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Physiological and behavioral stress parameters in calves in response to partial scrotal resection, orchidectomy, and Burdizzo castration

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ABSTRACT

Establishing artificial cryptorchids by partial scrotal resection without removing the testicles is a technique for castration of bull calves that recently has gained new interest. In contrast to orchidectomy and Burdizzo castration, the stress response of calves to shortening of the scrotum is unknown. In this study, partial scrotal resection in bull calves was compared with orchidectomy, Burdizzo castration, and controls without intervention (n = 10 per group, ages 56 ± 3 d). Procedures were performed under xylazine sedation and local anesthesia. We hypothesized that partial scrotal resection is least stressful. Salivary cortisol, heart rate, heart rate variability, behavior, and locomotion were analyzed. Cortisol concentration peaked 60 min after start of the procedures. Cortisol release was at least in part xylazine induced and none of the experimental procedures released additional cortisol. Heart rate increased in calves of all groups with initial handling, but immediately after xylazine sedation decreased to 30% below initial values and was not modified by surgical procedures. The heart rate variability variables standard deviation of beat-to-beat interval and root mean square of successive beat-to-beat differences increased when calves were placed on the surgery table but effects were similar in calves submitted to surgeries and control calves. Locomotion increased, whereas lying time decreased in response to all surgeries. Locomotion increase was most pronounced after orchidectomy. Plasma fibrinogen concentrations increased after orchidectomy only. With adequate pain medication, orchidectomy, Burdizzo castration, and partial scrotal resection do not differ with regard to acute stress and, by inference, pain. Partial scrotal resection when carried out under xylazine sedation and local anesthesia thus is an acceptable castration technique in bull calves.
Key words: short scrotum, calf, castration, stress

INTRODUCTION

Castration of bull calves from dairy breeds during the first weeks of life is a standard veterinary procedure with the aim to reduce male behavior and to improve meat quality (Baker and Gonyou, 1986; Faulkner et al., 1992). In addition, utilization of grazing land shared with female cattle is only possible if sexual activity of young males is prevented. Castration is considered a stressor and potentially painful experience for the animal (Mellor et al., 1991; Robertson et al., 1994; Stafford and Mellor, 2005). Animal welfare concerns thus warrant that surgical procedures are performed in a way that causes the least stress and pain. Options for pain mitigation include local anesthesia and the use of analgesics such as nonsteroidal antiinflammatory drugs, opioid drugs, and α_2-adrenergic receptor agonists (Stafford et al., 2002). Pain perception of calves at castration and the subsequent stress response do not only depend on the surgical techniques but also on the animals' age, with a less-pronounced response in younger animals (Robertson et al., 1994; Ting et al., 2005). In addition, castration may have a negative effect on feed intake and growth of calves (Faulkner et al., 1992; Bretschneider, 2005).

Behavioral signs of pain can be difficult to recognize in prey species. Thus, mostly physiological and behavioral stress parameters are determined, assuming that they are closely correlated with the pain experienced by the animal. To choose the least stressful and, by inference, least painful method, castration techniques in cattle have to be compared with regard to animal stress and pain. The most common techniques are surgical removal of the testicles (orchidectomy), bloodless castration by crushing the spermatic cord and thus inhib-

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iting testicular blood supply with a Burdizzo clamp, or inhibition of testicular blood supply with rubber rings placed on the neck of the scrotum (King et al., 1991; Robertson et al., 1994; Stafford et al., 2002; Bretschneider, 2005). Because gonadal steroids stimulate growth and increase feed efficiency, interest exists in males that are infertile but exposed to endogenous testicular steroid hormones. Such a situation occurs naturally in cryptorchids and has been imitated surgically by shortening the scrotum to an extent that the testes are located in a near-inguinal position. Short scrotum bulls, due to the anabolic properties of androgens, are more similar to intact bulls than steers in growth rate, carcass characteristics, and meat tenderness but have the advantage that their infertility simplifies management (Glimp et al., 1971; Albaugh et al., 1975). Although a considerable number of studies have been performed on castration-induced stress in bull calves (reviewed by Stafford et al., 2002; Bretschneider, 2005), the stress response and, by inference, pain perception of calves in response to shortening of the scrotum as a means of castration has not been investigated so far.

Stress caused by castration has been studied using a variety of physiological and behavioral parameters (Faulkner et al., 1992; Fisher et al., 1996; Knight et al., 2000; Ting et al., 2003; Pang et al., 2006; González et al., 2010). Increases in cortisol release have been suggested to correspond with predicted noxious stimuli (Mellor et al., 2000). Because cortisol rapidly diffuses into saliva, salivary cortisol concentrations reliably mirror changes in cortisol concentrations in blood plasma (Kirschbaum, 2000; Peeters et al., 2011) but have rarely been determined in cattle at castration so far (González et al., 2010). The most immediate stress response is an increase in adrenomedullary and sympathetic nervous activity. An acute stress elicits an immediate release of epinephrine and increase in heart rate. Besides heart rate, heart rate variability (**HRV**) is used as an indicator for the response of the autonomic nervous system to stress. Heart rate variability (i.e., short-term fluctuations in heart rate) is essentially based on the antagonistic oscillatory influences of the sympathetic and parasympathetic nervous system on the sinus node of the heart. It thus reflects the prevailing balance of sympathetic and parasympathetic tone. In general, increases in the values of the HRV variables standard deviation of beat-to-beat (**RR**) interval (**SDRR**) and root mean square of successive RR differences (**RMSSD**) reflect a shift toward more sympathetic dominance, whereas reduced values indicate a shift toward parasympathetic dominance (von Borell et al., 2007).

In this study, effects of partial scrotal resection, castration by orchidectomy, and crushing of the spermatic cord with a Burdizzo clamp on the stress response of bull calves were analyzed. All procedures were performed with the animals sedated and under local anesthesia. We hypothesized that shortening of the scrotum is less traumatic and, therefore, less stressful than orchidectomy or Burdizzo castration. As physiological stress parameters, salivary cortisol, heart rate, and HRV were determined and supplemented by observation of the animals' behavior and locomotion recordings with pedometers.

MATERIALS AND METHODS

Animals

A total of 40 male Fleckvieh (Austrian dairy/dual-purpose Simmental) calves were included into the study over a 5-mo period (October–February). Each month, 8 calves were bought at a livestock market and delivered to the University of Veterinary Science (Vienna, Austria) the same day. Age of the calves on the day of surgery was 56 ± 3 (±SD) days and did not differ significantly between groups. The calves were housed on straw in pairs of 2 in pens measuring 3 × 2.5 m. They were fed 2.5 L of milk replacer (1.25 L twice daily; Kalbi Milch Fit Protect; H. Wilhelm Schaumann GmbH & Co. KG, Brunn, Austria) and concentrates (corn, soybean, and mineral mixture; Kalvicin Pro; H. Wilhelm Schaumann GmbH & Co. KG; 150–300 g twice daily) and had free access to hay and water. The calves had not been handled before except feeding. Calves were allowed to adjust to the stable for 4 d and were made familiar with saliva sampling, heart rate recordings, and pedometers during this time. Before the recordings started, the calves were handled and brushed daily to make them acquainted to handling by humans.

Experimental Design

The 8 calves of each of the 5 lots were assigned randomly to 4 groups (n = 2 each). Calves were castrated either by shortening of the scrotum without removing the testes (partial scrotal resection; **SR** group; n = 10), crushing of the spermatic cords with a Burdizzo clamp (**BZ** group; n = 10), orchidectomy (**OR** group; n = 10), or were left gonad-intact as controls (**CO** group; n = 10). The animals were followed from 2 d before to 8 d after the surgical intervention. All examinations were carried out in the same stable familiar to the calves. The experiment was approved by the competent authorities for animal experimentation in Austria (Federal Ministry for Science and Research, license number BMWF-68.205/0108-II/3b/2011).