



Stillbirth in dairy calves is influenced independently by dystocia and body shape



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ABSTRACT

The objectives of this study were to determine (1) if stillborn calves born following dystocia present with specific injuries/pathological changes compared to stillborns delivered without difficulty, and (2) whether such stillborns differ in conformation from dystocic calves that survive. Post-mortem examinations were carried out on 20 stillborns that were either unassisted (N) or were 'farm-staff'-assisted/normally presented (FN) at birth. Evidence of greater trauma and bruising was observed in the FN calves and parameters such as body length, birth-weight and thyroid:body weight were similar.

In a second part of the study birth-weight, body length and height, girth length, body mass (BMI), and ponderal (PI) indices were assessed in 490 calves. Regardless of the severity of dystocia, stillborns had greater body lengths and lower BMIs and PIs than calves born alive ($P < 0.05$), suggesting prenatal factors contribute to their post-natal survival. FN calves were heavier than N calves ($P < 0.05$), and both FN and farm-staff-assisted/malpresented calves had lower PIs than N calves ($P < 0.05$). The study found that criteria such as grossly visible carcass haemorrhage, bruising, and brain congestion were not reliable in terms of identifying calves that had experienced dystocia. Half of the stillborns had breathed indicating they were alive and possibly had experienced pain/distress at time of delivery. Body conformation was related to stillbirth independently of dystocia, a finding likely reflecting inadequate prenatal development.

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Introduction

Worldwide, perinatal mortality of dairy calves varies from 2% to 10% (Mee et al., 2008). Up to 8% of dairy calves die in the first 48 h after birth in the UK (Esslemont and Kossaibati, 1996; Wathes et al., 2008; Brickell et al., 2009b), with mortality rates in the Holstein breed estimated at 11.6% and 4.3% from first and later parity dams, respectively (Eaglen et al., 2011). The losses to the dairy industry have been estimated to cost the US and UK dairy industries, respectively, up to US\$125 million¹ (Meyer et al., 2001), and £60 million (DEFRA, 2003) annually.

Ninety per cent of calves that die perinatally are alive at the commencement of the calving process (Mee, 2008b,c), emphasizing the critical nature of the course and management of the birth process. Difficulty at birth, or dystocia (as reflected by the amount of assistance provided at birth), contributes to up to half of the perinatal mortalities in cattle (Meyer et al., 2001; Berglund et al.,

2003; Eriksson et al., 2004) and between 10% and 50% of dairy cow calvings are assisted to some degree (Mee, 2008a).

There are multiple risk factors and underlying reasons for stillbirth in dairy cattle (Meijering, 1984; Mee, 2008c). With regards to dystocic stillbirths, these mainly result from trauma and anoxia (Mee, 2008c). Assisted deliveries may result in haemorrhages, injuries to the central nervous system and in increased risk of rib and limb fractures in neonates and in pelvic fractures in dams (Wilmore, 1986; Aksoy et al., 2009). Necropsies of stillborn calves are typically focussed on determining the cause of death (Berglund et al., 2003; Mee, 2010; Waldner et al., 2010), but do not tend to relate the described injuries to the dystocic/eutocic status of the stillborn. Although a significant proportion of dystocic dairy calves are stillborn, a proportion survive, and it has been reported that calves born with and without difficulty usually differ in terms of their size and conformation (Johanson and Berger, 2003; Kolkman et al., 2010; Becker et al., 2011). However it remains unknown if calf conformation influences survival.

The objective of this study was to determine if dystocic stillborns (as reflected in requiring assistance during birth) present with a specific profile of pathological changes/injuries compared to eutocic stillborns, and whether dystocic stillborns differ in con-

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¹ 1 US\$ = £0.63; €0.79 at 16 November 2012.

formation from their counterparts that survive. The first part of the study involved the collection of descriptive data relating to the specific pathological changes/injuries occurring in stillborns following dystocia. The second part investigated the birth-weight and conformation of calves born alive or dead with various degrees of difficulty.

Materials and methods

Animal selection, housing and management

The study was conducted at the Crichton Royal Farm (Dumfries, UK), in accordance with UK regulations and authorities (Home Office, project licence PPL 60/3361). As part of a long-standing, on-going trial on the farm, cows and their respective calves were derived from two genetic lines: 'S', selected for greater milk fat and proteins; and 'C', selected to match the 'rolling' UK average for these parameters. Adult cows from each group were fed three different diets (non-trial, low forage or high forage) during lactation and dry periods (Bell and Roberts, 2007).

Calving was managed by experienced farm staff with dams assisted when judged to be in difficulty (Barrier et al., 2012). Such assistance was therefore used as a proxy measure for dystocia which was scored as follows: N (no assistance); FN (farm-staff assistance provided with calf in normal presentation); FM (farm-staff assistance provided with malpresented calf); and V (veterinary assistance provided including caesarean section and fetotomy). Malpresentation was defined as any deviation from an anterior, dorsal presentation with both front limbs and head extended in the birth canal. Any calf receiving assistance (i.e. a score other than N) was considered as having experienced a difficult birth (i.e. a dystocic calf).

Part one: Post-mortem examination of stillborns born with/without dystocia

Stillborn details

Twenty full-term stillborn (as recorded by farm-staff) purebred Holstein calves (gestation length >370 days) born following varying degrees of dystocia between August 2009 and September 2010 were sent for post-mortem examination (N, $n = 10$; FN, $n = 10$). The dataset contained two twin calves, a bull (FN) and a heifer (N), from two different dams. There were seven bull and three heifer calves in each N and FN group. A total of 11/20 stillborns were from primiparous dams although stillborns from primiparae were more prevalent in the FN (8/10) than the N (3/10) group. Two and four calves were from the 'S' genetic line in the N and FN groups, respectively.

Post-mortem examinations

Gross post-mortem examinations were carried out by two veterinary surgeons from the UKAS accredited SAC Disease Surveillance Centre at Dumfries, UK, following the same protocol usually <24 h after death of the calf. Calves were weighed and their crown-rump length (CRL) measured (supine length from the crown of the head to the base of the tail [in cm]). Lungs were assessed for evidence of inflation by determining whether or not sampled tissue floated in water. The carcass was examined for the presence of meconium staining, and for the presence, extent and location of petechiation, bruising (haemorrhage in interstitial tissues ranging from 'small' [size of a fingerprint] to 'large' [area of the palm of a hand]), haemorrhages (defined as 'small' and 'large'), fractures, congestion of the brain (evidence of blood pooling within blood vessels) and any other obvious abnormalities (petechiation, bruising and haemorrhage will hereafter be referred to as 'lesions').

The thyroid gland was weighed and the ratio of thyroid gland weight:birth-weight (BW) calculated as a potential indicator of iodine status. Ultimately there were four missing CRLs (three in the FN and one in the N group, respectively), and thyroid weights (two in the FN and N groups, respectively), which were deemed 'missing values'.

Data analysis

Two-sample Student's *t* tests were used to compare BW, length and thyroid:body weight ratios between the two groups using Minitab 15 (2006, Minitab).

Part two: Incidence of stillbirth and body characteristics of calves born dead and following dystocia

Birth records of calves

Full-term purebred, non-deformed calves born between September 2008 and July 2010 were recruited for the study ($n = 490$), of which 23.5% had required assistance at calving. For each calf, the following characteristics were recorded: 'life status' at birth (born alive/dead); twinning (single/twin); sex; parity of dam (primiparous/multiparous); genetic line of calf; diet of dam during pregnancy (non-trial, low forage, or high forage); sire and dam of calf; season of birth (summer [April–September] or winter [October–March]); or month and year of birth.

Body characteristics of calves at birth

All calves born either alive or dead were weighed at birth (kg) using a calibrated mechanical scale, and their CRL (cm) and heart girths (cm) measured using the same flexible tape measure. The withers height (cm) was determined using a 'height-stick' (Swali et al., 2008; Brickell et al., 2009a). Dead calves were placed on the ground in a 'straight-legged' position so that a rigid height measurement could be taken that approximated as closely as possible this measurement in a live calf. Up to four suitably trained personnel recorded these measurements in order to achieve consistency. For each calf, the ponderal (PI) and body mass (BMI) indices were calculated as BW/CRL^3 (kg/m^3) and BW/CRL^2 (kg/m^2), respectively.

Statistical analysis

The effect of dystocia on the status of the calf at birth (born alive/dead) was analysed using a Fisher exact test (grouping all scores of difficulty together). The body characteristics of the 490 calves (BW, CRL, girth, height, BMI and PI) were analysed with REML (restricted maximum likelihood) in Genstat (11th edition, 2008, VSN International), using a forward-stepwise technique. Calf characteristics and the identity of the person recording the measurements (recorder) were tested independently as univariates and became potential candidates for the multivariate model (Haskell et al., 2009). Only biologically plausible interactions were tested. Calf identity 'nested' within sire of the calf was used as a random model. Diet of the dam during pregnancy did not become eligible for inclusion in any of the models. Unless otherwise stated hereafter, all the models included recorder, twinning, parity, sex, interaction between year and season, birth difficulty and stillbirth.

'Recorder' was not included in the final analysis of BW. An interaction between 'twinning' and 'genetic line' was fitted for analysis of BW and girth. Twinning was not included for the analysis of PI. An interaction between 'parity of dam' and 'sex of calf' was fitted to the analysis of CRL, PI and BMI. The interaction between 'year' and 'season' was not included for the analysis of CRL and height. For the latter, only 'year of birth' was included. Finally, an interaction was fitted between 'birth difficulty' and 'genetic line' for CRL and girth.

Results

Part one: Post-mortem examination of stillborns born with/without dystocia

There was no difference in the BWs, CRLs and thyroid weight:bodyweight between stillborns born with or without assistance (Table 1). Table 2 details that only one calf (1 N) had traces of meconium visible macroscopically and no calves had obvious fractures. Regardless of level of assistance, half of the calves (6 N, 4 FN) had breathed. Bruising was only reported in the animals assisted at calving (4/10) including two with significant bruising. Petechiation (4 N, 3 FN), was largely found on the parietal pleura regardless of assistance, with the exception of one FN calf that also had petechiae on the adjacent thymus and heart. Only calves born without assistance had limb lesions whereas both assisted and unassisted calves had lesions in the thoracic and cervical regions (in total 12/20).

Part two: Incidence of stillbirth and body characteristics of calves born dead and following dystocia

A total of 35 (7%) of the calves were born dead, of which 20 (57.1%) had experienced assistance at birth. Fifteen (4%) N, ten

Table 1

Birth-weight (BW), crown-rump length (CRL), and thyroid:bodyweight ratio in 20 stillborn calves that were either unassisted (N) or 'farm-staff'-assisted and normally presented (FN) at birth. No statistically significant differences were found. ($P > 0.05$).

	N ($n = 10$)	FN ($n = 10$)
BW (kg)	43.3 ± 1.8	41.5 ± 1.4
CRL (cm) ^a	96.8 ± 2.8	94.4 ± 2.2
Thyroid/bodyweight (g/kg) ^b	0.38 ± 0.02	0.41 ± 0.03

^a N group, $n = 9$; FN group, $n = 7$.

^b N group, $n = 8$; FN group, $n = 8$.

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