Comparative study between target-controlled-infusion and continuous-infusion anesthesia in dogs treated with methotrimeprazine and treated with propofol and remifentanil[1]

Estudo comparativo entre anestesia venosa total alvo-controlada e por infusão contínua em cães pré-tratados com levomepromazina e tratados com propofol e remifentanila

Eduardo Hatschbach[I], Fernando do Carmo Silva[I], Suzane Lílian Beier[II], Alfredo Feio da Maia Lima[III], Flávio Massone[IV]

[I] Master, Fellow PhD, Experimental Anesthesiology, Faculty of Medicine of Botucatu, UNESP, São Paulo, Brazil.

[II] Associate Professor, Clinic and Pathology Department, Santa Catarina State University, Lages, Santa Catarina, Brazil.

[III] PhD, Experimental Surgery, Faculty of Veterinary Medicine and Zootechny, UNESP, Botucatu, São Paulo, Brazil.

[IV] Full Professor, Department of Surgery and Veterinary Anesthesiology, Faculty of Medicine of Botucatu, UNESP, São Paulo, Brazil.

ABSTRACT

Purpose: To compare two propofol infusion techniques in bitches subjected to ovaryhisterectomy by estimating the efficiency of the propofol target-dose, evaluating the cardiorespiratory and hemogasimetric attributes, and the bispectral scale index (BIS) as well as the recovery period characteristics. **Methods**: Twenty anesthetized bitches were divided into two groups of 10 each (G1, G2). Animals of G1 were pre-treated with methotrimeprazine and anesthetized with target-controlled propofol infusion by means of a Harvard infusion pump combined to remifentanil through a syringe pump. **Results**: Bradycardia and light hypotension, hemogasimetric and respiratory stability besides a good myorelaxation, more evident during continuous infusion and good hypnosis. **Conclusions**: Dosis used in both techniques, after methotrimeprazine pre-treatment and combined to the opioid, were efficient for the surgery. The target-controlled anesthesia required a smaller anesthetic consumption (propofol) with faster recovery periods.

Key words: Anesthesia. Propofol. Methotrimeprazine. Dogs.

RESUMO

Objetivo: Comparar duas técnicas de infusão de propofol em cadelas submetidas à ovariohisterectomia, estudando a eficácia da dose alvo de propofol, avaliando os atributos cardiorrespiratórios, hemogasométricos e escala do índice bispectral, (BIS) bem como as características do período de recuperação. **Métodos**: Foram anestesiadas 20 cadelas, distribuídos em dois grupos (GI e GII). Em GI, os animais foram pré-tratados com levomepromazina e anestesiados com propofol por infusão alvo controlada, através de bomba de infusão Harvard pump, associado com remifentanila, através de bomba de seringa. Em GII, os animais receberam o mesmo tratamento de GI, só que ao invés de receberem o propofol por infusão alvo controlada, receberam o propofol em infusão contínua de velocidade fixa. **Resultados**: Bradicardia e discreta hipotensão, estabilidade hemogasométrica e respiratória, além de um bom miorrelaxamento, mais evidente na infusão contínua e boa hipnose. **Conclusões**: As doses de propofol utilizadas em ambas as técnicas, após o pré-tratamento de levomepromazina e associadas ao opióide, foram eficazes para a realização cirúrgica. A técnica de anestesia alvo controlada obteve um menor consumo de anestésico (propofol) com períodos mais rápidos de recuperação.

Descritores: Anestesia. Propofol. Metotrimeprazina. Cães.

1. Research performed at the School of Medicine, Laboratory of Anesthesiology, São Paulo State University (UNESP), Botucatu, São Paulo, Brazil.

Introduction

The first reports on intravenous anesthesia appeared in 1875 when the chloral hydrate was obtained. The high mortality rate cohibited this anesthetic modality for practice in the second half of the 20th century. With the advent of barbiturics, the venous anesthesia came back, not only as an induction method but even for maintenance, in spite of the results. When the use of sodium thiopental had its start, the search for an ideal venous hypnotic agent resulted in the development of several other venous anesthetic drugs aiming at smaller cardiovascular and respiratory depression characteristics, such as the cumulative effect. In the mids 80's, propofol became the elected one, among others, for its safety and stability for intravenous anesthesia maintenance.

The total venous anesthesia has, as an advantage, its greater hemodynamic stability and reduction in surgical stress, besides preventing the surgical room pollution brought about by inhalatory agents. However, its disadvantages include the possible extension of the recovery period (depending on the drug used) and the possibility of patients individual variability related to the venous anesthetic pharmacokinetics.

In the last two decades, great advances have been achieved by intravenous anesthesia thanks to the introduction of new drugs and development of new techniques such as the drug continuous infusion at a steady speed, by means of different infusion pumps, besides the newer total intravenous anesthesia, i.e., the target-controlled infusion. This system requires a computerized control with an interface to an infusion pump, in which the drug is administered according to its pharmacokinetics and pharmakodynamics. The operator determines the drug target concentration in the blood or plasma which reaches the nervous central system and the effector site leading to activity and keeping the target concentration as long as needed.

As time went by, the total target-controlled anesthesia became an elected technique with a large potential in medicine and veterinary medicine anesthesiology. Currently, new computer programs have been utilized to study dogs, providing more knowledge for safer anesthesias, faster and greater parametric stability, resulting in faster recoveries.

Methods

This work was approved by the Animal Experimentation Ethical Committee, School of Medicine, Unesp, Botucatu. Twenty different breed(*) healthy bitches, averaging 19.8 +- 2.33 kg and aged from 2 to 8 years, were randomly assigned to two groups of 10 animals each (G1, G2). Animals of G1 were pre-treated with methotrimeprazine, 0.5mg/kg IV, and anesthetized with propofol by target-controlled infusion with an induction dose of 3.5 μg/mL, and 1.5 μg/mL IV for maintenance, by means of an Harvard infusion pump, combined to remifentanil, 0.3 μg/min, through a syringe pump. Animals of G2 were subjected to the same treatment as in G1, but instead of propofol target-controlled infusion, they were given 5 mg/kg as induction and 0.2mg/kg/min steady-speed propofol continuous infusion. So, the two infusion techniques were compared, i.e., steady-speed versus target-controlled.

The motor response to surgical stimulus was the technique used in both groups in which, in positive case or evidence of anesthesia superficiality, the dose was gradatively increased by 0.1 mg/kg/min until motor response blockage occurred or the anesthetic plan became appropriate. In case of a initial negative response and evidence of anesthesia deepness, the dose was gradatively reduced to 0.1 mg/kg/min.

The anesthetic maintenance as well as remifentanil infusion and fluidtherapy, in both groups, lasted for 60 minutes. For both groups a 30 minute-period was established for anesthetic maintenance before the onset of the surgery, but considering the necessary time for propofol being in balance within tissues.

The parameters measured were: esophageal temperature (ET), cardiac frequency (CF), systolic arterial pressure (SAP), average and diastolic arterial pressure(DAP), oxygen saturation ($SatO_2$), respiratory frequency (*f*), CO2 concentration at the end of expiration ($ETCO_2$), tidal volume (V_T), ventilation (V), bispectral scale index (BIS), electromyography (EMG) at the following moments: M0= before starting the surgery, M1= skin incision, M2= muscle incision, M3= traction and resection of the left ovary suspender ligament, M4= traction and resection of the right ovary suspender ligament, M5= resection of uterus body, M6= laparorraphy ,and M7= skin suture. Hemogasimetric analysis, $PaCO_2$, PaO_2, pH and arterial blood HCO_3 were evaluated at three moments only, M0, M4 and M7 for assurance of the maintenance of CO_2 and 0_2 partial pressures.

In both groups, the volume of propofol infusion was estimated from anesthetic induction to maintenance end.

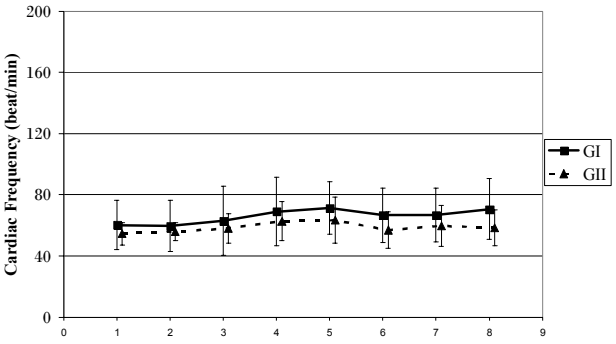
After the anesthetic maintenance end, recovery of animals was followed recording the necessary time for extubation, sternum recumbency, quadrupedal posture and recovery anesthetic quality (excitation, vocalization, shivering).

The *Student t* test was applied for comparison between groups as long as variables showed a normal distribution and variance homogeneity. For comparison between moments and groups, the profile analysis was used ($P<0.05$) including the interaction groups-moments, group effect at each moment and moment effect within each group.

Results

An esophageal temperature stability occurred in both groups. In G1 there was a light decrease, in terms of degree fractions during all moments. In G2 only a 0.1°C decrease was evident, from M0 to M1, and an average temperature of 37.7° was maintained thereafter.

Bradycardia was prevalent at all moments in both groups showing a light increase in G2 when compared to G1. In both groups the CF increased at moments with a maximum at M3 and M4, followed by a decrease at M5 and a light increase at M7 (Figure 1).



FIGIURE 1 - Physiological behavior of cardiac frequency in groups G1 and G2.

Arterial pressures followed the same behavior. At the beginning, a light hypotension progressed until M2 and a posterior increase occurred from M3 to M4 reaching the highest values at this moment, followed by a gradatively decline until M7, but still within physiological values (Figure 2).

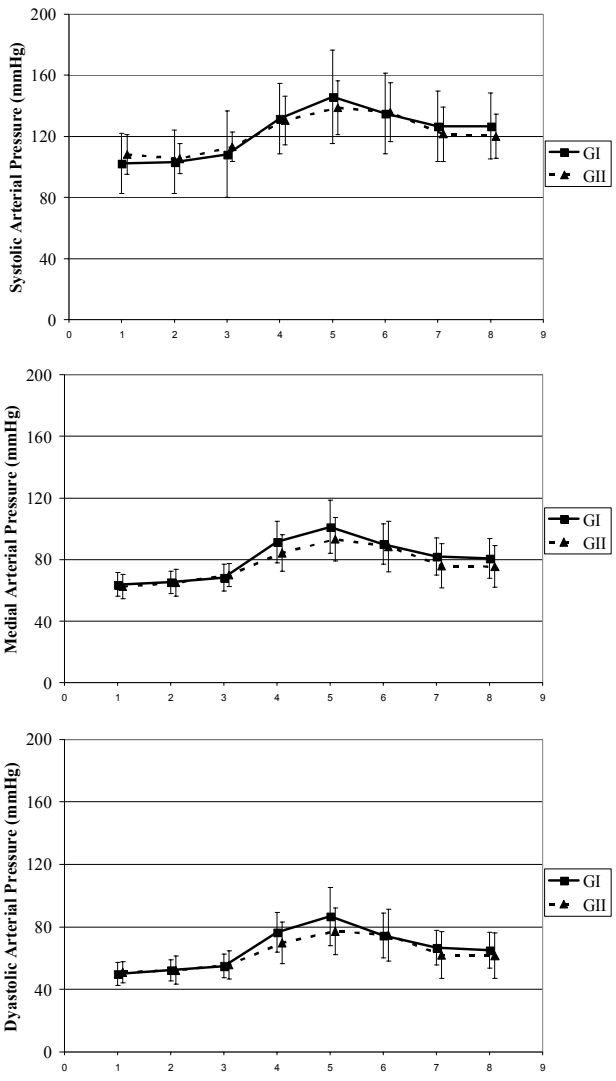


FIGURE 2 - Physiological behavior of systolic, average and diastolic arterial pressure (SAP, MAP, DAP) in G1 and G2.

The $EtCO_2$ was more stable at all moments in both groups, remaining within the physiological values, 35-45 mmHg (Figure 3).

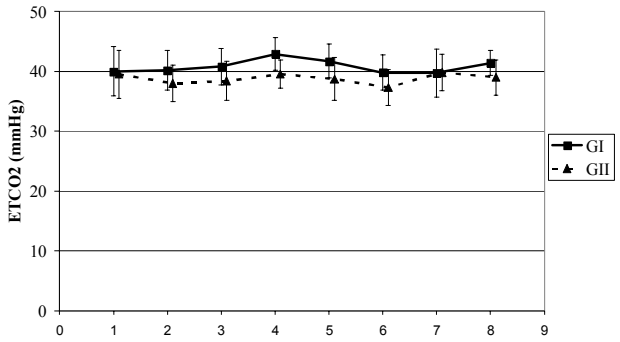


FIGURE 3 - Physiological behavior of $ETCO_2$ concentration in G1 and G2.

No relevant alterations were present for the BIS in both groups at the respective moments. The variation was 72-76 in G1 and 73-75 in G2, respectively (Figure 4). The electromyography values were higher at all moments in G1 as compared to G2. In spite of this small difference, both groups sustained low values reaching 38% at some moments in G1 and 34% in G2 (Figure 5). No significant differences were observed as for $PaCO_2$, PaO_2, pH and bicarbonate in the arterial blood.

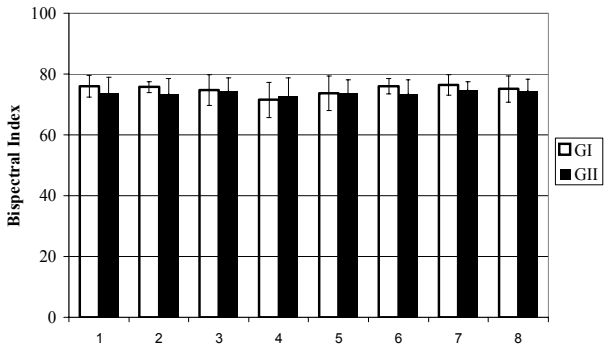


FIGURE 4 - Physiological behavior of in bispectral index in G1 and G 2.

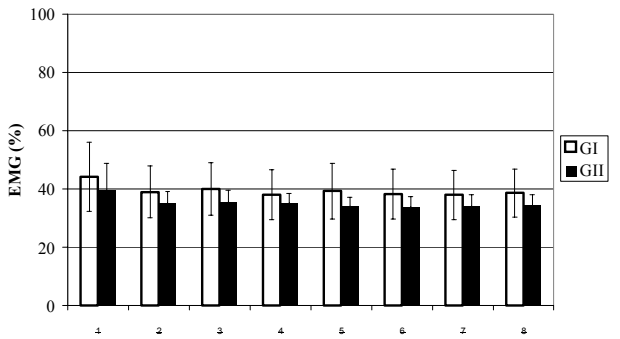


FIGURE 5 - Physiological behavior of EMG in G1 and G2.

A little variation in body weight occurred in both groups with a little difference of 3.3 kg, a superior average in G1 as compared to G2. Even though showing a superior average, the G1 propofol consumption was smaller throughout the procedure (Figure 6).

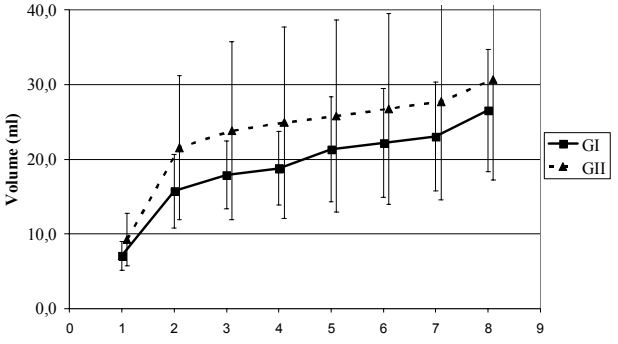


FIGURE 6 - Physiological behavior of anesthetic volume of propofol(ml) in G1 and G2

For all periods during the recovery period, G1 showed smaller values than G2. A difference of 10 minutes between groups was observed for extubation and sternal recumbency and 19 minutes for quadrupedal posture and, for the three period modalities, periods were always more premature in G1 (target-controlled) as compared to G2 (Figure 7). Yet, both groups showed a tranquil recovery with absence of undesirable effects like agitation, vocalization, moans, muscle shivering, vomiting or salivation.

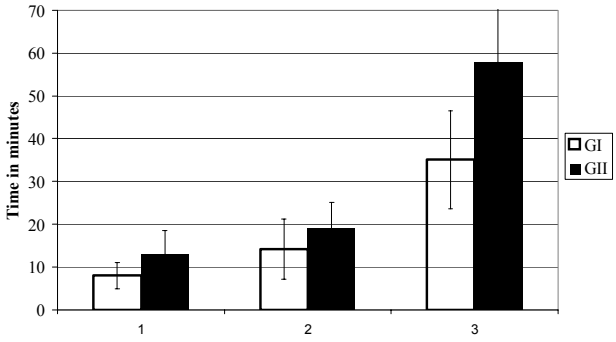


FIGURE 7 - Recuperation periods, 1=Extubation, 2=Sternal recumbency and 3=Quadrupedal posture in minutes in G1 and G2

All parameters are described in Table 1.

TABLE 1 - Parametrics variation, $\overline{X}$, ± sd in pre-treated dogs with methotrimeprazine and treated with propofol and remifentanil being target –controlled-infusion (G1)and continuous infusion (G2).

Variable	Groups	M0	M1	M2	M3	M4	M5	M6	M7
T (°C)	G1	37,4±0,7b A	37,2±0,7b B	37,2±0,7b B	37,1±0,7b B	37,2±0,7b B	37,1±0,7b B	37,0±0,7b B	37,0±0,8b B
	G2	37,8±0,6a A	37,7±0,5a A	37,7±0,5a A	37,7±0,5a A	37,7±0,5a A	37,7±0,5a A	37,7±0,5a A	37,7±0,5a A
CF (Beat/min)	G1	60,3±16,0	59,6±7,4	63,1±22,5	69,3±22,6	71,3±17,3	66,6±17,9	66,8±17,4	70,7±19,8
	G2	54,6±7,4	55,9±5,9	58,1±9,7	62,7±12,7	63,3±15,0	56,9±12,0	59,7±13,5	58,4±11,7
SAP mm Hg	G1	102,2±19,7	103,2±20,8	108,2±28,3	131,7±23,1	145,7±30,6	135,0±26,6	126,6±22,9	126,7±21,5
	G2	108,0±12,9	105,4±9,8	113,1±9,7	130,4±16,0	138,7±17,7	135,7±19,3	121,4±17,8	120,1±14,3
MAP mm Hg	G1	63,9±7,5	65,3±7,3	68,2±8,7	91,5±13,5	101,3±17,4	90,1±13,2	81,9±12,1	80,7±13,0
	G2	62,4±7,9	65,0±8,6	70,0±7,4	84,3±12,0	93,2±14,2	88,5±16,4	76,0±14,3	75,5±13,5
DAP mm Hg	G1	49,9±7,4	52,3±6,7	55,1±7,4	76,6±12,9	86,7±18,7	74,6±14,4	66,8±10,9	65,1±11,6
	G2	51,1±6,7	52,3±9,0	55,8±8,5	69,9±13,2	77,3±14,9	74,8±16,6	62,1±14,9	61,7±14,5
f (breath/min)	G1	11,0±1,9	10,8±2,3	11,0±2,5	11,2±2,3	11,4±2,5	11,2±2,3	11,0±2,2	11,0±2,2
	G2	11,8±3,0	11,8±2,4	11,6±2,5	11,6±2,5	11,4±2,7	11,4±2,7	11,2±2,9	11,8±3,2
VT (mL/kg)	G1	16,5±4,5a AB	17,7±4,7a AB	14,9±5,6a B	17,4±5,2a AB	16,5±5,3a AB	18,8±5,0a A	19,1±4,3a A	19,1±5,2a A
	G2	16,1±9,1b A	17,6±7,7b A	18,0±8,9a A	17,0±7,9a A	16,8±7,4a A	17,2±7,1b A	15,9±4,9b A	16,1±3,7b A

V_M (L/min)	G1	3,6±0,8a AB	3,9±1,0a AB	3,2±0,8a B	3,8±0,7a AB	3,7±0,8a AB	4,2±1,0a A	4,3±1,2a A	4,2±1,1a A
	G2	3,0±0,9a A	3,4±0,8a A	3,4±0,9a A	3,2±0,8a A	3,1±0,8b A	3,3±1,0b A	3,0±1,0b A	3,3±1,2b A
$ETCO_2$ mmHg	G1	40,0±4,1	40,2±3,3	40,8±3,0	42,9±2,8	41,7±2,8	39,8±2,9	39,7±4,0	41,1±2,7
	G2	39,5±4,0	38,0±3,0	38,4±3,3	39,5±2,4	38,7±3,6	37,3±3,0	39,8±3,1	39,0±2,9
$SatO_2$ (%)	G1	98,2±2,3	98,4±2,3	98,2±2,6	98,6±0,8	98,5±0,8	98,4±1,4	98,6±0,8	98,5±1,0
	G2	98,9±0,6	99,0±0,9	99,0±0,8	98,8±1,3	98,7±0,9	98,8±0,9	99,1±0,9	99,2±0,9
BIS (un.)	G1	76,0±3,5	75,7±1,8	74,8±5,1	71,5±5,8	73,7±5,6	76,0±2,5	76,4±3,3	75,7±4,4
	G2	73,7±5,3	73,4±5,1	74,5±4,2	72,9±5,7	73,7±4,4	73,5±4,7	74,8±2,6	74,5±3,9
EMG (%)	G1	44,2±11,8	39,0±9,0	39,9±9,0	38,0±9,6	39,3±9,6	38,2±8,5	37,9±8,6	37,8±8,6
	G2	39,6±9,2	35,1±4,0	35,6±4,0	35,1±3,4	34,1±3,0	33,9±3,4	34,1±3,8	34,5±3,5
$PaCO_2$ mmHg	G1	38,7±5,1				39,0±3,9			38,9±3,8
	G2	38,1±4,0				37,6±3,8			37,7±4,8
PaO_2 mmHg	G1	248,7±49,6				322,4±55,4			315,3±96,6
	G2	320,2±75,3				315,9±64,9			330,1±80,5
Ph	G1	7,3±0,1				7,3±0,0			7,3±0,0
	G2	7,3±0,0				7,3±0,1			7,3±0,0
HCO_3 (mmol/L)	G1	20,5±1,4				20,4±1,2			20,3±0,9
	G2	19,8±0,8				19,6±0,9			20,0±0,8

[ABC] Comparision of each moment in each group
[abc] Comparision means of groups in each moment.
* Comparision means between groups..

Discussion

Considering that the normal body temperature range in dogs is 38.0 to 39.0ºC [1], results showed a light hypothermia which was due to the central effects on thermoregulation inhibition, besides the peripheral vasodilatation and myorelaxation brought about by propofol [2], as well as by the vasodilatation caused by the phenotiazinics which favored the reduction in body temperature [3]. This light hypothermia was due to the techniques to reduce heat loss during the anesthetic procedure like thermal mattress, warm fluidtherapy and warm air insufflator.

Bradycardia may be explained by two factors: at the beginning, a smaller baroflex sensitivity, through sympathetic activity inhibition, for this function is the one responsible for controlling the cardiovascular stability[4], and the propofol concentrations above 5 µg/mL can inhibit this reflex [5]. The second and main factor that led to bradycardia was the opioid used, for it is known that opioids with a high affinity to type µ , like methotrimeprazine, exert significant effects on the cardiovascular system by reducing the CF through a mediated parasympathetic central mechanism.

The arterial pressure was the most sensitive parameter in the evaluation of the autonomic response to surgical stimuli, when compared to the CF which showed a significant ($P<0.05$) difference among moments, although clinically irrelevant.

Systolic, average and diastolic arterial pressures showed a similar behavior with light differences related to the moments, mainly at M3 and M4 in which traction and resection in left and right ovary suspender ligaments occurred, with a more intense nociceptive

stimulus. These traction and resection ligaments are ranking as degree 3 in a scale of 4[6].

The significant increase at these moments meant more than 20% of basal values. Although this parameter has not been used to evaluate the analgesia degree, the 0.3 μg/kg/min infusion of remifentanil were not enough to completely eliminate the autonomic responses brought about by surgical stimuli [7].The fast remifentanil extra-hepatic biotransformation carried out by esterases in the blood and unspecific tissues [8] can explain this behavior as long as for this infusion rate there is a more extended period for plasmatic balance and further, a drug fraction is immediately metabolized before reaching its effector site.

According to average values at initial moments, M0, M1 and M2, arterial pressures kept lower levels than normal, in agreement to studies on vascular effects of propofol [9].

During anesthesia with propofol, the existence of a light hypotension can be related to the combination of the following factors: peripheral vasodilatation, reduction in cardiac output, baroreflex activity inhibition and direct depression on myocardium [10]. Moreover, the α-adrenergic blockage caused by methotrimeprazine may lead to hypotension by vasomotor regulation decrease[11].

Due to the respiratory depression as a consequence of propofol and opioids affinity to μ receptor and indications for the use of O_2 supplementation during anesthesia, when utilizing these drugs [12], the use of controlled ventilation in all animals of both groups was indicated in order to assure a good ventilation maintenance by providing a 100% oxygen concentration aiming at keeping $ETCO_2$ between 35 and 45 mm Hg. There was no alteration in *f* which remained stable at all moments.

The little alterations in these variables (V_T and V_M) were probably due to constant adjustments carried out to keep the capnometry values in the range of 35 to 45 mm Hg, like changes in *f*, pressure and utilization of the PFEP resort (Positive Final Expiration Pressure).

By checking the appropriate ventilation through $ETCO_2$ [13], results showed that the adjustments carried out during anesthesia were suitable for remaining stable in both groups, close to the physiological values (35 and 45 mm Hg). The $ETCO_2$ is an estimate of $PaCO_2$ (14) and expresses the range 1 to 3 mm Hg under Pa CO_2 [15], results, therefore, obtained in this work.

There were no significant differences for other hemogasimetric parameters like pH and HCO_3 demonstrating an efficient ventilation.

As for the Sat CO_2, values for animals of both groups were superior to 98%, within the physiological limits of 97 and 100% [16], and stable during all the anesthesia due to the 02 high inspired fraction, also true for the Pa O_2.

Taking into consideration the average values related to BIS, it was observed a deep sedation and a light hypnosis[17] in which, theoretically, it would not be possible to carry out cruel manipulations. However, the latter were successfully undertaken, with no increase in values after the nociceptive stimulation, demonstrating that the propofol-remifentanil combination was efficient when proposed doses were used for both techniques. The nociceptive stimulation can trigger the awaking from hypnosis state and led to an increase in BIS values [18,19], mainly in those animals under a superficial anesthetic plan [20] in which a change in these values can be exerted by the electromyographyc activity [21].This fact did not occur for no increase in BIS and EMG values was observed. However, the relatively high values for BIS are not related to nociceptive stimulation but by remifentanil utilization, as long as opioids do not respond to the anesthesia hypnotic component in which the opioid addition results in consciousness loss, with BIS higher values [20,22].

It was possible to realize some coherence, through electromyography, related to BIS values. In both groups, low muscular activity percentages (good myorelaxation) were prevalent during maintenance.

The techniques were different for while in the target-controlled one mass was measured as μg/mL, the steady-speed infusion was taken as mg/kg/min.

The infusion of the total propofol volume, including induction and maintenance, was based upon the average body weight which was lower in G1 as compared to G2, i.e., a lower propofol volume was employed after the end of anesthesia, averaging 26.5 mL/kg when compared to G2, 31.6 mL/kg; a propofol reduction of 16.2% when compared to steady-speed infusion.

This fact can be explained by the mechanism target-controlled infusion works for, in this technique, the propofol infusion was intermittent, and so, not constant, according to the desired plasmatic concentration in which the fast distribution half life (t1/2 α) and the metabolic clearance are compensated, in an attempt to keep the stability of plasmatic propofol concentration [23].

As for the anesthetic volume, another study, on the contrary, showed a greater propofol consumption when using the target-controlled infusion technique as compared to the steady-speed infusion. However, the flexibility and easy use of this technique (target) encouraged the authors of this work to deepen the anesthesia levels, leading to a greater anesthetic volume consumption [12], however a certain care has to be taken.

The differences throughout the recovery period can be explained by the propofol cumulative effect due to the drug accumulation in the less irrigated peripheral tissues, thus extending the recovery period [24]. That is the reason why the utilization of the target-controlled anesthesia has been suggested as an alternative to prevent these cumulative effects[25].

Conclusions

Propofol dose used, either in the target-controlled infusion or steady-speed infusion technique, was efficient for ovaryhisterectomy procedures in bitches, whenever combined to remifentanil infusion and a methotrimeprazine pre-treatment.Both propofol infusion techniques, in its appropriate combinations, can be largely applied; however, the target-controlled infusion leads to a smaller consumption of this drug. The propofol infusion combined to remifentanil, utilized according to doses proposed for both techniques, led to a good myorelaxation, more evident

in continuous infusion and good hypnosis, but the combinations caused bradycardia and a light hypotension, deserving a good monitoring, but also provided a hemogasimetric and respiratory stability, through the used techniques. In both techniques, the recovery of animals was tranquil and with no collateral effects, however the recovery of target-controlled infusion treated animals was faster as compared to the steady-speed infusion treated ones.

References

1. Hard, RM. General physical examination of the canine patient. Veterinary Clinics of North America: Small Animal Practice. 1981; 11: 453-67.

2. Fonda, D. Continuous infusion anaesthesia with Propofol in dogs: clinically optimized dosages. In: International Congress of Anaesthesia, 4, 1991, Utrecht. Proceedings…Utrecht: State University of Utrecht. 43.

3. Hals, PH, Dahl, SG. Metabolism of methotrimeprazine in man. Europ J Drug Metab Pharmacokinetic. 1995;20: 61-71.

4. Ebert, TJ. Muzi, M, Berins, R. Sympathetic responses to induction of anesthesia in humans with propofol or etomidate. Anesthesiology. 1992;76: 725-33.

5. Sato, M, Tanaka, M, Umehara, S. Nishikawa, T. Baroreflex control of heart rate during and after propofol infusion in humans. Br J Anaesth. 2005;94: 577-81.

6. Rosa, AL, Massone, F. Avaliação algimétrica por estímulo nociceptivo térmico e pressórico em cães pré-tratados com levomepromazina, midazolam e quetamina associado ou não ao butorfanol ou buprenorfina. Act Cir Bras. 2005;20(1):39-45.

7. Egan, TD. Remifentanila pharmacokinetics and pharmacodynamics. A preliminary appraisal. Clin Phamacokinet. 1995:29(2):80-94.

8. Dershwitz, M, Randel, GI, Rosow, CE. Initial clinical experience with remifentanil, a new drug metabolized by esterases. Anest & Anal. 1995;81:619-23.

9. Rouby, JJ, Andreev, A, Leger, P. Peripheral vascular effects of thiopental and propofol in humans with artificial hearts. Anesthesiology. 1991;75:32-42.

10. Hoka, S, Yamamura, K, Takenaka, T. Propofol-induced increase in vascular capacitance is due to inhibition of sympathetic vasoconstrictive activity. Anesthesiology. 1998;89:1495-500.

11. Santos, PSP. Nunes, N, Rezende, ML, Souza, AP, Nishimori, CT, Paula, DP. Okamura, M. Efeito cardiorrespiratórios do butorfanol em cães pré-tratados ou não pela Levomepromazina. Ciênc Rural, 2006;36(5):1429-35.

12. RusselL, D, Wilkes, MP, Hunter, SC. Manual compared with target-controlled infusion of Propofol. Br J Anesth. 1995;75:562-6.

13. Braz, JRC. Monitorização da oxigenação e da ventilação. Rev Bras Anestesiol. 1996;46(3):223-40.

14. Grosenbaugh, BA, Muir, WW. Accuracy of noninvasive oxyhemoglobin saturation, and tidal carbon dioxide concentration, and blood pressure monitoring during experimentally induced hypoxemia, hypotension or hypertension in anesthetized dogs. Am J Vet Res. 1998;59: 205-12.

15. Haskins, SC, Farver, TB. Patz, JD. Cardiovascular changes in dogs given diazepam and diazepam – ketamine. Am J Vet Res.1986;47:795–8.

16. Tremper, K, Barker, SJ. Pulse oximetry. Anesthesiology. 1987;70:98-103.

17. Vianna, PTG, Carvalho, WA. Monitor microprocessado (BIS) de profundidade anestésica. Anestesiologia, 2000;1:7-14.

18. March, PA, Muir, WW. Bispectral analysis of the electroencephalogram: a review of its development and use in anesthesia. Vet Anaesth Analg. 2005;32 :241-55.

19. Antognini JF, Wang, XW, Carstens, E. Isoflurane anaesthetic depth in goats monitored using the bispectral index of the electroencephalogram. Vet Res Commun. 2000;24:361-70.

20. Beths, T, Glen, JB, Reid, J, Monteiro, AM, Nolan, AM. Evaluation and optimization of target-controlled infusion system for administering Propofol to dogs as part of a total intravenous anaesthesia technique during dental surgery. Vet Rec. 2001;148:198-203.

21. Messner, M. The bispectral index declines during neuromuscular block in fully awake persons. Anesth & Analg. 2003;97:488-91.

22. Mi, WD. Hypnotic endpoints vs. the bispectral index, 95% spectral edge frequency and median frequency during propofol infusion with or without fentanyl. Eur J Anaesthesiol. 1999;16:47-52.

23.Bailey, J.M. A technique for approximately maintaining constant plasma level of intravenous drugs. Anesthesiology, 1993;78:116-23.

24. Reid, J, Nolan, A. Prolonged recovery following propofol infusion in a dog: a case report. J Vet Anaesth. 1992;19:61-4.

25. Glass, PSA, Glen, JR, Kenny, GNC, Schutller, J. Shafer, SL. Nomenclature for computer-assisted infusion devices. Anesthesiology. 1997;16:836-47.

Correspondence:
Flávio Massone
Rua Antonio Amaral Cezar, 186
18611-344 Botucatú-SP, Brazil
Phone: (55 14)3882-1865
btflama@uol.com.br

Conflict of interest:none
Financial source: none

Received: July 25, 2007
Review: August 22, 2007
Accepted: October 29, 2007

How to cite this article
Hatschbach E, Silva FC, Beier SL, Lima AFM, Massone F. Comparative study between target-controlled-infusion and continuous-infusion anesthesia in dogs treated with methotrimeprazine and treated with propofol and remifentanil. Acta Cir Bras. [serial on the Internet] 2008 Jan-Feb;23(1). Available from URL: http://www.scielo.br/acb