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.
ASSESSMENT AND ALLEVIATION OF CASTRATION DISTRESS IN LAMBS.

A Thesis presented in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

at Massey University

Andrew Selwyn Dinniss

November 1995
ACKNOWLEDGEMENTS

Without the contributions of knowledge, support, encouragement, humour and time of many people, the making of this thesis would not have been possible.

Professor David Mellor and Dr. Kevin Stafford who as my supervisors, provided invaluable knowledge, tremendous encouragement, often constructively polarised opinions, and above all invested large amounts of precious time.

Dr Robert Bruce who provided valuable practical advice, along with comic relief while doing field work.

Neil Ward who provided a lot of time, energy and practical knowledge, to ensure the field work ran smoothly.

MAF Animal Welfare Section who financed this project, and especially David Bayvel for encouragement and advice on animal welfare in New Zealand.

Kerry Kilminster, manager of Massey University Keebles farm, who supplied the right number of animals at the right time.

Cheryl McMeekan, Natalie Petrie, Shauna Sylvester, Mark Forman, Suzanne Hodgkinson, and the other students who greatly helped in the field work and also provided support and encouragement.

Associate Professor Ted Kirk who willingly provided his time and anatomical advise.

Associate Professor Alex Davies who helped incredibly with the anatomical diagrams and figures produced on the computer.

Friends and flatmates during the years who have encouraged and supported me.

I would like to thank my parents who have been extremely supportive emotionally and financially.

Finally I would like to thank Lisa who has provided love and support throughout.
There is increasing pressure on the farming community to assess and minimise the distress caused by husbandry procedures. This is due to an increase in awareness of animal welfare throughout New Zealand, and economic pressures from overseas. This study involved an investigations into the acute pain-induced distress of lambs caused by castration, the effectiveness of different anaesthetic methods to alleviate that distress, characterisation and validation of behavioural responses as indices of pain-induced distress, and the assessment of the use of the burdizzo to reduce the acute pain-induced distress caused by ring castration. The castration techniques examined were ring, burdizzo, and ring + burdizzo. Short scrotum creation was also assessed. The alleviation techniques were injections of local anaesthetic into the scrotum, spermatic cords, testes or the scrotum + spermatic cords, 15 minutes prior to castration.

This study assessed the effectiveness of using a burdizzo before application of a rubber ring to reduce the distress, as indicated by cortisol and behaviour responses, caused by ring application. The concept of using a burdizzo to reduce the distress caused by ring castration was based on the hypothesis that 'disabling the afferent nerves from the testes would prevent nociception caused by ring application from being transmitted' (Kent et al. 1993, 1995). It was found that the burdizzo used in the conventional manner (one application to each spermatic cord and the surrounding scrotal tissue with no overlap of 'cuts') together with ring application did not reduce the cortisol or behavioural responses to ring castration. Hence it is unlikely that pain will have been reduced.

This study characterised the cortisol and behavioural response to burdizzo castration. The cortisol response was found to have a duration of 180 minutes with a magnitude similar to that exhibited by ring lambs. However, the values remained elevated for longer than ring in lambs. Although the cortisol response is likely to indicate noxious sensory input caused by burdizzo application, it cannot be proved, using the results of this study, that sensory-independent
stimulation of the hypothalamic pituitary adrenal axis is not responsible for this cortisol response to burdizzo castration.

Local anaesthetic administrated into the scrotum, spermatic cords plus scrotum, or testes was found to abolish the cortisol response and either reduce or abolish different behaviours after ring castration suggesting that pain-induced distress caused by application of a rubber ring was prevented. The cortisol response and some behaviours caused by burdizzo plus ring castration were also prevented by injecting local anaesthetic into the scrotum prior to treatment indicating that pain-induced distress was also prevented. Local anaesthetic injected into the spermatic cords reduced numerically (although not significantly), but did not abolish the cortisol response to ring or burdizzo plus ring castration. This suggested that the scrotum, which was presumed to be unanaesthetised, was a significant source of nociception after these two treatments.

Local anaesthetic injected into the scrotum or spermatic cords did not reduce the cortisol or behavioural responses to burdizzo castration. This can lead to two conclusions; either local anaesthetic did not anaesthetise all the tissue effected by the burdizzo, or something other than sensory input stimulated the hypothalamic-pituitary-adrenal axis after burdizzo castration. Intuitively, the former seems most likely.

Some behaviour parameters were found to be useful when comparing the pain-induced distress caused by similar treatments that elicited similar behaviours, but not when comparing between treatments that caused different types of tissue damage and elicited different behavioural responses. Burdizzo castration did not cause any obvious abnormal behaviours, suggesting that either no significant sensory input was caused by burdizzo application or that our behaviour observation methodology was not sensitive enough to pick up nuances of behaviour. Hence it was not possible to use behaviour to compare intensities of pain-induced distress caused by ring or burdizzo castration.

Practically the use of the burdizzo in the conventional manner to reduce the pain-induced distress caused by ring application cannot be advised. Further
work needs to be done to assess practical aspects of the modified use of the
burdizzo (across the whole width of the scrotum suggested by Kent et al. 1993, 1995) before it can be recommended as an alternative method of
castration.

The use of local anaesthetic in the field needs to be investigated further before
it can be recommended. It seems that simple methods of local analgesia may
be possible, however the danger of possible complications such as sepsis must
be evaluated.
# TABLE OF CONTENTS

ASSESSMENT AND ALLEVIATION OF CASTRATION DISTRESS IN LAMBS. .................. i

ACKNOWLEDGEMENTS ...................................................................................... ii

ABSTRACT .......................................................................................................... iii

TABLE OF CONTENTS .......................................................................................... vi

LIST OF FIGURES ............................................................................................... x

LIST OF TABLES .................................................................................................... xiv

CHAPTER 1: GENERAL INTRODUCTION ................................................................. 1

1.1 ANIMAL WELFARE ....................................................................................... 1

1.2 ASSESSMENT OF WELFARE ....................................................................... 4

1.3 PAIN, STRESS, DISTRESS AND SUFFERING ............................................. 6

   1.3.1 Pain ....................................................................................................... 7

   1.3.2 Stress ................................................................................................... 11

1.4 DISTRESS IN RELATION TO HUSBANDRY PROCEDURES INCLUDING TISSUE REMOVALS ................................................................. 15

1.5 MEASURING DISTRESS ASSOCIATED WITH TISSUE REMOVAL ............ 16

   1.5.1 The Hypothalamic-Pituitary-Adrenal Axis (HPA) .................................. 16

   1.5.2 Behavioural measures of stress or distress ............................................ 18

1.6 CASTRATION .................................................................................................. 19

   1.6.1 Reasons for Castration ......................................................................... 20

   1.6.2 Methods of Castration ....................................................................... 21

   1.6.3 Distress Associated with Castration .................................................... 23

   1.6.4 Pain (as indicated by distress responses) associated with different methods of castration ................................................................. 26
1.7 THE THEORY OF NON-SENSORY STIMULATION OF THE HYPOTHALAMIC-PITUITARY-ADRENAL AXIS ........................................ 29
1.8 AIMS OF THE PRESENT STUDY .................................................. 32

CHAPTER 2: LOCAL ANAESTHETIC DISTRIBUTION AFTER INJECTION INTO THREE DIFFERENT SITES ........................................ 34
2.1 CHAPTER SUMMARY ................................................................. 34
2.2 INTRODUCTION ........................................................................... 34
2.3 MATERIALS AND METHODS ....................................................... 41
  2.3.1 Animals ........................................................................... 41
  2.3.2 Treatments ....................................................................... 41
  2.3.4 Presentation of results ...................................................... 41
2.4 RESULTS .................................................................................. 42
2.5 DISCUSSION ............................................................................ 48

CHAPTER 3: EFFECTS ON PLASMA CORTISOL CONCENTRATIONS OF CASTRATING LAMBS USING DIFFERENT METHODS, WITH OR WITHOUT PRIOR LOCAL ANAESTHETIC ADMINISTRATION ........................................ 51
3.1 CHAPTER SUMMARY ................................................................. 51
3.2 INTRODUCTION ........................................................................ 52
3.3 MATERIALS AND METHODS ....................................................... 58
  3.3.1 Animals ........................................................................... 59
  3.3.2 Experimental Procedures .................................................. 62
  3.3.3 Blood Sampling ................................................................. 66
  3.3.4 Assessment of Efficacy of Castration ................................. 66
  3.3.5 Radio-Immunoassay ........................................................ 67
  3.3.6 Presentation of Results ...................................................... 67
3.4 RESULTS ................................................................................................................. 68
  3.4.1 Cortisol Responses ......................................................................................... 70
  3.4.2 Integrated Cortisol Responses ....................................................................... 81
  3.4.3 Efficacy of Castration Methods ..................................................................... 86
3.5 DISCUSSION ......................................................................................................... 87

CHAPTER 4: EFFECTS ON Plasma Cortisol concentrations of Castrating and Tailing Lambs with Rings and Burdizzo .............................................................. 101

4.1 CHAPTER SUMMARY .............................................................................................. 101
4.2 INTRODUCTION ....................................................................................................... 101
4.3 MATERIALS AND METHODS ............................................................................... 104
  4.3.1 Animals ............................................................................................................. 104
  4.3.2 Plasma cortisol assays ..................................................................................... 104
  4.3.3 Treatments ....................................................................................................... 105
  4.3.4 Presentation of results ..................................................................................... 106
4.4 RESULTS ................................................................................................................ 106
4.5 DISCUSSION .......................................................................................................... 108

CHAPTER 5: Behavioural assessment of pain and/or distress caused by Castration ......................................................................................................................... 113

5.1 CHAPTER SUMMARY .............................................................................................. 113
5.2 MATERIALS AND METHODS ............................................................................... 117
  5.2.1 Animals ............................................................................................................. 117
  5.2.2 Observations .................................................................................................... 117
  5.2.3 Presentation of Results ..................................................................................... 119
5.4 RESULTS ................................................................................................................ 120
5.5 DISCUSSION ...................................................................................................................... 143

CHAPTER 6: GENERAL SUMMARY AND CONCLUSIONS .................................................. 156

APPENDIX 1: PLASMA CORTISOL CONCENTRATIONS (NMOL/L) IN LAMBS AFTER
DIFFERENT TREATMENTS (CHAPTER 3) ........................................................................... 163

APPENDIX 1(A): CORTISOL CONCENTRATIONS OF LAMBS EXCLUDED FROM CHAPTER
3 ........................................................................................................................................... 163

APPENDIX 1(B): PLASMA CORTISOL CONCENTRATIONS (NMOL/L) IN LAMBS
(CHapter 3) ......................................................................................................................... 164

APPENDIX 2: PLASMA CORTISOL CONCENTRATIONS (CHAPTER 4) ......................... 175

APPENDIX 3: BEHAVIOURAL DATA (CHAPTER 5) ............................................................ 177

REFERENCES .......................................................................................................................... 200
LIST OF FIGURES

CHAPTER ONE

Figure 1.1 The three aspects of an animal's reaction to a stimulus such as castration. 10
Figure 1.2 The domains of stress and distress 13
Figure 1.3 The domains of suffering. 15

CHAPTER TWO

Figure 2.1 The neural anatomy of the scrotum and testes. 38
Figure 2.2 The anatomy of the ram scrotum and contents. 39
Figure 2.3 Local anaesthetic injection sites. 40
Figure 2.4 Intratesticular injection of anaesthetic/dye mixture. 44
Figure 2.5 Injection of anaesthetic/dye mixture into the spermatic cords. 45
Figure 2.6 Cross section of epididymis. 46
Figure 2.7 Subcutaneous injection of anaesthetic/dye mixture into the scrotum. 46

CHAPTER THREE

Figure 3.1 Pen arrangement to separate lambs from their mothers. 60
Figure 3.2 Method of holding lambs for treatment. 61
Figure 3.3 Equipment used in this study to castrate lambs. 64
Figure 3.4 Injection of local anaesthetic into a testis 64
Figure 3.5 Pre-treatment cortisol concentrations of lambs in the twenty one different groups. 69
Figure 3.6 Change in plasma cortisol concentrations of lambs in response to control handling or ACTH injection. 71
Figure 3.7 Change in plasma cortisol concentrations in response to control handling, short scrotum creation, or ring castration. 71
| Figure 3.8 | Change in plasma cortisol concentrations in lambs in response to castration by a burdizzo (10 seconds) or a ring. |
| Figure 3.9 | Change in plasma cortisol concentration of lambs in response to castration with a burdizzo (1 second), or a ring. |
| Figure 3.10 | Change in plasma cortisol concentrations in lambs in response to castration with a burdizzo (1 or 10 seconds). |
| Figure 3.11 | Change in plasma cortisol concentrations in lambs in response to castration with a Burdizzo (10 seconds) + Ring, or a ring |
| Figure 3.12 | Plasma cortisol concentrations in lambs in response to castration with a burdizzo (5 seconds) + ring, or a ring alone. |
| Figure 3.13 | Change in plasma cortisol concentrations in lambs in response to castration with a burdizzo (1 second) + ring, or a ring alone |
| Figure 3.14 | Change in plasma cortisol concentrations of lambs injected with local anaesthetic in the scrotal neck, spermatic cord, testes, or spermatic cord + scrotal neck. |
| Figure 3.15 | Change in plasma cortisol concentrations of lambs in response to ring castration with or without prior local anaesthetic injected into the scrotum, scrotum + spermatic cords, or testes. |
| Figure 3.16 | Change in plasma cortisol concentration in lambs in response to ring castration with or without prior local anaesthetic in the spermatic cord. |
Change in plasma cortisol concentrations in lambs in response to burdizzo (10 seconds) castration with or without prior local anaesthetic injected into the scrotum or spermatic cords.

Change in plasma cortisol concentrations in response to Burdizzo 10 seconds + ring castration with or without prior local anaesthetic injection into the scrotum or spermatic cords.

Integrated cortisol responses to different treatments.

Integrated cortisol responses of Control and LA Control lambs

Integrated cortisol responses of lambs castrated with a ring, with or without pre-treatment with local anaesthetic.

Integrated cortisol response of lambs castrated with different treatments.

Pre-treatment cortisol concentrations of lambs in different groups.

Change in plasma cortisol concentrations in lambs castrated and tailed using different methods.

The percentage of behaviours observed during 60 minutes that were normal walking or standing.

The percentage of behaviours observed during 4 hours that were normal walking or standing.

The percentage of behaviours observed during 60 minutes that were abnormal walking or standing.
Figure 5.4  The percentage of behaviours observed during 4 hours that were abnormal walking or standing.  
Figure 5.5  The percentage of behaviours observed during 60 minutes that were ventral recumbency.  
Figure 5.6  The percentage of behaviours observed during 4 hours that were ventral recumbency.  
Figure 5.7  The percentage of behaviours observed during 60 minutes that were abnormal recumbency.  
Figure 5.8  The percentage of behaviours observed during 4 hours that were abnormal recumbency.  
Figure 5.9  The percentage of behaviours observed during 60 minutes that were ventro-lateral recumbency.  
Figure 5.10  The percentage of behaviours observed during 4 hours that were ventro-lateral recumbency.  
Figure 5.11  The percentage of behaviours observed during 60 minutes that were lateral recumbency.  
Figure 5.12  The percentage of behaviours observed during 4 hours that were lateral recumbency.  
Figure 5.13  The percentage of behaviours observed during 60 minutes that were recumbency behaviours.  
Figure 5.14  The percentage of behaviours observed during 4 hours that were recumbency behaviours.  
Figure 5.15  The percentage of behaviours observed during 60 minutes that were abnormal behaviours.  
Figure 5.16  The percentage of behaviours observed during 4 hours that were abnormal behaviours.  
Figure 5.17  The restlessness scores recorded during 60 minutes after treatment.
# LIST OF TABLES

## CHAPTER 2

<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>The percentage of lambs showing evidence of dye within a particular tissue.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## CHAPTER 3

| Table 3.1 | Integrated cortisol responses of the different treatments |
|-----------|-----------------------------------------------------------|----------|
|           |                                                           | PAGE 85  |
| Table 3.2 | The percentage of lambs that were successfully or partially castrated using different methods. | PAGE 86  |