cattle and measurements are read on a scale that is located outside of the animal (Deutscher, 1991).

The Rice pelvimeter is made up of stainless steel tubing and molding epoxy. It works as a simple caliper that is placed per rectum with a calibrated scale on the other end in 0.25 cm graduations (Rice and Wiltbank, 1972) and has readings from 3 to 20 cm. Although it is relatively straightforward to use with relatively moderate repeatability (Paputungan *et al*., 1993, Kolkman *et al.,* 2007), it requires regular calibration as it can be bent or sprung which results in inaccurate readings (Gaines, 1994). The Krautmann-Litton pelvimeter is comprised of a recorder and a receiver hydraulic chamber that each has a piston and cylinder. These chambers are connected by a flexible cable and movements of one piston results in the movement of the other. The recorder has a measurement indicator, on a 0.25 cm graduated scale from 10.5 to 18.5 cm, which gives readings that are directly proportional to the receiver's piston extension (Krautmann, 1975). This pelvimeter however can leak fluid which affects its readings (Gaines, 1994) and when compared to the Rice pelvimeter, it had lower within operator repeatability (Van Donkersgoed *et al.,* 1993). The Equibov pelvic clearance micrometer is an electronic pelvimeter which uses a piston-like sensor expanded by air compressed by an air pressure bulb (Wolverton *et al*., 1991) that exerts a constant force at any extension and is touted to give more repeatable results (Equibov N.D.). Once the two measurements are obtained, the unit automatically calculates the pelvic area and shows the reading on the digital display. This digital recorder measures to the nearest 0.1 cm with a range from 10.5 to 18.0 cm (Wolverton *et al*., 1991). Besides being small and light, it does not use hydraulic fluid, therefore eliminating leakage and entrapment of air. However, the cost of this unit is much higher compared to the two former pelvimeters mentioned. Currently, the Rice pelvimeteris preferred due to its ease of use, good repeatability, ability to read to at least 20 cm, and low cost compared to the other pelvimeters.

Figure 2. Rice pelvimeter

Welfare

The issue of animal welfare when internal pelvimetry is conducted has been brought up due to it being an invasive procedure that has a risk of damaging rectal mucosa (Murray *et al*., 2002). Additionally, the usage of epidural anesthesia to reduce arched backs and straining when measurements are taken requires special training whereas external pelvimetry needs neither specialized equipment nor training. In the author's opinion, there is an inherent risk for injury but internal pelvimetry done properly, gently, and with adequate lubrication can prevent damage to the rectal mucosa.

CONCLUSION

In Malaysia, there is limited usage of pelvimetry to predict calving difficulty especially in local breeds. As such, the opportunity for studies to evaluate the clinical utility of the pelvimeter to predict dystocia is high.

CONFLICT OF INTEREST

None of the authors of this paper has any financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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