Sedation in combination with local anesthesia was as effective as general anesthesia for canine castrations

Erika Silva Cuzmar,[a] John Schumacher,[b] Thomas Passler,[b] William R. Ravis[c]
[a]Instituto de Ciencias Clinicas Veterinarias, Facultad de Ciencias Clinicas Veterinarias, Universidad Austral de Chile, Valdivia, Chile
[b]Department of Clinical Sciences, College of Veterinary Medicine, Auburn University, AL
[c]Department of Drug Discovery and Development, Auburn University, AL

Abstract

The object of the study was to compare evidence of pain in dogs castrated while anesthetized with that of dogs castrated while sedated and after desensitizing the testes and site of incision with local anesthetic solution. All dogs were sedated with xylazine (1 mg/kg, intramuscularly). For the local anesthesia treatment, dogs were given 2% lidocaine subcutaneously in the pre-scrotal area and intratesticularly; total doses ranged from 4.2 to 14.9 mg/kg (10.7 mg/kg ± 2.4 mg/kg, mean ± SD). For the general anesthesia treatment, once dogs were sedated, they were given propofol (4.4 mg/kg, intravenously) as a bolus, with an additional bolus of propofol (2.2 mg/kg, intravenously) given if signs of insufficient anesthetic depth were evident during surgery. The interval from sedation to incision and overall duration of castration surgery were similar for both treatments. Movement scores during surgery did not differ significantly between treatments. Respiratory rates were not significantly different between treatments or over time. However, in both treatments, there was a significant reduction in heart rate during surgery as compared to the preoperative heart rate. Based on objective assessments, measured indicators of pain were not different for canine castrations performed under local versus general anesthesia.

Keywords: Dog, castration, sedation, lidocaine, xylazine, propofol

Introduction

Male dogs are routinely castrated for population control and to decrease their impulse to roam.[1] In many developing countries, free-roaming dogs transmit zoonotic diseases, most importantly rabies. Furthermore, roaming dogs are likely to suffer from malnutrition, starvation, fight wounds, abuse, and sexually transmitted diseases.[1] Access to low-cost neuter programs substantially promotes spay/neuter procedures.[2] Dogs are typically castrated while under general anesthesia. However, if dogs could be castrated using only sedation and local anesthesia, there is potential for lower anesthetic risk and expense, which could increase the number of dogs castrated. The object of the study was to compare evidence of pain in dogs castrated while anesthetized with that of dogs castrated while sedated and after desensitizing the testes and site of incision with local anesthetic solution.

Materials and methods

Dogs

Owners of 50 various breed male dogs presented for castration signed a consent form allowing participation of their dogs in the study, which was approved by the Universidad Austral de Chile Bioethics Committee for the Use of Animals in Biomedical Research (# 231-2015). Dogs were allocated to the following two treatments as follows: after assigning the first dog presented to be castrated under the influence of sedation and local anesthesia (LA), the next dog presented was assigned to the alternate treatment to undergo castration under general anesthesia (GA).

Physical examinations were performed before sedation. Dogs were excluded from the study if the heart rate (HR), rectal temperature, or respiratory rate (RR) were outside normal reference ranges, or if a

testicular abnormality, e.g. cryptorchidism, was detected. Dogs were fasted overnight but allowed access to water until they were sedated with xylazine HCl (Xilacina 2% Centrovet, Santiago, Chile; 1.0 mg/kg IM). Once recumbent, dogs were placed on a surgical table in lateral recumbency. Dogs in each treatment were prepared for surgery while sedated and laterally recumbent with the upper pelvic limb flexed and elevated. Following surgical preparation, either propofol (GA) or lidocaine (LA) were administered.

Movement scores, heart and respiratory rates were determined before sedation, 3 min after sedation and immediately prior to the skin incision. Data collected immediately before the skin incision were used as baseline. Heart and respiratory rates were determined by counting heartbeats for 15 seconds with a stethoscope and counting chest movements for 15 seconds, respectively.

For dogs in the LA treatment, 2% lidocaine HCl (Lidocalm® 2%, Drag Pharma, Santiago, Chile) was administered by the first author into each testis, until a slight swelling of the testis was detected, and subcutaneously, on the midline, cranial to the scrotum. Testicular injections were made by inserting a 21-gauge, 16-mm needle on the median raphe and then directing the needle, from its subcutaneous location into the parenchyma of each testis. The volume of lidocaine administered subcutaneously cranial to the scrotum depended on the estimated length of the incision necessary to remove the testes and was generally equal to the dose injected into each testis. For dogs in the LA treatment, propofol was to be administered if pain during castration became evident as indicated by vocalization, a head raise, an attempt to stand or purposeful movement. The interval from administration of the sedative to incision, duration of surgery from incision to placement of the last skin suture, and interval from completion of surgery to standing recovery were recorded. The interval from intratesticular injection of lidocaine to the beginning of surgery was retrospectively estimated.

After preparing the dog for surgery, anesthesia for dogs in the GA treatment was induced with a bolus of propofol (Propofol® 10 mg/ml, B. Braun Melsungen AG, Germany; 4.4 mg/kg IV administered via a hypodermic needle in the cephalic vein). These dogs were not intubated nor given supplemental oxygen. Another IV bolus of propofol (2.2 mg/kg) was given if the dog had purposeful movement during surgery (i.e., Grades 3 or 4; see grading system below). Castrations were performed with the dog in lateral recumbency and its upper pelvic limb elevated in a flexed position. Surgery was performed by the first author using a previously described open technique for castration of cats where the ductus deferens is separated from the spermatic cord and tied with the cord vasculature to form a knot.[3]

Parameters assessed during surgery

Dogs in the GA treatment were maintained at a surgical plane of anesthesia, as indicated by ventromedial eye position, relaxed jaw tone, slow or sluggish palpebral reflex, and lack of movement in response to the surgical incision. Heart and respiratory rates and movement during the surgery period (SURG) were determined for dogs in both treatments at 3, 5, 10, and 15 minutes after the skin was incised. Movement of dogs during the procedure was subjectively graded on a scale of 0-4 where: 0 = no movement; 1 = slight, non-purposeful movement that did not interfere with surgical manipulations; 2 = moderate, non-purposeful movement that interfered slightly with surgery; 3 = purposeful movement that interfered substantially with surgery; and 4 = purposeful movement that made continuation of surgery impossible. No focused attempt was made to associate movement with a surgical maneuver such as skin incision, traction on the testis, or placement of suture. A veterinary anesthesiologist, not blinded to the procedures being performed, determined heart and respiratory rates and graded the movement of dogs during all 48 surgeries. Signs that were considered to be indicative of pain included avoidance movement, vocalization, head raise, and attempts to stand. The last four dogs in the LA treatment were subjected to a toe pinch before the skin was incised and immediately after the last skin suture was placed, to detect a purposeful response to this noxious stimulus. If the dogs became aroused by the toe pinch, they were allowed to return to a state of sedation before proceeding with the castration.

All dogs were given a single dose of ketoprofen (1 mg/kg IM) and procaine penicillin G (20,000 IU/kg IM) at completion of surgery. After placement of the last suture, dogs were placed on a pad on the surgery room floor in lateral recumbency and interval to standing was recorded. Dogs were undisturbed during recovery. Sutures were removed after 10 to 14 days, either by the owner or hospital personnel.

Owners were contacted by telephone 4 or 5 days after the surgical procedure to determine if there were post-operative complications and the owner's evaluation of post-operative pain or abnormal behavior.

Data analyses

Statistical analyses were performed using commercial software (JMP® 11.0.1, SAS Institute Inc. Cary, NC, USA). Data were assessed for normality by visual inspection of frequency distributions and by the Shapiro-Wilk test. Descriptive statistics, including mean, median, standard deviation, minimum, and maximum, were calculated. Age, HR, RR, and movement were not normally distributed and were transformed logarithmically prior to statistical analysis. Statistical tests were performed to test the null hypothesis that means of each outcome variable were not different between LA and GA treatments. Outcome variables collected once (age, bodyweight, duration of surgery, time from sedation to incision, and time to stand) were compared using a Student's *t*-test. For outcome variables assessed at sequential time points during surgery (movement, HR, and RR), average rates determined during baseline assessment and following the skin incision were estimated from the area under the curve for percentage change in the rate from the baseline rate versus time, with average rate calculated as the area under the curve, divided by the duration of observation. Movement scores, RR differences, and HR differences were compared between treatments and over time using a mixed model repeated measures analysis, as implemented in the Full-Factorial Design (Mixed Model) add-on of JMP. For all analyses, $p < 0.05$ was considered significant. Graphs were generated in JMP Graph Builder, using untransformed data.

Results

Two dogs presented for castration were cryptorchid and were excluded from the study; thus, 48 dogs completed the study (24 per group). There was no difference between treatments for dog age ($p = 0.77$), but dogs in the LA treatment were heavier ($p = 0.023$; Table 1). Doses of lidocaine administered to dogs in the LA treatment ranged from 4.2 to 14.9 mg/kg (mean ± SD of 10.7 mg/kg ± 2.4 mg/kg), with 17 of 24 dogs given > 10 mg/kg. Muscle tremors, an early sign of lidocaine intoxication,[4] were not observed. One dog had a vocal reaction to intratesticular injection of lidocaine that was interpreted as an expression of pain. Two dogs in GA treatment developed purposeful movement during surgery and required additional administration of propofol (2.2 mg/kg, IV), each at 6 minutes after incising the skin.

Surgical times for both treatments are summarized in Table 1. The interval from intratesticular injection of lidocaine to the beginning of surgery was estimated to be ~ 2 minutes. However, the dog that reacted vocally to intratesticular administration of lidocaine was allowed ~5 minutes to return to a state of sedation before beginning surgery. Following surgery, dogs in treatment GA took longer to stand ($p = 0.017$).

Average percentage changes in HR from baseline values did not differ between treatments ($p_{treatment} = 0.289$; Figure 1). Over time, there were reductions in HR in both treatments, GA ($p_{period} = 0.008$) and LA ($p_{period} = 0.007$), at 3, 5, and 15 min (SURG) compared to baseline. Change in PRE RR did not differ between treatments ($p_{treatment} = 0.147$; Figure 2). However, during SURG, percentage decreases in RR from baseline were greater in LA versus GA ($p_{treatment} = 0.005$), with average percentage changes of -48.9 ± 42.3 versus -13.7 ± 39.7%. The RR were similar ($p_{period} = 0.977$) for PRE and SURG periods for GA dogs, but for LA dogs, decreases in RR were greater ($p_{period} = 0.008$) during SURG as compared to PRE.

Movement occurring between assessment times was never greater than that recorded at predetermined time points. Movement scores (Figure 3) decreased over time in both treatments during SURG ($p_{time} < 0.001$), with no difference between treatments ($p_{treatment} = 0.496$). After an initial decrease ($p_{treatment} = 0.018$) in movement for the GA treatment at 3 minutes, movement scores were not different between treatments. Average movement during SURG did not differ between treatments ($p_{treatment} = 0.202$) Nine dogs in the LA treatment and 16 dogs in the GA treatment did not move during castration. It was noteworthy that movement of dogs in the LA treatment did not interfere with surgery and subjectively appeared to be random rather than associated with pain perception. Two dogs receiving the lowest doses of lidocaine (4.2 and 5 mg/kg) had movement scores of 1 and 3 at three minutes, but had no movement at

five, 10 or 15 minutes. Four dogs in LA treatment that were subjected to a toe pinch before incising the skin and immediately after placing the last suture responded to this test with signs of pain [i.e., limb withdrawal, purposeful movement, head raise, and standing (one dog)] despite showing no signs of avoidance movement or head raise during orchiectomy. Owners were contacted by telephone at 4 or 5 days after their dog's castration. None of the owners reported signs of post-operative pain or any complications, other than slight swelling and redness of the pre-scrotal incision site.

Discussion

Based on objective assessments, indicators of pain did not differ between treatments. Furthermore, there were no significant differences in movement, or heart or respiratory rates. Although measures of pain were assessed at pre-determined time points rather than specific surgical manipulations that would likely elicit pain, the surgeon and anesthesiologist recorded obvious signs of apparent pain such as vocalization or avoidance movement (such as in one dog during injection). However, no additional signs that might be interpreted as pain were noted. Therefore, we attributed any movement of dogs in the LA treatment during surgery to insufficient sedation and reaction to environmental stimuli (e.g. noise and touch) rather than pain.

Castration of standing, sedated stallions is commonly performed without behavioral evidence of pain, after infiltrating the testes or spermatic cord and scrotum with local anesthetic.[5,6] Almost all testicular surgical procedures performed on men, sedated or unsedated, can be performed using local anesthesia.[7-11] In one report, 360 men underwent painless inguinal, scrotal, or testicular surgery (which was an orchiectomy in 40 cases) as unsedated outpatients after the spermatic cord of the testis being operated on and the surgical site were injected with lidocaine.[9]

In a study that evaluated the analgesic effect of intratesticular and incision line infiltration of local anesthetic (0.5% ropivacaine), 5 of 11 dogs sedated with medetomidine were castrated without movement, whereas two dogs required further sedation to prevent movement during castration.[12] Intraoperative data collected from one dog in that study was excluded from evaluation due to repeated movement in the absence of a surgical stimulus, despite repeated administration of medetomidine. Because of movement, four dogs in that study were given general anesthesia to complete the castration; however, the authors did not offer an opinion as to whether movement appeared to be in response to pain or possibly other environmental stimuli. Based on that study, we inferred that sedated dogs can be castrated after anesthesia of the testes and site of incision, as long as restraint is adequate.

A limitation of this study was failure to monitor blood pressure. Obvious effects of noxious stimuli are tachycardia and hypertension.[13] Because nociceptive impulses entering the central nervous system induce a sympathetic response affecting HR and blood pressure, these cardiovascular variables are often used in studies involving various species as objective data to indicate nociception.[13-15] Hemodynamic responses to nociception commonly occur even when anesthetic concentrations are sufficient to prevent motor and ventilatory responses.[13] A comparison of blood pressures between the two treatments may have provided evidence of the anti-nociceptive effects of intratesticular lidocaine. Physiological reflexes that control these autonomic responses to noxious stimuli are modulated in the cardio-respiratory centers of the medulla oblongata and do not necessarily reach cognitive centers of the brain; therefore, changes in cardiovascular variables are not necessarily evidence of pain perception.[15] However, while tachycardia and hypertension in response to surgical manipulation may not necessarily indicate nociception in dogs under general anesthesia, documentation of suppression of hypertension in dogs undergoing castration with intratesticular lidocaine would have provided additional evidence that these dogs did not perceive pain.

In a study that evaluated indicators of nociception in stallions undergoing castration, mean arterial blood pressure was a more sensitive indicator of nociception than was HR.[14] It was speculated that genital surgery may increase vagal tone, resulting in intra-operative bradycardia. Similar findings were reported in dogs undergoing ovariohysterectomy.[16] In that study, there was no change in heart rate during the ovariohysterectomy, but blood pressure increased during removal of ovaries, probably concurrent with maximum noxious stimulation.

We chose to inject the testes rather than the spermatic cord, because the former is simpler. In a study using radiolabeled lidocaine to determine distribution of intratesticularly administered lidocaine in stallions undergoing castration, lidocaine was quickly transported proximally and distributed diffusely throughout the spermatic cord, even though distribution of radiolabeled lidocaine within the testicular parenchyma was poor.[17] In men undergoing testicular biopsy, 0.5 to 1 ml of 1% lidocaine injected into a testis adjacent to the tunica albuginea allowed painless biopsy immediately (within 15 seconds) after injection.[18] Therefore, there appears to be rapid onset of anesthesia of the testis and spermatic cord after intratesticular injection of lidocaine. The interval from intratesticular injection of lidocaine to castration in our study was very short, consistent with rapid desensitization of testis and spermatic cord. We observed no obvious pain response to surgical manipulations from any dog in the LA treatment, even though the onset of surgery, for most dogs, was estimated to be ~2 minutes after lidocaine was administered intratesticularly. Although 17 of the dogs in the LA group received more than the recommended maximum therapeutic dose of lidocaine (10 mg/kg),[4] no signs of toxicity, such as seizure, muscle tremor, bradycardia, nausea, and vomiting.[4,19] were observed in any LA dog. Signs of lidocaine toxicity may not have been observed because of a masking effect of xylazine or because much of the lidocaine was removed along with testes and a portion of the spermatic cord, thus decreasing the amount of lidocaine reaching the general circulation. Serum lidocaine concentration in dogs peaks ~30 minutes after subcutaneous or intramuscular injection;[19] however, in our study, testes were removed much sooner. A much smaller dose of lidocaine (2 mg/kg) was given intratesticularly in a study examining analgesic effects of lidocaine administered into the testes of dogs castrated while anesthetized with an inhalant anesthetic agent (isoflurane).[20] This dose of lidocaine significantly decreased the hemodynamic effects of castration compared to a saline control indicating that this dose provided substantial analgesia during castration. That two of the dogs receiving the lowest doses of lidocaine had no movement after the 3-minute assessment indicates that administration of lidocaine far below the maximum recommend dose may provide sufficient anesthesia for castration of sedated dogs.

In the present study, we used lidocaine due to its broad availability and low cost. However, other local anesthetic agents, e.g., mepivacaine, bupivacaine, or ropivacaine, may be similarly effective. The anesthetic action of each of these local anesthetic agents is longer than that of lidocaine, and therefore, the use of any one of these local anesthetic agents might provide longer post-operative pain relief. One dog displayed signs of pain during intratesticular injection of lidocaine; perhaps this was caused by rapid distention of the testis or a burning sensation related to the low pH of lidocaine (~6[21]). Adding sodium bicarbonate to a solution of lidocaine (e.g., 1 ml of 8.4% sodium bicarbonate solution per 9 or 10 ml lidocaine) may decrease pain during injection by increasing pH.[21]

Xylazine was chosen as a sedative because one of the aims of this study was to demonstrate an economical method of dog castration, and due to limited availability of other alpha$_2$-adrenoreceptor agonists in some countries. Because xylazine is more likely to cause cardiac arrhythmia than medetomidine or dexmedetomidine, some anesthesiologists consider the use of xylazine in small animal practice unjustified.[22] The hemodynamic effects of xylazine can be reduced by administering it intramuscularly rather than intravenously.[23] Deaths associated with use of xylazine in dogs occur primarily when xylazine is used in combination with a general anesthetic agent.[22] Xylazine should be administered with caution or not at all to dogs that are debilitated or that have cardiovascular, respiratory, or renal dysfunction.[24]

It could be argued that general anesthesia in addition to local anesthesia is a better option for castration of dogs than is sedation plus local anesthesia. While this may be true for many circumstances, this study demonstrated that dogs can be castrated using only sedation and local anesthesia without displaying obvious evidence of pain. This technique may be useful for castration of dogs in underdeveloped regions of the world where economic factors make canine population control difficult.

Limitations of this study include failure to monitor mean arterial blood pressures during castration, as this would have provided better evidence of pain response than heart or respiratory rates. In addition, we relied on arbitrary, pre-determined time intervals to detect evidence of pain rather than trying to correlate components of the surgery most likely to elicit pain with the criteria we chose to evaluate for

evidence of pain. A more accurate determination of the minimal time that must elapse between intratesticular injection of local anesthetic and castration would allow surgeons to accurately determine when the procedure can safely begin. Finally, the study was not blinded, which may have biased some results.

Other than observing a purposeful response of one dog to intratesticular administration of lidocaine, no problems were encountered using sedation and local anesthesia to castrate 24 dogs. We concluded that IM xylazine and local anesthesia of the testes and surgical site provided a practical option for castration of dogs. Given these findings, this protocol warrants further study for castration of dogs when general anesthesia is inappropriate.

Conflict of interest

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

References

1. Jackman J, Rowan A: Free-Roaming Dogs in Developing Countries: The Benefits of Capture, Neuter, and Return Programs. In: Salem DJ, Rowan AN, editors. The state of the animals IV. Portland, OR: Humane Society Press, Book News; 2007. p. 55-78.
2. Frank JM, Carlisle-Frank PL: Analysis of programs to reduce overpopulation of companion animals: Do adoption and low-cost spay/neuter programs merely cause substitution of sources? Ecological Economics 2007;62:740-746. doi:10.1016/j.ecolecon.2006.09.011
3. Hedlund CS: Surgery of the reproductive and genital systems. In: Fossum TW, editor. Small animal surgery 3rd edition, St. Louis: Mosby Elsevier; 2007. p. 702-774.
4. Lemo N, Vnuk D, Radisic B, et al: Determination of the toxic dose of lidocaine in dogs and its corresponding serum concentration. Vet Rec 2007;160:374-375.
5. Joyce J, Henrickson DA: Comparison of intraoperative pain responses following intratesticular or mesorchial injection of lidocaine in standing horses undergoing laparoscopic cryptorchidectomy. J Am Vet Med Assoc 2006;229:1779-1783.
6. Schumacher J: Testis. In: Auer JA, Stick JA, editors. Equine surgery, 4th edition, St. Louis: Elsevier Sanders; 2012. p. 804-840.
7. Ather MH, Mushtaq A, Sulaiman MN: Urological surgical procedures under local anesthesia. In: Saadatniaki A, editor, Clinical use of local anesthetics. Rijeka, Croatia: InTech; 2012. p. 39-58. doi: 10.5772/31828
8. Desmond AD, Arnold AJ, Hastie KJ: Subcapsular orchidectomy under local anaesthesia. Br J Urol 1987;61:143-145.
9. Magoha GAO: Local infiltration and spermatic cord block for inguinal, scrotal and testicular surgery. East Afr Med J 1998;75:575-577.
10. Riba LWN: Subcapsular castration for carcinoma of prostate. J Urol 1942;48:384-387.
11. Rud O, Peter J, Kheyri R, et al: Subcapsular orchiectomy in the primary therapy of patients with bone metastasis in advanced prostate cancer: An anachronistic intervention? Adv Urol 2012. doi:10.1155/2012/190624
12. Kushnir Y, Toledano N, Cohen L, et al: Intratesticular and incisional line infiltration with ropivacaine for castration in medetomidine-butorphanol-midazolam sedated dogs. Vet Anaesth Analg 2017;44:346-355.
13. Ilkiw J: Balanced anesthetic techniques in dogs and cats. Clin Tech Small Anim Pract 1999;14:27-37.
14. Haga HA, Dolvik NI: Electroencephalographic and cardiovascular variables as nociceptive indicators in isoflurane-anaesthetized horses. Vet Anaesth Analg 2005;32:128-135.
15. Johnson C: Research tools for the measurement of pain and nociception. Animals; 2016. doi:10.3390/ani6110071
16. Höglund OV, Lövebrant J, Olsson U, et al: Blood pressure and heart rate during ovariohysterectomy in pyometra and control dogs: a preliminary investigation. Acta Vet Scand 2016;58:80. DOI 10.1186/s13028-016-0263-y
17. Haga HA, Lykkjen S, Revold T, et al: Effect of intratesticular injection of lidocaine on cardiovascular responses to castration in isoflurane-anesthetized stallions. Am J Vet Res 2006;67:403-408.
18. Kamal K, Zini A, Jarvi K: Testicular block using intra-testicular lidocaine: a new anaesthetic technique for percutaneous testis biopsy. Can J Urol 2002;9:1568-1570.
19. Hall LW, Clarke KW, Trim CM: General principles of local analgesia. In: Hall LW, Clarke KW, Trim CM, editors. Veterinary Anaesthesia. 10th edition, London: WB Saunders; 2000. p. 225-245.
20. Huuskonen V, Hughes JM, Bañon EE, et al: Intratesticular lidocaine reduces the response to surgical castration in dogs. Vet Anaesth Analg 2013;40:74-82.2000. p. 225-245.
21. Frank SG, Lalonde DH: How acidic is the lidocaine we are injecting, and how much bicarbonate should we add? Can J Plast Surg 2012;20:71-74.
22. Flaherty D: Alpha2-adrenoceptor agonists in small animal practice 1. Why they do what they do. In Pract 2013;35: 524-530.
23. Klide AM, Calderwood HW, Soma LR: Cardiopulmonary effects of xylazine in dogs. Am J Vet Res 1975;36:931-935.

24. Paddleford RR, Harvey RC: Alpha2 agonists and antagonists. Vet Clin North Am Small Anim Pract 1999;29:737-745.

Table 1. Age, bodyweight, and surgical times of interest are summarized for LA (sedation and local anesthesia) and GA (general anesthesia) dogs.

	Treatment	Mean	Median	Standard deviation	Minimum	Maximum
Age (months)	LA		18.9	28.4	6	108
	GA		16.5	31.3	4	120
Bodyweight (kg)*	LA	18.6		8.9	5.5	38
	GA	13.3		6.6	4.3	26
Lidocaine dose (mg/kg)	LA	10.7		2.4	4.2	14.9
	GA	N/A		N/A	N/A	N/A
Duration of surgery (min)	LA	11.1		2.5	8.0	16.0
	GA	10.0		2.5	6.0	19.0
Interval from sedation to incision (min)	LA	21.6		4.8	14.0	33.0
	GA	21.8		5.0	11.0	31.0
Interval from placement of last suture to standing (min)*	LA	14.5		10.6	2.0	42.0
	GA	23.2		13.4	3.0	58.0

*difference between treatments ($p < 0.05$); N/A = Not administered. Treatment means are displayed for normally distributed data whereas treatment medians are displayed for non-normal data.

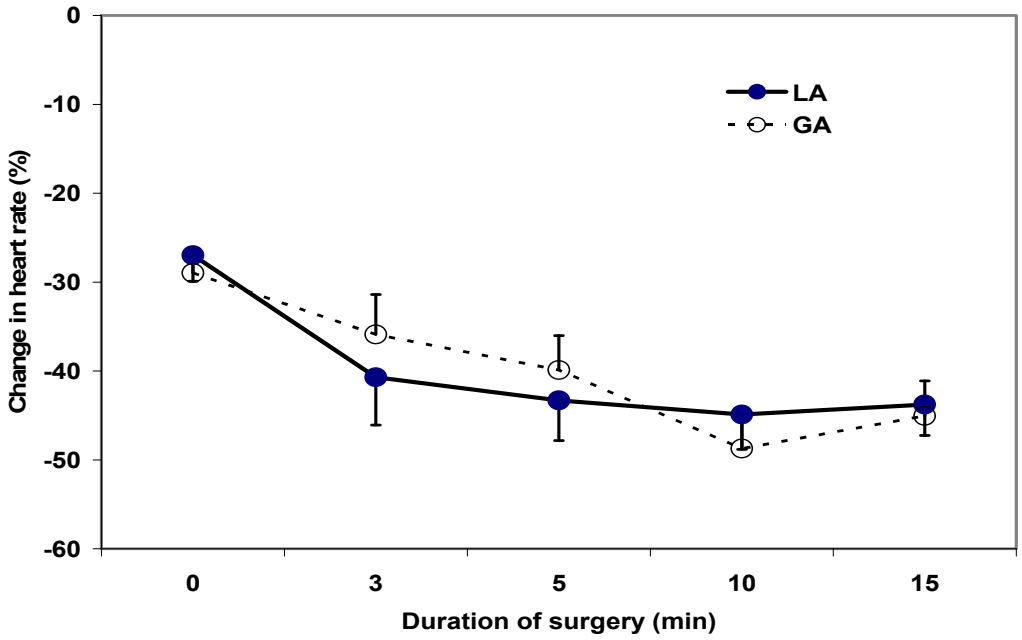

Figure 1. Average difference in heart rate of each treatment during surgery compared to the average heart rate measured immediately before the skin incision; LA (sedation and local anesthesia) and GA (general anesthesia) dogs.

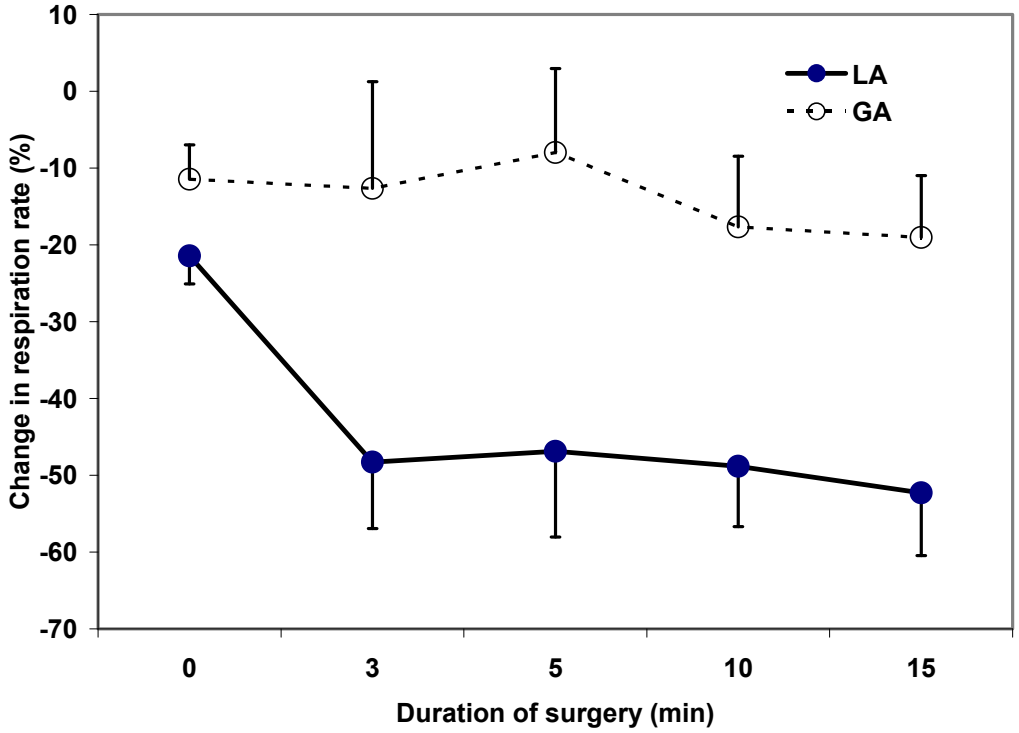

Figure 2. Average difference in respiratory rate of each treatment during surgery compared to the average respiratory rate measured immediately before the skin incision (first point on graph); LA (sedation and local anesthesia) and GA (general anesthesia) dogs.

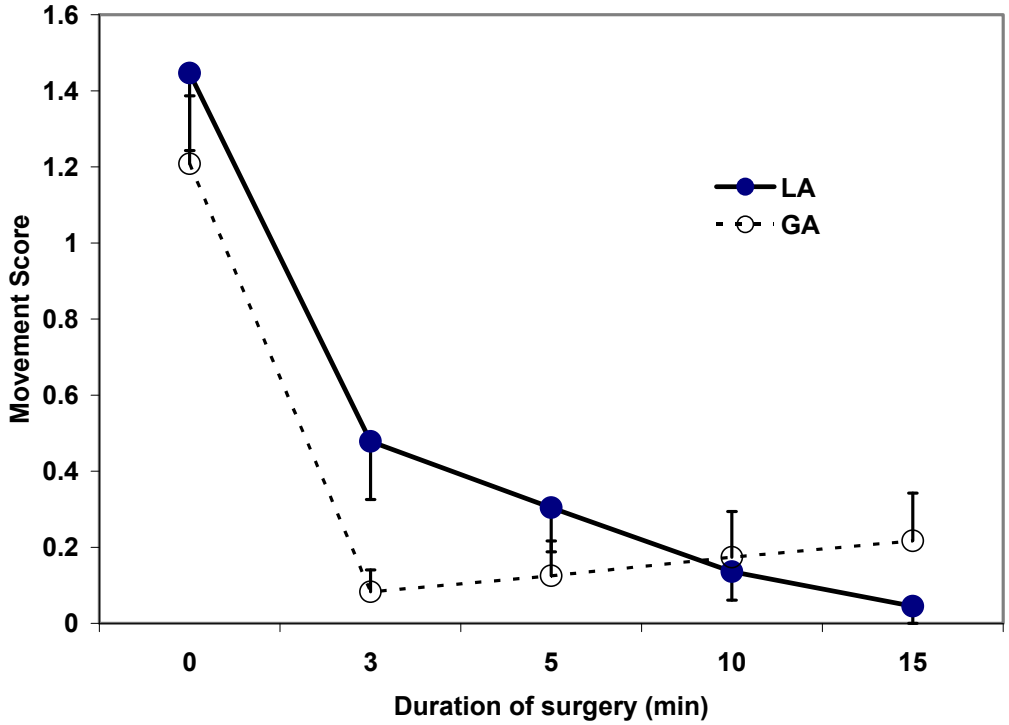

Figure 3. Average movement scores during surgery for two groups of dogs. The first point on the graph indicates movement immediately before the skin incision; LA (sedation and local anesthesia) and GA (general anesthesia) dogs.