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The effects of a propofol/alfentanil admixture on total intravenous anaesthesia in dogs undergoing splenectomy

N. Jia, C. Zhao, L. Wang, Y. Li, J. Cui, S. Cao, R. Li, C. Wang, Y. Wu, A. Wen

Xijing Hospital, Fourth Military Medical University, Xi'an, Shaanxi, China

ABSTRACT: The aim of this study was to compare the cardiovascular and respiratory effects and the bispectral scale index (BIS) as well as the recovery period characteristics in response to treatment with a propofol/alfentanil admixture of different concentrations in dogs undergoing splenectomy. We conducted a **p**rospective, randomised, blinded experimental trial. Anaesthesia was induced and maintained by continuous-infusion anaesthesia of propofol and alfentanil or a propofol/alfentanil admixture after premedication with acepromazine (0.03 mg/kg). Dogs were assigned to receive different concentrations of the admixture. Changes in BIS value, heart rate (HR), respiratory rate (f_R), non-invasive arterial blood pressure, pulse oximetry (SpO_2), end-tidal carbon dioxide concentrations ($ETCO_2$) and rectal temperature (RT) were recorded at predefined time points during anaesthesia. Data [mean ± standard deviation (SD)] were analysed by analysis of variance (ANOVA) for repeated measures followed by a Dunnett's test and Student's t-test ($P < 0.05$) and where necessary, the Mann-Whitney U-test. No significant differences were found between groups with respect to age, body mass, SpO_2, $ETCO_2$, f_R, systolic, diastolic and mean arterial blood pressure (SAP, DAP and MAP). BIS values were significantly lower in Group 2 when compared to Group 1 at T7, T8, T9. The HR of Group 2 was significantly lower at T2 to T9 when compared to Group 1. The propofol and alfentanil admixture provided satisfactory results in dogs undergoing splenectomy. Thus, an admixture of propofol/alfentanil may be used for total IV anaesthesia in dogs at the infusion rates determined in this study.

Keywords: propofol; alfentanil; admixture; total intravenous anaesthesia; dogs

Total intravenous anaesthesia (TIVA) has become a popular technique in humans because of its advantages compared with inhalant techniques, and the development of drugs such as propofol and short-acting opioids, as well as improved infusion systems (Cicek et al. 2005). During TIVA, combinations of intravenous anaesthetics with opioid analgesics have been used to achieve balanced anaesthesia with reduced side-effects, and their use promotes earlier recovery time and less postoperative nausea and vomiting.

Propofol is a highly lipophilic anaesthetic agent characterised by rapid onset, distribution and elimination phases after intravenous administration (Aguiar et al. 2001). Alfentanil is a derivative of fentanyl, with quicker onset and shorter duration and more intense vagomimetic properties than those of fentanyl and sufentanil. It may cause less intense respiratory depression than equianalgesic doses of fentanyl. Clinical trials indicate that alfentanil can be used effectively as an analgesic, or as an analgesic supplement in anaesthesia, and as the major component of a general anaesthetic (Vuyk et al. 1996). Alfentanil reduced the hypnotic and anaesthetic dose of propofol in humans by 20% and 73%, respectively (Short et al. 1992). In the clinic, alfentanil has been combined with propofol to achieve more effective intravenous anaesthesia.

The propofol/alfentanil admixture (PA) provides the double effects of anaesthesia and analgesia with the advantages of fast onset and convenience of use. It is especially appropriate for short-term and

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emergency anaesthesia. In recent years, the efficacy of an admixture of propofol and alfentanil has been explored. Our earlier research suggested that the combination of alfentanil and propofol synergistically suppressed acute phasic and tonic pain in mice (Wu et al. 2014). The combined effect of these agents has been previously associated with a favourable haemodynamic profile. Each drug could partially attenuate the undesirable effects of the other (Ilkiw et al. 2003). The safety and stability of this combination have been documented (Vuyk et al. 1996; Mendes and Selmi 2003; Auckburally et al. 2008; Padilha et al. 2011). However, prior work largely evaluated the effect of continuous infusions for procedural sedation and with variable ratios of propofol and alfentanil. There is a paucity of data regarding fixed-ratio regimens of PA for the purpose of induction and maintenance of general anaesthesia. Moreover, drug combinations typically reduce the total dose of both drugs individually which may be beneficial in certain situations (Smischney et al. 2012).

Combinations of propofol and alfentanil have been shown to be pharmaceutically stable (Taylor et al. 1992). Since the pharmacokinetic profile of alfentanil is similar to propofol, the resultant mixture is suitable for induction and maintenance of short-term anaesthesia (Auckburally et al. 2008). To date, there are no published clinical studies, in which PA was used for induction and maintenance of anaesthesia in dogs undergoing surgery. The aim of this study was to assess the cardiovascular and anaesthetic effects of PA for induction and maintenance of anaesthesia in dogs undergoing splenectomy. Dosages of the admixture required to attenuate autonomic responses during surgery were also evaluated.

MATERIAL AND METHODS

This study adhered to the National Institutes of Health Guidelines for the Use of Laboratory Animals and was approved by the Fourth Military Medical University Committee on Animal Care.

Animals. The experiments were carried out on forty dogs with an average weight of 24.2 ± 7.5 kg and average age of 3.1 ± 0.5 years. All dogs were determined to be healthy as judged by physical examination and any animal considered to be overweight was excluded from the study. All dogs were fasted for 12 h prior to anaesthesia, but were allowed free access to water. The dogs were kept under controlled environmental conditions, (temperature 20–22 °C, humidity (55 ± 5%). All animals underwent a period of acclimation of 48 h before the study. The dogs were randomly allocated to four different groups (n = 10), using computer-generated random numbers: Group 1 – the control group: in which a variable ratio of propofol (Diprivan, AstraZeneca, London, UK) and alfentanil (Rapifen, Janssen-Cilag Ltd, High Wycombe, Bucks, UK), was administered by the anaesthetist; Group 2 – PA [10 mg (1 ml) propofol with 133.0 μg (0.266 ml) alfentanil]; Group 3 – PA [10 mg (1 ml) propofol with 66.7 μg (0.133 ml) alfentanil]; Group 4 – PA [10 mg (1 ml) propofol with 33.3 μg (0.067 ml) alfentanil]. The infusion rate of drugs could be adjusted by the anaesthetist as needed during the surgery in all groups.

Anaesthesia, surgery and treatments. An intravenous cannula was placed in a suitable peripheral vein and preoxygenation was performed with a face mask using 100% oxygen for 5 min prior to induction of anaesthesia. Anaesthesia was induced and maintained with the PA except in the control group. The induction dose of the admixture (4 mg/kg) was given over approximately 20 s by the intravenous (*i.v.*) route, until a moderate depth of anaesthesia (eyeball rotation, absence of palpebral reflex and decreased jaw tone) was achieved and intubation with an appropriately sized, cuffed endotracheal tube could be performed. The tube was connected to a Bain-circuit system and 100% oxygen was provided. The fresh gas flow was set at 300 ml/kg/min. After induction of anaesthesia, dogs were then positioned in dorsal recumbency on a thermal blanket for instrumentation and surgery. Anaesthesia was managed by a single observer (STP) and the infusion rates of drugs were adjusted to keep the bispectral (BIS) value at 50 ± 5 in all groups (Bleijenberg et al. 2011). The anaesthesia was continued with a continuous infusion of propofol (0.4~0.6 mg/kg/min) or alfentanil (4.0~6.0 μg/kg/min) in Group 1, and an infusion of PA 0.4~0.6 mg/kg/min was administered to Groups 2 to 4, respectively.

A lactated Ringer's solution was administered at 10 ml/kg/h throughout surgery. In the case of hypotension, a fluid bolus of 15 ml/kg was administered over 15 min. The expected surgery time was less than 60 min. All surgical procedures were performed by one experienced surgeon. Using a scalpel blade, a ventral midline incision was performed over the skin, subcutaneous tissue and the *linea*

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alba. A standard three-clamp technique was used. The abdominal wall and subcutaneous tissues were closed separately using a simple continuous pattern of absorbable sutures and the skin was closed in a simple interrupted pattern.

Monitoring and time points. The BIS was recorded using the BIS monitor (Bispectral monitor A-2000 XP; Aspect Medical Systems Inc, USA). Before premedication, the head was clipped and the skin was cleaned with ether. The sensors for assessing the BIS were attached in a frontal-temporal configuration. Electrode 1 was positioned on the mid-sagittal plane, at the rostral third of an imaginary line connecting the zygomatic process of the frontal bone to the more caudal portion of the front crista, while electrodes 2 (earth) and 4 (reference) were positioned at an angle of 15–30° to the transverse plane. Thus, electrodes 2 and 4 were automatically dorsal to the eyelid and caudodorsal to the lateral corner of the eye, respectively. Electrode 3 was placed in the temporal region, just above the zygomatic process. This configuration was adapted from the one recommended by the manufacturer for the human BIS (de Mattos Jr et al. 2011). Rectal temperature (RT) was monitored with a digital thermometer. Airway gas samples were continuously obtained from the proximal end of the endotracheal tube and analysed with an infrared gas analyser to monitor respiratory rate (f_R) and end-tidal carbon dioxide concentrations ($ETCO_2$). Assisted ventilation was provided to maintain eucapnia ($ETCO_2$ values from 32 to 37 mmHg) in all dogs. Heart rate (HR) and systolic, diastolic and mean arterial blood pressure (SAP, DAP and MAP) were monitored using Doppler pulse detection with the cuff placed around the antebrachium; cuff width was approximately 40% of the circumference of the limb. Adhesive electrodes were placed to obtain a continuous lead II ECG. Pulse oximetry (SpO_2) was estimated with a pulse oximeter with an infrared sensor attached to the dog's tongue.

All dogs underwent splenectomy. Data were collected 15 min after pre-anaesthetic administration, immediately before skin incision (T0), and then at specific time points during surgery: at the midpoint of endotracheal intubation (T1); at 1 (T2), 3 (T3) and 5 (T4) min post endotracheal intubation; T5 at 10 min after the start of anaesthesia maintenance; T6 at immediately after skin incision; T7 at excision of the spleen; T8 at muscle suturing; T9 at skin suturing and T10 at 10 min after the end of anaesthetic administration.

All infusions were discontinued at the end of the surgery. Surgery time (time elapsed from the first incision until placement of the last suture), anaesthesia time (time elapsed from injection of propofol or the PA to termination of propofol or PA infusion), and extubation time (time elapsed from termination of propofol or PA infusion until extubation) were recorded for each dog. Time to first head lift, time to attain sternal recumbency, and time to standing (defined as ability to ambulate at least 5 s without assistance) were recorded for each dog. Extubation was performed once the dog's palpebral reflexes were evident and prior to swallowing. Recovery time points were recorded as time elapsed from the end of the infusions to observation of the specified event.

Statistical analysis. Data are presented as mean ± SD unless otherwise stated. Data were analysed using commercial software (Graphpad Prism software, version 4.00, Graphpad Software, San Diego, California, USA). All data were considered nor-

Table 1. Body weight, surgery time, anaesthetic time, and specific recovery times (mean ± SD) in dogs (*n* = 10/group) undergoing splenectomy

Variable	Group			
	1	2	3	4
Body weight (kg)	11.8 ± 0.3	12.0 ± 0.2	11.7 ± 0.3	11.9 ± 0.1
Surgery time (min)	53.3 ± 10	55.2 ± 11	49.4 ± 9	56.7 ± 12
Anaesthetic time (min)	58.0 ± 13	63.1 ± 12	55.9 ± 10	60.8 ± 13
Time to extubation (min)	40.4 (6–10)	67.9 (12–17)*	45.7 (9–6)	43.7 (11–24)
Time to head lift (min)	51.6 ± 12.4	77.3 ± 23.0*	58.2 ± 17.5	55.8 ± 19.1
Time to sternal recumbency (min)	54.9 ± 17.2	81.2 ± 20.4*	58.5 ± 11.1	54.8 ± 26.9
Time to standing (min)	62.5 ± 19.4	90.3 ± 30.3*	67.4 ± 19.5	65.1 ± 28.6

*$P < 0.05$ from Group 1

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mally distributed and passed normality tests using the Shapiro-Wilk test. Data within each treatment group were analysed for changes with time by use of one-way analysis of variance (ANOVA) for repeated measures followed by Dunnett's test, if appropriate. Variables were compared between groups using Student's *t*-test or the Mann-Whitney *U*-test, and all differences were considered to be significant at $P < 0.05$.

RESULTS

All groups showed a tranquil recovery without undesirable effects such as agitation, vocalisation, moans, muscle shivering, and vomiting or salivation. None of the dogs required additional propofol during the study period, which indicated that the dose of the sedative was sufficient. No significant differences ($P = 0.201$) were found between groups in body weight, anaesthetic duration and surgery time (Table 1). Extubation time, time to head lift, time to sternal recumbency and time to standing were longer in Group 2 than other groups ($P = 0.032$) (Table 1). No significant differences in RT, f_R, $ETCO_2$ and SpO_2 values were found in any of the groups compared to the baseline ($P = 0.082$), with the exception of RT, which was lower at T9 and T10 compared to T0 ($P = 0.016$) (Table 2). Thus, usage of PA may result in a light hypothermia during the surgery.

We observed a decrease in BIS from the T0 values at all-time points in all groups. In the comparative assessment, the values obtained at T0 and T1 were similar in each group. At T2, the values recorded in Group 2 were lower than the values recorded in Groups 1, 3 and 4. At T7, T8 and T9, BIS values were significantly lower in Group 2 compared to Group 1 ($P = 0.0006$) (Figure 1). In Group 2, HR was significantly lower at T2 to T9 compared to Group 1 ($P = 0.007$) (Figure 2). The results revealed that the HR values were close to bradycardia in Group 2. The differences in SAP, DAP and MAP between the four groups did not achieve statistical significance (Figure 3). Arterial pressures followed the same pattern. A light hypotension was evident from T1 onwards. Notably, no dogs had undesirable symptoms during the PA anaesthesia compared with the control group.

DISCUSSION

This study shows that the PA provided satisfactory results in forty dogs undergoing splenectomy. Recovery from anaesthesia was uneventful in all four groups. To the authors' knowledge, there are as of yet no published studies on the application of a propofol and alfentanil admixture in dogs undergoing splenectomy. In addition, these doses will be useful in clinical practice as there are only a few reports re-

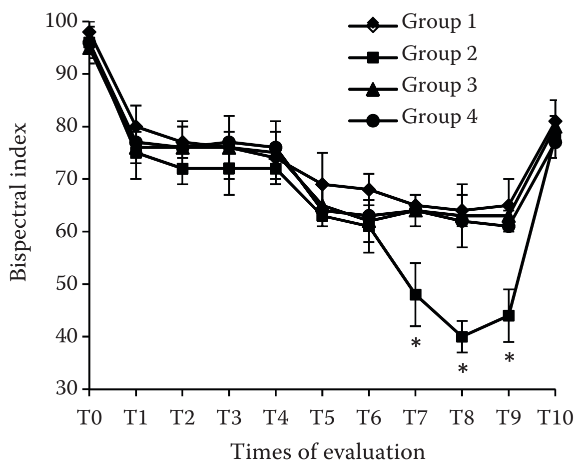

Figure 1. Mean (± SD) bispectral index (BIS) measurements in different groups and time points of evaluation. *Statistically significant ($P < 0.05$) when compared to the control group within the treatment. This variable was expressed as mean ± standard deviation as both tests used for analysis (Student's *t*-test or Mann-Whitney *U*-test) detected a significant difference between groups

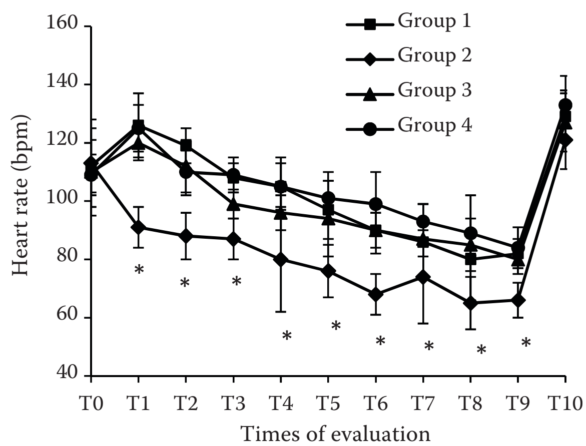

Figure 2. Comparison of mean heart rate (± SD) measurements in different groups and time points of evaluation. *No significant differences were found between four groups in SAP, MAP and DAP. This variable was expressed as mean ± standard deviation as both tests used for analysis (Student's *t*-test or Mann-Whitney *U*-test) detected a significant difference between groups

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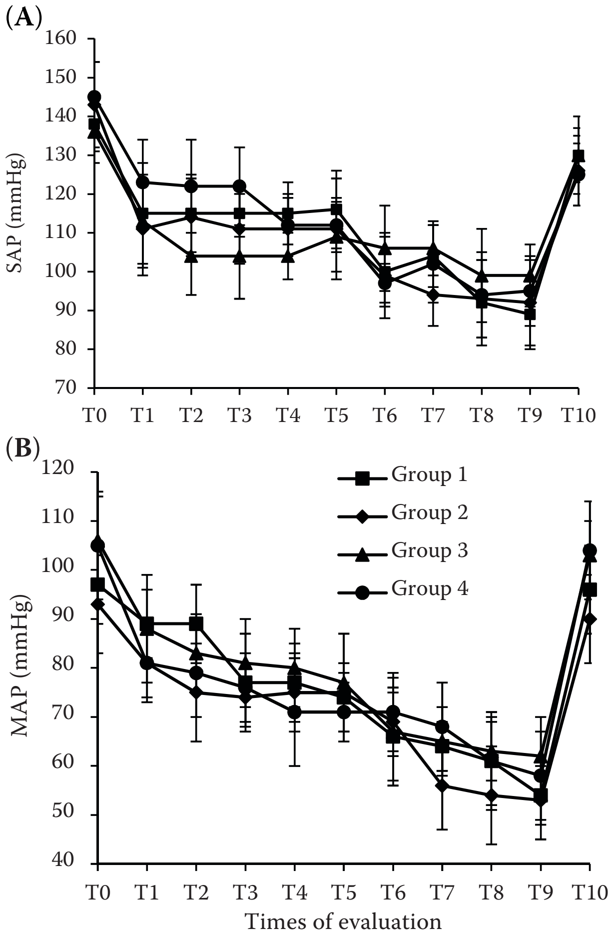
Table 2. Respiratory rate, pulse oximetry, end-tidal carbon dioxide concentration, and rectal temperature in dogs (*n* = 10/group) undergoing splenectomy

Variable	Group	Time points										
		T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
f_R (bpm)	1	30 ± 2	28 ± 3	27 ± 2	27 ± 4	27 ± 7	27 ± 2	27 ± 3	25 ± 4	25 ± 2	25 ± 3	25 ± 3
	2	26 ± 4	26 ± 3	26 ± 2	26 ± 2	26 ± 3	26 ± 2	26 ± 3	26 ± 1	26 ± 5	26 ± 2	26 ± 3
	3	31 ± 2	24 ± 4	24 ± 3	24 ± 2	24 ± 5	24 ± 2	25 ± 1	25 ± 2	25 ± 3	25 ± 4	25 ± 2
	4	29 ± 5	23 ± 2	23 ± 4	23 ± 3	23 ± 2	23 ± 5	23 ± 2	23 ± 4	23 ± 2	23 ± 6	23 ± 2
SpO_2	1	99.6 ± 0.3	98.2 ± 1.2	99.0 ± 0.9	99.5 ± 0.5	99.4 ± 0.2	98.4 ± 1.2	99.6 ± 0.1	98.5 ± 0.8	99.2 ± 0.3	99.1 ± 0.8	98.0 ± 1.6
	2	98.3 ± 0.6	99.5 ± 0.4	97.8 ± 1.9	99.3 ± 0.6	98.3 ± 1.4	97.6 ± 1.3	99.3 ± 0.5	99.8 ± 0.1	98.2 ± 0.7	99.4 ± 0.6	99.6 ± 0.3
	3	99.7 ± 0.1	97.4 ± 2.3	98.3 ± 1.6	98.1 ± 1.8	99.6 ± 0.3	99.4 ± 0.5	98.5 ± 0.9	99.6 ± 0.2	99.4 ± 0.5	99.2 ± 0.7	97.7 ± 2.0
	4	99.5 ± 0.3	99.8 ± 0.1	99.7 ± 0.2	97.5 ± 2.4	99.6 ± 0.2	99.7 ± 0.2	97.3 ± 2.5	98.9 ± 0.9	99.8 ± 0.1	98.2 ± 1.4	99.4 ± 0.5
$ETCO_2$	1	–	–	–	–	–	35 ± 4	35 ± 3	35 ± 5	34 ± 3	36 ± 2	36 ± 3
	2	–	–	–	–	–	37 ± 2	36 ± 4	36 ± 4	37 ± 2	34 ± 5	35 ± 7
	3	–	–	–	–	–	36 ± 2	35 ± 3	33 ± 5	33 ± 6	33 ± 2	33 ± 5
	4	–	–	–	–	–	33 ± 6	34 ± 3	34 ± 5	34 ± 2	35 ± 6	33 ± 4
RT(°C)	1	38.6 ± 0.2	38.4 ± 0.4	38.4 ± 0.5	38.4 ± 0.4	38.4 ± 0.1	38.2 ± 0.5	38.0 ± 0.6	37.8 ± 0.5	37.6 ± 0.2	37.3 ± 0.8*	36.9 ± 0.5*
	2	38.6 ± 0.3	38.4 ± 0.2	38.4 ± 0.4	38.4 ± 0.1	38.4 ± 0.5	38.2 ± 0.4	37.9 ± 0.2	37.7 ± 0.7	37.6 ± 0.7	37.4 ± 0.5*	37.0 ± 0.8*
	3	38.5 ± 0.4	38.3 ± 0.6	38.3 ± 0.5	38.3 ± 0.2	38.3 ± 0.2	38.1 ± 0.3	38.0 ± 0.5	37.7 ± 0.3	37.5 ± 0.3	37.3 ± 0.6*	36.7 ± 0.4*
	4	38.6 ± 0.6	38.4 ± 0.3	38.4 ± 0.3	38.4 ± 0.2	38.4 ± 0.3	38.2 ± 0.6	38.0 ± 0.5	37.8 ± 0.2	37.5 ± 0.4	37.2 ± 0.2*	36.8 ± 0.7*

*$P < 0.05$ from Group 1



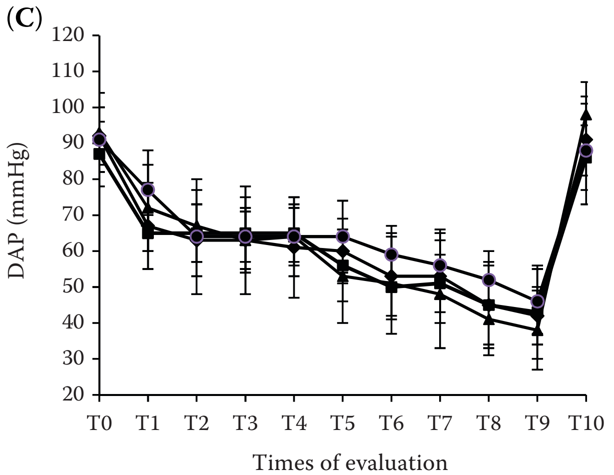


Figure 3. Physiological behaviour of SAP (**A**), MAP (**B**), DAP (**C**) in different groups and time points of evaluation. No significant differences were found between four groups in SAP, MAP and DAP. This variable was expressed as mean ± standard deviation as both tests used for analysis of data (Student's *t*-test or Mann-Whitney *U*-test) detected a significant difference between groups.

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garding the effects of ultra-short-acting opioids in dogs. In the aforementioned study by Auckburally et al. (2008), a propofol and alfentanil admixture was used to induce anaesthesia in dogs. During surgery, propofol was adjusted as needed. In the current study, we evaluated the fixed concentration ratio of propofol and alfentanil admixture in induction and maintenance of anaesthesia in dogs. Our previous study suggested that propofol and alfentanil exhibit synergetic effects. Combinations of intravenous anaesthetics with opioid analgesics have been used for achieving balanced anaesthesia with reduced side-effects, and promote earlier recovery time and less postoperative nausea and vomiting (Wu et al. 2014).

The reported dose of propofol required to induce general anaesthesia in dogs is approximately 4 mg/kg (Auckburally et al. 2008). In comparison, the mean dose of propofol in Group 1 was 4.1 mg/kg. Alfentanil has also been used as an intravenous bolus as part of a co-induction technique in dogs (Chambers 1989). Based on previous studies and the authors' clinical experience (Chambers 1989; Freye et al. 1998; Michou et al. 2012), the mean doses of alfentanil administered in the present study were selected to be 53.3, 26.7 and 10.8 μg/kg in Groups 2, 3 and 4, respectively. During surgery in dogs, the minimum infusion rate (MIR) for propofol was 0.3–0.35 mg/kg/min, and surgical anaesthesia was induced in all dogs at 0.4 mg/kg/min (Hall and Chambers 1987; Ilkiw et al. 2003). We found a dosage of propofol (0.4~0.6 mg/kg/min) that provided a satisfactory depth of anaesthesia in dogs, which suggests a maintenance dose of propofol in prospective clinical studies. Pharmacodynamic interactions between propofol and alfentanil have been described in human patients; propofol reduced the dose of alfentanil required to suppress responses to a variety of clinically relevant stimuli (Pavlin et al. 1996; Vuyk et al. 1996; Hui et al. 2002). According to the infusion rate of propofol, an initial infusion rate of 0.4~0.6 mg/kg/min of the propofol/alfentanil admixture was chosen for Groups 2 to 4.

During anaesthetic procedures, BIS was found to objectively monitor the degree of sedation in humans (Ibrahim et al. 2001). Dogs and other species can also be quantified by bispectral monitoring (Greene et al. 2003; Martin-Cancho et al. 2003). In humans, BIS values above 90 indicate consciousness and values below 50 are considered to be ideal for surgical procedures (Glass et al. 1997). The values described in this study demonstrate that BIS values above 95 for dogs do not differ from those in humans, since the animals were conscious and responsive to stimuli even after sedation. The values in our study are similar to those described by Carrasco-Jimenez et al. (2004) in non-sedated dogs (mean 97). It is expected that the administration of opioids to the anaesthetic protocol does not change the values of BIS, because these drugs have no direct hypnotic action. Lysakowski et al. (2001) studied the effects of fentanyl, alfentanil, remifentanil and sufentanil on the bispectral index during anaesthesia with propofol in humans; no significant differences were observed between the fentanyl group and the placebo group. Hatschbach et al. (2008) found that the addition of remifentanil did not change the bispectral index in dogs undergoing propofol-mediated anaesthesiology. In our study, BIS values in Groups 3 and 4 were similar to the control group (Group 1) (Figure 1). The BIS values in Group 2 were lower than in Group 1 at the T7, T8 and T9 time points. This may be explained by the use of propofol in combination with a high dose of alfentanil. It is well known that co-administration reduces the dose of hypnotic required and minimises the adverse effects of each individual drug. Alfentanil can reduce the hypnotic and anaesthetic dose of propofol required in humans (Short et al. 1992; Vuyk et al. 1996; Glass et al. 1997). The same dosage of propofol was used in each group, but a combination of propofol with a high dose of alfentanil resulted in lower BIS values (Group 2), while the administration of alfentanil alone does not change BIS values (Lysakowski et al. 2001). In other words, the combination of alfentanil with propofol could reduce both the hypnotic and anaesthetic doses of propofol.

In Group 2, HR was much lower than in other groups during surgery. This may be due to the fact that the highest dose of alfentanil was used in Group 2. The HR values were close to what we would consider to be bradycardia. Bradycardia may be explained by two factors: firstly, inhibition of sympathetic activity, which leads to a smaller baroreflex sensitivity at the beginning of surgery, and which is also responsible for controlling the cardiovascular stability (Hatschbach et al. 2008); the second and main factor was the usage of alfentanil which has a high affinity to the μ receptor, and thus exerts significant effects on the cardiovascular system by reducing the CF through a parasympathetically mediated central mechanism. In Group 3 and 4, HR values were close to the control group. Surgical stimulus may have induced higher HR values at T6, T7, T8 and T9 due to autonomic nervous system activation.

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Co-induction of anaesthesia with an infusion of propofol combined with a suitable opioid usually resulted in cardiovascular stability (Auckburally et al. 2008), and the administration of PA has been shown to induce minimal cardiovascular depression when used for maintenance of anaesthesia in adult human patients (Taylor et al. 1992). In our present study, SAP, DAP and MAP were determined. There was no significant difference between the control and other three groups in blood pressure. Cardiovascular and respiratory functions were well maintained, even at doses at which all somatic reflex responses were lost.

The administration of opioids and propofol is associated with respiratory depression and hypercapnia in a dose-dependent manner (Aguiar et al. 2001). For this reason, dogs were allowed to breathe spontaneously, but adjuvant ventilation was provided intermittently in order to maintain eucapnia ($ETCO_2$ values from 32–37 mmHg). All groups exhibited a significant decrease in respiratory rate during surgery. Both propofol (Muir and Gadawski 1998) and alfentanil (Freye et al. 1997) have been shown to cause respiratory depression or apnoea in previous studies. This effect may be dose-dependent. In this study, none of the dogs stopped breathing for any length of time with either agent. Four medicinal groups showed significantly lower body temperatures at the T6–T10 time points compared to the baseline. The normal body temperature range in dogs is 38.0–39.0 °C; therefore, the results evidenced a light hypothermia which was due to the central effects on thermoregulation inhibition, besides the peripheral vasodilatation brought about by propofol, which favoured the decrease in body temperature (Hatschbach et al. 2008). This light hypothermia was due to practices that serve to reduce heat loss during the anaesthetic procedure such as thermal mattresses, warm fluid therapy and warm air insufflators. No significant difference in anaesthetic recovery time was found between Groups 3, 4 and 1. But recovery time was dramatically prolonged in Group 2 compared to Group 1 (Table 2). Excessive alfentanil infusions may cause significantly delayed anaesthetic recovery in dogs (Hoffman et al. 1993). The prolonged recovery time was to be expected as dogs were given a propofol-opioid infusion for approximately an hour. Prolonged propofol infusions cause significantly delayed anaesthetic recoveries in cats (Padilha et al. 2011).

In summary, the administration of PA provided effective and satisfactory anaesthesia in dogs undergoing splenectomy. Side effects were not observed in this study. Nevertheless, assisted ventilation was provided and marked respiratory depression could have occurred otherwise. In the four groups, the extubation and recovery of dogs was steady and with no collateral effects; however recovery in Groups 3 and 4 was faster than in Group 2. The PA infusion led to good hypnosis, but the combinations caused bradycardia, while also maintaining stability of blood pressure and respiration.

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Corresponding Authors:

Aidong Wen and Yin Wu, Fourth Military Medical University, Xijing Hospital, Department of Pharmacy, Changle West Street 127, Xi'an, Shaanxi, China
E-mail: adwen2014@outlook.com; wuyin_2005@126.com