

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**STUDIES OF CASTRATION AND TAILING
IN YOUNG LAMBS; INFLUENCES OF DIFFERENT
METHODS ON ACUTE DISTRESS RESPONSES.**

**A thesis in partial fulfilment of the requirements for the
Degree of**

MASTER OF SCIENCE

**in
Physiology
at
Massey University.**

STEPHEN JOHN LESTER

1991

ABSTRACT

An investigation of the acute effects of several methods (rubber rings, knife and docking iron) of castrating and tailing 4 to 5 week old lambs was performed. The investigation consisted of a study of certain anatomical aspects of the sites of castration and tailing, experimental validation of the behavioural responses as indices of distress, ranking of the various methods of castration and tailing according to the acute responses and testing of the effects of handling on lambs castrated plus tailed with the knife x

The innervation of the external genitalia and the tail was described and the pattern of innervation was discussed with respect to castration and tailing.

The behaviour elicited by castration and tailing was dependent upon the method used. Following rubber ring application the behaviours exhibited were increased activity, increased recumbency of which a high proportion was lateral, and these behaviours were associated with elevated plasma cortisol concentrations and are therefore suggested to be indicative of distress.

After use of the knife or the docking iron abnormal standing/walking behaviour was associated with elevated plasma cortisol concentrations and therefore appeared to indicate distress. The behavioural and plasma cortisol responses continued beyond the 4 hour observational period of the first experiment so a second experiment was performed. It demonstrated that the response to castration plus tailing with the knife approached completion at 8 hours. Handling of lambs to effect blood sampling did not appear to significantly affect the response.

Ranking of the methods of castration plus tailing, castration only and tailing only showed that the use of the knife was apparently more distressing than any other procedure. Apparently less distressing than the use of the knife but similar to each other were castration plus tailing with the rings, castration only with the ring, short-scrotum plus tailing with the rings and castration with the ring plus tailing with the docking iron. Tailing only with the ring and tailing only with the docking iron were apparently as distressing as handling with jugular venipuncture, although it is

suggested that the quality of the distress apparently experienced would have been different.

Thus in order to minimise the acute effects on lambs, there is evidence that the best methods are as follows.

1. For castration plus tailing: castration plus tailing with the rubber rings, short-scrotum plus tailing with the rubber rings or castration with the rubber ring plus tailing with the docking iron.

2. For castration only: castration only with the rubber ring.

3. For tailing only: tailing only with the rubber ring or the docking iron.

However there are other factors to be considered in conjunction with the above recommendations, and these are discussed.

ACKNOWLEDGEMENTS

All those who have experienced research as a student will know that the completion of a research project is only possible with direction and help from others. I would like to thank all those who have helped me over the past two years.

Thanks is particularly directed to my chief supervisor Professor David Mellor for his input and support both practical and philosophical. Also to my other supervisor Dr Ted Kirk for all his help and perseverance. Dr Robert Holmes helped with aspects of the experimental design and I appreciate his guidance.

I would like to thank Neil Ward and Nick Broomfield for all their technical help, especially in setting up the docking trials and help with the computer functions. Many thanks to the team who helped with the castration and tailing experiment: Professor Mellor, Dr Holmes, Neil Ward, Nick Broomfield, Rae Ming Ong, Roy Sparksman, Irene Hall, Debbie Anthony, Linda Randle and the Massey Sheep and Beef Cattle Research Unit staff, especially Lynley Watt, Tim Harvey and Mike Hogan. Thanks to Dr Keith Lapwood and Jane Candy for help and direction with the RIA procedures.

Also I would like to thank the many people in the Physiology and Anatomy Department for their comments and suggestions throughout the project, particularly Dr Heather Simpson and Dr Craig Franklin. Finally, I would like to thank my flatmates for all their support.

CONTENTS

PAGE

CHAPTER ONE - GENERAL INTRODUCTION

15	1.1 Animal Welfare
17	1.2 Aims
19	1.3 Stress/Distress
20	1.4 Measurement of Stress/Distress
24	1.5 Pain
25	1.6 Stress and the Hypothalamic-Pituitary-Adrenal Axis
26	1.6.1 Regulation
26	1.6.2 Metabolic Effects
27	1.6.3 Immunosuppressive Effects
28	1.6.4 Anti-inflammatory Effects
28	1.6.5 Theories on the Stress/Distress Response
28	1.7 Outline of Present Study

CHAPTER TWO- ANATOMY

30	2.1 Introduction
35	2.2 Materials and Methods
35	2.2.1 Preparation
36	2.2.2 Surgical Exposure of Nerves
37	2.2.3 Neurophysiological Mapping
37	2.2.4 Confirmation of Identification of Nerve Branches
38	2.2.5 Preparation of Figures
39	2.3 Results
39	2.3.1 Innervation of the Perineum
39	A. Anatomical Arrangements
39	B. Cutaneous Areas
40	2.3.2 Innervation of the External Genitalia
40	A. Anatomical Arrangements
41	B. Cutaneous Areas

41	2.3.3	Innervation of the Tail
41	A.	Cauda Equina
42	B.	Anatomical Arrangements
43	C.	Cutaneous Areas
45	2.4	Discussion
45	2.4.1	Innervation of the Perineum
45	2.4.2	Innervation of the External Genitalia
46	2.4.3	Innervation of the Tail

CHAPTER THREE- CASTRATION AND TAILING TRIAL

51	3.1	Introduction
57	3.2	Materials and Methods
57	3.2.1	Experimental animals
57	3.2.2	Experimental procedures
60	3.2.3	Experimental equipment
60	3.2.4	Blood sampling
60	3.2.5	Behaviour
62	3.2.6	RIA
63	3.2.7	Presentation of results
67	3.3	Results
67	3.3.1	Behavioural and cortisol responses
67	A.	General summary
69	B.	Control lambs
70	C.	Rings
70	(i)	Castration plus tailing
71	(ii)	Castration only
72	(iii)	Tailing only
73	(iv)	Short-scrotum plus tailing
74	D.	Knife
74	(i)	Castration plus tailing

75	(ii) Castration only
76	(iii) Tailing only
77	E. Docking iron
77	(i) Tailing only
78	(ii) Castration with the ring plus tailing with the iron
79	F. Restlessness
80	3.3.2 Integrated cortisol responses
81	A. Control lambs
81	B. Tailing
82	C. Castration
82	D. Castration plus tailing
82	E. Effects of different tools
82	F. Miscellaneous treatments
83	G. ACTH injection
84	3.4 Discussion
84	3.4.1 Behavioural and cortisol responses
84	A. Responses to the ring
86	(i) Validation of behavioural responses as indices of distress
89	(ii) Comparison of behavioural responses to treatments
91	B. Responses to the knife
93	C. Responses to the docking iron
94	D. Restlessness
96	3.4.2 Integrated cortisol responses
97	A. Tailing
98	B. Comparison of castration plus tailing, castration only and tailing only
100	C. Miscellaneous treatments
101	D. Conclusions
103	E. Age differences

CHAPTER FOUR - EFFECT OF HANDLING ON LAMBS CASTRATED PLUS TAILED WITH THE KNIFE

106	4.1 Introduction
107	4.2 Materials and Methods
109	4.3 Results
109	4.4 Discussion

CHAPTER FIVE - SYNOPSIS

111	5.1 Integrated Cortisol Responses
111	5.2 Behavioural Responses

114 REFERENCES

- APPENDIX A:** Example of a behaviour recording sheet
- APPENDIX B:** Plasma cortisol concentrations from Trial 1
- APPENDIX C:** Plasma cortisol concentrations from Trial 2
- APPENDIX D:** Plasma cortisol concentrations of excluded lambs

LIST OF TABLES:

PAGE	Note that Fa indicates facing page; Fo indicates following page and the number pertains to the page of text.
59	Table 3-1: Details of treatment groups, mean ages, numbers used and sex of lambs used in the castration and tailing experiment.
81	Table 3-2: Integrated cortisol responses (area) for lambs castrated and/or tailed by various methods.
108	Table 4-1: Schedule of blood samples taken.
109 Fa	Table 4-2: Mean plasma cortisol concentrations for lambs that were castrated plus tailed with the knife and blood sampled according to the schedule in Table 4-1.
109 Fa	Table 4-3: Increments in plasma cortisol concentrations from pretreatment cortisol concentrations for lambs that were castrated plus tailed with the knife and blood sampled according to the schedule in Table 4-1.

LIST OF FIGURES:

PAGE	Note that Fa indicates facing page; Fo indicates following page and the number pertains to the page of text.
20 Fa	Figure 1-1: Diagram of an 'hourglass' view of stress.
21 Fa	Figure 1-2: Model of the response to stress based on Moberg (1985).
31 Fo	Figure 2-1: Diagram of a spinal nerve.
37 Fo	Figure 2-2: Diagram of the Neurolog system used for neurophysiological mapping.
39 Fo	Figure 2-3: Arrangements of the sacral plexus and branches.
39 Fo	Figure 2-4: Cutaneous areas recorded from the proximal cutaneous branch of the sacral plexus.
39 Fo	Figure 2-5: Cutaneous areas recorded from the distal cutaneous branch of the sacral plexus.
39 Fo	Figure 2-6: Cutaneous areas recorded from the deep perineal branch of the sacral plexus.
40 Fo	Figure 2-7: Nerves of the external genitalia arising from the pudendal nerve.
40 Fo	Figure 2-8: Cutaneous areas recorded from the Dorsal Nerve of the Penis and the Scrotal Nerve.
41 Fo	Figure 2-9: Cutaneous areas recorded from the scrotal nerve.
41 Fo	Figure 2-10: Cutaneous areas recorded from the dorsal and ventral branches of the scrotal nerve.
42 Fo	Figure 2-11: Diagram of the cauda equina of the adult ram.
42 Fo	Figure 2-12: Cutaneous areas recorded from spinal rootlets at S2, S3 and S4.
42 Fo	Figure 2-13: Diagram of the cauda equina of the hogget ram.
42 Fo	Figure 2-14: Cutaneous areas recorded from spinal rootlets at S3, S4, Ca1 and Ca2.
42 Fo	Figure 2-15: Cutaneous areas recorded from dorsal and ventral spinal rootlets at Ca1 and Ca2.
42 Fo	Figure 2-16: Cutaneous areas recorded from ventral spinal rootlets at Ca1 and Ca2.
43 Fo	Figure 2-17: Arrangements of the nerve trunks in the tail.
43 Fo	Figure 2-18: Arrangements of the spinal and peripheral nerves at the proximal end of the tail.
43 Fo	Figure 2-19: Maximum extent of cutaneous areas recorded from the tail.

- 43 Fo Figure 2-20: Cutaneous areas recorded from the superficial nerve trunk of the tail at each vertebral level.
- 58 Fo Figure 3-1: Application of a rubber ring to the neck of the scrotum.
- 58 Fo Figure 3-2: Severing the distal third of the scrotum with the knife to expose the testes.
- 58 Fo Figure 3-3: Withdrawing a testis with the serrated tongs.
- 58 Fo Figure 3-4: Amputating the tail at the level of the junction of the caudal fold and tail using the docking iron.
- 60 Fo Figure 3-5: Experimental site with pens created from wire mesh gates. Lambs are adjacent to their mothers.
- 60 Fo Figure 3-6: Treatment tools; rubber ring applicator with rubber ring in place, serrated tongs, knife.
- 61 Fa Figure 3-7: Example of an abnormal posture.
- 61 Fa Figure 3-8: Example of ventral recumbency flexed posture.
- 62 Fa Figure 3-9: Example of lateral recumbency head down posture.
- 62 Fa Figure 3-10: Example of lateral recumbency with rolling and kicking.
- 64 Figure 3-11: Graph of changes in plasma cortisol concentration to illustrate calculation of the integrated cortisol response.
- 65 Figure 3-12: Diagram representing the trigonometry used to calculate parts of the area under the cortisol response curve.
- 69 Fa Figure 3-13: Changes in plasma cortisol concentrations in control lambs.
- 69 Fa Figure 3-14: Incidence of standing/walking and recumbent behaviour of control lambs.
- 69 Fa Figure 3-15: Incidence of ventral and lateral recumbent behaviour of control lambs.
- 69 Fo Figure 3-16: Incidence of normal and abnormal standing/walking behaviour of control lambs.
- 69 Fo Figure 3-17: Incidence of restlessness of control lambs.
- 70 Fa Figure 3-18: Changes in plasma cortisol concentrations in lambs castrated plus tailed with the rubber rings.
- 70 Fa Figure 3-19: Incidence of standing/walking and recumbent behaviour of lambs castrated plus tailed with the rubber rings.
- 70 Fa Figure 3-20: Incidence of ventral and lateral recumbent behaviour of lambs castrated plus tailed with the rubber rings.
- 70 Fo Figure 3-21: Incidence of normal and abnormal standing/walking behaviour of lambs castrated plus tailed with the rubber rings.
- 70 Fo Figure 3-22: Incidence of restlessness of lambs castrated plus tailed with the rubber rings.
- 71 Fa Figure 3-23: Changes in plasma cortisol concentrations in lambs castrated with the ring.
- 71 Fa Figure 3-24: Incidence of standing/walking and recumbent behaviour

of lambs castrated with the ring.

- 71 Fa Figure 3-25: Incidence of ventral and lateral recumbent behaviour of lambs castrated with the ring.
- 71 Fo Figure 3-26: Incidence of normal and abnormal standing/walking behaviour of lambs castrated with the ring.
- 71 Fo Figure 3-27: Incidence of restlessness of lambs castrated with the ring.
- 72 Fa Figure 3-28: Changes in plasma cortisol concentrations in lambs tailed with the ring.
- 72 Fa Figure 3-29: Incidence of standing/walking and recumbent behaviour of lambs tailed with the ring.
- 72 Fa Figure 3-30: Incidence of ventral and lateral recumbent behaviour of lambs tailed with the ring.
- 72 Fo Figure 3-31: Incidence of normal and abnormal standing/walking behaviour of lambs tailed with the ring.
- 72 Fo Figure 3-32: Incidence of restlessness of lambs tailed with the ring.
- 73 Fa Figure 3-33: Changes in plasma cortisol concentrations in short-scrotumed plus tailed with the rings.
- 73 Fa Figure 3-34: Incidence of standing/walking and recumbent behaviour of lambs short-scrotumed plus tailed with the rings.
- 73 Fa Figure 3-35: Incidence of ventral and lateral recumbent behaviour of lambs short-scrotumed plus tailed with the ring.
- 73 Fo Figure 3-36: Incidence of normal and abnormal standing/walking behaviour of lambs short-scrotumed plus tailed with the rings.
- 73 Fo Figure 3-37: Incidence of restlessness of lambs short-scrotumed plus tailed with the rings.
- 74 Fa Figure 3-38: Changes in plasma cortisol concentrations in lambs castrated plus tailed with the knife.
- 74 Fa Figure 3-39: Incidence of standing/walking and recumbent behaviour of lambs castrated plus tailed with the knife.
- 74 Fa Figure 3-40: Incidence of ventral and lateral recumbent behaviour of lambs castrated plus tailed with the knife.
- 74 Fo Figure 3-41: Incidence of normal and abnormal standing/walking behaviour of lambs castrated plus tailed with the knife.
- 74 Fo Figure 3-42: Incidence of restlessness of lambs castrated plus tailed with the knife.
- 75 Fa Figure 3-43: Changes in plasma cortisol concentrations in castrated with the knife.
- 75 Fa Figure 3-44: Incidence of standing/walking and recumbent behaviour of lambs castrated with the knife.
- 75 Fa Figure 3-45: Incidence of ventral and lateral recumbent behaviour of lambs castrated with the knife.
- 75 Fo Figure 3-46: Incidence of normal and abnormal standing/walking behaviour of lambs castrated with the knife.

- 75 Fo Figure 3-47: Incidence of restlessness of lambs castrated with the knife.
- 76 Fa Figure 3-48: Changes in plasma cortisol concentrations in tailed with the knife.
- 76 Fa Figure 3-49: Incidence of standing/walking and recumbent behaviour of lambs tailed with the knife.
- 76 Fa Figure 3-50: Incidence of ventral and lateral recumbent behaviour of lambs tailed with the knife.
- 76 Fo Figure 3-51: Incidence of normal and abnormal standing/walking behaviour of lambs tailed with the knife.
- 76 Fo Figure 3-52: Incidence of restlessness of lambs tailed with the knife.
- 77 Fa Figure 3-53: Changes in plasma cortisol concentrations in tailed with the docking iron.
- 77 Fa Figure 3-54: Incidence of standing/walking and recumbent behaviour of lambs tailed with the docking iron.
- 77 Fa Figure 3-55: Incidence of ventral and lateral recumbent behaviour of lambs tailed with the docking iron.
- 77 Fo Figure 3-56: Incidence of normal and abnormal standing/walking behaviour of lambs tailed with the docking iron.
- 77 Fo Figure 3-57: Incidence of restlessness of lambs tailed with the docking iron.
- 78 Fa Figure 3-58: Changes in plasma cortisol concentrations in lambs castrated with the ring plus tailed with the docking iron.
- 78 Fa Figure 3-59: Incidence of standing/walking and recumbent behaviour of lambs castrated with the ring plus tailed with the docking iron.
- 78 Fa Figure 3-60: Incidence of ventral and lateral recumbent behaviour of lambs castrated with the ring plus tailed with the docking iron.
- 78 Fo Figure 3-61: Incidence of normal and abnormal standing/walking behaviour of lambs castrated with the ring plus tailed with the docking iron.
- 78 Fo Figure 3-62: Incidence of restlessness of lambs castrated with the ring plus tailed with the docking iron.
- 79 Fa Figure 3-63: Restlessness for all treatment groups.
- 79 Fa Figure 3-64: Restlessness for lambs treated with the ring.
- 79 Fa Figure 3-65: Integrated cortisol responses up to one hour of lambs treated with the ring.
- 80 Figure 3-66: Changes in plasma cortisol concentration for control, CT Ring, CT Knife and ACTH lambs.
- 82 Fa Figure 3-67: Integrated cortisol responses of control and ACTH Injected lambs.
- 82 Fa Figure 3-68: Integrated cortisol responses of control and tailed lambs
- 82 Fa Figure 3-69: Integrated cortisol responses of castrated lambs.

- 83 Fa Figure 3-70: Integrated cortisol responses of control and castrated plus tailed lambs.
- 83 Fa Figure 3-71: Integrated cortisol responses of control lambs and lambs treated with the ring.
- 83 Fa Figure 3-72: Integrated cortisol responses of control lambs and lambs treated with the knife.
- 83 Figure 3-73: Integrated cortisol responses to miscellaneous treatments.