Parturition duration and birthing difficulty in twin and triplet lambs

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ABSTRACT

The primary objective of this study was to investigate the relationship between parturition duration, localised oedema in lambs (as determined by post mortem findings) and lamb survival. Parturition behaviour was recorded for 131 mixed age Coopworth ewes and their 303 lambs (twins n=180; triplets n=123). Twin lambs and first born triplet lambs that did not survive to three weeks of age took at least twice as long to be born than lambs that survived ($P<0.05$). The duration of parturition for lambs that died and had moderate to severe subcutaneous oedema was more than three times longer than for those that had none and minor localised subcutaneous oedema at post mortem examination ($P<0.05$). Further research is required to understand the factors contributing to prolonged parturition for twins and triplets. This information is needed so that appropriate management techniques and animal breeding programmes can be developed to reduce birthing difficulties (dystocia) and lamb mortality rates.

Keywords: ewe parturition behaviour; lamb mortality; post mortem; dystocia.

INTRODUCTION

Improved lambing percentage is the biggest contributor to higher profits on New Zealand sheep farms. Many sheep breeders have selected and bred ewes for increased fecundity over the last four decades. Lamb survival is an important issue in highly fecund sheep flocks. The national mean lambing percentage from 2000-2003 was 119%, which was greater than 100% recorded ten years ago (1990-1993) (Anon, 2003). Davis *et al.* (1983) reported that as mean litter size increases above 1.7 the decline in single-bearing ewes is offset by an increase in triplet bearing ewes. The increased proportion of ewes having triplets is of concern to farmers and to industry as lamb mortality is highest in triplets (Kerslake *et al*., 2005; Everett-Hincks *et al*., 2005a; 2005b). The majority of lamb deaths occur in the first two days after birth and range from 5% to 30% for individual sheep flocks. These losses are unacceptable from animal welfare and production perspectives.

The relationship between lambing rate and cause of lamb death in highly fecund ewes is poorly understood. Previous research has shown that under New Zealand conditions starvation/exposure accounts for approximately 30% of new-born lamb losses (McCutcheon *et al.*, 1981). Dalton *et al*. (1980) reported dystocia rates of 27% in dead single lambs and 17% in dead multiple lambs. A recent study by Kerslake *et al*. (2005) showed that the predominant cause of death from birth to 3 days of age was dystocia, accounting for 57% of single and 47% of multiple lamb deaths. Haughey (1980) suggested that between 20-60% of neonatal lamb deaths pathologically categorised as starvation/exposure are actually consequences of birth stress. Differing results between studies may be due to differences in clinicopathological diagnoses.

The study by Kerslake *et al.* (2005) characterised 'primary dystocia' as localised moderate to severe (>3 mm thickness) subcutaneous oedema on the lamb's body at post mortem. McFarlane (1965) describes local oedema as a sign of viability during the birth process and its quantity probably a function of time as the part of the lamb protruding from the ewe may develop an oedema which is related to the degree of pressure as much as the duration of protrusion.

Dystocia occurrence is due to a number of complex factors. Dystocia can be a consequence of lamb birth weight, sire breed, dam pelvic conformation (Fogarty & Thompson, 1974), mal-presentation, maternal overfeeding or prolonged parturition (Sargison, 1997). In addition, lambs that endure difficult births have trouble maintaining body temperature and have inhibited behaviours in teat searching and suckling (Eales *et al.,* 1982). This can increase the chances of death when subjected to cold stress or under-nutrition.

Lamb birth weight has been reported as the predominant factor leading to dystocia in single lambs (Fogarty, 1992). However, birth weight is unlikely to be the only reason for high dystocia rates in larger litters. Kerslake *et al.* (2005) reported that across all flocks in the study there was no significant weight difference between triplet lambs that died with signs of primary dystocia compared with triplet lambs that died with no signs of primary dystocia (other causes). Twin born lambs that died with signs of primary dystocia

were significantly heavier than twin born lambs that died of other causes. The high rate of deaths from dystocia in twin and triplet lambs was unexpected. It may indicate that dystocia as a primary cause of lamb death is underestimated within highly fecund sheep flocks. The incidence of dystocia in singles and multiples was not consistent across all flocks. The authors proposed that the variability between farms in dystocia rate offered hope that a genetic or management solution may be able to alleviate the problem.

A better understanding of lamb mortality, the mechanisms which cause dystocia and the relationship between birth difficulty and levels of oedema were investigated further at AgResearch Woodlands in 2004. This paper investigates the relationship between difficult births (as determined by parturition behaviour observations), localised subcutaneous oedema (as determined by post mortem findings) and lamb survival.

MATERIALS AND METHODS

Animals and measurements at lambing

This study was approved by the AgResearch Invermay Animal Ethics Committee (Project 10295). Performance recorded Coopworth ewes (750 mixed age ewes of known age) were monitored from mating through to lamb weaning at AgResearch's Woodlands farm in the 2004 season. Lambing commenced on 5 September. The Coopworth ewes were observed continuously during daylight hours. Ewes had been ear-tagged so that they could be individually identified from a distance and binoculars were used when necessary.

It was expected that approximately one third of the 750 ewes (n=225) would be observed and recorded at parturition. However only 131 ewes (less than 20%) were observed at parturition, including 90 twinning ewes and 41 tripleting ewes, reflecting the unexpected higher proportion of ewes lambing at night.

Perinatal behaviour data was collected in the field from a distance of approximately 20 metres. Close observation during daylight hours ensured that the parturition process were anticipated and subsequently observed and recorded. The observation period commenced from the first external sign, the presence of a 'water bag', to 30 minutes after the last of the litter was born. The observation period varied depending on litter size and the time taken between births of twin and triplet lambs. The presence of the water bag was not always detected and therefore the analyses included in this paper record the parturition time from the first sign of feet seen at the vulva for the first born lamb to the time the lamb was completely expelled (cumulative parturition duration = time lamb expelled – the time the feet of the first born lamb were first seen).

In many cases the lamb was presented normally *i.e.* two forelegs with the head between them. In other situations there was a mal-presentation - one or both forelegs back, or head back, or hind legs instead of fore legs, or one or both hind legs back, or breech presentation, only the tail and rump seen.

Ewes in which labour did not progress for over one hour or which were in distress were assisted for the purposes of the study, which was more frequent than 'normal' farm practice. The ewe would be checked and assisted with delivery if she: continued to strain, but there was no sign of the water bags, or continued to strain an hour after the rupture of the water bags but there was no sign of a lamb, or if the lamb appeared to be wedged in the birth canal, or if the lamb's mal-presentation was causing difficulty and parturition had not progressed.

Physical markings were used to identify individual twin and triplet lambs during the observation period. At the end of the observation period lambs were spray marked so that first born, second born and third born lambs could be identified from their tag number and monitored to weaning. This also ensured that parentage was 100% accurate as the lambs were permanently identified at ear tagging, approximately 4-8 hours after birth. The date, litter size, sex, weight and body size measurements were recorded for all lambs at tagging. Litter size and survival to birth, tagging, 3 days from birth, tailing (3 weeks) and weaning was recorded for all lambs. Lambs and ewes were weighed at weaning.

Cause of lamb death

All lambs that died before 4 days of age were collected, tagged, weighed, measured and autopsied (fresh not frozen) to determine time and cause of death. The post mortem procedure identified congenital abnormalities and iodine deficiency problems and was modified from McFarlane (1965), in consultation with Veterinary practitioners and described by Kerslake *et al*. (2005). The central nervous system was not examined. Spleen tissue and blood were collected for DNA extraction.

All lambs were assigned one or more causal signs of mortality based on post-mortem and farmer records. These causes included; 'primary' dystocia (localised moderate/severe; >3 mm subcutaneous oedema on head, neck, brisket, rib cage or breech), 'secondary' dystocia (localised minor; visible but not measurable subcutaneous oedema on head, neck, brisket, rib cage or breech),

starvation/exposure (no brown fat on heart or kidneys), rupture (organ rupture and or haemorrhage), amnion over nose, unnatural (accident) and disease (navel infection or watery mouth). A lamb can have a range of causal signs associated with its mortality; therefore each lamb was assigned a 'primary' and a 'secondary' cause of death. The 'primary' causes of death were categorised as follows; dystocia, starvation/exposure, amnion over nose, organ rupture, disease and unknown. The 'primary' cause was assigned depending on the estimated chronological order of the causes resulting from the parturition process and post-parturient events.

Statistical analyses

Animals that were observed and recorded at parturition were included in the analyses. Data were collected and entered into a custom designed Microsoft Access® database. Differences between birth order within litter size for continuously distributed parturition behaviours, lamb measurements and weights were analysed using the MIXED procedure (SAS, 2005). A simple univariate mixed effects mixed model was fitted to test for the fixed effects of lamb litter size, birth order (first born, second born and third born) and the interaction between litter size and birth order. Lamb parturition times were adjusted for the random maternal + litter effect common for the lambs born in the same litter and of known birth order. The fixed effects of lamb status (coded as'0' = dead and '1' = alive at three weeks after birth) or 'primary' dystocia signs (coded as '0' = no dystocia signs and '1' = dystocia signs) were also added to the linear model to analyse differences in lamb measurements and parturition behaviours for these effects. Least squares means for the main factors affecting the trait of interest were estimated using SAS (SAS, 2005). Parturition duration was recorded as a lamb trait and parturition times were log transformed for analysis and were reported as back transformed values.

To help decide the pathways involved in the differences in lamb performance and ewe and lamb behaviour, covariates were tested and retained in the model if statistically significant at $P<0.05$. β is the regression of the trait on the covariate tested. Results are given as least square means and their standard errors. Comparisons between least squares means for twin and triplet litters, first born, second born and third born lambs, survival to 3 weeks post birth, primary dystocia signs and combinations between these fixed effects were performed and only reported if statistically significant at $P<0.05$.

RESULTS

Lambing behaviour

The mean lambing date was 17 September 2004. 303 lambs were observed at parturition where behaviours, measurements and physiological status were recorded. For the observed lambs nearly three quarters of their dams lay down to give birth, nearly 20% were mal-presented for birth and one third were assisted with birth (Table 1).

The interaction between birth order and litter size had a significant effect on parturition duration ($P<0.0001$, Table 2). From the first sign of the feet of the first born lamb, first born lambs were born 11 minutes later, second born lambs 39 minutes later and the third born lamb an hour later on average, overall. Ewe age at parturition had a significant effect on the time taken for each of her litter to be born, where lambs born to younger ewes had prolonged parturition times ($\beta=-6.4 \pm 2.55$ minutes/year of age, $P<0.05$).

Table 1: The parturition behaviours observed for each lamb, recorded for twinning and tripleting ewes.

	Total	Twins	Triplets
Total number of lambs observed at parturition	303	180	123
Ewe position at lamb expulsion			
Lying	74% (213)	75% (120)	74% (93)
Standing	26% (73)	25% (41)	26% (32)
Lamb presentation at birth			
Normal	83% (237)	84% (136)	80% (101)
Abnormal (malpresented)	17% (48)	16% (25)	20% (23)
Assisted birth	33% (97)	30% (50)	37% (47)
Not assisted birth	67% (199)	70% (122)	63% (77)

Number in parentheses was where lambs were positively identified with the parturition behaviour.

Table 2: The cumulative parturition duration in minutes from the first sight of first born feet to: the birth of the first born (FB), second born (SB) or third born (TB) litter mate (least squares mean x/÷ standard error).

Birth order	Cumulative duration from:	All (n=303)	Twins (n=180)	Triplets (n=123)	P (twins and triplets)
First born	FB feet to FB birth	10.8 x/÷1.13	12.6 x/÷1.16	7.9 x/÷ 1.25	ns
Second born	FB feet to SB birth	38.6 x/÷1.12	37.6 x/÷ 1.15	41.6 x/÷ 1.21	ns
Third born	FB feet to TB birth		na	56.4 x/÷1.22	na

ns=not significant (P≥ 0.05).
Cumulative parturition duration = time lamb expelled – the time the feet of the first born lamb were first seen (minutes).

Table 3: Cumulative parturition duration for lambs: whose dam genuinely required assistance with parturition; dam was lying down or standing at time of lamb expulsion; lamb was presented normally or abnormally at time of parturition; lambs that survived up to three weeks of age or died. Cumulative times taken in minutes from the first sight of the feet of the first born (FB) to expulsion of the FB, second born (SB) and third born (TB) lambs (least squares mean x / ÷ standard error).

Birth order	Cumulative duration from	Twin Lambs	Twin Lambs	P	Triplet Lambs	Triplet Lambs	P
		No assistance (n=133, 77%)	Assistance (n=39, 23%)		No assistance (n=96, 77%)	Assistance (n=28, 23%)	
FB	FB feet to FB birth	7.9 x/÷ 1.17	49 x/÷ 1.32	****	6.1 x/÷ 1.24	35.3 x/÷ 1.62	**
SB	FB feet to SB birth	34.7 x/÷ 1.56	47.2 x/÷ 1.29	ns	45.6 x/÷ 1.22	29.4 x/÷ 1.47	ns
TB	FB feet to TB birth				59.8 x/÷ 1.23	45.9 x/÷ 1.41	ns
		Dam lying (n=120, 75%)	**Dam standing** (n=41, 25%)		**Dam lying** (n=92, 75%)	**Dam standing** (n=30, 25%)	
FB	FB feet to FB birth	14.5 x/÷ 1.18	7.7 x/÷ 1.33	*	11 x/÷ 1.28	3.6 x/÷ 1.43	**
SB	FB feet to SB birth	38 x/÷ 1.18	35.1 x/÷ 1.26	ns	44.5 x/÷ 1.23	32 x/÷ 1.49	ns
TB	FB feet to TB birth				59.8 x/÷ 1.25	50.4 x/÷ 1.36	ns
		Abnormal (n=25, 16%)	**Normal** (n=136, 84%)		**Abnormal** (n=23, 19%)	**Normal** (n=101, 81%)	
FB	FB feet to FB birth	16.7 x/÷ 1.29	9.3 x/÷ 1.14	*	31 x/÷ 1.43	6.5 x/÷ 1.23	***
SB	FB feet to SB birth	39.6 x/÷ 1.39	36.5 x/÷ 1.12	ns	94.3 x/÷ 1.48	48 x/÷ 1.17	ns
TB	FB feet to TB birth				125.3 x/÷ 1.43	68.4 x/÷ 1.19	ns
		Died (n=10, 6%)	**Survived** (n=159, 94%)		**Died** (n=24, 20%)	**Survived** (n=95, 80%)	
FB	FB feet to FB birth	26.6 x/÷ 1.57	10.1 x/÷ 1.18	*	31.9 x/÷ 1.64	6.6 x/÷ 1.27	**
SB	FB feet to SB birth	106.8 x/÷ 1.78	35.9 x/÷ 1.15	*	74.5 x/÷ 1.65	40.2 x/÷ 1.22	ns
TB	FB feet to TB birth				69.6 x/÷ 1.39	65.7 x/÷ 1.25	ns

ns=not significant (P≥ 0.05), * P<0.05, **P<0.01; ***P<0.001; ****P<0.0001.

Parturition duration and difficult births

Mal-presented births and births requiring assistance can be classified as difficult births. This section explores these effects on parturition duration. Parturition duration for lambs born to assisted ewes is presented in Table 3. The proportion of ewes assisted in the study was higher than that for the flock (12%) that were not observed at parturition. There was a significant birth order by litter size by dam assistance interaction for lamb cumulative parturition duration, where the duration was recorded from the feet of the first born lamb to expulsion (P<0.0001, Table 3). Twin and triplet first born lambs from assisted ewes took six times longer to be born than lambs from non-assisted ewes (twins P<0.0001 and triplets P<0.01, Table 3).

There was a significant lamb birth order by litter size by dam position at time of lamb birth interaction for cumulative parturition duration (P<0.0001). Parturition duration was significantly shorter for first born twin and triplet lambs when the dam was standing during delivery than when she was lying down and this effect was greater for triplet lambs (Table 3).

Mal-presented (abnormal presentation) first born lambs took on average 2.4 times as long to be born than normally presented first born lambs and the effect was greater for first born triplet than twin lambs (Table 3). Mal-presented second born and third born triplets also tended to have longer (about double) parturition times (P=0.11 and P=0.12 respectively) (Table 3). Delivery time for normally and mal-presented lambs was significantly affected by lamb girth size (β=2.6 ± 0.67 minutes/cm, P<0.05).

Table 4: Cumulative parturition duration for lambs that did not survive to 3 days post birth and those that did and did not have moderate to severe amounts of localised subcutaneous oedema. Times taken in minutes for all dead lambs, twins and triplets and all first born (FB), second born (SB) and third born (TB) lambs (least squares mean x/÷ standard error).

	Cumulative duration from	No oedema (n=17)	Oedema (n=9)	P
All		14.1 x/÷ 1.46	50.1 x/÷ 1.74	*
Twins		15.9 x/÷ 1.96	116 x/÷ 2.18	*
Triplets		13.4 x/÷ 1.57	21.7 x/÷ 2.18	ns
FB	FB feet to FB birth	13.3 x/÷ 1.68	84 x/÷ 3.93	ns
SB	FB feet to SB birth	7.7 x/÷ 2.20	136.2 x/÷ 2.63	*
TB	FB feet to TB birth	30.2 x/÷ 2.20	21.7 x/÷ 2.20	ns

ns=not significant (P≥ 0.05), * P<0.05, **P<0.01; ***P<0.001; ****P<0.0001. Oedema= localised subcutaneous oedema (>3mm thick). Cumulative parturition duration = time lamb expelled – the time the feet of the first born lamb were first seen (minutes).

Parturition behaviour and survival

There was a significant litter size by birth order by survival to three weeks of age interaction on cumulative parturition duration (P<0.0001, Table 3). First born twin and triplet lambs and second born twin lambs that survived to 3 weeks after birth had significantly shorter (2-5 times) parturition durations than their counterparts that died (Table 3). Lamb birth weight had a significant effect on parturition duration, where heavier lambs took significantly longer to be born (β=12.9 ± 3.11 minutes/kg, P<0.001).

Insufficient numbers restricted the statistical analysis comparing parturition durations of lambs with and without localised subcutaneous oedema diagnosed at post mortem (Table 4). Parturition duration time was associated with the presence of oedema in dead lambs at post mortem (P<0.05; overall, for twin and triplet lambs and for second born lambs). Parturition durations were significantly longer, greater than 3 times, overall for lambs diagnosed with localised subcutaneous oedema compared with those that did not have localised oedema at post mortem. In particular twin lambs with localised oedema had taken on average 116 minutes to be born from the time the feet were observed for the first born litter mate compared with 16 minutes for those that did not have localised oedema at time of post mortem (Table 4).

DISCUSSION

The objective of the study was to investigate the relationships between difficult births (as determined by parturition behaviour observations), localised subcutaneous oedema (as determined by post mortem findings) and lamb survival.

This study showed that prolonged parturition times are associated with birth trauma and lowered survival rates, observed from the localised subcutaneous oedema diagnosed at post mortem for dead lambs. Twin lambs and first born triplet lambs that did not survive to three weeks of age took at least twice as long to be born as corresponding lambs that survived.

Parturition durations were greater than three times longer for all lambs diagnosed with localised subcutaneous oedema compared with those that did not have localised oedema at post mortem. From the first sign of the feet of the first born lamb, on average first born lambs were born 11 minutes later, second born lambs 39 minutes later and the third born lamb an hour later. However, the following factors resulted in prolonged parturition delivery times:

- Ewe age at parturition had a significant effect on lamb parturition duration, where lambs born to younger ewes had prolonged parturition times.
- Twin and triplet lambs from assisted ewes took six times longer to be born than lambs from non-assisted ewes.
- Mal-presented first born lambs took about two and a half times longer to be born than normally presented first born lambs.
- Ewes lying down to give birth took at least twice as long as ewes giving birth standing up.
- There is evidence that lambs with larger girths and heavier lambs had longer parturition durations.

Dystocia occurrence is due to a number of complex factors. Our results are in agreement with Fogarty & Thompson (1974) and Sargison (1997). These authors reported that dystocia can be a consequence of lamb birth weight, mal-presentation, smaller pelvic area or prolonged parturition. In addition, lambs that endure difficult births have trouble maintaining body temperature and have inhibited behaviours in teat searching and suckling (Eales et al., 1982). This can increase the chances of death when subjected to cold stress or

under-nutrition.

Further research is required to better understand the factors contributing to prolonged parturition and delivery times for larger litters. It is necessary to examine if the mechanisms which cause prolonged parturition, birth trauma and subsequent oedema operate differently over a range of physiological, anatomical and management conditions for different ewe ages. With this information appropriate management techniques can be identified and appropriate animal breeding programmes formulated to reduce birth trauma (dystocia) and lamb mortality rates.

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