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Effects of Sex, Breed, Callipyge Phenotype, and Docked Tail Length on Rectal Prolapse in Lambs

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Summary

The objective of this study was to investigate the effects of sex, breed, docked-tail length, and the expression of the callipyge phenotype on the incidence of rectal prolapse in lambs. To test whether these factors influence rectal prolapse in a controlled feedlot environment, lambs (n = 382) representing both sexes and four breed types were assigned randomly to one of three docking treatments: 1) tail removed as close to the body as possible (short-docked, n = 139); 2) tail removed midway between the attachment of the tail to the body and the caudal folds to the tail (medium-docked, n = 124); and 3) tail removed at the attachment of the caudal folds to the tail (long-docked, n = 119). Incorporating the callipyge phenotype into the study design assessed the effect of enhanced muscle development on rectal prolapse. The overall incidence of rectal prolapse in this study was 2.1 percent. Ewe lambs were no more likely to experience prolapses than male lambs ($P > 0.09$). Seven of the eight (87 percent; $P < 0.01$) lambs that prolapsed were hair sheep. No lambs expressing the callipyge phenotype prolapsed. There was no difference ($P > 0.05$) in rectal prolapse occurrence among the three docking treatments. In this study sex, tail dock length, and muscling did not appear to contribute to rectal prolapse in lambs. However, there may be an over-looked genetic component that influences the occurrence of prolapses in response to the practice of docking.

Key Words: Lambs; Docking; Sheep; Rectal Prolapse; Tail Length

Introduction

Docking of lambs is a common practice to remove the tail to decrease the chances of fly strike *(Cutaneous myiasis)* occurring when fecal matter and dirt collect on the tail, thereby creating a desirable environment for flies to lay eggs. Results of studies indicate that the incidence of fly strike is reduced in lambs that were docked (French et al., 1994; Ware et al., 2000) although a recent review questioned the evidence that docking decreases fly strike (Sutherland and Tucker, 2011). Battaglia (1998) reported that docked ewes had increased production because the tail did not interfere with breeding and lambing, and docked lambs had greater marketability.

Most producers remove the tail within days of birth. The length of the remaining docked tail has been the subject of several studies. Complete removal of the tail increased the likelihood of fly strike (Watts and Luff, 1978; Watts and Marchant, 1977) and Windels (1990) reported that shorter docked tails contributed to the occurrence of rectal prolapses. A rectal prolapse occurs when the rectum protrudes past the anus and remains outside the body with the soft tissue susceptible to tearing, infection, and sometimes resulting in the death of affected animals. Rectal prolapses significantly affect animal welfare and lamb performance.

The results of Windels (1990) formed the basis for a large-scale study that found short-docked lambs had a greater incidence of rectal prolapses than medium- or long-docked lambs (Thomas et al., 2003). These results corroborated recommendations of sheep management guidelines for leaving 2.5 cm to 7.6 cm of tail length on a lamb to help prevent rectal prolapses (ASI, 2002; Battaglia, 1998; Williams, 1990).

Purebred sheep breeders and producers for exhibition prefer the silhouette created by short-docking, which puts their practices at odds with several U.S. animal welfare policies (AFBF, 2002; AVMA, 2010) and the above mentioned management guidelines. The results of Windels (1990) and Thomas et al. (2003) prompted many states (e.g., California, Colorado [National Western Stock Show], Maryland, Washington, West Virginia, and Wyoming) to adopt rules governing the length of dock for livestock-show exhibition. One of those rules is "docked such that the tail can be lifted". Complicating docking considerations is the variable tail growth known to occur after docking (Goodwin et al., 2007; Lewis, 2013). Goodwin et al. (2007) reported that 17.8 percent of lambs had measurably shorter tails at market than at the time of docking, which the investigators speculated may be due to accumulated body condition; accumulated fat and muscle mass during the feeding phase might affect whether a tail can be lifted. Techniques used to assess whether a tail can be lifted also vary by region and fair. Wyoming Woolgrowers, Wyoming State Fair Board, and Wyoming Lamb Club Association agreed that all exhibited lambs have a minimum of three coccygeal vertebrae with verification by x-ray if necessary, although the revised policy now calls for the Animal Care Committee to palpate to determine "the presence of tail vertebrae" (Guidelines, 2013). The absence of a consistent and effective method of measuring the length of the docked tail has resulted in youth being disqualified from livestock shows. The most notable disqualification of lambs having tails determined to be too short was at the Wyoming State Fair, with 41 lambs disqualified in 2003 and 47 in 2005 (Delbridge, 2005). Disqualification of a youth exhibitor causes economic hardship and decreased participation in youth agricultural programs.

The establishment of policy to improve the welfare of exhibited lambs as related to rectal prolapse requires an understanding of causal factors. It is important to note that the previous studies that evaluated the effect of dock length on rectal prolapse indicated that sex, feeding regimens, environmental conditions, and body condition also affected the incidence of rectal prolapse (Thomas et al., 2003; Windels, 1990). The present study was undertaken to directly assess factors contributing to the incidence of rectal prolapses in growing lambs raised in a common environment. Specifically, the effects of sex, breed, dock length, and enhanced muscling on incidence of rectal prolapse were evaluated in a controlled feedlot environment.

Materials and Methods

Animal Housing and Nutritional Management

Lambs were born at the Texas Tech Sheep Center in New Deal, Texas, in spring of 2004 (n = 212) and 2005 (n = 170). The Texas Tech University Institutional Animal Use and Care Committee approved the experimental protocols for this study. During pregnancy, ewes had ad libitum access to long-stemmed Sudangrass hay (*Sorghum bicolor* L.) and were supplemented with 0.91 kg of whole corn per (as-fed basis) once daily during the final trimester and lactation. Lambing occurred in large indoor, soil-surfaced pens with outdoor access, and type of birth was recorded for each ewe. Ewes and their lambs were moved to larger outdoor pens when lambs were approximately 14 d of age.

Before weaning, lambs had ad libitum access to creep feed (Table 1) and ewes and lambs had ad libitum access to long-stemmed Sudangrass hay and sheep mineral block (Hi-Pro Feeds, Friona, Texas). At approximately 3 wk of age, ewe and lamb pairs were moved to non-irrigated wheat pasture (*Triticum itdeis* L.) for daylight grazing; the wheat was in the jointing stage of growth.

Lambs were weaned at approximately 60 d of age or when they reached 22.7 kg of BW, at which time they were treated with the parasiticide Valbazen (Pfizer Animal Health, Exton, Pa.) and moved to the feeding facility. At the feeding facility, weaned lambs were group-housed in comparable and adjacent soil-surfaced feeding pens that were partly sheltered with outdoor access. Lambs were fed a cracked-corn-based-concentrate diet (Table 1) in concrete fence-line feeders and had access to water using an automatic watering system. Lambs were dewormed again 60 d after weaning using Ivomec (Merial, Duluth, Ga.). Lambs were fed once daily according to NRC (NRC US, 1985)

Table 1: Composition of the Creep and Growing Diet on DM basis

Ingredient	% of diet on DM
Cracked Corn	63.2
Cottonseed Meal (41% crude protein)	5.75
Soybean Meal (44% crude protein)	3.76
Cottonseed Hulls	10.5
Alfalfa Pellets	10.0
Calcium Carbonate	1.2
Ammonium Chloride	0.5
Cane Molasses	5.0
Premix[a]	0.03
Chemical Composition	
DM, %	87.26
Ash, %[b]	7.53
CP, %[b]	13.82
Ca, %[b]	1.03
P, %[b]	0.39

[a] Premix included vitamin A, selenium, and Deccox (Zoetis, Florham Park, NJ) as recommended by the NRC (1985)
[b] Presented as percentage of DM

requirements for growing lambs until they reached a target weight of 56.7 kg, at which time they were removed from the study.

Lamb Processing

Lambs were processed at 10 d to 14 d of age. Processing included an individual ear tag, vaccination with Bar Vac Clostridium perfringens types C and D with tetanus toxoid (Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Mo.), and tail docking (described in a subsequent section). Lamb-identification number, type of birth (single, twin, or triplet), dam-identification number, and breed were recorded. Approximately 21 d after initial vaccination, lambs were revaccinated as above, inspected for tail infection or "fly strike", and then placed in the feeding pens. In the rare case of an infection, lambs were treated with fly spray and oxytetracycline (1 mL/100 mg, Oxy-Tet 100; Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Mo.).

All male lambs were castrated with Elastrator bands at approximately 30 d of age. The scrotal area was sprayed with a fly repellent, and lambs were monitored for infection for 14 d after application of the Elastrator band.

Treatments

Breed and Callipyge:

Lambs were from ewes of the following breeds and crosses: Rambouillet, Suffolk x Hampshire cross, crossbred (various combinations of Rambouillet, Suffolk, Hampshire, and hair sheep), and hair sheep (Barbado and St. Croix). The same six sires were used in the two-year study and included Rambouillet (two sires), St. Croix, Suffolk, Hampshire, and Barbado. To determine if enhanced muscle growth influenced the incidence of rectal prolapse, the callipyge mutation was included as a variable (Table 2). The callipyge gene is an autosomal dominant mutation that significantly increases the muscle mass of lambs during 45 d to 60 d of age (Jackson and Green, 1993; Koohmaraie et al., 1995). One Rambouillet sire was homozygous for the callipyge mutation, two sires were heterozygous, and the remaining sires were homozygous normal. The expression of the callipyge trait is governed by a 'polar overdominance' mode of inheritance (Cockett et al., 1996) in which the callipyge phenotype is expressed only if inherited from the sire; if a lamb has two copies, one from the dam and one from the sire, the lamb has normal phenotype. Some dams used in the study were heterozygous or homozygous for the callipyge mutation. Although the callipyge phenotype is discernible only after three weeks of age (Cockett et al., 1999), which is after docking, the callipyge phenotype was represented in all breed, sex, and docking-length groups.

Docking Procedure and Treatments

The tail of the lamb was docked with an Elastrator band, similar to that employed by Windels (1990) and Thomas et al. (2003). To ensure consistency in dock length, all lambs in the two-year study were docked by the same person. Lambs were stratified by breed (Rambouillet, Suffolk x Hampshire cross, crossbred, or hair), sex, and type of birth, then within these strata, lambs were assigned randomly to one of three docking-length treatments: 1) short-docked,

Table 2. Sires used in the study and number of lambs presenting with rectal prolapse. Sire genotype for the callipyge mutation is designated as normal (NN), heterozygous for the mutation (CN), or homozygous for the mutation (CC).

Sire Breed	No. Lambs Sired	No. of Rectal Prolapse
Hampshire (NN)	36	0
Suffolk (CN)	78	0
Rambouillet (NN)	80	0
Rambouillet (CC)	53	1
Barbado (CN)	49	2
St. Croix (NN)	86	5

* Hair sheep (lambs sired by the Barbado and St. Croix rams) had significant ($P < 0.01$) contribution to prolapse occurrence.

in which an Elastrator band was placed as close as possible to the body (n = 139); 2) medium-docked, in which the Elastrator band was placed on the tail midway between attachment of the tail to the body and attachment of the caudal folds to the tail (n = 124); and, 3) long-docked, in which the Elastrator band was placed on the tail at the attachment of the caudal folds to the tail (n = 119). Caudal folds of the tail are the webs of skin on both sides of the anus, with one end connected to the ventral side of the tail and the other end connected to the body. These treatments were similar to those used by Thomas et al. (2003). At weaning, lambs were assigned randomly to the feeding pens, such that all breeds, both sexes, all dock lengths, and callipyge phenotype were represented in each pen.

Data Collection

Lambs were evaluated for rectal prolapse every 24 h. Rectal prolapse for this study was defined as the eversion of the rectum with a protrusion of 4 cm or more through the anus, which remained protruded when the lamb was standing. If a lamb prolapsed and the prolapse was exteriorized for a sustained time within a 24-h period, the event was recorded as a prolapse. Any lamb observed with a rectal prolapse that remained exteriorized as defined, yet subsequently resolved without treatment, was still classified as having a rectal prolapse (Thomas et al., 2003).

Statistical Analyses

Proportions of lambs that exhibited rectal prolapse were analyzed using the Glimmix procedure of SAS (SAS Inst., Inc., Cary, N.C.), assuming a binomial distribution (prolapse vs. no prolapse). Initial analyses fitted models with effects of dam nested within breed, sire nested within breed, breed, sex, type of birth, callipyge phenotype, year, and treatment. Nested-dam and sire effects were not significant, and subsequent models were reduced to the fixed effect of breed. Year was treated as a fixed effect because models would not converge when it was considered a random effect. Interactions among breed, sex, type of birth, and callipyge phenotype were not evaluated, but interactions of breed, sex, type of birth, and callipyge phenotype with docking length were not significant ($P > 0.10$). After removal of type of birth and callipyge phenotype ($P > 0.10$), the final model included fixed effects of breed, sex, docking length, and year.

Results and Discussion

The objective of this study was to determine if sex, breed, docking length, and enhanced muscling represented by the callipyge phenotype influenced the incidence of rectal prolapse in lambs under uniform processing and feedlot conditions.

Overall Incidence of Prolapse in Male and Female Lambs

Of 382 lambs used in this study, 174 were ewe lambs, and 208 were wethers. The callipyge phenotype was expressed in 76 of the lambs, with approximately equal representation in ewe and wether lambs. Over the two years, the overall incidence of rectal prolapse in lambs of the present study population was 2.1 percent. Only eight lambs were observed to have a rectal prolapse, of which six occurred in ewe lambs, though sex was not a significant factor ($P > 0.09$). Previous studies assessing rectal prolapse in lambs have reported the incidence to range from 0.12 percent to nearly 8 percent depending on the geographical location within the United States. Reported variability might reflect differences in climate, housing, diets, as well as operator variation in execution of the docking protocol. The present study was designed to minimize those environmental differences.

Type of birth (single, twin, triplet) had no significant effect on occurrence of rectal prolapse ($P > 0.1$). Further, no full siblings having different docking lengths experienced rectal prolapses, which prevented any further evaluation of birth type on prolapse. The study was conducted over a 2-year period (2004 and 2005). In 2004, seven lambs prolapsed; whereas in 2005, there was only one rectal prolapse; the prolapses in the two years were from different dams. Year was not a significant effect ($P > 0.07$). In contrast, Windels (1990) observed a significant effect of year, with one year yielding two rectal prolapses and the following year yielding 21. Though not significant in the present study, year effects on prolapse incidence might be attributed to environmental factors, such as rainfall, heat, and humidity. The study by Thomas et al. (2003) had dramatically different incidences of prolapses depending on geographic location, perhaps reflecting dissimilar environmental variables at the various sites, while also suggesting a role of environmental conditions on prolapse.

Breed and Callipyge phenotype

Breeds represented in the lambs of present study included hair sheep (Barbado and St. Croix), Rambouillet, Suffolk x Hampshire crosses, and crossbreds of various combinations of Rambouillet, Suffolk, Hampshire, and hair sheep (Table 3). There were 131 Rambouillet, 63 Suffolk x Hampshire crosses, 58 crossbred, and 130 hair sheep used in the study. The incidence of prolapse was greater ($P < 0.01$) for lambs of hair sheep (seven of eight lambs) than that for the other breeds or crossbreeds of sheep. Hair sheep lambs represented 34 percent of the study population. The fine wool Rambouillet breed, also representing 34 percent of the study population, had only a single prolapse. No prolapses were observed in Suffolk x Hampshire crosses or other crossbred lambs. This last result is surprising relative to the other large study in which the greatest prolapse incidences were observed in black-face breeds (Thomas et al., 2003).

Progeny from a single hair-sheep, St. Croix ram accounted for five of the eight prolapsed lambs (62.5 percent), one Barbado ram accounted for two lambs (25 percent), and the homozygous Rambouillet ram accounted for one prolapsed lamb (12.5 percent). Taken together, lambs from these two hair rams accounted for 87.5 percent ($P < 0.01$) of the observed prolapses. There is interest in the genetic contribution in the predisposition to rectal prolapse. Producers have noted certain sires seem to predispose progeny to rectal prolapse. For example, in a feedlot-growth study in which two Suffolk sires were used on commercial Polypay ewes, 37 percent of the 43 commercially, long-

Table 3. Incidence of rectal prolapse in lambs with short, medium and long tail docking.

		No. of Lambs/ Treatment[a]			No. Rectal Prolapses		
Breed	**Sex[b]**	**S**	**M**	**L**	**S**	**M**	**L**
Hair	M	23	22	18	0	1	0
Hair	F	23	22	22	1	5	0
Rambouillet	M	29	24	21	0	0	1
Rambouillet	F	20	21	16	0	0	0
Crossbred[c]	M	15	10	8	0	0	0
Crossbred	F	9	9	7	0	0	0
Suffolk x Hampshire cross	M	15	8	15	0	0	0
Suffolk x Hampshire cross	F	6	7	12	0	0	0
Total within docking treatments		139	124	119	1	6	1

[a] Docking treatment: S = Short, M = Medium, L = Long. Docking length was not significant ($P > 0.05$).
[b] Sex: M = Male, F = Female.
[c] Crossbred is a combination of two or more breeds.

docked lambs exhibited rectal prolapse (Smith et al., 2006). In the present study, all but one of the breeds were represented by one sire, and any breed effect might by caused by, or confounded with, our use of single sires within a breed. The two hair-sheep sires used in the present study may have transmitted a greater genetic propensity for rectal prolapse. Alternatively, if the length of the docked tail is a factor contributing to rectal prolapse in lambs, then it is possible that hair-sheep producers have not genetically selected against rectal prolapse, and any docked lamb would be more prone to prolapse.

Although not documented, it has been suggested that the callipyge mutation, with its enhancement of muscle hypertrophy, might be associated with a greater incidence of rectal prolapses in lambs. The present is the first study to evaluate a relationship between the callipyge phenotype and rectal prolapse in lambs. Of the 76 callipyge lambs in the study, none experienced a rectal prolapse (Table 4). These results indicate that the presence of the callipyge gene with its concomitant increased muscling does not increase the incidence of rectal prolapse, though the overall low incidence of rectal prolapse across all lambs in the study should be considered.

Dock Length

There were 139 short-, 124 medium-, and 119 long-docked lambs. Of the eight lambs that experienced a rectal prolapse, one was from the short-docked treatment, six were from the medium-docked treatment, and one from the long-docked treatment (Table 3). Of the 139 lambs that received the short-docked treatment, no cases of fly strike were observed. In 2005, two long-docked lambs were treated for fly strike after scouring and fecal matter collected around the long dock provided the opportunity for flies to lay eggs in the soiled wool.

There was no difference ($P > 0.05$) of docking treatments on rectal prolapse: 0.27, 1.6, and 0.27 percent for short-, medium-, and long-docked lambs, respectively. The current results differ from those of Thomas et al. (2003), in which the incidence of rectal prolapse was greater for short-docked lambs (7.81 percent) than for either medium (3.97 percent) or long-docked (1.85 percent) lambs. Windels (1990) also reported a lower incidence of rectal prolapse in lambs with a longer dock length. The method for short docking used by Windels (1990) was equivalent to the medium-docking method used in the study by Thomas et al. (2003) and the present study. In all three studies, lambs docked midway between the attachment of the tail to the body and the caudal folds to the tail resulted in a greater tendency of rectal prolapse than that of long-docked lambs.

The differences between the results for length of dock in the present study and those of the previous studies may be related to differences in experimental design across the studies. The present study balanced the short-, medium-, and long-docking treatments across four breed types. Furthermore, the common environment and diet permitted a direct comparison of docking treatments. In the earlier study by Thomas et al. (2003), the investigators used different docking protocols at different research facilities, with some facilities not employing all three dock lengths, as well as variability in the different operators performing the docking; the latter is recognized to introduce variability in tail length (Goodwin et al., 2007). The low-overall incidence of rectal prolapse observed in the present study may reflect concerted, genetic selection by producers to reduce susceptibility to prolapse within commercial sheep breeds that use docking as a common practice. A final point to be considered is that although the study employed the docking conditions defined by Thomas et al. (2003), the present study may not have adequately captured the ultra-short docking that has been implicated in rectal prolapses.

Table 4. Distribution of docking treatments across callipgye lambs; no callipyge lamb presented with a rectal prolapse.

	No. of Lambs/Treatment[a]		
Phenotype	**S**	**M**	**L**
Callipyge	28	18	30
Normal	111	106	89

[a] Docking treatment: S = Short, M = Medium, L = Long.

Conclusions

This study was conducted to evaluate factors contributing to rectal prolapse in lambs. Noting the limitations of earlier experiments, the experiment was designed to eliminate as many variables as possible; the present study was undertaken at a single facility with a single docking operator, common diets throughout fetal and postnatal life, and common vaccination protocols with the docking treatments evenly distributed across breed, sex, and muscling. Results of the present study indicate a lower percentage of lambs exhibiting rectal prolapse compared to the overall percentage in the study by Thomas et al., (2003). However, the incidence observed in the present study was not different than that reported by Thomas et al. (2003) for some of their experimental sites. Furthermore, there were no statistically significant differences among the three tail docking lengths. Differences were noted with respect to breed type. There exist numerous theories regarding causal factors for rectal prolapse in lambs including excessive body condition, environment, genetics, nerve damage at docking, and diets; however, there is limited research that assesses their contributory role. While the results of the present study do not eliminate dock length as a contributing factor to rectal prolapse, the results underscore that other factors can have equal or greater effects on the prevalence of rectal prolapse in finishing lambs. Collectively, the few studies that have evaluated dock length in a controlled fashion have identified numerous factors that contribute to rectal prolapse beyond dock length, indicating the need for further research.

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