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Evaluation of the Rice pelvimeter for measuring pelvic area in double muscled Belgian Blue cows

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ABSTRACT

The accuracy of the Rice pelvimeter for measuring pelvic area of double muscled Belgian Blue (BB) cattle was investigated by comparing measurements in the live animal with these obtained from the same animal after slaughter. Pelvic measurements from 466 BB-cows aged 2–10 years old and of an excellent carcass qualification (S and E in the SEUROP classification) were measured with the pelvimeter approximately 12 h prior to, and by graded ruler within 2 h after, slaughter. The mean difference of measurements between living and dead cattle were −0.2 cm for pelvic width (95% limits of agreement −2.5–2.1 cm), and 1.2 cm for pelvic height (95% limits of agreement −1.8–4.1 cm). The correlation coefficient between all pelvic measurements was between 0.46 and 0.59 ($p<0.001$). The age of the animals influenced only pelvic height whilst carcass weight influenced all the components of the pelvic area. There was a significant correlation between the pelvimetric measurements of the birth canal in living cattle obtained using a Rice pelvimeter compared to actual measurements obtained from the carcass. The Rice pelvimeter is a suitable tool for assessing accurate pelvic skeletal conformation and to select animals in this breed with a larger birth canal and hence less dystocia problems.

1. Introduction

After many years of selection for the double muscled characteristic, the Belgian Blue (BB) breed is well known for its high killing out percentage, carcass conformation and good eating quality. Consequently, the Belgian Blue bull is used widely as a terminal sire in both beef and dairy herds (Lips et al., 2001). This selection for the double muscled conformation has created incompatibility between the extreme fetal muscle development and growth and the pelvic canal of the dam. As a result, there is a high incidence of dystocia and surgical management of parturition in the pure breed (Kolkman et al., 2007). Such elective caesarean sections (CS) pose serious ethical questions which limits the use of this exceptional breed for beef production to a large extent.

Dystocia is an important factor associated with stillbirths, particularly in the beef herd. The disparity between fetal oversize and the dimensions of the birth canal is an important common cause of dystocia (Rice and Wiltbank, 1972). Johnson et al. (1988) showed that calf birth weight and maternal pelvic area accounted for most of the variation in calving difficulty. To increase the pelvic area without decreasing the conformation and the size of these cows, selection in the dam directly for increased pelvic area should be considered.

Pelvimetry may offer an accurate method for measuring pelvic conformation and hence the pelvic area, to determine whether the calf can be delivered naturally *per vagina* (Rice and Wiltbank, 1970; Laster, 1974; Morrison et al., 1986; Johnson et al., 1988; Naazie et al., 1989; Basarab et al., 1993; Glaze et al., 1994; Murray et al., 1999, 2002). The practical

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Table 1
SEUROP carcass classification according to the European Community 2003-10-03/37

Conformation characteristics	Grade	Sub-grade	Fatness characteristics	Grade
Extreme muscularity	S	+ = −	Extreme fat	5
Excellent muscularity	E	+ = −	Fat	4
Very good muscularity	U	+ = −	Moderate fat	3
Good muscularity	R	+ = −	Light fat	2
Moderate muscularity	O	+ = −	Low fat	1
Poor muscularity	P	+ = −		

application of pelvimetry for identifying heifers with an increased risk of dystocia is controversial. Deutscher (1978, 1988, 1989) used the pelvimeter to select heifers with a lower risk for dystocia prior to the breeding season. Similarly, Johnson et al. (1988) correctly predicted dystocia rate in 67% of Hereford heifers. In contrast, Basarab et al. (1993) considered that knowing pelvic area was not a useful tool to predict dystocia because 86% of supposedly difficult calvers subsequently calved easily and Van Donkersgoed et al. (1990, 1993) were of a similar opinion.

In the BB-breed, the size of the birth canal has also been identified as a limiting factor in calving ease. In order to select the maternal trait of larger pelvic area and to reduce dystocia in practice, we should be able to measure it on live animals. This is done by measuring animals with a Rice pelvimeter. Murray et al. (1999, 2002) performed pelvimetry in adult BB-cows in Belgium and the UK, but no observations were made on the suitability of measuring pelvic area to predict and reduce dystocia rates in calving heifers. It has never been questioned whether the Rice pelvimeter can be used to measure accurately the pelvic area of BB-cows. The pelvis of these animals has a somewhat different shape in comparison with other beef breeds, associated with a decrease in overall body size, including pelvic height, through years of selection for hypermuscularity. (Kieffer, 1972; Hanset, 1998; Coopman et al., 2003). If measurements with the Rice pelvimeter are accurate, they may be used to measure growth of the pelvic area in young animals relative to time. Furthermore, some factors which influence pelvic development in juvenile cattle could be investigated, in order to advise farmers to modify their heifer rearing programs and reduce dystocia in calving heifers.

The aim of the present study was to determine whether the Rice pelvimeter could be used to predict accurately pelvic dimensions in BB-cows by comparing values obtained by the Rice pelvimeter with those taken from the same cattle in the abattoir.

2. Materials and methods

2.1. Animals and accommodation

Data were collected during 2005 and 2006 at an abattoir in Flanders from female BB-cattle. All carcasses were weighed and classified by an authorized inspector. Within the SEUROP carcass classification system of the European Community (Anon, 2003; Table 1) BB-cattle fall into the S category with only some cattle having an E classification. Officially this system scores six conformation grades further divided in sub-grades, reflecting small distinctions in muscularity within the respective grade. Besides conformation grades, all animals were also assessed for fatness (Table 1). At weekly visits to the abattoir, an ante-mortem examination was carried out within 12 h prior to slaughter and pelvic height and width measured using a Rice pelvimeter. The carcass pelvic measurements were obtained in the refrigerator within 2 h of slaughter and the cold carcass weight (CW), its carcass classification (CC), and the birth date of the animals were recorded.

2.2. Measurements

A Rice pelvimeter (Lane Manufactering, 2075 So. Balentia St., Unit C, Denver, Colorado, USA) with an accuracy of 0.25 cm was used to measure internal pelvic height and width in live cattle. The choice of the Rice pelvimeter was based on its good accuracy in other breeds, low price and easy application. Before the measurements, low epidural analgesia was administered using 2 ml of 4% procaine hydrochloride (Eurovet®, Belgium); there is nil meat withholding time for this drug. As a result, the Pelvimeter measurements could be obtained in cattle adapting a normal stance during rectal

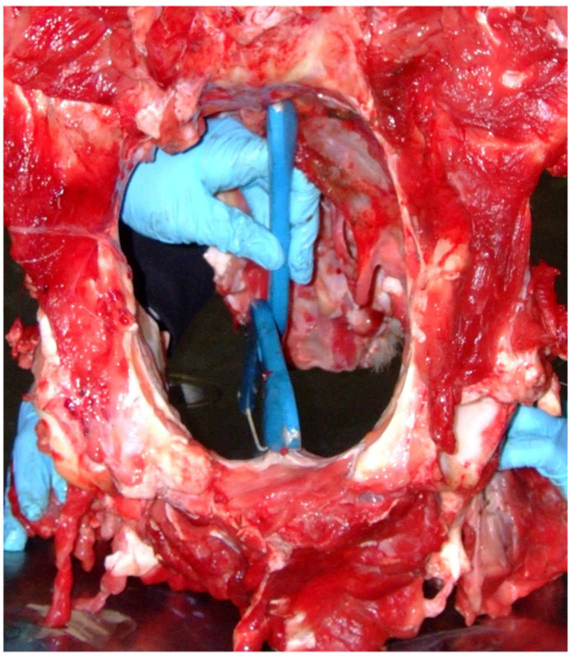

Fig. 1. Position of the Rice pelvimeter in the pelvic entrance for measuring pelvic height.

manipulation. The closed pelvimeter was slowly introduced into an empty rectum and the pelvic height (PH) measured by opening the device within the pelvic canal between the pubic *symphysis* and the sacral vertebrae (Fig. 1). The pelvic width (PW) defined as the horizontal distance between the shafts of the *ilium* at the widest point was measured similarly; the ends of the pelvimeter were placed on the *tubercula psoadica* of the *ilium* in the pelvic entrance (Fig. 2). Both pelvic width and height were measured three times consecutively by the same technician and the resulting mean value was used for further analyses.

After slaughter, the pelvic height and width were measured directly on the carcass by means of a graduated ruler. The perpendicular distance between pubic *symphysis* and the ventral part of the *sacrum* for pelvic height were obtained from both carcass halves and the mean was used for further analyses. The pelvic width was estimated by adding the distance of the *tubercula psoadica* of the *ilium* to the middle of the carcass of both halves of the carcasses. The pelvic area (PA) was then calculated by multiplying pelvic height and width. All measurements were obtained by the same researcher.

2.3. Statistical analyses

Using SPSS 14.0 for Windows, the dataset was tested for normality using the Kolmogorov–Smirnoff test and by controlling the *Q*–*Q* plots. For data distributed normally, a paired *t*-test examined differences between the pelvimetric and carcass measurements. Assessment of agreement between the two methods was obtained (Bland and Altman, 1986, 1999), using a simple plot of the difference between the ante- and post-mortem measurements against the calculated mean of carcass and pelvimetric measurements together. As the differences were normally distributed, the 95% limits of agreement were calculated as the mean difference ± 1.96 SD. To check whether a lack of agreement was associated with poor repeatability of the measuring techniques used, a one-way ANOVA was used to estimate the within-subject variance and through this compare the standard deviations (within-subject standard deviation = $(\text{variance})^{1/2}$) of the two different methods (carcass and pelvimetric measurements) to see which is more repeatable. We used the within-subject standard deviation instead of other approaches (e.g. variation coefficient) to test the repeatability because of the possibility to compare with the limits of agreement. The *repeatability coefficient* was calculated from the expression: $1.96\sqrt{2}\ s_w$ where s_w = standard deviation within (Bland and Altman, 1999).

Correlations between the pelvimetric and carcass measurements were investigated using the Pearsons correlation coefficient on the complete dataset and on subsets describing the different conformation and fatness grades. No correlation coefficient was assessed for fatness grade 1 as there were too few animals in this category. A general linear model was used to assess whether factors such as age, carcass weight, conformation and fatness were associated significantly with the difference between the carcass and the pelvimetric measurements. Every single factor was analysed in a univariable model and factors with a probability smaller than 0.20 were used in a backward analysis conducting a multivariable model $Y=\beta_0+\beta_1x+\ldots+\beta_kx+\varepsilon$ (*Y*: dependant variable; β_0: *y*-intercept of regression line; $\beta_1, \ldots,\beta_k$:" regression coefficients; ε: unexplained, random error).

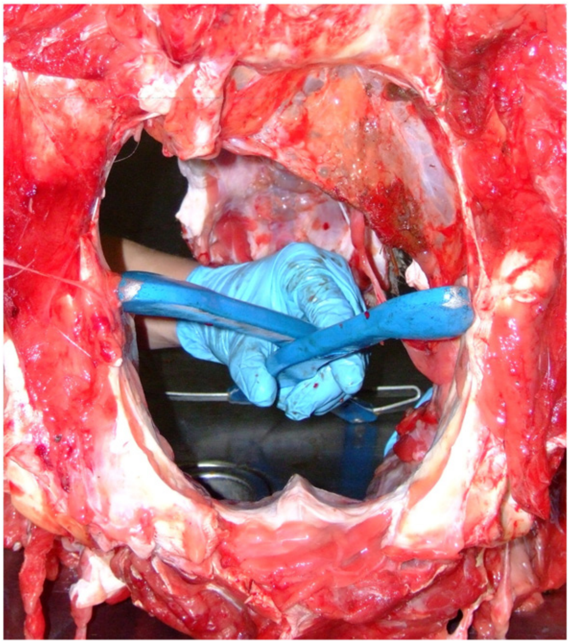

Fig. 2. Position of the Rice pelvimeter in the pelvic entrance for measuring pelvic width.

3. Results

3.1. Descriptive statistics

During the two years 466 BB-cows aged 2–10 years old were measured, 244 of which growing (2–5 years old) and 222 were mature cows (6–10 years old). Of these, 401 (86%) had an S classification whilst 65 animals (14%) had an E classification. Within the S category, 275 (69%) of the animals belonged to '+', 65 animals (16%) to '=' and 61 (15%) animals to the subdivision '−'. Fifty-five animals (85%) of the 65 E classified cattle were categorized in the subdivision '+', while 6 animals (9%) belonged to the subdivision '=' and 4 (6%) to the subdivision '−'. Within the classification based on the degree of fatness, 2 animals (S and E category) belonged to the low fat category (1), 455 to the light fat category (2), and 11 to the moderate fat category (3).

The pelvimetric measurements of growing animals showed a mean pelvic width, pelvic height and pelvic area of 15.8 ± 1.2 cm, 19.3 ± 1.2 cm and 306.0 ± 36.2 cm^2 respectively. Adult cows measured a pelvic width of 16.6 ± 1.2 cm, a pelvic height of 19.5 ± 1.4 cm and a pelvic area of 326.2 ± 40.8 cm^2. When comparing these data with the measurements obtained from the carcasses, significant differences for all three pelvic dimensions were noted, for growing cattle: PW = 15.6 ± 1.2 cm, PH = 20.0 ± 1.5 cm and PA = 312.7 ± 38.1 cm^2; for mature cows: PW = 16.4 ± 1.1 cm, PH = 21.1 ± 1.3 cm and PA = 346.7 ± 35.4 cm^2 ($p<0.01$). The mean and the standard deviation of all measurements related to age at slaughter are

Table 2
The mean ± SD of pelvic width (PW), pelvic height (PH) and pelvic area (PA) measured by Rice pelvimeter and after slaughter (carcass measurements) related to age at slaughter (years) and carcass weight (CW; kg)

		Method of measurement						
		Pelvimetric			Carcass			
Age	*n*	PW	PH	PA	PW	PH	PA	CW
2	5	15.1 ± 1.98	18.7 ± 1.57	283.6 ± 56.60	15.3 ± 2.34	19.2 ± 1.98	295.9 ± 70.46	452.5 ± 79.75
3	40	14.9 ± 1.04	18.6 ± 1.42	278.5 ± 36.65	14.8 ± 0.96	18.5 ± 1.36	273.3 ± 30.03	438.3 ± 42.42
4	90	15.6 ± 1.05*	19.2 ± 1.18*	300.8 ± 31.87*	15.4 ± 1.01	20.0 ± 1.22	308.6 ± 31.42	470.6 ± 36.44
5	109	16.4 ± 1.11*	19.6 ± 1.01*	321.3 ± 31.67*	16.1 ± 1.01	20.6 ± 1.37	331.4 ± 31.54	493.9 ± 49.50
6	100	16.6 ± 1.22	19.4 ± 1.45*	321.9 ± 42.23*	16.4 ± 1.05	20.8 ± 1.24	340.7 ± 33.62	510.5 ± 45.36
7	67	16.5 ± 1.12	19.6 ± 1.37*	324.9 ± 38.56*	16.4 ± 1.07	21.2 ± 1.40	348.6 ± 35.19	518.0 ± 51.83
8	31	16.5 ± 1.29	19.6 ± 1.21*	324.8 ± 39.01*	16.2 ± 0.98	21.4 ± 1.33	347.3 ± 34.81	505.7 ± 42.69
9	17	17.2 ± 1.16	19.8 ± 1.04*	340.9 ± 34.90	16.5 ± 1.01	21.6 ± 1.35	356.3 ± 34.59	507.5 ± 48.70
10	7	18.1 ± 1.20	20.4 ± 1.31*	369.3 ± 40.06	17.6 ± 1.47	22.0 ± 1.21	387.6 ± 42.27	530.4 ± 60.71

*Significant difference between pelvimetric and carcass measurement ($p < 0.05$).

shown in Table 2. In general, measuring pelvic width by pelvimetry resulted in higher numbers compared to the carcass measurement, while the pelvimetric pelvic height tended to be smaller compared to these obtained from the carcass. The older the animal, the larger the difference between ante- and post-mortem measurements; that for pelvic height (0.8–1.8 cm) was larger than for pelvic width (0.1–0.8 cm).

Results similar to the complete dataset for pelvic width and height were obtained after separating the two conformation grades (S and E) (Table 3). Within the fatness categories significant differences between the pelvimetric and carcass measurements were seen but only in cattle graded in the light fatness category, resulting in bigger pelvic width and smaller pelvic height measured with the Rice pelvimeter compared to the carcass measurements (Table 3; $p < 0.001$). From the numeric values in this table there was no difference in discrepancy between the pelvimetric and the carcass measurements among the conformation grades E and S. The leaner the carcass, the bigger the discrepancy between the two methods of measurement.

3.2. Limits of agreement

The difference between the pelvimetric and carcass measurements for pelvic width (Fig. 3) was −0.2 cm (95% limits of agreement are −2.5 cm and 2.1 cm). Similarly, for pelvic height the difference was 1.2 cm (95% limits of agreement between −1.8 cm and 4.1 cm (Fig. 4).

The measurement of pelvic height on the carcass had a within-subject variance of 0.303 and a *repeatability coefficient* of 1.5 cm. For the pelvimetric pelvic height, the within-subject variance was 0.173 with a *repeatability coefficient* of 1.2 cm. A comparison of the *repeatability coefficient* of pelvic height measured on the carcass with the limits of agreement, shows that the limits of agreement (−1.8–4.1 cm) for pelvic height are considerably wider than the *repeatability coefficient* for the carcass measurements. Since, the pelvimetric pelvic height *repeatability coefficient* falls within the limits of agreement, these results show that the repeatability of both methods was good.

3.3. Correlations and general linear models

The Pearsons correlation coefficient between pelvimetric and carcass measurements on the whole dataset was moderate albeit significant (PW: $r = 0.56$; $p < 0.001$; PH: $r = 0.46$; $p < 0.001$, PA: $r = 0.59$; $p < 0.001$).

In the whole dataset, age was moderately correlated with the pelvimetric pelvic width ($r = 0.41$; $p < 0.001$) and poorly with pelvic height ($r = 0.20$; $p < 0.001$) and correlated moderately with the carcass measurements (PW: $r = 0.41$; PH: $r = 0.47$; $p < 0.001$). Regarding carcass weight, the correlations with the pelvimetric and carcass measurements were moderate, albeit significant (Pelvimetric PW: $r = 0.39$; Pelvimetric PH: $r = 0.28$; Carcass PW: $r = 0.49$; Carcass PH: $r = 0.47$; $p < 0.001$). Table 4 investigated correlations between the two methods related to age; growing cattle had better correlations between pelvimetric and carcass measurements than mature

Table 3
The mean ± SD for pelvimetric and carcass pelvic width (PW) and pelvic height (PH) related to conformation and fatness grades

				Method of measurement		Significance
Independent variable	Grade	*n*	Measurement	Pelvimetric	Carcass	
Conformation	E	65	PW	16.0 ± 1.20	15.8 ± 1.03	n.s.
			PH	19.2 ± 1.31	20.2 ± 1.60	0.001
	S	401	PW	16.3 ± 1.30	16.0 ± 1.21	0.001
			PH	19.4 ± 1.28	20.6 ± 1.51	0.001
Fatness	1	2	PW	16.3 ± 1.06	16.5 ± 0.21	n.s.
			PH	19.5 ± 2.12	21.4 ± 2.97	n.s.
	2	453	PW	16.2 ± 1.30	16.0 ± 1.19	0.001
			PH	19.4 ± 1.30	20.5 ± 1.53	0.001
	3	11	PW	16.3 ± 1.01	16.2 ± 1.16	n.s.
			PH	19.7 ± 0.82	20.2 ± 1.45	n.s.

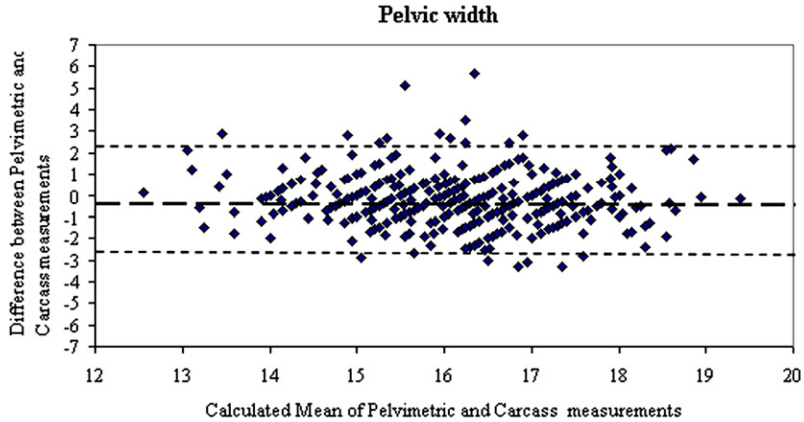

Fig. 3. Limits of agreement between the mean difference for pelvimetric and carcass measurements for pelvic width, and 95% limits of agreement.

cattle, suggesting an influence of age on the discrepancy between the two methods.

After subdividing the dataset in conformation and its subgrades (Table 5), Pearsons correlation showed that the highest correlation coefficient was in animals of extreme conformation (S = category) for pelvic width and in animals of the excellent conformation (E = category) for pelvic height. Cattle in the moderate fatness category show higher correlation coefficients for pelvic width and height compared to cattle in the light fatness category and compared to the total dataset.

The influence of the variable factors age, carcass weight, conformation and fatness grades on the discrepancy between carcass and pelvimetric measurements were assessed in a general linear model. Only the carcass weight had a significant influence on pelvic width differences, whereas age and carcass weight both had a significant influence on the pelvic height and area differences, resulting in the models listed in Table 6.

4. Discussion

In the present study we assessed the efficacy of the Rice pelvimeter for the measurement of several pelvic dimensions in live double muscled BB-cows. This was done by comparing these pelvimetric measurements with those obtained from the carcass 2 h after slaughter. The results show small significant differences in pelvic width, pelvic height and pelvic area; measurements obtained from living cattle were generally less than those obtained after slaughter.

The agreement between the two methods of measurements was moderate to good, being −0.2 (−2.5–2.1) cm for pelvic width and 1.2 (−1.8–4.1) cm for height. Even if the two methods agree, a poor repeatability of the one can still lead to poor agreement between the methods. If the 95% limits of agreement are similar or smaller compared to the *repeatability coefficient*, the lack of agreement between the methods can be explained by a lack of repeatability. If the limits of agreement are wider than the repeatability coefficient would indicate, there must be other factors reducing the agreement between the two measuring methods (Bland and Altman, 1999). Generally this can indicate that the one method is likely to differ from the other, in this case a possibly explanation can be the removal of fat and connective tissue after the carcass is split as discussed below. In our study, the pelvimetric pelvic height repeatability coefficient fell within the limits of agreement.

Generally, the pelvic width measured with the pelvimeter is larger than the carcass measurement. For pelvic height, the

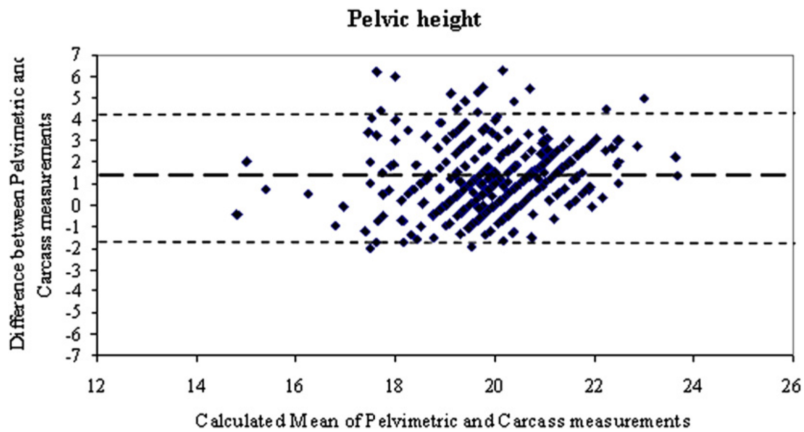

Fig. 4. Limits of agreement between the mean difference for pelvimetric and carcass measurements for pelvic height, and 95% limits of agreement.

Table 4
Correlation between pelvimetric and carcass measurements for pelvic width (PW) and pelvic height (PH) related to age

Age (years)		Carcass measurements 2		3		4		5		6		7		8		9		10	
		PW	PH	PW	PH	PW	PH	PW	PH	PW	PH	PW	PH	PW	PH	PW	PH	PW	PH
Pelvimetric measurements	PW	0.96**		0.53**		0.63**		0.32**		0.30**		0.51**		0.55**		0.15		0.41	
	PH		0.70		0.70**		0.33**		0.38**		0.37**		0.37**		0.59**		0.40		0.38

**($p<0.001$).

carcass measurements show higher values compared to those of the Pelvimeter. The difference between the two methods is larger for pelvic height than width. These small significant statistical difference in pelvic dimension are not always biological relevant to the decision an obstetrician has to make in the field. For example, the differences in pelvic area are around 20 cm^2, which is only 7% of the total pelvic dimension. “It is difficult, if not impossible, to indicate a precise percentage of difference in pelvic area that would guarantee biological relevant as this also depends on factors such as the calf dimensions, pelvic inclination, and general management. Further research will be necessary to investigate the influence of the above factors on the required pelvic area (Laster, 1974; Johnson et al., 1988).”

There may be several reasons for the differences mentioned above; for example that measurements in a living animal, affected by muscular tone and normal stance, intrapelvic fat and connective tissue differ from carcass measurements influenced by relaxation of connective tissue and muscle post-mortem due to the pendulous position of the hanging carcass. After the carcass is split in two halves a large amount of pelvic fat and connective tissue is removed. Logically this would lead to bigger discrepancies between the two methods of measurements in animals of a fatter grade, but our results show larger differences ($p<0.05$) in leaner carcasses. Another reason which can explain the existence of a disagreement between the two methods of measurement is the hypermuscularity of the BB which might lead to compression of the pelvic entrance and pelvic canal. The muscular hypertrophy gene (mh gene) is known as a monogenic trait characterized by general hyperplasia of skeletal muscle, particularly of the hindquarters, the back and the shoulders, accompanied by a relative decrease in the size of the viscera and length of the limb bones (Arthur et al., 1988). Comparison of the pelvic area of cattle of the BB-breed with other beef breeds assent this decrease (Bellows et al., 1971; Deutscher, 1988; Johnson et al., 1988; Murray et al., 1999, 2002; Coopman et al., 2003). The average fetal weight at birth for the BB-breed is also higher, making the discrepancy between the dam and her calf even bigger. Ménissier and Vissac (1971) demonstrated a significantly smaller pelvic height, width and area in double muscled animals compared to non-double muscled animals. Results of our study do not support this hypothesis since cattle in the less muscled E category did not differ significantly compared to these in the S category. The general linear model comparing differences in pelvic height between the pelvimetric and carcass measurements shows some influence of hypermuscularity on the measurements' accuracy. Coopman et al. (2003) found a good correlation between internal pelvic measurement and live weight, and his multiple regression models show that live weight, among other traits, was a good estimator of internal pelvic sizes.

Correlation between the two methods of measurements was moderate albeit significant for both pelvic width and height. The variation between the two methods can also be explained by other factors. The growth pattern of the pelvis and its relation to age has been described by Brown et al. (1972). In this present study, younger animals gave better correlations compared to the complete dataset and to adult cows. Influence of age on Pelvimeter measurements was also suggested by Murray et al. (1999) who found a higher correlation of age with pelvic height ($r^2=0.37$), pelvic width ($r^2=0.42$) and pelvic area ($r^2=0.45$) in adult cows. Overall, results suggest that the age of cattle should be taken in account. Van Donkersgoed et al. (1990) found that the positive predicting value of pelvic area measurements for dystocia was lower in young cattle, whereas Basarab et al. (1993) found that heifer age, irrespective of pelvic area, body weight and hip height, was an important trait in

Table 5
Correlations between the pelvimetric and carcass measurements of pelvic width (PW), pelvic height (PH), and pelvic area (PA) in relation to conformation grades and sub-grades

	Conformation	Sub-grade	Carcass measurements −		=		+	
	Grade		PW	PH	PW	PH	PW	PH
Pelvic measurements	E	PW	0.401	−0.203	0.526	0.645	0.527**	0.403
		PH	0.706	0.815	0.803	0.876*	0.290*	0.390**
	S	PW	0.347**	0.316**	0.696**	0.418**	0.593**	0.371**
		PH	0.068	0.320*	0.561**	0.471**	0.290**	0.487**

*($p<0.05$).
**($p<0.001$).

Table 6
General linear model for difference in pelvic width (PW), pelvic height (PH) and pelvic area (PA)

	F-value	*p*-value
Difference PW = −1.003 + 0.003 CW	F_{CW} = 4.512	$p<0.05$
Difference PH = −3.137 + 0.225 Age + 0.005 CW	F_{Age} = 27.860	$p<0.001$
	F_{CW} = 11.504	$p<0.001$
Difference PA = −72.727 + 2.509 Age + 0.135 CW	F_{Age} = 5.235	$p<0.05$
	F_{CW} = 13.639	$p<0.001$

CW = carcass weight.

predicting dystocia. Discriminant analyses carried out by Morrison et al. (1985) indicated the influence of age of the cow in addition to precalving pelvic area; other factors were conformation and fatness grades, and carcass weight, as shown in the general linear model analysis of this study. For pelvic width, only the carcass weight had a significant influence, whereas age and carcass weight both had a significant influence on pelvic height and area differences. The best correlation for pelvic width occurred in cattle with extreme conformation, whereas that for the pelvic height was found in cattle of excellent conformation. Since Belgian Blue cows have an S conformation, the correlation for pelvic width is better than that for pelvic height. Besides age, conformation and fatness grades, the moderate correlation between the measurements can also be explained by straining of the animals, the removal of the fat and connective tissue after splitting the carcass and the hypermuscularity of the BB-breed.

In Belgium, because of the high value of the calves and the relatively low price of the CS, nearly all BB-cows are nowadays delivered by CS (Kolkman et al., 2007). However, ethical criticism of this method of managing parturition is increasing. Selection for the mh gene has caused general hyperplasia of skeletal muscle accompanied by a relative reduction in the comparative size of the viscera and length of the limb bones (Arthur et al., 1988). Coopman et al. (2003) indicated that the increased muscular conformation within the double muscled BB-animal is related to a decrease in inner pelvic dimension. Other genes besides the mh gene are involved in the hypermuscularity but their number, location and function is unknown. Genetic improvement during the last ten years has produced improvement to muscling score and meaty type in the BB-breed in Belgium, whilst height and length traits have decreased. An improvement for rump slope, chest width, tail set and pelvic width were offset by a slight decrease for pelvis and body length (Hanset, 1998, 2004, 2005). Years of selection for hypermuscularity have created a decrease in overall body size including pelvic height. As genetic selection is a continuous process, a new goal would be to reduce the antagonistic effect between muscle growth and dystocia managed by caesarean section. Selection for bigger pelvic sizes and the simultaneous use of bulls giving calves with lower birth weight and shorter gestation periods may be the only solution in this breed. Pelvimetry might enable dam selection for ease of calving, based on pelvic conformation. Based on the results of the present study it is clear that variation in pelvic measurement is not due inaccuracy of measurement.

5. Conclusion

Our results show a significant however small difference in pelvic dimensions measured by means of the Rice pelvimeter when compared to measurements on the carcass. A moderate to good agreement between the two methods was found. According to these results pelvimetry is presumed to be a useful tool for veterinarians and farmers to select animals in the BB-breed with a larger birth canal and hence less dystocia problems. Knowing the pelvic area of BB-animals, a stockholder can preselect cows that might calve naturally, breeding from a bull that produces calves with lower birth weight and shorter gestation periods. Besides, the Rice pelvimeter can be used to follow the growth of the pelvic area in young animals longitudinally. Such a study could investigate those environmental factors that may influence pelvic growth of cattle.

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