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Research Article

# Behavioural and Physiological Responses of West African Dwarf Bucks to Burdizzo Castration After Scrotal Neck Infiltration with Lignocaine or Bupivacaine

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## Abstract

Unmitigated pain in farm animals is associated with suffering and distress and represents a welfare concern. To assess the efficacy of pre-emptive analgesia induced by the scrotal neck infiltration of either lignocaine (LIG) or bupivacaine (BUP) in goats, behavioral, physiological and serum cortisol responses were used as indicators of post- Burdizzo castration distress. Fifteen West African Dwarf male goats, aged between 9 and 11 months and weighing between 6 and 12 kg, were randomly allocated into three groups each treated with the scrotal neck infiltration with lignocaine (LIG), bupivacaine (BUP) or normal saline (SAL) respectively and followed 20 minutes later by Burdizzo castration. Frequency of pain behaviors of the treated goats were recorded over a 3h post-castration period by continuous direct observation from outside the pen. Heart rate (HR), respiratory rate (RR), rectal temperature (RT) and serum cortisol concentrations were determined at 10-, 90- and 180-minutes post-castration. Restlessness, head turning, bleating, ataxia and extended hind limb were observed in both treatment and control groups, Restlessness was however the most frequent. There were no significant ($p > 0.05$) differences in mean HR, RR and RT between and within the three treatment groups. In both LIG and BUP treatment groups, serum cortisol concentrations increased but decreased in the control group up to the 90 minutes interval. It was concluded that subcutaneous infiltration of the goats' scrotal neck with either LIG or BUP did not influence pain behaviors but even tended to increase post-Burdizzo castration pain as measured by serum cortisol concentrations.

**Keywords:** West African Dwarf Bucks; Castration; Burdizzo; Lignocaine; Bupivacaine; Scrotal

## Abbreviations

SAL: Saline; LIG: Lignocaine; BUP: Bupivacaine; HR: Heart Rate; RR: Respiratory Rate; RT: Rectal Temperature

## Introduction

Castration is the removal or disruption of the function of the testes by excision, constriction or crushing of testicular blood supply [1]. Several methods have been described for the castration of male ruminants, including surgical removal of the testes, bloodless techniques that interrupt the blood supply to the testes such as elastic rubber ring or Burdizzo castration, as well as chemical or immunological castration [1,2].

Castration is performed as elective procedure in ruminants to prevent indiscriminate mating that allows for a controlled system of breeding. It is also performed to decrease aggressiveness and libido so that both male and female animals may be safely housed or run together, thereby facilitating animal management. An improved carcass quality in castrates has also been asserted [3].

Aside from immunological castration, other methods of castration may induce varying degrees of pain depending on the tech-

nique employed. Surgical removal of the testes is more painful than bloodless castration [4-6].

Broom [7] has proposed a clinically useful definition of animal pain state as "an aversive feeling or sensation associated with actual or potential tissue damage, resulting in physiological, neuroendocrine and behavioral changes that are indicative of a stress response".

Animal pain has been categorized broadly into adaptive or maladaptive [8]. Adaptive pain increases the potential for survival by protecting the animal from injury and promoting healing. In contrast, maladaptive pain is induced by pathological processes that result in the persistence of pain for long after the removal of the initiating cause [8].

Whereas pain cannot be measured directly, indirect physiological and behavioral indices may be used as indicators of pain. Activity of the sympathetic nervous system [9], activity of the hypothalamo-pituitary-adrenal axis [10-12] as well as changes in posture, locomotor activity and behavior [2,13] feasible ways to assess animal pain [14,15]. Several authors have used analysis of plasma cortisol concentration and/or observation of behaviour and postures to assess castration pain and distress in lambs after the first few post-castration hours [2,12,14,16-18].

To minimize pain and distress in animals, sedation and/or local or general anaesthesia, as well as non-steroidal anti-inflammatory drugs (NSAIDS) have been used [15,19]. Although sedatives may be beneficial in reducing handling distress [20,21], sedation alone is not appropriate for castration of ruminants. Whereas general anaesthesia may also reduce acute pain and distress, it is hazardous in ruminants and does not prevent the occurrence of post-castration pain [20]. When injected prior to castration, NSAIDs have significant beneficial effects on the overall cortisol response and on the time spent in abnormal postures caused by Burdizzo castration in lambs [22]. However, the pre-treatment use of carprofen did not reduce the discomfort scores after rubber ring castration or tail docking in lambs [23,24]. Local anaesthetics reduce behavioural and physiological changes by preventing the afferent impulses from reaching the brain [22,25]. These agents can thus be administered before noxious stimulation to prevent sensitization of neurons and wind-up, thereby providing pre-emptive analgesia. Depending on the local anaesthetic agent, volume and injection site, however, local anaesthetic agents may vary in efficacy. For rubber ring castration in lambs, for example, injection of a local anesthetic into the testes was reported to be less effective when compared with its injection into the neck of the scrotum at the site of the ring [26].

Burdizzo castration involves the application of the Burdizzo castrator to the scrotal neck so as to irreversibly crush blood vessels of the spermatic cord, producing testicular ischemia and atrophy within 2 to 3 weeks [27]. Although this method is suitable for use in goats of any age and carries no risk of sepsis, it is associated with a prolonged period of pain, suffering and distress [28].

Unmitigated pain in farm animals is associated with suffering and distress and has detrimental effects on the animal's physical health, as well as animal welfare concern. A technique aimed at alleviating such pain should be of interest to practicing veterinarians and livestock farmers.

This study was therefore designed to evaluate the efficacy of pre-emptive analgesia induced by scrotal neck skin infiltration of either lignocaine or bupivacaine, based on the behavioral and physiological responses of the goats in the first 3 hours following the application of Burdizzo castrator.

## Materials and Methods

### Animals

Fifteen West African Dwarf (WAD) male goats, aged between 9 and 11 months, and weighing between 6 and 12 kg, were used for the study. They were purchased at goat markets in Iwo and Ibadan, Nigeria. Selection of the goats at the markets was based on absence of any abnormal findings at cursory physical examination. The goats were housed indoors in groups of five in 1.3 m x1.8 m pens with straw-bedded floors, and had visual and tactile contact with the pen mates. The goats were fed twice daily on cassava peels (*Manihot esculenta*) supplemented with cut elephant grass (*Pennisetum purpureum*) and water was given *ad-libitum*. During a one-week acclimatization, faecal samples were obtained from the goats for egg floatation tests and those found positive were treated with Albendazole (A-Zole®, Lumiere Life Sciences Pvt. Ltd., Gujarat, India) 600 mg/tablet at a dose rate of 10 mg/kg orally. All the goats received multivitamins (Envit® Vet India Pharmaceuticals Ltd, Kushaiguda, India) injection at 1ml per 10 kg body weight to reduce stress. Before the commencement of the study, the goats were judged to be in good general health based on the findings at physical examination, complete blood count and serum chemistry.

## Drugs

The drugs and other materials used in this study were as follows:

- Lignocaine hydrochloride (Xylocaine®, Elcee laboratories, UK), supplied as a 2 percent aqueous solution for injection
- Bupivacaine hydrochloride (Marcain®, Astra Zeneca, UK) supplied as a 0.5 percent solution for injection
- Normal saline, supplied as 0.9 percent NaCl aqueous solution for injection.
- Disposable hypodermic syringes (5ml, 10ml sizes) with hypodermic needles attached
- Glass bottles for serum collection
- Cotton wool swabs soaked in methylated spirit for skin antisepsis
- Burdizzo clamp, 23 cm.

## Study design

Treatment groups included Burdizzo castration following subcutaneous infiltration of the goats' scrotal neck with (a) lignocaine (LIG), (b) bupivacaine (BUP) and (c) normal saline (SAL). The study used a simple randomized design in which the operator was blinded to the treatment employed. The goats were randomly allocated to one of the above three treatment groups by drawing lots from a hat. The hat included one lot for each group. Each time a lot was drawn it was removed from the hat and not put back until a group of five goats was assigned to the different treatment groups. No attempt was made to balance the groups for body weight of goats. Post-Burdizzo castration assessments were made at 10, 90 and 180 minutes.

## Castration procedure

The syringes containing the local anaesthetic agents and saline solution were prepared by an assistant, while the operator carried out the injections, castration and all subsequent assessments. The operator, therefore, was blinded as to LIG, BUP or SAL injection. After disinfection of the skin of the goats' scrotal neck with methylated spirit-soaked cotton swab, 2ml each of LIG, BUP, and SAL was infiltrated subcutaneously around the scrotal neck. After each injection, 20 minutes was allowed before Burdizzo castration.

At each trial, the goat was restrained by an assistant in such a way as to expose the animal's scrotum to the operator. The operator grasped the right testis with the left hand, draws it down into the bottom of the scrotal sac, while holding the spermatic cord with his left thumb and forefinger against the lateral edge of the scrotal neck. The Burdizzo clamp was held in the right hand and its jaws clamped across the width of the right spermatic cord 3-4 cm above the testis in order to crush it. The Burdizzo remained in place for 1 minutes and the clamping was repeated 1 cm distal to the previous crushing point. This double crushing procedure was repeated on the left scrotal neck, ensuring that there was at least 1 cm gap between the crush lines on both sides, as previously described [14].

## Recording behavioral responses

Frequency of behaviors of the treated goats was recorded within the 3h post-castration by direct observation from outside the goat pen without disturbing the animals. The following behaviors were recorded as previously described [22].

- Foot stamping and kicking- The number of times a front or hind limb was lifted and forcefully placed on the ground while standing or was used to kick while lying.
- Restlessness- The number of times a goat stood up and laid down; each unit scored included both the act of rising and lying down.
- Head turning- Movement of the goat's head beyond the shoulders: including both looking and touching at the source of pain and grooming per minutes.
- Bleating- Occurrence of each vocal sound was recorded.
- Ataxia- Standing or walking unsteadily; walking backwards; walking on knees, circling; leaning on a support.
- Extended hind limbs- Sternal or lateral recumbency with at least one hind limb partially or fully extended with the head up or down.

## Physiological variables

Heart rate, respiratory rate and rectal temperature of each treated goat were determined at 10-, 90-, and 180-minutes post-castration. Heart rate was counted using a precordial stethoscope. Respiratory rate was counted by visual observation of thoraco-abdomininal excursions while rectal temperature was measured using a mercury-in-glass thermometer.

## Blood sampling and serum cortisol assays

Blood samples (3 ml) from each goat were collected from the jugular vein in a bottle at 10-, 90- and 180-minutes post-castration. The samples were allowed to clot for 30 minutes at room temperature. The serum was decanted and stored at -20°c until cortisol analysis was performed. The serum samples were taken to a com-

mercial medical laboratory for cortisol assay, using a solid phase, EIA-steroid-cortisol da-cor 151 kit (Rapid Labs Ltd Unit 2 and 2A Hall Farm Business Centre Church Road, Colchester, United Kingdom).

### Statistical analysis

Data distribution was tested for normality by constructing frequency histograms of the data series. Data with a normal distribution were expressed as Mean ± Standard Error of Mean (SEM). Physiological variables and serum cortisol values were both compared for differences within and between treatments using Analysis of Variance (ANOVA) for repeated measures. The least significant difference was used for post-hoc analysis. Statistical analysis was performed using SPSS 17.0 software (SPSS Inc, Chicago IL, USA). A value of $p < 0.05$ was considered significant in all comparisons.

## Results and Discussion

### Behavioural responses

Figure 1 shows the mean frequencies of the goats' pain behaviours for the different treatment groups during the observable 180 minutes after Burdizzo castration. Restlessness, head turning, bleating, ataxia and extended hind limb were observed in all the three treatment groups, with restlessness being the most frequent. Foot stamping and kicking were also frequently observed except in the BUP-treated group. Overall, both LIG and BUP- treated groups of goats had higher mean frequency of pain behaviors than the control group.

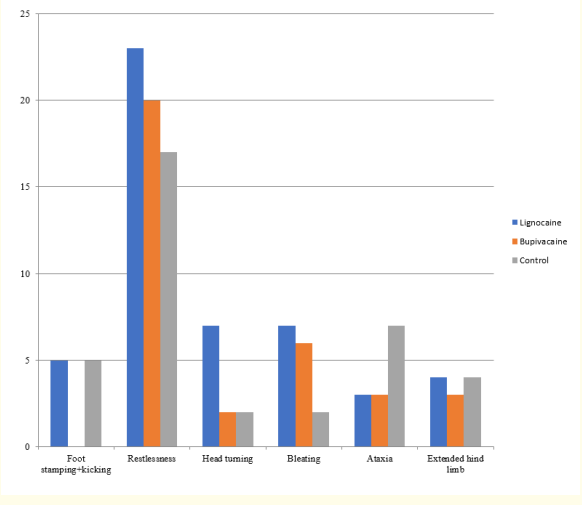


**Figure 1:** Behavioural responses of goats to Burdizzo castration after scrotal neck infiltration with Lignocaine, Bupivacaine or Normal saline.

### Physiological and cortisol responses

The heart rate, respiratory rate and rectal temperature responses of the goats to Burdizzo castration in the first 3 hours are shown in table 1. There were no significant ($p > 0.05$) differences in these physiological variables between and within the three treatment groups. The mean serum cortisol concentrations at 10, 90, and 180 minutes post- Burdizzo castration are shown in table 2. Serum cortisol level reached its peak at the 90-minutes interval for both LIG and BUP- treated groups and fell gradually. In the control group, serum cortisol level decreased to its lowest value at the 90-minutes interval and then started to increase.

| Treatment group | Post castration time intervals (min) | | |
|---|---|---|---|
| | 10 | 90 | 180 |
| Heart rate/min | | | |
| LIG | 84.8 ± 7.2 | 81.2 ± 6.2 | 84.8 ± 13.3 |
| BUP | 80.8 ± 8.7 | 90.0 ± 7.5 | 80.0 ± 2.8 |
| SAL | 80.0 ± 9.4 | 82.8 ± 5.4 | 83.2 ± 9.1 |
| Respiratory rate/min | | | |
| LIG | 32.8 ± 5.2 | 32.8 ± 5.2 | 37.2 ± 4.8 |
| BUP | 32.0 ± 5.7 | 30.4 ± 5.4 | 32.8 ± 5.9 |
| SAL | 32.0 ± 4.0 | 31.2 ± 4.4 | 29.6 ± 4.6 |
| Rectal temperature $^{O}C$ | | | |
| LIG | 38.9 ± 0.5 | 39.2 ± 0.4 | 39.9 ± 0.4 |
| BUP | 39.8 ± 0.4 | 39.5 ± 0.5 | 39.7 ± 0.4 |
| SAL | 40.8 ± 0.6 | 40.6 ± 0.8 | 40.5 ± 0.9 |

**Table 1:** Physiological responses of goats to Burdizzo castration with or without local anaesthetic infiltration of scrotal neck.

Data are expressed as means ± sem of 5 goats.

LIG, Lignocaine-treated group.

BUP, Bupivacaine-treated group.

SAL, Normal Saline-treated group (control).

| Treatment group | Post-castration time intervals (min) | | | Cortisol concentration (ug/dL) | | |
|---|---|---|---|---|---|---|
| LIG | 10 | 90 | 180 | 60.5 ± 10.3 | 102.7 ± 5.3 | 67.7 ± 10.9 |
| BUP | 10 | 90 | 180 | 63.4 ± 8.8 90 | 110.1 ± 7.2 | 69.9 ± 11.0 |
| SAL | 10 | 90 | 180 | 63.0 ± 9.2 | 51.0 ± 8.0 | 54.9 ± 4.7 |

**Table 2:** Serum cortisol responses of goats to Burdizzo castration with or without local anaesthetic infiltration of scrotal neck.

Data are expressed as means ± sem of 5 goats.

LIG, Lignocaine-treated group.

BUP, Bupivacaine-treated group.

SAL, Normal saline-treated group (control).

The trends in physiological and cortisol responses of each treatment groups are shown in figures 2, 3, and 4. There was no correlation between heart rate and cortisol responses except in the BUP-treated group.

Although other methods of castration are in use in ruminant, including elastrator, rubber ring and surgical knife [2], the Burdizzo clamp method was studied because it is simple and often carried out by the stockman without professional help or the use of anaesthetics.

Whereas the method is suitable for use in goats of any age and carries no risk of sepsis, it is reported to be associated with a prolonged period of pain and distress [28], making the procedure to be of animal welfare concern. It is currently believed that the administration of analgesic agents prior to the anticipated noxious stimuli (pre-emptive analgesia) will inhibit changes within the nervous system that contribute to heightened pain post-operatively [29]. This study was therefore designed to test this hypothesis using Burdizzo castration method in the goat.

Castration is often carried out in young farm animals prior to weaning because of associated ease of handling, low exposure to pain and rapid rate of healing [20]. However, in the United Kingdom, the Veterinary Surgeon Acts prohibit castration of bulls under 2 months of age and requires the use of anaesthetics [30]. In North America, delayed castration is also being advocated and devices de-

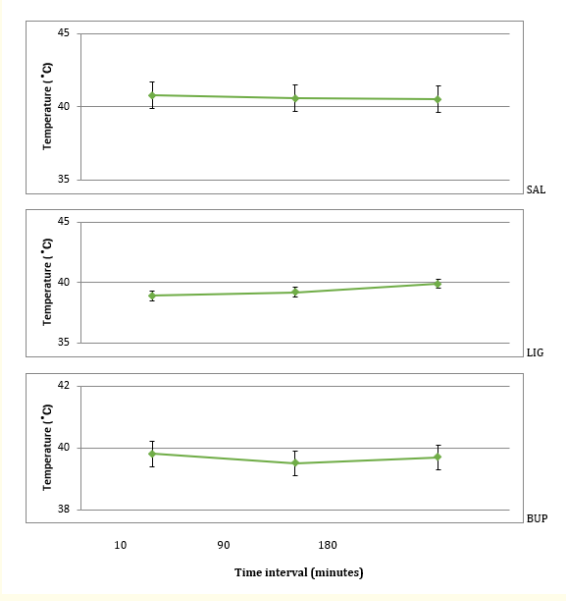


**Figure 2:** Comparison of temperature responses to post-burdizzo castration pain among the SAL, LIG-treated and BUP- treated groups respectively.

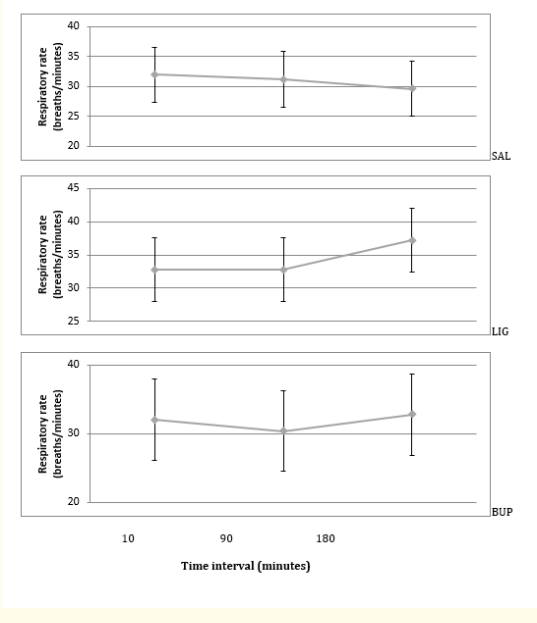


**Figure 3:** Comparison of respiratory rate responses to post-burdizzo castration pain among the SAL, LIG-treated and BUP-treated groups respectively.

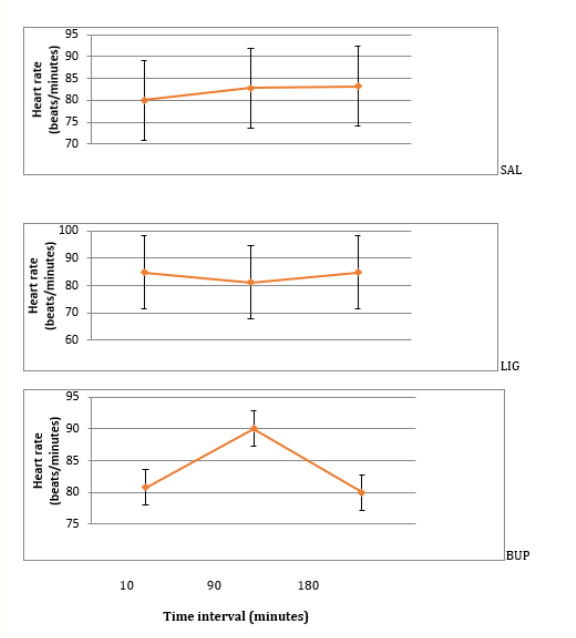


**Figure 4:** Comparison of heart rate responses to post-burdizzo castration pain among the SAL, LIG-treated and BUP-treated groups respectively.

signed to fit mature bulls are now being marketed [31]. The lack of regulation on goat castration in Nigeria coupled with the practice of castration of older animals in other countries underscored this study in relatively older goats.

Two amide-linked local anaesthetic agents, lignocaine and bupivacaine, were used for the study due to their availability and wide usage in general veterinary practice. Although local anaesthetics can be administered by a variety of routes, the subcutaneous infiltration of the drugs was employed in this study because the technique is simple to carry out than other methods such as epidural nerve block under field conditions in which ruminant castration is usually carried out. After the subcutaneous infiltration of the goats' scrotal neck with either local anaesthetic agent, 20 minutes was allowed to enable the drugs develop their full effects before Burdizzo castration was performed.

However, it is recognized that variability in pharmacokinetics of lignocaine and bupivacaine and pain responses between goats would have benefited from more frequent sampling of greater number of animals.

It is surprising that subcutaneous infiltration of the goats' scrotal neck with either lignocaine or bupivacaine did not influence pain behaviors as there was no appreciable difference between the treated and control groups of goats (Figure 1). Indeed, restlessness indicating suffering and distress had the most frequent occurrence in the LIG- and BUP- treated groups of goats. The absence of treatment differences in pain behaviors in this study may be due to an early loss of anaesthetic potency in local tissue as a consequence of local degradation of the infiltrated drug. This is however unlikely since all amide-linked local anaesthetics are degraded only in the liver following absorption into circulation [32]. Another possible explanation may be that the afferent activity in the spermatic cord increased and evoked visceral pain due to the compression of the mechanoreceptors in the pampiniform plexus [25]. The latter is most likely, since the closure of the jaws of the Burdizzo clamp damaged the skin, subcutaneous tissue and spermatic cord, including the pampiniform plexus. Therefore, visceral pain might be the cause of the respective pain behaviors. Therefore, it would be necessary to infiltrate both the subcutaneous tissue and the spermatic cord to eliminate associated visceral pain.

It is interesting to find that serum cortisol levels increased up to the 90 minutes interval and then begin to decrease in both LIG- and BUP- treated goats (Figures 3 and 4). This finding further supports the lack of efficacy of both local anaesthetic agents against post-Burdizzo castration pain in spite of the longer duration of action of bupivacaine than lidocaine [19].

Furthermore, tissue injury produced by Burdizzo clamp could result in inflammation which local anaesthetics could not treat without the adjunct parenteral injection of a non-steroidal anti-inflammatory drug (NSAID). The decreasing cortisol level of the 90 minutes interval might be a reflection of effective pain modulation by endogenous opioids in the central nervous system.

## Conclusion and Recommendations

In conclusion, subcutaneous infiltration of the goat's scrotal neck with either lignocaine or bupivacaine did not influence pain behaviors but tended to increase pain as measured by serum cortisol following Burdizzo castration.

For effectiveness of the local anaesthetics used, additional infiltration of the spermatic cord and co-administration of an NSAID would appear to be necessary.

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