Scrotal ablation and orchectomy in the domestic laboratory goat (Capra hircus)☆

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ABSTRACT

Domestic goats (Capra hircus) have been used as animal models in biomedical research, and for numerous years for agricultural research and models for human diseases. This column describes an improved surgical technique, for castration of male goats, similar to companion animal techniques for use in the laboratory setting. The technique discussed supports a more in-depth perioperative protocol for performing scrotal ablation and orchectomy in the male goat.

1. Introduction

Domestic goats (Capra hircus) have been used as animal models in biomedical research, and for numerous years for agricultural research and models for human diseases (Underwood et al., 2015). This column describes an improved surgical technique, for castration of male goats, similar to companion animal techniques for use in the laboratory setting. The ideology behind this method is to reduce the risk of anesthetic and post-operative complications (i.e. anesthetic death, scrotal swelling, hematomas, infection) usually associated with “in the field” castration procedures. A 2-month old male Spanish-Cross kid belonging to the institutional teaching colony protocol was presented for routine castration. Goats in research are routinely castrated for population and herd management, prevention of reproductive diseases, and unwanted aggressive behaviors (Edmondson, Roberts, Baird, Bychawski & Pugh, 2012; Smith & Sherman, 2009). There are several testicular and scrotal diseases reported in the goat including: varicoceles, epididymitis (Brucella spp.), orchitis (trauma or infection), sperm granulomas, testicular hypoplasia and degeneration (zinc deficiency, hypothyroidism) and cryptorchidism (genetic predisposition) (Edmondson et al., 2012; Smith & Sherman, 2009).

2. Materials and methods

2.1. Restraint and anesthesia

It is recommended to fast small ruminants from feed and water for no more than 12 h and 8 h respectively prior to surgery (Lin, Caldwell, & Pugh, 2012; Smith & Sherman, 2009b). Fasting neonates is not recommended due to the potential for hypoglycemia. Several anesthetic protocols can successfully be used in young goats, the following described is an example of a protocol used at our respective institution. A combination of dexmedetomidine hydrochloride at a dose of 0.15mg/kg (Dexdomitor®, Zoetis Inc., Kalmazoo, MI, USA; 0.5mg/mL) and butorphanol tartrate at a dose of 0.2mg/kg (Torbugesic®, Zoetis Inc., Kalmazoo, MI, USA; 10mg/mL) was given intravenously (IV) for preanesthesia. Propofol was given at a dose of 4-5 mg/kg (PropoFlo®, Abbot Laboratories, North Chicago, IL, USA; 10 mg/mL) IV as the induction agent via a size 22G x 1 in. cephalic catheter. Following intubation, the animal was maintained on gas anesthesia 1.5–2% isoflurane (Fluriso™, MWI Veterinary Supply, Boise, ID, USA; each mL contains 99.9% isoflurane) combined with 100% O2 at a flow rate of 2 LPM. The animal was maintained on IV fluid therapy at a rate of 10 mL/kg/h (Lactated Ringers Solution, Hospira Inc., Lake Forest, IL, USA, 1000 mL bag) throughout the procedure. Upon completion of the surgical castration, the animal was reversed using atipamezole hydrochloride at a dose of 0.1–0.2 mg/kg (Antisedan®, Zoetis Inc., Kalmazoo, MI, USA; 5 mg/mL) (Blackburn, 1985; Fossum et al., 2007).

2.2. Endotracheal intubation procedure

Endotracheal intubation in goats and sheep can be difficult due to several factors: inability of the mouth to open widely, narrow
intermandibular spacing, and deep caudal anatomical location of the laryngeal opening resulting in poor visualization (Figs. 1 and 2) (Lin et al., 2012; Smith & Sherman, 2009b). Young goats are also known to be susceptible to laryngospasm, so it is advised to apply injectable lidocaine topically (a total of 0.25mL was used in this patient) by trickling down the endotracheal tube to allow contact prior to performing intubation (Lin et al., 2012; Smith & Sherman, 2009b). When a state of adequate anesthesia was reached, the animal was placed in sternal recumbency with the neck extended, allowing the oral cavity to be comfortably held open using roll gauze (Fig. 3). The laryngoscope was placed over the back of the animal’s tongue and positioned towards the larynx. Using a long narrow plastic stylet, the endotracheal tube was directed into the tracheal opening over the stylet. Confirmation for correct placement was performed via direct visualization and by application of the Beck Airway Airflow Monitor whistle (BAAM®, Great Plains Ballistics Inc., Lubbock, TX, USA) (Fig. 4). A loud whistling sound was heard upon correct placement into the trachea. Animal was maintained on a closed circle rebreathing anesthesia circuit with a standard anesthetic gas scavenging system to protect operating personnel.

2.3. Scrotal ablation and orchiectomy

The animal was placed in dorsal recumbency and all surgical intermandibular spacing, and deep caudal anatomical location of the laryngeal opening resulting in poor visualization (Figs. 1 and 2) (Lin et al., 2012; Smith & Sherman, 2009b). Young goats are also known to be susceptible to laryngospasm, so it is advised to apply injectable lidocaine topically (a total of 0.25mL was used in this patient) by trickling down the endotracheal tube to allow contact prior to performing intubation (Lin et al., 2012; Smith & Sherman, 2009b). When a state of adequate anesthesia was reached, the animal was placed in sternal recumbency with the neck extended, allowing the oral cavity to be comfortably held open using roll gauze (Fig. 3). The laryngoscope was placed over the back of the animal’s tongue and positioned towards the larynx. Using a long narrow plastic stylet, the endotracheal tube was directed into the tracheal opening over the stylet. Confirmation for correct placement was performed via direct visualization and by application of the Beck Airway Airflow Monitor whistle (BAAM®, Great Plains Ballistics Inc., Lubbock, TX, USA) (Fig. 4). A loud whistling sound was heard upon correct placement into the trachea. Animal was maintained on a closed circle rebreathing anesthesia circuit with a standard anesthetic gas scavenging system to protect operating personnel.

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Monitoring equipment was applied (Fig. 5). Standard recommended surgical parameters were observed throughout the procedure: temperature, pulse (EKG), respiration, blood pressure, peripheral capillary oxygen saturation (SpO₂) and end tidal CO₂. A surgical clip and aseptic surgical site preparation were performed using 2% chlorhexidine scrub and 70% isopropyl alcohol (Fig. 6). A local anesthetic block near the base of the scrotum and intratesticularly using bupivacaine at 2mg/kg (Bupivacaine HCl 0.5%, AuriMedics Pharma LLC, Dayton, NJ 08810, USA; 5mg/mL) was performed as per the surgeons preference for perioperative analgesia. The pendulous scrotal sac was elevated away from the body wall and steriley draped. An elliptical skin incision was made approximately 1.5–2 cm cranial to the base of the scrotal sac. It is important for the surgeon to remember not to excise too much scrotal skin preventing inadequate tissue for skin closure at the end of surgery. Each testicle was exteriorized and removed using the 3-clamp closed castration technique (Fig. 7). To perform this method, the spermatic cord was exteriorized by reflecting fat and connecting fascia from the parietal tunic using sterile gauze. Three crushing hemostatic forceps (Rochester-Carmalt) were applied to the entire spermatic cord in a stacking arrangement, followed by removal of the testicle using surgical blade or scissors. The cord was ligated using 2-0 Polydioxanone (PDS) absorbable material between each clamp with a modified millers knot. Upon confirmation of adequate ligature security hemostatic forceps were removed and the cord was inspected for any hemorrhage. When cord evaluation was complete it was return into the body cavity. The median raphe was then closed using a simple continuous pattern with 3-0 PDS. Subcutaneous tissue was apposed with a simple continuous suture pattern using 3-0 PDS. The skin layer was closed using an intradermal pattern with 3-0 PDS (Fig. 8). This technique was adapted from the described surgical techniques used in companion animals (Fossum et al., 2007).

Fig. 5. The animal is placed in dorsal recumbency for optimal surgical positioning. Surgical parameters observed throughout procedure included: temperature, pulse (EKG), respiration, blood pressure, SpO₂ and ETCO₂.

Fig. 6. (A) Aseptic surgical preparation using 2% chlorhexidine and 70% isopropyl alcohol. B) Flushing of preputial sheath and orifice using 2% chlorhexidine solution (authors' preference to prevent any potential breach in sterility during surgery). (C) Local testicular block using bupivacaine HCl 0.5%. (D) Surgical draping for scrotal ablation and orchiectomy.
3. Discussion

Postoperative care involved non-steroidal anti-inflammatory therapy using chewable carprofen tablets off label at a dose of 4.4 mg/kg daily for 5 days (Rimadyl®, Zoetis Inc., Kalamazoo, MI, USA; 100 mg tablets). The incisional site was monitored daily for two weeks. This animal's surgical recovery was unremarkable. No complications or adverse reactions were seen during the post-operative period. Goats and related species used in biomedical research possess the unique opportunity to receive state-of-the-art surgical care, often as result of easy accessible surgical and monitoring equipment, which at times is not always available to the general practicing or ambulatory veterinarian. The technique discussed supports a more in depth perioperative protocol for highly valuable caprine and ovine research animal models. Historically agricultural and livestock sources have investigated numerous methods and techniques for castration in goats (Edmondson et al., 2012; Smith & Sherman, 2009). Procedures well described include non-invasive techniques such as elastrator banding.

![Fig. 7. (A) Make a circumferential incision into the scrotal sac (SS). (B) Exteriorize testicle (T) and spermatic cord (SC) by reflecting fat and connecting fascia from the parietal tunic using sterile gauze. (C) Apply three crushing hemostatic forceps (Rochester-Carmalt) to the entire spermatic cord in a stacking arrangement. (D) Remove testicle and ligate spermatic cord using 2-0 PDS between each clamp with a modified millers knot or surgeon's knot. (E) Confirm adequate ligature knot security by removing hemostatic forceps and inspecting cord for any hemorrhaging. When satisfied return cord with ligatures into the body cavity.](image-url)
and application of the Burdizzo emasculatome, and more invasive techniques such as the incisional orchietomy using a scalpel blade or Newberry knife (± ligatures; with older kids requiring ligation) (Edmondson et al., 2012; Smith & Sherman, 2009). Alternative chemical castration therapies have additionally been reported in scientific literature, these include injectable 88% solution of lactic acid (Chemcast, Bio-Ceutic Labs Inc., St. Joseph, Missouri, USA) and cadmium chloride (Blackburn, 1985; Edmondson et al., 2012; Levy et al., 2008; Smith & Sherman, 2009). There is some discussion on the potential use of the recently released zinc gluconate injections that has been licensed for use in dogs, but further research is however required (Levy et al., 2008; Smith & Sherman, 2009). As large animal species continue to be used in biomedical research, it is critical for veterinary professionals to improve clinical techniques and surgical procedures in efforts of enhance overall animal care and well-being.

Conflict of interest statement

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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