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Welfare outcomes for 3- and 6-month-old beef calves in a tropical environment castrated surgically or by applying rubber rings

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ABSTRACT

Castration of cattle using rubber rings is becoming increasingly popular due to the perceived ease of the procedure and greater operator safety when compared with surgical castration. Few comparative studies have investigated the effects of different castration methods and calf age on welfare outcomes, particularly in a tropical environment. Thirty Belmont Red (a tropically adapted breed), 3-month-old (liveweight 71–119 kg) and 30, 6-month-old (liveweight 141–189 kg) calves were assigned to a two age × three castration (surgical, ring and sham) treatment factorial study (Surg3, Surg6, Ring3, Ring6, Sham3 and Sham6, $n = 10$ for each treatment group). Welfare outcomes were assessed post-castration using: behaviour for 2 weeks; blood parameters (cortisol and haptoglobin concentrations) to 4 weeks; wound healing to 5 weeks; and liveweights to 6 weeks. More Surg calves struggled during castration compared with Sham and Ring ($P < 0.05$, 90 ± 7% vs. 20 ± 9% and 24 ± 10%) and performed more struggles (1.9 ± 0.2, 1.1 ± 0.3 and 1.1 ± 0.3 for Surg, Sham and Ring, respectively), suggesting that surgical castration caused most pain during performance of the procedure. A significant ($P < 0.05$) time × castration method × age interaction for plasma cortisol revealed that concentrations decreased most rapidly in Sham; the Ring6 calves failed to show reduced cortisol concentrations at 2 h post-castration, unlike other treatment groups. By 7 h post-castration, all treatment groups had similar concentrations. A significant ($P < 0.01$) interaction between time and castration method showed that haptoglobin concentrations increased slightly to 0.89 and 0.84 mg/mL for Surg and Ring, respectively over the first 3 days post-castration. Concentrations for Surg then decreased to levels similar to Sham by day 21 and, although concentrations for Ring decreased on day 7 to 0.76 mg/mL, they increased significantly on day 14 to 0.97 mg/mL before reducing to concentrations similar to the other groups (0.66 mg/mL) by day 21. Significantly ($P < 0.05$) more of the wounds of the 3-month compared with the 6-month calves scored as 'healed' at day 7 (74% vs. 39%), while more ($P = 0.062$) of the Surg than Ring scored as 'healed' at day 21 (60% vs. 29%). At day 14 there were significantly ($P < 0.05$) fewer healed wounds in Ring6 compared with other treatment groups (13% vs. 40–60%). Liveweight gain was significantly ($P < 0.05$) greater in 3-month (0.53 kg/day) than in 6-month calves (0.44 kg/day) and in Sham calves ($P < 0.001$, 0.54 kg/day), than in Ring (0.44 kg/day) and Surg (0.48 kg/day) calves. Overall, welfare outcomes were slightly better for Surg than Ring calves due to reduced inflammation and faster wound healing, with little difference between age groups.

1. Introduction

Castration is one of the most common routine husbandry procedures conducted in beef production systems and some of the largest of these systems (e.g. North and South America and Australia) rear calves on extensive rangelands where interactions with people are infrequent. In northern Australia, for example, calves are likely to be mustered (gathered) from paddocks to yards for handling once or twice a year. In addition, many of the large beef producing areas are located in the tropics and sub-tropics where highly seasonal rainfall can temporarily restrict or prevent access to cattle and interfere with the timing of routine management procedures, such as castration (Petherick, 2005). Also, rearing of

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cattle in tropical environments has resulted in the increased use of tropically adapted breeds, such as Zebu (*Bos indicus*) and Sanga (*Bos taurus africanus*) cattle, and their crosses. There is evidence of differences between cattle breeds in physiological (e.g. Ledger, 1959; Phillips et al., 1987; Arthington et al., 2004) and production (e.g. Hammond et al., 1996; Frisch and O'Neill, 1998) parameters, and behavioural responses (e.g. approachability, Murphey et al., 1980; temperament or reactivity, Hearnshaw and Morris, 1984; Fordyce et al., 1988). Thus, it is not unreasonable to suggest that breeds will differ in their responses to routine husbandry procedures.

The majority of studies on the welfare impacts of calf castration have been conducted in temperate climates using dairy calves and *Bos taurus* crossbreeds derived from British and European parent stock (e.g. see reviews by Bretschneider, 2005; Coetzee, 2011). Furthermore, from the review by Bretschneider (2005), most experiments on castration have used calves accustomed to confinement, people and handling. Such studies on British or Continental breeds of calf may not provide an appropriate model for investigating the impacts of castration on the welfare of commercial beef calves reared in tropical and sub-tropical environments. Thus, one aim of this experiment was to assess the welfare impacts of castration on calves that are representative of extensive beef cattle production systems located in the tropics and sub-tropics.

The application of rubber rings is perceived to be "a simple, inexpensive and effective method of castration" (Becker et al., 2012) and, as a consequence, the method is, at least in Australia, increasingly being used. Furthermore, manufacturers and retailers promote rings as being the least stressful method of castration (e.g. see ht***tp://ww***w.thecattleshop.com.au/category17_1.htm) and also encourage beef producers to delay castration (to 5–8 months of age) to exploit the superior liveweight gains and musculature of bulls compared with castrates (e.g. see ht***tp://horsleywholesale.com.au/products/Jumbo_Marking_Castration_Bander_Delivery-487-113.html). Currently in some parts of Australia it is legally permissible to castrate cattle of any age without the use of anaesthetics or analgesics, although in some States and Territories it is illegal to castrate an animal older than 6 months of age unless it is undertaken by a veterinarian (Primary Industries Standing Committee (PISC), 2004). It is incongruous, therefore, that this same Welfare Code of Practice (PISC, 2004) stipulates that "castration with rubber rings is only recommended for calves up to 2 weeks of age." Thus, the second aim of this study was to compare the welfare outcomes for different ages of calves castrated using rings and surgical castration, the latter being the most common method used in both the USA (Coetzee et al., 2010) and Australia (Meat and Livestock Australia, pers. comm.). Herd management practices in tropical Australia made it impractical to study calves less than 2 weeks of age. In this environment, however, some commercial enterprises castrate calves of 2–3 months of age without known adverse effects on welfare, although most enterprises routinely castrate calves at around 6 months of age. Therefore, the age comparison comprised 3 months and 6 months.

To assess welfare status we used a combination of measures in line with our previous research on cattle castration (Petherick et al., 2014a,b) and that of other authors (e.g., Robertson et al., 1994; Molony et al., 1995; Stafford et al., 2002). Behavioural responses to pain can be difficult to interpret in isolation due to their variability both between and within individuals (Mellor et al., 2000) and so are best supported by other measures. Although there can be difficulties with interpretation of pain vs. generalised stress (Mellor et al., 2000), plasma cortisol concentration and liveweight changes have been measured to assess the pain and stress associated with castration in many studies (e.g., see review by Bretschneider, 2005). Increases in plasma concentrations of creatine kinase (CK) are associated with muscle damage (Radostits et al., 2007) and changes in total protein (TP) and pack cell volume (PCV) reflect dehydration and blood loss (Carlson, 1997). Thus, we included these measures anticipating that they would assist with assessing welfare status in animals subjected to a castration method that involves cutting tissue (surgical) and one that does not (application of rubber rings).

Our specific hypothesis was that welfare outcomes, as assessed by changes in behaviour, certain blood parameters, wound healing rates and liveweight, would be no different for 3-month-old or 6-month-old calves castrated surgically or using rings.

2. Method

The use of the cattle in this experiment was approved by the CSIRO (Queensland) Animal Ethics Committee (approval A1-2012).

2.1. Location and experimental design

The experiment was conducted at Belmont Research Station, approximately 26 km north of Rockhampton, Queensland, Australia (150° 22′ 57″ E, 23° 13′ 26″ S) during the late wet season to early dry season (26 February–13 April), a time at which commercial enterprises in the region would castrate calves. The range of mean minimum and maximum temperatures were 15.1–24.4 and 25.4–34.7 °C respectively, with 218 mm of rainfall (14 wet days) during the experimental period.

Belmont Red (a stabilised African Sanga × *Bos taurus* hybrid) calves that were born on Belmont Research Station between 30 August and 20 December of the previous year were used for the experiment. The calves were ear-tagged within 24 h of birth and branded in early January, but were not dehorned to eliminate potential confounding due to experience of restraint and pain. Sixty calves were assigned to six treatment combinations ($n = 10$ per treatment group) according to birth date (3-month or 6-month age group), and stratified within age group by liveweight and flight speed as measured at the time of branding. Flight speed was measured according to a validated method (Burrow et al., 1988) using specially manufactured equipment (Ruddweigh–Gallagher Animal Management Systems, Campbellfield, Vic, Australia). Three flight speeds, taken in succession, were recorded but as has been found previously, the first speed was poorly correlated with the others (Petherick et al., 2009a), thus a mean of the second and third was used. It was considered important to take into account flight speed in the allocation of the calves to the treatments, as previous work has found relationships between flight speed and stress responses and liveweight gains (Petherick et al., 2002, 2009b).

There were six treatment combinations of age of calf (two levels) and castration method (three levels): sham castration of 3-month-old calves (Sham3); surgical castration of 3-month-old calves (Surg3); ring castration of 3-month-old calves (Ring3); sham castration of 6-month-old calves (Sham6); surgical castration of 6-month-old calves (Surg6) and ring castration of 6-month-old calves (Ring6). Due to limitations on calf numbers from which to select the experimental animals, there was a range of ages within the two age groups; the 6-month-old calves ranged in age from 5 to 7 months and the 3 month-old calves ranged from 2.5 to 4 months. Liveweights averaged 163.3 kg (range 141–189 kg) and 93.7 kg (range 71–119 kg) for the 6- and 3-month-old groups, respectively.

Due to time and daylight constraints, 30 calves were castrated on 2 successive days (day 0). Calves were allocated to 10 blocks, each containing one animal from each treatment. Five blocks (randomly selected) were treated on each day (batch A and B) with the procedures for the five blocks starting at approximately 7:00, 8:00, 8:45, 9:45 and 11:00 h, respectively on both days.