A comparative study on the impact of the Breeching Process, on merino lambs.

J Brady^, J Steinfort*

Objective To determine the impact of the Breeching Process (BP), applied to the tail and perineal breech of merino lambs at lamb marking, as measured by their average body weight gain (AWG), and average fleece weight, in the period following the cryogenic process.

Design The three groups of lambs in the trial are as follows: **Breeching Process (BP)** (now known as "Steining") group, a **Surgically Mulesed (SM)** group, and **Lamb Mark Only (LMO)** group. The results for the **BP** and **SM** groups will be compared to each other, with the **LMO** group acting as a control.
The trial was conducted at lamb marking and in conjunction with the other procedures listed.

Results The BP group had a 1.3 kg higher AWG in the first 36 days of the trial, and a 1.1 kg higher AWG up to day 267 of the trial, compared to the SM group. The fleece weights of the BP group were 0.1 kg heavier than the SM group.
The BP group had the same AWG in the first 36 days, and had a 0.1 kg lower AWG, up to day 267, compared to the LMO group. The fleece weights of the BP and LMO groups were the same.

Conclusion There was no evidence of a negative impact on the lambs that had the BP process.

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Introduction

Mulesing is the removal of wool-bearing skin from around the tail and breech of a sheep using mulesing shears. The wool around the tail and breech can retain faeces and urine, which attracts flies. Mulesing is a common practice in Australia, particularly on highly wrinkled merino sheep. There are animal welfare concerns associated with the mulesing procedure.

The Breeching Process aims to reduce the excess skin on the tail and excess breech skin and or wrinkles adjacent the perineum, and to tauten the skin in these areas to allow ease of shearing and crutching. This in effect, will reduce dag accumulation and by correlation reduces the risk of breech fly strike.

Referring to the Breeching Process, wool-bearing skin from sides of the tail and adjacent to the perineal breech is tented upwards and clamped in between the applicator jaws, each being a length of 75mm on lambs. The liquid nitrogen is released from these jaws onto the base of the tented clamped skin. The cryogenic liquid freezes the clamped skin fold. As liquid nitrogen is applied to the base of the tented skin, the effective freeze ascends the clamped skin fold. This ensures a complete cryogenic freeze to the area of skin targeted. The gathering, tenting and clamping at the base of the targeted skin ensures the subcutaneous tissues and underlying muscles are protected.

There is some immediate discomfort experienced with the release of liquid nitrogen onto the tented skin. After release from the cradles, the lambs are noted to be moving around quite freely immediately and are actively moving and mothering up within the holding paddock.

The skin that has been cryogenically targeted goes through an initially swelling then contraction process, over the next 6 to 8 weeks. The process results in scab formation which covers the targeted skin area. When the underlying skin is fully healed, the scab lifts off as a narrow banded eschar with the associated wool. The adjacent skin tautens during the healing process and the junctional area has a fine lineal scar.

The cryogenic action is to freeze the full skin thickness of the targeted area. When the skin freezes, ice crystals are formed within the cells and the interstitial area. Intracellular components are structurally changed and results in a strategic degenerative and regenerative physiological process.

Joe Brady, a veterinarian, was the trial supervisor and Chris Parker was the livestock contractor and certified livestock weigher.

The trial was conducted with the assistance of Richard McShane, the manager of the property, “Mokanger”, at Cavendish, Vic. Richard commented that they had a very good spring in 2016. The ewes and lambs were on a phalaris and subterranean clover pasture, and the lambs were later weaned onto a crop of Winifred brassica, and supplemented with a ration of oats and lupins.

All of the ewes included in this mob of 550 ewes had been pregnancy tested by ultrasound, and were diagnosed with single lamb pregnancies. The ewes were run as one mob prior to and after lambing. The age of the lambs in this trial ranged from 11 weeks down to 4 weeks of age, at the start of the trial.

Method

On the trial start day, on the 10.11.2016, three lambs at a time were loaded from a catching pen onto a five cradle rotary sheep handler, by the manager, Richard McShane. The first lamb loaded was allocated to the SM group, the second lamb loaded was allocated to the BP group, and the third lamb loaded was allocated to the LMO group. If a lamb had a very low body condition score, it was not included in the trial.

The SM group was tail docked with a gas knife, castrated with a ring if they were a ram lamb, and surgically mulesed. Tri-Solfen was applied to the mules wound, and the tail end wound. The BP group was tail docked with a Steinfort Agvet gas knife, and castrated with a ring if they were a ram lamb. The BP process was applied to the tail and breech of this group, and Tri-Solfen was applied to the tail end wound. The LMO group was tail docked with a Steinfort Agvet gas knife, castrated with a ring if they were a ram lamb, and Tri-Solfen was applied to the tail end wound.

All the lambs were identified with an Enduro Tags EID tag, with the back of the tag a different colour for each group. All the lambs had Click applied as a precaution to prevent fly strike, and were vaccinated with Gudair, Scabby Scratch, and 6 in 1 vaccines.
All the lambs had their EID tag read, and were weighed.
There were 536 lambs included in the trial. There were 188 in the SM group, 177 in the BP group, and 171 in the LMO group. The average weight for each group at the start of the trial was, 18.1 kg for the SM group, 18.9 kg for the BP group, 19.0 kg for the LMO group.

The first revisit was on the 16.12.2016, at day 36 into the trial. There were 534 lambs presented and their EID tags scanned, and each lamb was weighed. The second revisit was on the 30.1.2017, at day 81 into the trial. There were 534 lambs presented, and their EID tags scanned, and each lamb was weighed. The third revisit was on the 18.4.2017, at day 159 into the trial. There were 526 lambs presented, and their EID tags scanned, and each lamb was weighed.
All the lambs were then shorn, and each lambs fleece was weighed.

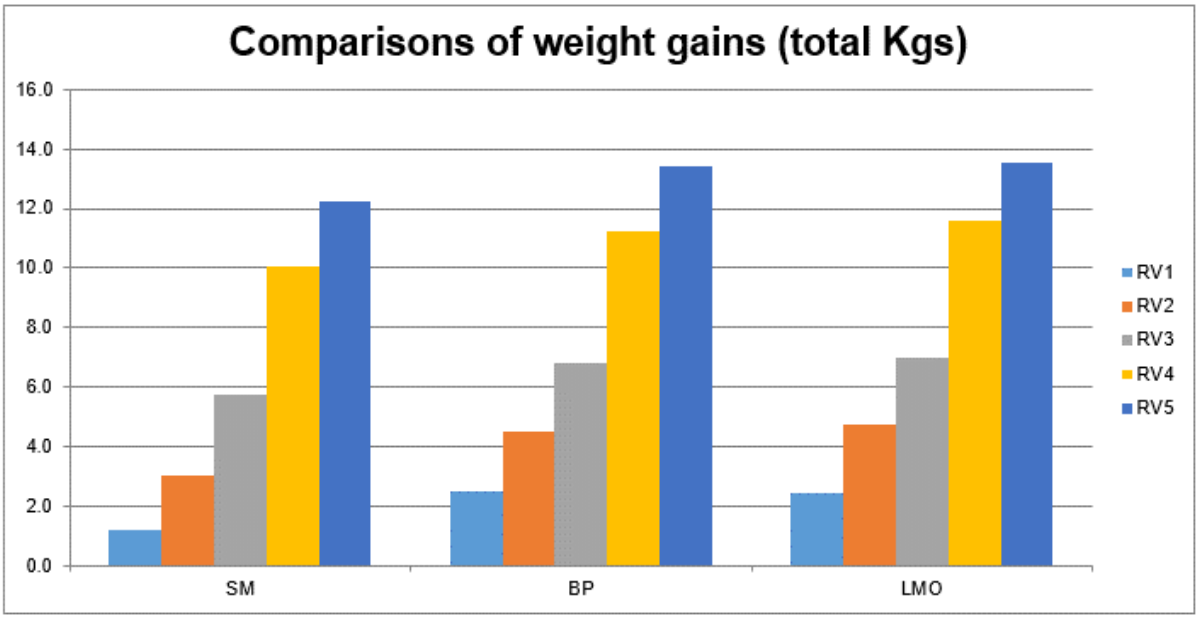
The fourth revisit was on the 21.6.2017, at day 223 into the trial. There were 525 lambs presented, and their EID tags scanned, and each lamb was weighed. The fifth revisit was on the 4.8.2017, and 520 lambs were presented, and their EID tags scanned, and each lamb was weighed.

Results

The average body weight gains for each group, in the interval between each weighing of the lambs, are displayed in the following table and graph.

Comparision of average interval weight gains (Kgs)

Process	Day 36 (RV1)	Day 81 (RV2)	Day 159 (RV3)	Day 223 (RV4)	Day 267 (RV5	RV2 - RV1	RV3 - RV2	RV4 - RV3	RV5 - RV4
SM	1.2	3.0	5.7	10.1	12.3	1.8	2.7	4.3	2.2
BP	2.5	4.5	6.8	11.2	13.4	2.0	2.3	4.5	2.2
LMO	2.5	4.7	7.0	11.6	13.5	2.3	2.3	4.6	1.9



For the first trial weight interval, the AWG for lambs in the SM group was 1.2 kg, for the BP group it was 2.5 kg, and for the LMO group it was 2.5 kg. For the second trial weight interval, the AWG for lambs in the SM group was 1.8 kg, for the BP group it was 2 kg, and for the LMO group it was 2.3kg.

For the third trial weight interval, the AWG for lambs in the SM group was 2.7 kg, for the BP group it was 2.3 kg, and for the LMO group it was 2.3 kg. For the fourth trial weight period, the AWG for lambs in the SM group was 4.3 kg, for the BP group it was 4.5 kg, and for the LMO group it was 4.6 kg. For the fifth trial weight interval, the AWG for lambs in the SM group was 2.2 kg, for the BP group it was 2.2 kg, and for the LMO group it was 1.9 kg. The AWG over the whole trial period in the SM group was 12.3 kg, in the BP group it was 13.4 kg, and in the LMO group it was 13.5 kg.

Fleece Weights

Average Fleece Weight (Kgs)	RV3
SM	1.70
BP	1.80
LMO	1.80

The average fleece weight for SM group was 1.7 kg, for the BP group it was 1.8 kg, and for the LMO group it was 1.8 kg

Discussion

The SM group had a lower AWG compared to the BP group, in both the first and second weight interval periods. This lower AWG was particularly noticeable in the first weight interval period, where the AWG for the SM group was 50% below that of the BP group.

There was no AWG difference between the BP group and the LMO group in the first weight interval period.

The AWG over all periods, totaling 267 days, was 1.1 Kg lower in the SM group compared to the BP group. The initial difference between these two groups in the first revisit period was 1.3 Kg. The AWG over all periods, totaling 267 days was 0.1 kg lower in the BP group compared to the LMO group.

There was only a small difference in the fleece weights between the groups, with the SM group fleeces 0.1 Kg lighter than those of the BP and LMO group.

Conclusions

The SM group received an initial setback due to the surgical mulesing procedure, that was quite marked compared to that of the BP group. This was evident at the first revisit, where there was a 50% reduced AWG.

After 267 days of the trial, the SM group had an AWG that was still less than the AWG of the BP group. This is evidence that the impact of the surgical mulesing procedure was having a prolonged effect on AWG for the lambs that were mulesed.

As there was no AWG difference between the BP and LMO groups at the first revisit, it is evident by the AWG comparisons that the BP process did not provide a negative impact on the lambs.

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Study design

The study examined the effect of different procedures (treatments) and combinations of procedures comprising a suite of lamb marking interventions on subsequent lamb growth and fleece production. Lambs were allocated to procedure groups and processed accordingly at recruitment. Sex and starting weights were recorded. Regular revisits occurred. Lambs were weighed at most of these visits. Completion of lamb-marking interventions occurred at a subsequent revisit for some procedures and some sexes (ram lambs). This intervention occurred after the third reweighing visit.

The events that variously occurred and combined to make an individual procedure group included:

1. Lamb marking procedure with SAV cautery docking apparatus.
2. Ram lamb marking (with elastrator rings)
3. Mulesing using traditional surgical technique & Standard cautery docking apparatus.
4. Breeching Process with liquid nitrogen with SAV cautery docking apparatus.

Combinations of these interventions were used to define procedure groups. Sex was included as a variable of interest. The presence of multiple perfectly (collinear) interventions within each procedure group will make it difficult to confirm that any individual intervention component of the procedure was the cause of differences in performance between groups. Sheep were shorn at reweigh visit 3.

There were three procedure groups (Table 1). The statistician was blinded to the nature of the lamb marking interventions that comprise each procedure group.

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Table 1: Procedure groups

Tag Colour	Procedure group
Black	X
Red	Y
Yellow	Z

The following activities occurred (Table 2):

Table 2: Study activities

Time point	Visit No.	Date	Activity
1	Wt1	2016-11-10	Initial visit & weigh
2	Wt2	2016-12-16	Revisit & weigh
3	Wt3	2017-01-30	Revisit & weigh
4	Wt4	2017-04-18	Revisit & weigh
5	V5	2017-05-30	Breeching process - mechanical issues (non-start)
6	Wt5	2017-06-21	Breeching process - procedure completed
7	Wt6	2017-08-04	Revisit & weigh

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Descriptive statistics

The number of lambs per group is presented in Table 3.

Table 3: Total lambs per group

Procedure	No. Lambs
Black	183
Red	177
Yellow	171

The number of lambs by sex status per group is presented in Table 4.

Table 4: Lamb sex status by group

Procedure	Sex	No. Lambs
Black	Female	94
Black	Male	89
Red	Female	86
Red	Male	91
Yellow	Female	76
Yellow	Male	95

The number of observations per lamb per group is presented in Table 5.

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Table 5: Total measurements per lamb per group

Procedure Group	No. Measurements	No. Lambs
Black	1	1
Black	2	3
Black	3	2
Black	4	3
Black	5	174
Red	1	1
Red	2	2
Red	4	2
Red	5	172
Yellow	4	6
Yellow	5	165

The number of lambs per group providing 6 revisit observations per group is presented in Table 6.

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Table 6: Number of valid trial lambs (5 revisits) per procedure group

Procedure Group	No. Lambs
Black	174
Red	172
Yellow	165

The number of lambs per group and sex class providing 6 revisit observations per group is presented in Table 7.

Table 7: Number of valid trial lambs (5 revisits) by sex category per procedure group

Procedure Group	Sex	No. Lambs
Black	Female	90
Black	Male	84
Red	Female	84
Red	Male	88
Yellow	Female	72
Yellow	Male	93

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Weight data was normally distributed. See Figure 1 and Figure 2. No transformations were required prior to statistical analysis.

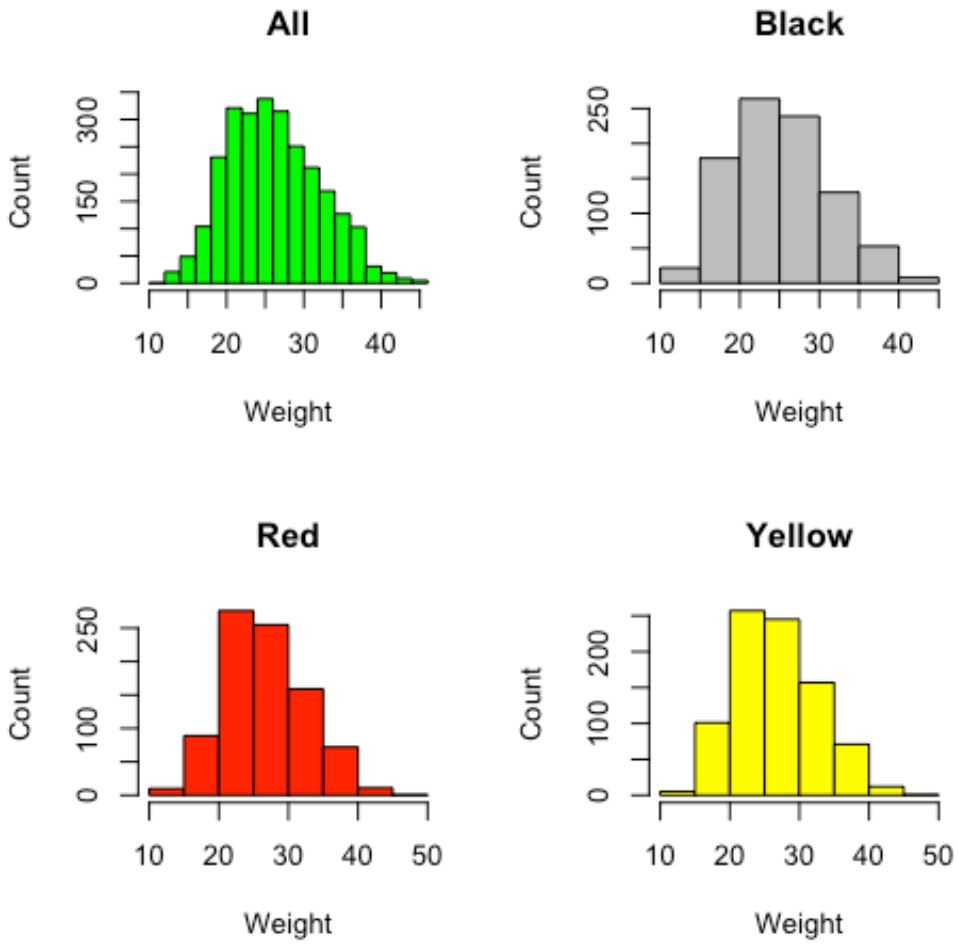

Figure 1: Histogram of weights for all lambs and by individual procedure group (all weighing time points)

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The boxplots of weights at the initial visit (day 0) is presented in Figure 2 below. Note that the average starting weight of the black tag group appears to slightly lighter than the red and yellow tag groups.

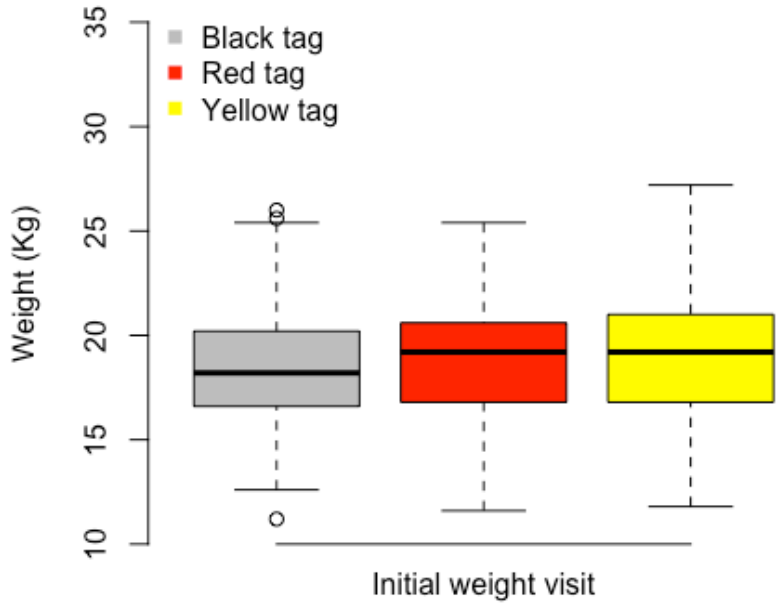

Figure 2: Lamb weight boxplots by procedure group at recruitment

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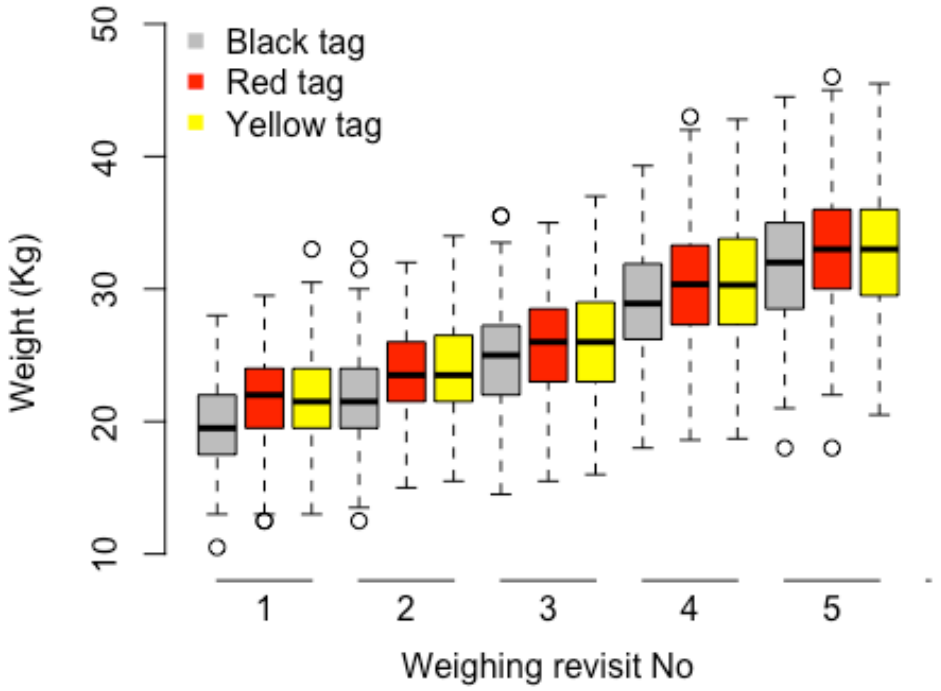

Figure 3: Boxplots of lamb weights by procedure group and reweigh visit number

The histogram of weights at each revisit time by sex class is presented in Figures 4 to 5 below.

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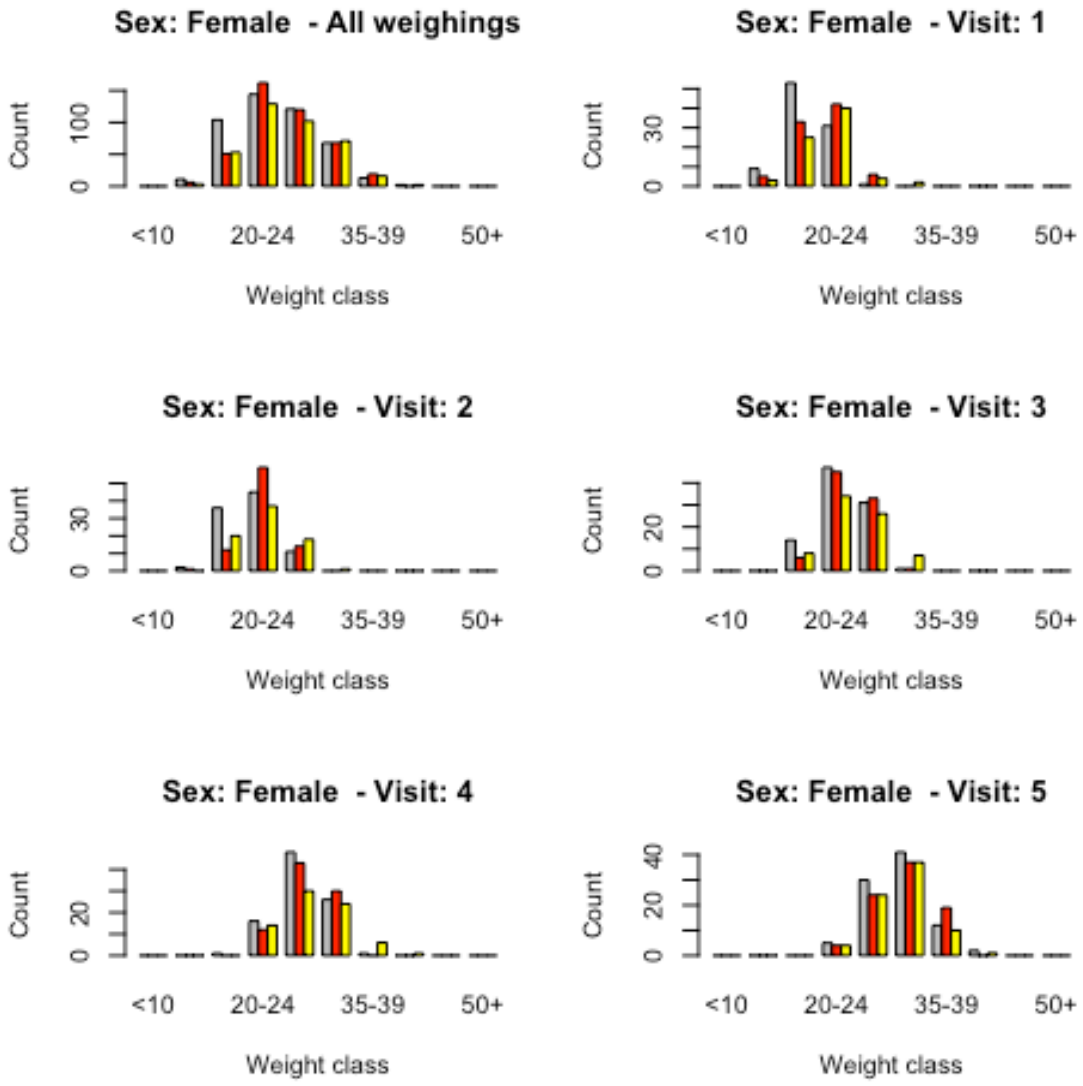

Figure 4: Histogram of lamb weight class by procedure group at each reweigh visit for ewe lambs

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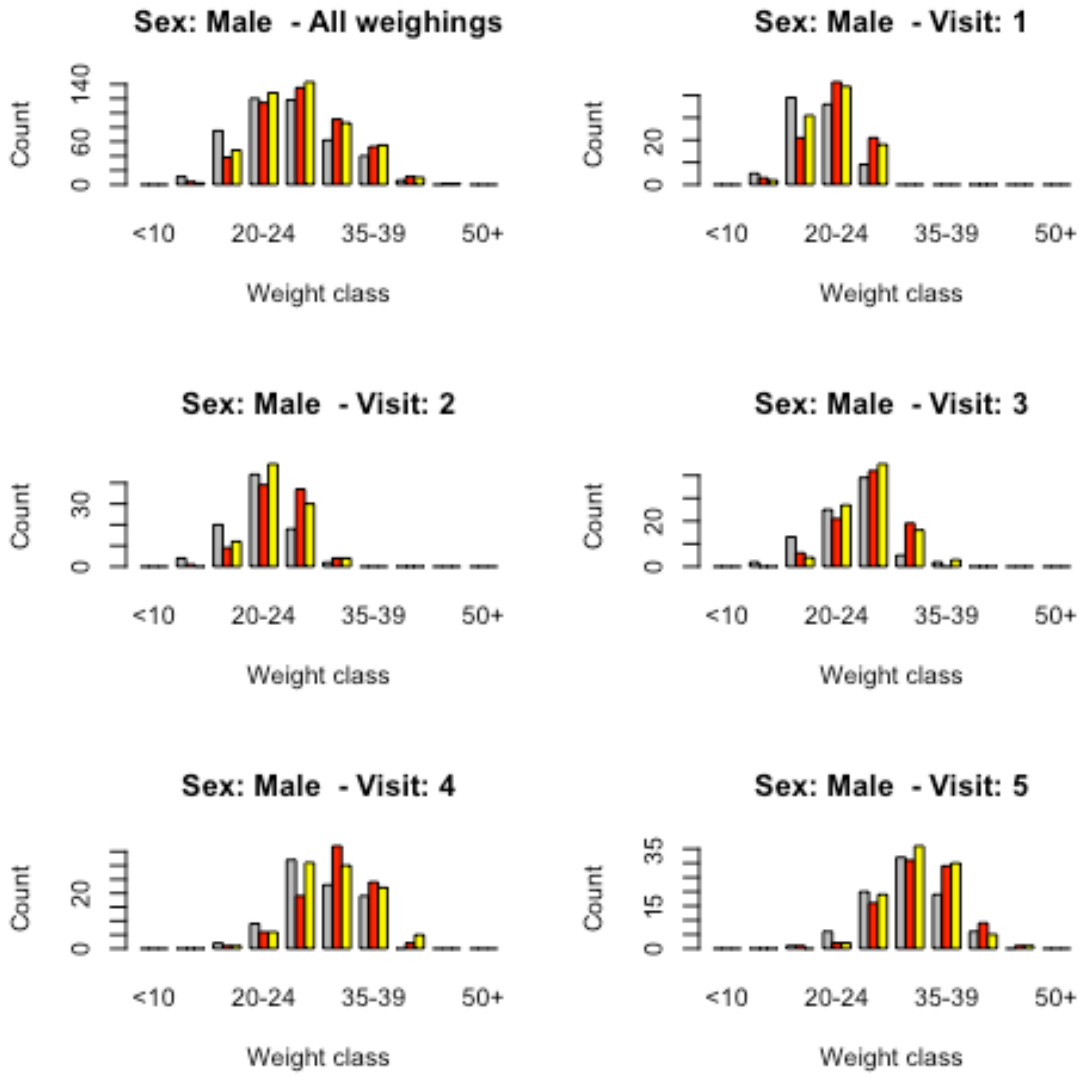

Figure 5: Histogram of lamb weight class by procedure group at each reweigh visit for ram lambs

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Statistical analysis

Weight data was normally distributed so linear methods were applied using non-transformed (raw) weight data. A generalized linear model (GLM) to predict weight at each visit time. Predictor variables were sex and procedure group.

Weight ~ Sex + Procedure

For reweigh data, the initial weight of the lamb was also included into the model as an offset variable. This adjustment helps to control for differences in revisit weight that were due to differences in starting weight.

Revisit Weight ~ Sex + Procedure + Initial Weight (Wt1)

Results are presented in Tables 8 to 13 below

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Initial weights

Table 8: GLM of initial lamb body weights by procedure group and sex

	Estimate	Std. Error	T stat.	P value
(Intercept)	17.913	0.236	75.85	0.000
Procedure - Red	0.516	0.292	1.76	0.078
Procedure - Yellow	0.559	0.295	1.89	0.059
Sex - Male	1.190	0.241	4.94	0.000

Individual procedure group comparisons for starting weights of lambs is presented in Table 9 below.

Table 9: Pairwise comparison of initial lamb weights by procedure group and sex

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	0.516	0.292	1.765	0.183
Yellow - Black	Yellow-Blue	0.559	0.295	1.892	0.142
Yellow - Red	Yellow-Red	0.043	0.297	0.145	0.988

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Individual reweighing time points

Revisit 1

Table 10: GLM of reweigh visit 1 lamb body weights by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	3.981	0.690	5.77	0.000
Procedure - Red	1.388	0.247	5.63	0.000
Procedure - Yellow	1.364	0.250	5.45	0.000
Sex - Male	0.221	0.208	1.06	0.287
Wt1	0.845	0.037	22.92	0.000

Individual procedure group comparisons for weight at reweigh 1 is presented in Table 11 below.

Table 11: Pairwise comparison of reweigh visit 1 lamb weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	1.388	0.247	5.628	0.000
Yellow - Black	Yellow-Blue	1.364	0.250	5.450	0.000
Yellow - Red	Yellow-Red	-0.025	0.250	-0.099	0.995

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Revisit 2

Table 12: GLM of reweigh visit 2 lamb body weights by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	5.498	0.712	7.72	0.000
Procedure - Red	1.589	0.255	6.22	0.000
Procedure - Yellow	1.539	0.258	5.97	0.000
Sex - Male	0.385	0.215	1.79	0.074
Wt1	0.858	0.038	22.55	0.000

Individual procedure group comparisons for weight at reweigh 2 is presented in Table 13 below.

Table 13: Pairwise comparison of reweigh visit 2 lamb weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	1.59	0.255	6.222	0.00
Yellow - Black	Yellow-Blue	1.54	0.258	5.970	0.00
Yellow - Red	Yellow-Red	-0.05	0.258	-0.192	0.98

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Revisit 3

Table 14:GLM of reweigh visit 3 lamb body weights by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	8.405	0.901	9.32	0.000
Procedure - Red	1.009	0.324	3.12	0.002
Procedure - Yellow	0.991	0.326	3.04	0.003
Sex - Male	1.078	0.272	3.96	0.000
Wt1	0.835	0.048	17.34	0.000

Individual procedure group comparisons for weight at reweigh 3 is presented in Table 15 below.

Table 15:Pairwise comparison of reweigh visit 3 lamb weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	1.009	0.324	3.116	0.006
Yellow - Black	Yellow-Blue	0.991	0.326	3.037	0.007
Yellow - Red	Yellow-Red	-0.019	0.327	-0.057	0.998

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Revisit 4

Table 16: GLM of reweigh visit 4 lamb body weights by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	12.429	1.048	11.86	0.000
Procedure - Red	1.026	0.377	2.72	0.007
Procedure - Yellow	0.970	0.381	2.55	0.011
Sex - Male	1.778	0.317	5.61	0.000
Wt1	0.846	0.056	15.10	0.000

Individual procedure group comparisons for weight at reweigh 4 is presented in Table 17 below.

Table 17: Pairwise comparison of reweigh visit 4 lamb weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	1.026	0.377	2.719	0.019
Yellow - Black	Yellow-Blue	0.970	0.381	2.549	0.030
Yellow - Red	Yellow-Red	-0.056	0.379	-0.148	0.988

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Revist 5

Table 18: GLM of reweigh visit 5 lamb body weights by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	15.332	1.171	13.093	0.000
Procedure - Red	0.637	0.421	1.512	0.131
Procedure - Yellow	0.342	0.424	0.805	0.421
Sex - Male	0.623	0.354	1.762	0.079
Wt1	0.872	0.063	13.923	0.000

Individual procedure group comparisons for weight at reweigh 5 is presented in Table 19 below.

Table 19: Pairwise comparison of reweigh visit 5 lamb weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	0.637	0.421	1.512	0.286
Yellow - Black	Yellow-Blue	0.342	0.424	0.805	0.700
Yellow - Red	Yellow-Red	-0.295	0.422	-0.700	0.764

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Total weight gain

Results for total weight gain is presented in Table 20 below. Because there may be growth rate differences between ram and ewe lambs over time there is potential for a procedure time by sex interaction, so this was included the the total weight gain analysis

Table 20: GLM of total weight gains by procedure group, sex and starting weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	15.131	1.361	11.119	0.000
Procedure - Red	0.371	0.674	0.551	0.582
Procedure - Yellow	0.359	0.699	0.513	0.608
Sex - Male	-0.520	0.675	-0.770	0.442
Wt1	-0.115	0.071	-1.610	0.108
Procedure – Red : Sex - Male	1.108	0.953	1.163	0.246
Procedure – Yellow : Sex - Male	1.111	0.965	1.151	0.250

Individual procedure group comparisons for total weight gain is presented in Table 21 below.

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Table 21: Pairwise comparison of total weight gains by procedure group, sex and starting weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	0.371	0.674	0.551	0.846
Yellow - Black	Yellow-Blue	0.359	0.699	0.513	0.865
Yellow - Red	Yellow-Red	-0.013	0.712	-0.018	1.000

Repeated measures — body weight

Repeated-measures model results are presented in Table 22 below.

Table 22: Repeated measures model of weight by procedure group, sex, starting weight (Wt1) and visit number

	T stat.	Std.Error	DF	T stat.	P value
(Intercept)	-1.090	0.769	2065	-1.417	0.157
Procedure - Red	1.180	0.274	521	4.309	0.00002
Procedure - Yellow	1.095	0.277	521	3.959	0.00009
Sex - Male	0.770	0.230	521	3.344	0.0009
Wt1	0.855	0.041	521	20.929	0.000000
Visit No.	2.303	0.021	2065	111.117	0.000000

The pairwise comparison are presented in Table 23

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Table 23: Pairwise comparison of lamb body weight change by procedure group, , sex, starting weight and visit number

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	1.180	0.274	4.309	0.00
Yellow - Black	Yellow-Blue	1.095	0.277	3.959	0.00
Yellow - Red	Yellow-Red	-0.085	0.277	-0.306	0.95

Fleece weight

Results for fleece weight is presented in Tables 24 below. Initial body weight was used as an offset variable in analysis to control for differences in fleece weight due to different body weights at first visit.

Table 24: GLM model of fleece weight by procedure group, sex and starting body weight (Wt1)

	Estimate	Std. Error	T stat.	P value
(Intercept)	0.836	0.078	10.67	0.000
Procedure - Red	0.070	0.028	2.50	0.013
Procedure - Yellow	0.056	0.028	1.99	0.048
Sex - Male	-0.040	0.024	-1.70	0.091
Wt1	0.050	0.004	11.87	0.000

Individual procedure group comparisons for fleece weight is presented in Table 25 below.

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Table 25: Pairwise comparison of fleece weights by procedure group, sex and starting body weight

	Comps	Coeffts	Sigma	T stat.	P value
Red - Black	Red-Blue	0.070	0.028	2.500	0.034
Yellow - Black	Yellow-Blue	0.056	0.028	1.985	0.117
Yellow - Red	Yellow-Red	-0.014	0.028	-0.497	0.873

Conclusions

There was no significant difference between body weights of lambs at recruitment although black tag group lambs tended to be lighter than yellow tag and red tag lambs. The inclusion of weight at recruitment into all statistical models reduced the effect of any confounding due to random differences in the starting weight of lambs. However, if differences in starting weights between groups are not due to random variation—such as a selection bias from differential allocation of individual lambs to procedure groups—statistical adjustment is not possible and any inference on causation for procedure differences between groups may not be valid.

A significant procedure effect was observed in:

- Individual timepoint (revisit) weights
- Total weight gain
- Fleece weights

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Repeated measures analysis also indicated there were differences between procedures in the rate of weight gain. Pairwise comparisons identified differences between black tag and red tags and between black tag and yellow tag groups. No difference was identified between red tag and yellow tag groups for weight at any individual reweight time point, for overall weight gain or for rate of weight gain and there was no difference in fleece weight between red and yellow tag groups.

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