Comparison of analgesic techniques for antler removal in wapiti.

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Abstract

The purpose of this research was to compare the effectiveness of ring block anesthesia (LA) and "electroanesthesia" (EA), for antler removal in elk given a long acting tranquillizer to remove the background stress from restraint Thirty-two male wapiti were given zuclopenthixol acetate (Acuphase™) and the next day restrained in a hydraulic chute, given "electroanesthesia" or a lidocaine ring block anesthesia, and their antlers removed Behavioural response to antler removal was scored Significantly more ($p = 0.032$) animals responded negatively to antler removal in the EA group Heart rates (HR) and arterial pressures were measured by a catheter connected to a physiological monitor. HR increased significantly over time with EA, but not LA HR increased from baseline significantly more in the EA group immediately prior to antler removal ($p = 0.017$), immediately post antler removal ($p = 0.001$), and at 1 min post antler removal ($p = 0.037$). It was concluded that EA is not as effective as LA for antler removal anesthesia

Introduction

Antler removal from farmed elk for commercial purposes is now an established agricultural practice in North America. In 2000 an estimated 70 tonnes of antler was harvested from Canadian red deer and wapiti for export to Asia for the practice of Traditional Chinese Medicine and for an expanding North American nutraceutical market Antler is typically harvested during the annual growth phase, when it consists of well-vascularized and innervated cartilaginous tissue rather than the highly mineralized hard bone of mature antler (1)

Growing antlers possess sensory innervation that has been well described in the literature (2, 3, 4) The careful manner in which animals protect velvet antlers from striking objects and obstacles in the environment and the persistent rubbing of calcifying antler at velvet shedding indicate that an animal sensation in their antlers throughout the growth phase Interruption of the nerve supply to the antler makes it prone to injury through the loss of spatial awareness and sensation, and results in damage to the antler (2, 5). Antler removal procedures have been shown to be aversive (6) and controlled experiments on antler removal techniques clearly indicate the need for analgesia (7, 8, 9, 10). Various techniques for the injectable application of antler anesthesia have been described (4, 10, 11). The most reliable and widely used technique is the ring block, requiring bilateral circumferential subcutaneous injections of lidocaine hydrochloride to the skull at the base of the antler pedicle (10).

The potential for local anesthetic drug residues in antler intended for health conscious consumers has been of concern to velvet antler producers and marketers Canadian regulations require a 5-day withdrawal period for lidocaine products used in food animals. Consequently there has been increased elk industry interest in the use of non-chemical means of inducing analgesia (12, 13)

The use of one non-chemical method called "electroanesthesia" has become widespread in the North American elk industry (14) "electroanesthesia" is also known as transcutaneous electrical nerve stimulation or TENS, an analgesic treatment used to rehabilitate musculoskeletal injuries and alleviate various types of pain in humans and as a method of analgesia in human dentistry (15, 16, 17, 18).

The object of our research was to compare and evaluate the effectiveness of local lidocaine ringblock anesthesia (LA) and "electroanesthesia" (EA), two different methods of providing analgesia for velvet antler removal in elk Previous Canadian studies investigating the relative effectiveness of analgesic methods used for antler removal were equivocal due to problems in separating experimental effects from background physiological effects created by fear and stress (19, 20). In those studies the pain of antler removal could not easily be distinguished from the "flight or fight" reaction caused by being touched or handled Conversely, the effect of the anesthetic techniques used could not be separated from the endorphin release or dissociative effects seen with extreme fear resulting from physical restraint and handling. The present study attempted to remove most of the background effects of handling stress by administration of zuclopenthixol acetate, a long acting tranquillizer shown to be effective for that purpose (21)

Material and Methods

The animals used in the study belonged to Manitoba Agriculture and were maintained on a farm in southern Manitoba with other, privately owned wapiti. Thirty-two male wapiti aged 2 or 3 years old were available for the study that took place over 2 days during the first week of July, 2000

Each animal was moved through a handling system and held in a hydraulic squeeze chute for identification and administration of long acting tranquillizer Animals were identified, weighed, randomly assigned a treatment group, antler pedicle circumference recorded, and given 1 mg/kg of body weight of zuclopenthixol acetate (Clopixol Acuphase®, 50 mg/ml, Lundbeck Canada Inc Montreal, Quebec, Canada) intramuscularly into a hind limb

Approximately 18 - 24 hours later each animal was brought into the hydraulic chute and restrained for antler removal A halter was fitted to the animal and ropes attached to the D-rings of the halter nosepiece were tied down to cleats on the chute, preventing head tossing during the procedure A 22 gauge Teflon catheter was placed in the left or right medial auricular artery and secured with cyanoacrylate cement (Crazy Glue) and tape The arterial catheter was connected to a pressure transducer and a physiological monitor (Propaq 400, Protocol Systems Inc , Beaverton, Oregon, USA) was used to measure direct arterial pressures and heart rate

Each animal was provided with either "electroanesthesia" or lidocaine anesthesia prior to antler removal "electroanesthesia" (EA) was furnished by an experienced operator (Baumann) using a commercially available "electroanesthesia" unit (Vet EA®, 101 Street North, Grant, Minnesota, USA). An alligator style electrode clip was placed firmly on the anterior margin at the base of both ears. The electrode clips were plugged into the EA unit and the current applied in an incremental fashion according to a calibrated dial on the unit The amount of current applied was adjusted upward by the operator until it was judged using behavioural observation and ear and eyelid positioning, that analgesia was sufficient for antler removal, and the animal would tolerate no further increase in intensity. EA was applied to each animal in the treatment group for a standard 4 minutes prior to antler removal and stopped immediately after

Local anesthesia (LA) using 1 2 ml of lidocaine per cm of pedicle circumference was performed in a ring block technique After infiltration of lidocaine a standard 4 minutes was allowed to pass prior to antler amputation

Hemostasis was maintained with a tourniquet made from surgical tubing, placed tightly around each pedicle immediately after the waiting period and before antler removal. This particular time was deliberately chosen to preclude any anesthesia due to compression effects of the tourniquet as reported by Matthews (13). All tourniquets remained in place during the post-velveting data recording period of approximately 5 minutes, after which they were removed and the animals turned out into a 10-acre observation paddock

Antlers were removed with a coarse steel saw (9 teeth/in) approximately 3 centimeters above the antler-pedicle junction Behavioural response scores were estimated and recorded during antler removal by a neutral third party attending for that purpose. The obvious presence or absence of the EA device during antler removal did not allow blinding to the analgesic method.

Behavioural response scores were used to quantify the reaction of the wapiti to antler removal according to Wilson et al (10) (Table1) Scores were 0 - no movement, 1 - slight head movement, flinch, 2 - head movement or shake, moderate avoidance of the saw, 3 - whole body struggle, "flight response"

Baseline measurements of blood pressures and heart rate parameter were taken prior to application of analgesic treatment (T_1), during the administration of analgesia (T_2), 4 minutes after analgesia and immediately prior to antler removal (T_3), immediately after antler amputation (T_4), and at 1 (T_5), 2 (T_6) and 3 min after antler removal (T_7) (Figure 1) Blood was drawn from the arterial catheter prior to analgesia and at 3 minutes post amputation for analysis of serum cortisol. It was allowed to clot at room temperature and placed on ice for transport to a veterinary laboratory where cortisol analysis was performed using standard methods

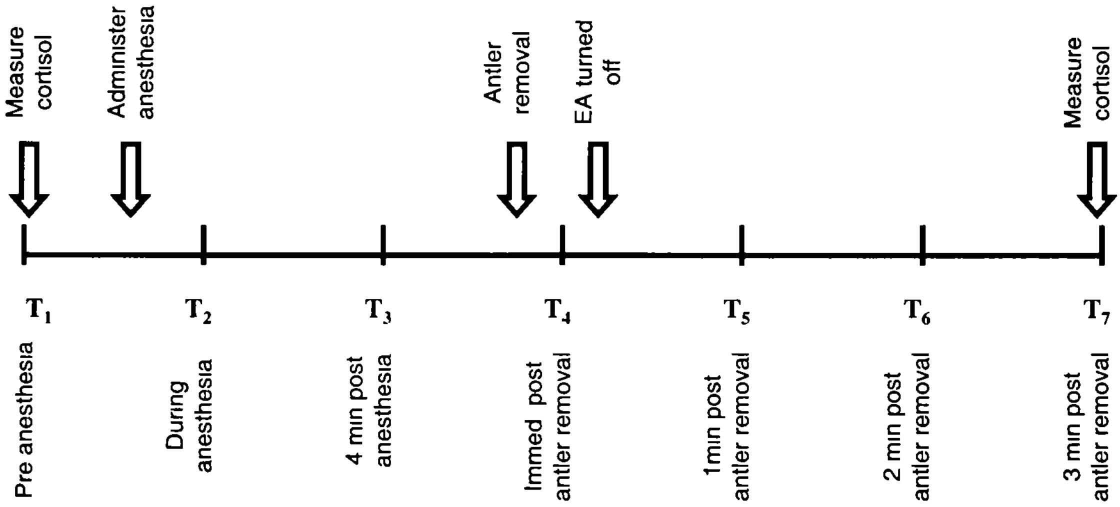

Figure 1 Time-line drawing showing antler removal events with heart rate and blood pressure data points (T)

Statistical analysis and graph generation was performed using Prism® (Version 3 0, GraphPad Software Inc , San Diego, California, USA) The significance level for all analyses was set at $P < 0\ 05$ Pain scores were compared using a Wilcoxon signed-rank test Changes in heart rate (HR) and systolic arterial pressures (SAP) were determined by subtracting the baseline heart rate from

the heart rate at each subsequent measurement. A positive value indicated an increase in heart rate or arterial pressure at that time The changes in heart rate and arterial pressure were compared between treatments with a paired t-test One-way ANOVA for repeated measures was used to compare HR and SAP over time A Bonferroni multiple comparison test was used to determine where differences occurred (22). Mean pre and post antler removal serum cortisol values were also compared using a paired t-test

Results

The result of administration of zuclopenthixol acetate was similar to that reported by Read et al (21). All animals were reasonably alert and sensitive to handling pressure at the time of experimentation but lacking in the usual alarm or sympathetic response to human touch. At no time was a panic response detected during handling or antler removal.

The mean pedicle circumference in the LA group was 20 1± 1.9 cm and the mean estimated volume of lidocaine needed for a ring block of both pedicles at 1.2 ml per cm was 40 2 ± 3 9 ml In practice, the amount of lidocaine needed to complete the individual ring block varied, some needing more and others less than the estimated dose. The mean actual volume of lidocaine used in both antlers was 48.0 ± 9.27 ml

The intensity of EA applied to each animal to achieve the behavioral and physical signs of local anesthesia also varied Although individual settings were not recorded, in each case there was an end point corresponding to a dial setting of approximately 3 0 where further increase was not tolerated by any animal. Momentary aversive movements and a brief struggle occurred when EA intensity was increased to a new level, and persistent movement occurred whenever the animal's threshold level was reached, preventing further increases

Behavioral response scores for each antler following LA or EA during antler removal are shown in Table 1. No response was observed in 11/16 lidocaine-treated animals and in 2/16 EA-treated animals. A significantly greater ($P = 0.011$) number of animals in the EA group demonstrated behaviour indicative of pain during antler removal (Figure 2).

Heart rates did not change significantly from baseline values over time with the LA group, but increased significantly over time with EA (Figure 3). The significant increases occurred after the 4-min post anesthesia waiting period (T_3) ($P < 0.01$) and immediately after antler removal (T_4) ($P < 0.01$). Heart rates increased from baseline (T_1) throughout the application of anesthesia and after antler removal for those animals given EA but not for those given LA (Figure 3).

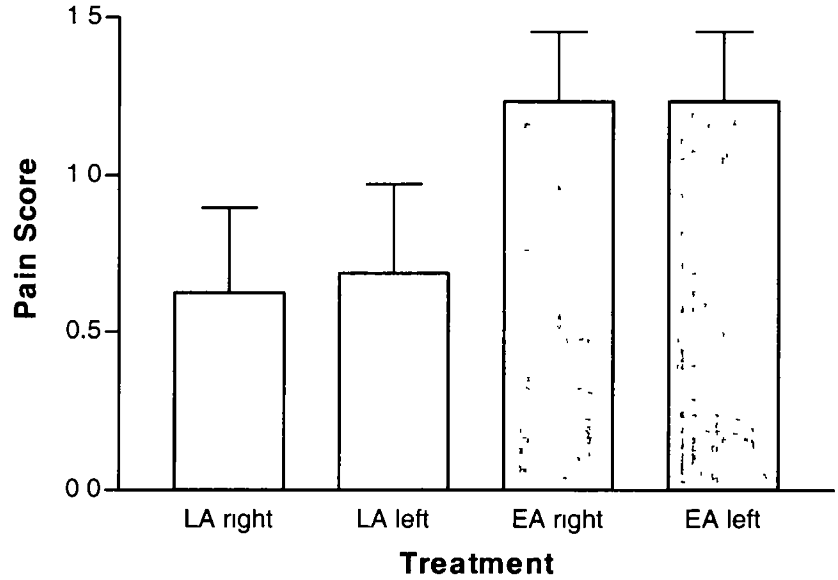

Figure 2 Mean behavioural response (pain) score results using lidocaine anesthesia (LA) n=16, or electroanesthesia (EA) n=16, to induce antler anesthesia in wapiti. Error bars show SEM

Table 1 Behavioural response scores used to quantify reaction to antler removal using lidocaine anesthesia (LA) n=16, or electroanesthesia (EA) n=16, to induce antler anesthesia in wapiti

Score *	LA L antler	LA R antler	EA L antler	EA R antler
0 - no movement	11/16	11/16	2/16	2/16
1 - slight head movement, flinch	2/16	1/16	9/16	9/16
2 - head movement or shake, moderate avoidance by head movement only	1/16	2/16	3/16	3/16
3 - whole body struggle, "flight response"	2/16	2/16	2/16	2/16

* Wilson *et al.*, 1999

Comparison of heart rate differences from baseline between EA and LA at each stage of the antler removal procedure revealed significantly higher heart rates in the EA group immediately prior to antler removal (T_3) ($P = 0.017$), immediately after antler removal (T_4) ($P = 0.001$), and at 1 min after antler removal (T_5) ($P = 0.037$) (Figure 3).

Systolic blood pressure did not change significantly from baseline values over the experimental period in either group, but the trend was to see greater systolic arterial pressure (SAP) changes with EA (P =

0.438) than with LA (P = 0 081) When the change from baseline value was compared at specific times, the magnitude of arterial pressure increase was significantly greater in the EA than in the LA group after the 4-min analgesic induction period (T_3) (P = 0 015) and at 1 min after antler removal (T_5) (P = 0.038) (Figure 4)

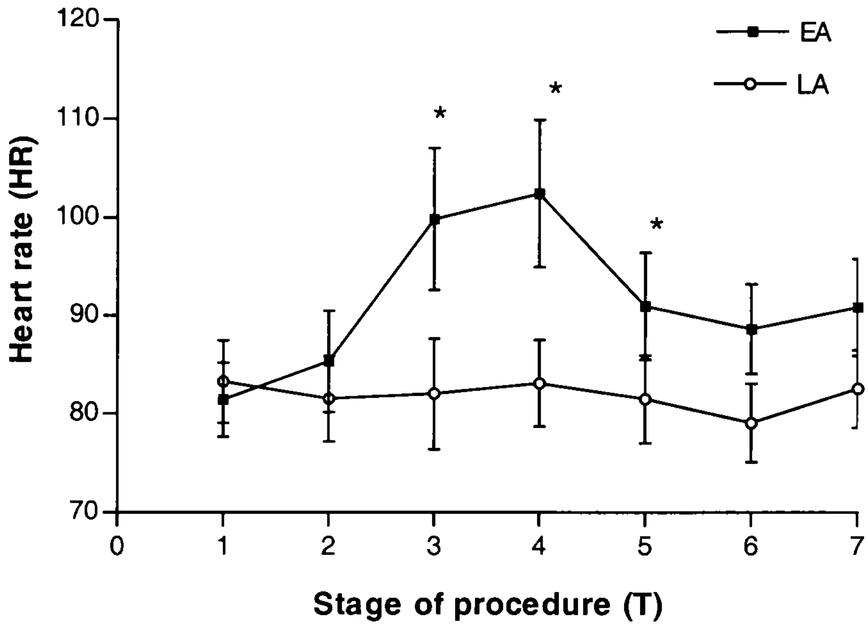

Figure 3 Comparison of heart rates in elk given electroanesthesia(EA) and lidocaine anesthesia (LA) for pain relief during antler removal T_1 - pre anesthesia, T_2 - during administration of anesthesia, T_3 - 4 min post administration of anesthesia, T_4 - immediately post antler removal, T_5 - 1 min post antler removal, T_6 - 2 min post antler removal, T_7 - 3 min post antler removal Heart rates were significantly higher for EA than LA at specific times during antler removal and are indicated by (*). Error bars show SEM

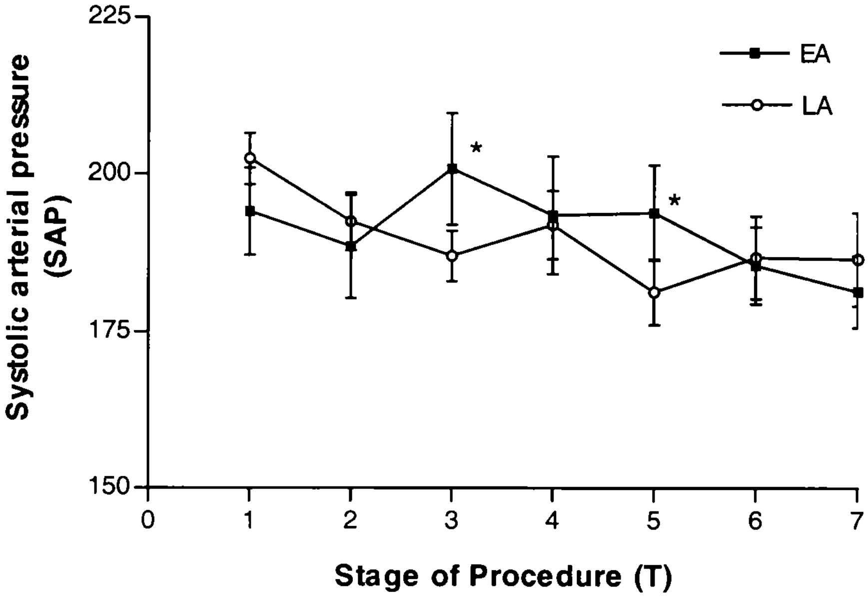

Figure 4 Comparison of systolic arterial pressure in elk given electroanesthesia(EA) and lidocaine anesthesia (LA) for pain relief during antler removal. T_1 - pre anesthesia, T_2 - during administration of anesthesia, T_3 - 4 min post administration of anesthesia, T_4 - immediately post antler removal, T_5 - 1 min post antler removal, T_6 - 2 min post antler removal, T_7 - 3 min post antler removal Arterial pressures were significantly higher for EA than LA at specific times during antler removal and are indicated by (*) Error bars show SEM

There was no significant difference between pre or post antler removal serum cortisol levels either within groups or between groups

Discussion

Previous studies evaluating the effectiveness of anesthetic techniques used for antler removal reported difficulty in separating the stress response resulting from animal handling and restraint from that resulting from pain associated with antler removal (20, 7, 8, 10, 23). Read et al (21) demonstrated the usefulness of zuclopenthixol acetate for reducing handling stress We believe that similar results were obtained in the present study Animals were observed at rest in sternal recumbency in the modular handling system, some of them eructating Animals cautiously entered the squeeze but once restrained permitted the placement of arterial catheters and movement around the head without struggle Upon release the animals exited the squeeze in the usual manner without showing any signs of heavy sedation We are confident that our data reflect the effects of antler removal and not the fear associated with handling and restraint The administration of this drug unmasked the effects of antler removal and minimized the background stress of handling, restraint and experimental manipulation

While it was not our intention to evaluate the effect of EA application itself, but only to assess its effectiveness against traditional lidocaine anesthesia in antler removal applications, examination of the methodology used in this experiment reveals that the onset of "electroanesthesia" is painful in most animals This is shown by increased heart rate and systolic blood pressure measurements at the time of application of analgesia The significant increase in those parameters from baseline or resting values in the EA but not the LA group, and the significant difference in the magnitude of change at the point of application indicates that the application of EA causes significant physiological reaction, whereas the injection of local anesthetic does not This assertion is supported by the observation that there was often flinching and avoidance movement by the animal each time the EA intensity was adjusted upward The observation that EA causes discomfort was also reported by Matthews (12).

The behavioural response scores also demonstrated a difference between EA and LA (Fig 2). There was an equal number of clearly inadequate applications of anesthesia in each group (2) causing maximum behavioural scores to be assessed A similar rate of apparent anesthetic failure with lidocaine application (8%) was reported by Matthews et al (8) and Wilson (10) who attributed this to non-specific reaction due to saw cut vibration or reaction to being touched around the head. Other possibilities are individual variation in drug response to lidocaine and human performance error However, overall there were fewer zero response scores in the EA group compared to the LA group The EA group of animals most often responded to the use of the saw and the LA group did not, showing a clear difference in the results obtained by the two anesthetic methods This indicates that LA is superior to EA for providing analgesia to the antler It also shows that antler removal under EA is a stressful event. Matthews (12) also used behavioural observation to evaluate the use of EA for antler removal and concluded that in no instance did EA completely protect the animal from pain and in many cases provided very little analgesia

Changes in heart rates have been used as an indicator of stress resulting from both handling and antler removal in red deer (23) Matthews (7) and Stookey (20) suggested that the actual experience of handling and restraint was as stressful to red deer as antler removal The separation of stress due to the pain of antler removal from that caused by fear during handling in those studies proved to be difficult In the present study the addition of a tranquillizer to the experimental protocol greatly diminished the background stress of restraint, allowing the expression of pain due to antler amputation. The LA group showed no significant increase in heart rate over the experimental period indicating the absence of pain from the injection of local anesthetic solution as well as the saw incision In contrast, a significant increase in heart rate over time in the EA group signalled a sympathetic system response, likely from pain The differences in heart rate increase suggests that LA is superior to EA in providing analgesia during antler removal. Importantly, the increases in heart rate while using EA techniques were seen not only during antler removal, but during the application of EA itself The observation that EA causes discomfort was also reported by Matthews (12)

The increase in heart rates were significantly higher in EA animals than LA animals at key points during the antler removal procedure (Fig 3) A comparison of the methods shows significant differences at induction of anesthesia (T_2,) at antler removal T_4,) and at 1 min post removal (T_5) These findings suggest that LA offers superior analgesia to that created by EA at the actual point of antler removal

Although there was no statistically significant EA group increase in arterial pressure over time were analysed, the arterial pressure in the EA group was observed to have a larger increase than the LA group This observation suggests that there is some difference in the analgesic methods, and that lidocaine analgesia gives superior overall results

Comparing the SAP at specific points in the antler removal process permits observations to be made about the pain protection provided by EA and LA at those times (Fig 4). The significant increase in systolic blood pressure in EA over LA after 4 min of analgesia induction (T_2) is an indication that the application of EA causes more discomfort and stress than LA Likewise, the significant increase in systolic blood pressure in EA over LA at 1 min after antler removal (T_5) indicates that EA affords less pain protection than LA in the period immediately after antler removal

There is a strong conviction among veterinarians from Australia and New Zealand where antler removal techniques were first introduced that this procedure must be done under humane circumstances and that not to do so would be jeopardizing the velvet antler industry internationally (9, 24) Presently the only universally accepted form of pain control for amputating antlers from mature animals not under general anaesthesia is the application of nerve blocks to the antler pedicle using lidocaine or a similar local anaesthetic solution. The Model Code of Practice for the Welfare of Animals The Farming of Deer (Australian). The Code of Recommendations and Minimum Standards for the Welfare of Deer During the Removal of Antlers (New Zealand), and The Recommended Code of Practice for the Care and Handling of Farmed Deer (Canada) have guidelines for the removal of velvet antler that have been created and agreed upon by the respective industry representatives, animal welfare organizations and veterinary associations These guidelines call for the application of local anaesthetic infiltration techniques to block pain sensation to the antler and pedicle

There is a growing demand in the elk velvet industry for suitable alternatives to lidocaine anesthesia, not only because of the potential for drug residues but because of the relatively time consuming and complex nature of the process Research has begun on compression analgesia, an ancient and simple means of drug free surgical pain relief (13) Many producers have suggested that it is not time efficient or cost effective to use LA in large velveting operations and are currently using EA despite its unproven nature Many have expressed satisfaction with the results obtained using Vet EA® and similar devices for antler removal in their operations Indeed, in the present study there were some individuals that showed no behavioural or physiological response to antler amputation while under the influence of EA, apparently feeling no pain A 1995 report by the Canadian Coordinating Office for Health Technology Assessment on TENS and pain management in humans concluded that for the management of acute pain, the evidence showing TENS to be effective is about equal to that suggesting it to be no more effective that sham TENS, or a placebo treatment (15) There is a need to investigate the circumstances if any under which these electrical devices will provide reliable effects in animals

There have been no studies to date that have satisfactorily demonstrated the effectiveness of EA for antler removal in cervids (19, 20, 12) However, given that these investigations have exhibited evidence of analgesia in at least some animals, perhaps more reliable configurations of EA could be developed for antler removal In the meantime, we have found that EA in its present form was not as effective as LA in producing reliable anesthesia for the purposes of antler removal in wapiti.

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