RESEARCH PAPER

Femoral and sciatic nerve blockade of the pelvic limb with and without obturator nerve block for tibial plateau levelling osteotomy surgery in dogs

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Abstract

Objective To determine the effect of blocking the obturator nerve in addition to performing femoral nerve and sciatic nerve blocks on intraoperative nociception in dogs undergoing unilateral tibial plateau levelling osteotomy (TPLO) surgery.

Study design Prospective, blinded, randomized, placebo-controlled, clinical comparison.

Animals A total of 88 client-owned dogs undergoing unilateral TPLO surgery (100 procedures).

Methods Dogs were randomly assigned to either group FSO (femoral, sciatic and obturator nerve blocks) [$n = 50$; ropivacaine 0.75% (0.75 mg kg^{-1})] or group FSP (femoral, sciatic and placebo) [$n = 50$; ropivacaine 0.75% (0.75 mg kg^{-1}) femoral and sciatic nerve blocks plus saline solution 0.9% (0.1 mL kg^{-1}) as a placebo injection around the obturator nerve]. The anaesthetic protocol was standardized. Data collection included intraoperative cardiopulmonary variables and opioid consumption. Rescue analgesia consisted of an intravenous bolus of fentanyl (2 μg kg^{-1}) and was administered when a change in cardiopulmonary variables (20% increase in mean arterial pressure or heart rate) was attributed to a sympathetic stimulus. Data were analysed using generalized linear mixed models, cross tables and multivariable binary logistic regression. Results were expressed as adjusted odds ratios with 95% confidence intervals and Wald p values ($\alpha = 0.05$).

Results There were no clinically relevant differences between groups in intraoperative cardiopulmonary variables and need for rescue analgesia. The requirement for rescue analgesia was significantly higher in dogs with a body weight >34 kg.

Conclusions and clinical relevance Anaesthesia of the obturator nerve in addition to the femoral and sciatic nerves was not associated with clinically significant differences in cardiopulmonary variables or a reduced need for rescue analgesia. Therefore, the clinical benefit of an additional obturator nerve block for intraoperative antinociception in dogs undergoing unilateral TPLO surgery using the described anaesthetic regimen is low.

Keywords dog, locoregional anaesthesia, obturator nerve, pelvic limb, peripheral nerve blockade.

Introduction

Locoregional anaesthesia is commonly used as part of the anaesthetic regimen for orthopaedic surgery in small animals. In recent years, modern techniques such as peripheral nerve blocks (PNB) guided by electrical nerve localization and ultrasound (US) are increasingly adapted from human medicine as an alternative to neuraxial anaesthesia to achieve optimal control of nociception with limited complications (Gurney & Leece 2014; Mogicato et al. 2015; Portela et al. 2018).

Cruciate ligament disease is the most common orthopaedic problem of the pelvic limb in dogs (Hayashi et al. 2004) and tibial plateau levelling osteotomy (TPLO) is a frequently performed surgery in canine patients with rupture of the cranial cruciate ligament (Kim et al. 2008). It includes a medial arthrotomy and a tibial osteotomy with subsequent plate fixation and is, due to its invasive nature, associated with significant intraoperative nociception.

Peripheral nerve blockade is an alternative technique to neuraxial anaesthesia to improve antinociception and analgesia in dogs undergoing major surgery of the pelvic limb (Campoy et al. 2012a; Caniglia et al. 2012; Boscan &

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Wennogle 2016). In general, the combination of femoral nerve and sciatic nerve blocks has been considered sufficient for nociceptive control during surgery distal to the mid femur in human and canine patients (Ben-David et al. 2004; Campoy 2006; Caniglia et al. 2012). Nevertheless, studies in human anaesthesia have demonstrated that an additional block of the obturator nerve significantly improves nociceptive control and analgesia in patients during and after major knee surgery (Macalou et al. 2004; Sakura et al. 2010). Little and conflicting information exists about the role of the obturator nerve as a sensory nerve in dogs. The only detailed anatomical study on this subject dates from 1982 (O'Connor & Woodbury 1982) and found that the obturator nerve contributed to the innervation of the medial stifle in 27% of dogs. Areas of innervation include the medial collateral ligament, the cranial, medial, and caudal joint capsule, the infrapatellar fat pad and the attachments of the cruciate ligaments and the meniscal horns. Therefore, it has been hypothesized that incomplete block of the pelvic limb would occur in those individuals where supplementary sensory fibres arise from the obturator nerve (Bartel et al. 2016). The need for further clinical studies that compare different techniques of PNB has therefore been highlighted (Portela et al. 2018).

Few veterinary clinical studies have investigated the combination of femoral and sciatic nerve blocks for procedures performed on the pelvic limb in dogs and none of them were designed to identify obturator nerve involvement in nociception (Portela et al. 2010; Campoy et al. 2012a,b; Caniglia et al. 2012; Tayari et al. 2017). The goal of this study was to compare the quality of intraoperative antinociception in dogs undergoing the same type of stifle surgery, specifically TPLO. The null hypothesis was that no differences in heart rate (HR), systemic arterial pressures (sAP) or requirement for rescue analgesia would be observed between the two groups.

Materials and methods

The study was approved by the responsible Animal Welfare Officer of the Department of Veterinary Medicine at the Free University of Berlin and conducted in accordance with the standards of good clinical practice to ensure animal welfare as required by international guidelines and national laws. The reporting of this study is based on the CONSORT guidelines (Schulz et al. 2010) and flow diagram (Fig. 1). With informed owner consent, 96 client-owned dogs of different breeds, sex, age and body weight were initially enrolled in the study (Table 1). All animals underwent elective, unilateral TPLO surgery for cranial cruciate ligament injury (Slocum & Slocum 1993).

A physical examination, serum chemistry, haematology and a coagulation profile were performed in all animals before the surgery. Only animals with an American Society of Anesthesiologists (ASA) classification score of I or II were included in the study. A body weight of $\geq$16 kg was chosen as an inclusion criterion in order to minimize differences in drug response between smaller and larger animals caused by their size-dependent, different metabolic rates (Singer 2006) as it is reflected in the dexmedetomidine dose curve (Zoetis, NJ, USA). Exclusion criteria were concurrent neurological disease, coagulopathy, skin infection at the injection site, persistent hypotension that was unresponsive to treatment with a fluid bolus and required additional treatment (e.g., vasopressors) and a previous history of hypersensitivity to local anaesthetics.

The animals were randomly assigned (drawing a red or yellow chip from 100 chips in a closed bag in a 1:1 ratio) to either group FSO (femoral, sciatic and obturator nerve block) or group FSP (femoral and sciatic nerve block plus placebo injection). The syringe for the perineural injection of the obturator nerve was then prepared by a veterinary assistant who was exclusively informed about the nature of the colour coding and filled with either 0.75% ropivacaine (Naropin; Aspen, Switzerland) or 0.9% saline solution (NaCl 0.9%; B. Braun, Germany) in equal volumes. Each dog was premedicated with dexmedetomidine (2 μg kg^{-1}; Dexdomitor; Pfizer, Germany) and methadone (0.2 mg kg^{-1}; Comfortan; Dechra, Germany) via an intramuscular (IM) injection into the biceps femoris muscle 15 minutes prior to the induction of anaesthesia. Anaesthesia was induced by an intravenous (IV) injection of midazolam (0.1 mg kg^{-1}; Midazolam; Rotexmedica, Germany) and propofol (PropoVet; Abbott, Germany) to effect (usually 1−2 mg kg^{-1}) until intubation was achieved. Anaesthesia was maintained with propofol using intermittent bolus injections for approximately 15−20 minutes to take a lateral radiograph of the stifle, clip the fur and prepare the pelvic limb. Supplemental oxygen from an oxygen concentrator (OxyVet; Eickemeyer, Germany) and, if necessary, ventilatory support were given during this period via the endotracheal tube. On entering the operating theatre, the dogs were connected to an anaesthetic machine (Sulla; Draeger, Germany) and anaesthesia was maintained with isoflurane (Vetflurane; Virbac, Germany) in an oxygen/air mix (FIO_2 0.5−0.9). Target value for end-tidal isoflurane was 1.3% for the time of surgery. Mechanical ventilation (Servo 300; Siemens, Germany) was employed and adjusted in all cases to maintain end-tidal carbon dioxide levels within the range of 35−45 mmHg (4.6−6.0 kPa). All dogs were administered IV fluid therapy (Sterofundin ISO; B. Braun) at a rate of 5 mL kg^{-1} $hour^{-1}$. Hypotension defined as mean arterial pressure (MAP) $<$ 60 mmHg for more than 5 minutes or 3 consecutive, noninvasive measurements was treated with a fluid bolus of 10 mL kg^{-1} administered over 15 minutes. Antibiotic treatment with cefazolin (10 mg kg^{-1}; Cefazolin; Fresenius, Germany) was initiated at this stage in all animals. Non-steroidal anti-inflammatory drug therapy was started immediately after the surgery with IV meloxicam (0.2 mg kg^{-1}; Metacam; Boehringer Ingelheim, Germany). Once a stable plane of anaesthesia was achieved, PNB of the pelvic limb were performed by an

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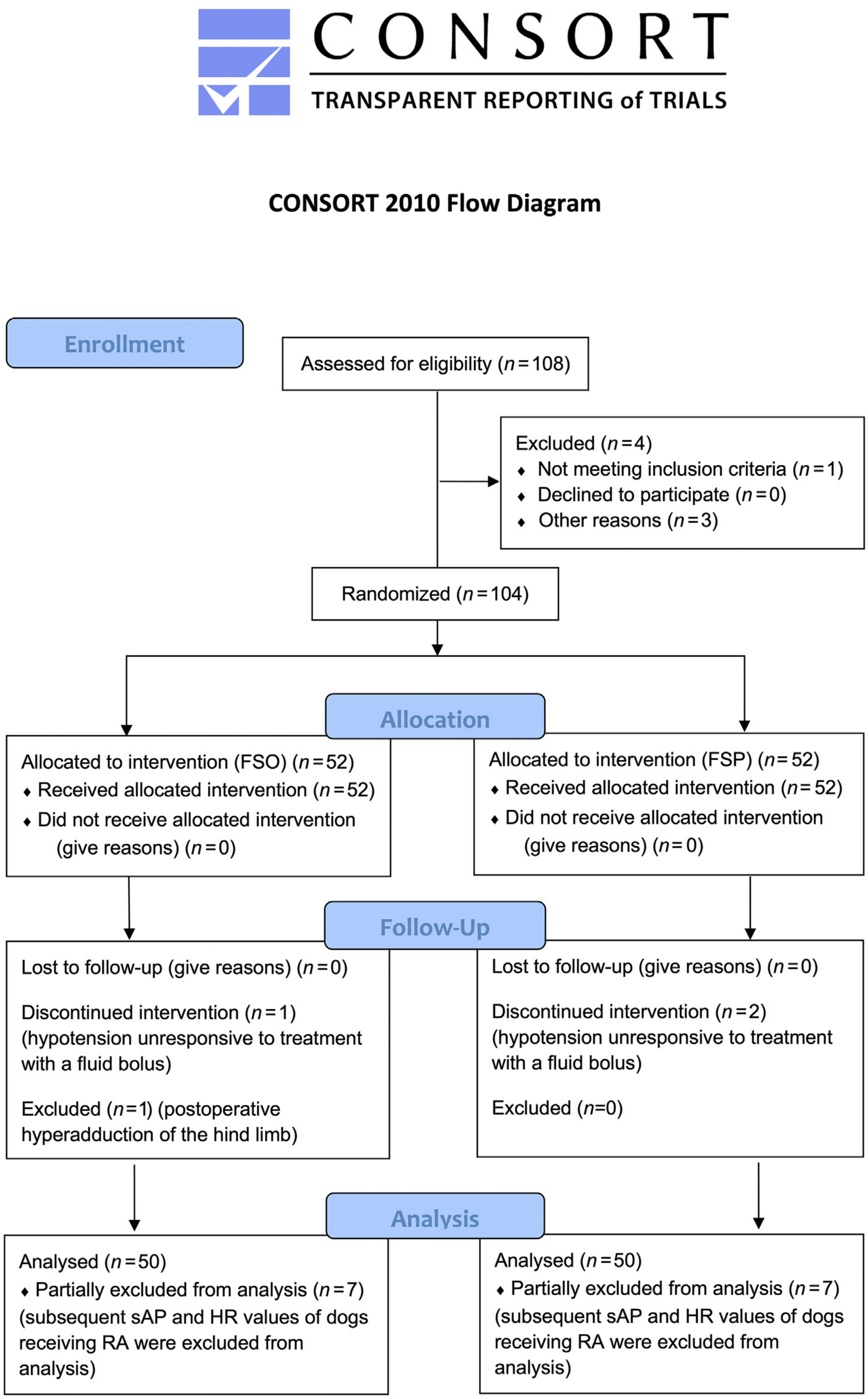

Figure 1 Consolidated Standards of Reporting Trials (CONSORT) flow diagram of the progress through the phases of a parallel randomized trial of two groups. FSO, femoral, sciatic and obturator block; FSP, sciatic and femoral nerve block plus placebo; HR, heart rate; RA, regional anaesthesia; sAP, systemic arterial pressures.

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Table 1 Mean values ± standard deviation of age and body weight, absolute numbers of sex and breed distribution of 100 dogs undergoing tibial plateau levelling osteotomy surgery. Dogs were divided into two groups determined by the nerve blocks that were performed: group FSO (femoral, sciatic and obturator nerve blocks) and group FSP (femoral and sciatic nerve blocks plus a placebo injection)

	FSO $n = 50$	FSP $n = 50$
Age (months)	84.1 ± 35.7	71.7 ± 40.7
Weight (kg)	31.3 ± 12.3	29.2 ± 7.7
Sex	Male intact 13	Male intact 5
	Castrated male 9	Castrated male 15
	Female intact 12	Female intact 14
	Spayed female 16	Spayed female 16
Breed	American Bulldog 1	Airedale Terrier 1
	American Staffordshire 1	Border Collie 1
	Akita Inu 1	Boxer 1
	Beagle 2	Doberman 1
	Bernese Mountain Dog 3	English Bulldog 7
	Ca De Bestiar 1	English Pointer 3
	Continental Bulldog 1	German Hound 1
	Dogue De Bordeaux 1	German Shepherd 2
	English Bulldog 4	Golden Retriever 6
	English Pointer 1	Hovawart 1
	German Hound 1	Labradoodle 1
	Giant Schnauzer 1	Labrador 6
	Golden Retriever 1	Mixed Breed 12
	Great Dane 1	Pitbull Terrier 2
	Irish Wolfhound 1	Rottweiler 2
	Labrador 4	Samoyed 1
	Large Münsterländer 1	Siberian Husky 1
	Leonberger 1	Vizsla 1
	Mixed Breed 19	
	Rottweiler 1	
	Siberian Husky 3	

experienced anaesthetist who was unaware of the contents of the syringe used for the perineural injection of the obturator nerve. The equipment consisted of two Stimuplex A needles (B. Braun), a nerve stimulator (HNS; B. Braun) and an US machine (Logiq 9; GE, Germany). The femoral nerve was identified using electrolocation and US guidance and anaesthetized with ropivacaine 0.75% (0.75 mg kg^{-1} equalling 0.1 mL kg^{-1}) at the inguinal region as described by Campoy et al. (2010). This technique avoided inadvertent blockade of the obturator nerve. Once a clear contraction of the quadriceps muscle (stifle extension) was elicited at a current of 0.48 mA, the local anaesthetic was slowly injected. The spread of the local anaesthetic around the nerve was assessed in cross sectional and long axis views. The sciatic nerve was anaesthetized through a parasacral approach (Portela et al. 2010) using electrical nerve localization only. Contraction of the cranial tibial muscle (tarsal flexion) at a current of 0.48 mA was considered an acceptable end point for needle placement and ropivacaine 0.75% was administered at a dose of 0.75 mg kg^{-1} equalling 0.1 mL kg^{-1}. Then, the second needle and the covertly prepared syringe were used to anaesthetize the obturator nerve using electrical nerve localization only. The needle was inserted as for the parasacral approach to the sciatic nerve. On contact with the ilium, the needle was tilted approximately 20 degrees, orientated in a cranial direction and advanced through the pelvic fascia along the medial cortex of the ilial wing. The obturator nerve could regularly be located after advancing the needle for 2−3 cm (Fig. 2). The position was controlled by palpating a clear contraction of the adductor muscles at a stimulation current of 0.48 mA. At this point, the content of the syringe was injected using the same volume as for the sciatic nerve block.

All TPLO procedures were performed by the same experienced orthopaedic surgeon and included a small, medial arthrotomy, exploration of the joint using a stifle distractor, a possible partial meniscectomy and the use of a jig. Time from premedication to surgery was between 45 and 60 minutes. Duration of the surgery was planned for approximately 75 minutes based upon the team's experience with the procedure. Relevant variables were measured continuously as part of the intraoperative monitoring and included HR in beats minute^{-1} and systolic, mean, and diastolic (SAP_{inv}, MAP_{inv}, DAP_{inv}) invasive arterial blood pressure measured from the dorsal pedal artery in mmHg. Alternatively, oscillometric, noninvasive blood pressure was measured at 2 minute intervals with the cuff (single-patient or reusable noninvasive blood pressure cuff; Philips, Germany) placed around the right or left antebrachium just distal to the elbow. The cuff width chosen was approximately 40% of the circumference of the limb. Other monitoring techniques and variables included pulse oximetry, respiratory rate, capnography, electrocardiography (IntelliVue MP40 Monitor; Philips), spirometry (Servo 300; Siemens) and anaesthetic gas analysis (gas anaesthesia module M1019A; Philips). For SAP_{inv}, MAP_{inv} and DAP_{inv}, a single-use, precalibrated transducer (Combitrans Einweg-Transducer; B. Braun) was used. The transducer was zeroed immediately before the start of the monitoring at the level of the right atrium.

All intraoperative and postoperative evaluations were performed by an assessor blinded to the group identity of the animals. Nociception was indirectly evaluated by sudden and clinically significant changes in HR and MAP values. Clinically significant changes were defined as an increase > 20% in HR or MAP. This methodology was derived from similar studies (Adami et al. 2016; Tayari et al. 2017); however, values of MAP and HR were not compared with their respective baseline values at the beginning of the surgery, but rather compared with the values immediately preceding the sudden increase. Animals that either showed these cardiovascular changes or

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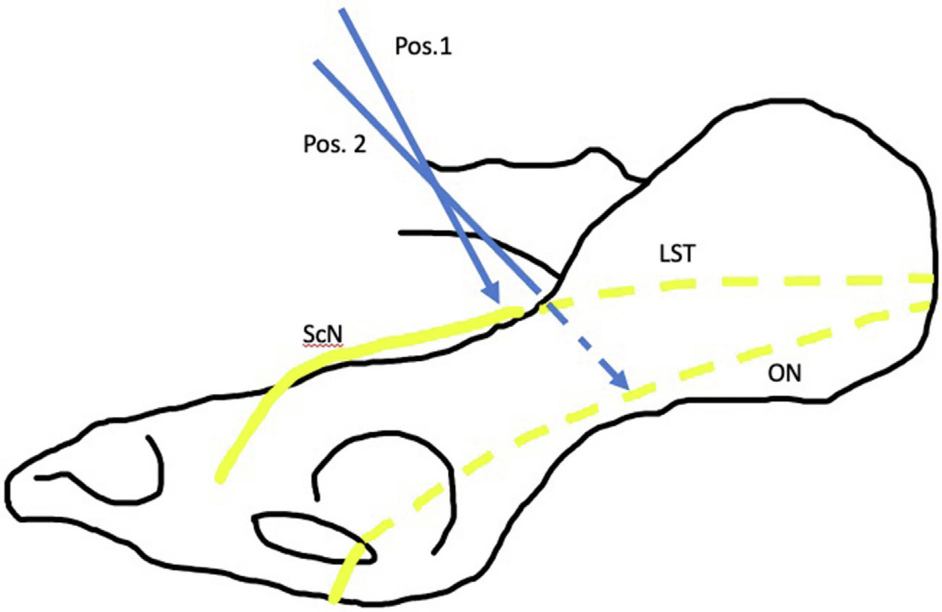

Figure 2 Positioning of the needle for sciatic and obturator nerve block. LST, lumbosacral trunk; ON, obturator nerve; Pos.1, needle position for sciatic nerve block through a parasacral approach; Pos.2, needle position for obturator nerve block; ScN, sciatic nerve.

reacted to a surgical stimulus with spontaneous breathing against mechanical ventilation or with other body movements (e.g., retraction of a limb, movement of the head) were immediately administered rescue analgesia in the form of an IV bolus of fentanyl (Fentadon; Dechra) at a dose of 2 μg kg^{-1}. Additionally, three time points were chosen for statistical comparison of MAP and HR, namely t_1 at the time of the skin incision, t_2 during tibial osteotomy and t_3 at the end of the skin closure.

Postoperative evaluation of the obturator nerve block was performed in all cases by assessing the adductor muscle function approximately 1−2 hours after the end of anaesthesia. At the same time, the femoral and sciatic nerve blocks were evaluated by assessing the patellar and cranial tibial reflexes. The respective dermatomes medial and caudal to the stifle joint were tested for sensitivity by pinching them with artery forceps and observing withdrawal of the limb or a turn of the head (Jaggy 2007; Shimada et al. 2017) and compared with the reactions on the contralateral limb. Animals were discharged from hospital on the day of surgery with meloxicam (Metacam; Boehringer Ingelheim) and re-evaluated the following day. By this time, the effect of the blocks had worn off and most dogs would be walking on the operated limb. If at this stage the stifle was painful at palpation, metamizole (Vetalgin; MSD Tiergesundheit, Germany) was administered as an additional analgesic starting with a subcutaneous injection of 50 mg kg^{-1} followed by oral application (Novalgin; Sanofi-Aventis, Germany) twice daily at the same dose. None of the dogs required re-hospitalization, and no opioids were used postoperatively. Owing to the short hospitalization period, postoperative pain evaluation was incomplete and therefore not included in the scope of this study.

Statistical analysis

Sample size was determined based on the assumption that on average dogs would require rescue analgesia with a probability of 20% due to failure of the pelvic limb block (Abrahams et al. 2009), and that in 27% of dogs the obturator nerve contributes to stifle nociception (O'Connor & Woodbury 1982). In order to detect a difference of proportions between the two independent study groups in the magnitude of delta = 0.2522, with a power of 0.8 and an alpha of 0.05, a minimum sample size of 46 surgeries per study group was calculated (www.pass.com; comparison of two independent proportions; two-sided Z-test).

All data were analysed using software packages SPSS v25 (IBM Corp., NY, USA), NCSS v10 (NCSS, UT, USA) and STATA v15 (StataCorp LLC, TX, USA). Normality of measurements within each group and time point was checked using Kolmogorov−Smirnov and Shapiro−Wilk tests. To identify differences in sAP and HR between the groups and time points, generalized linear mixed models were developed using the *meglm* routine in STATA v15. Group (FSO, FSP), time (Δ1, Δ2) and a group*time interaction were included as categorical variables. Subject (animal identification) was included as a random effect to account for the repetition of measurements over time. Model results were adjusted for the influence of sex

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(male, female), age (≤60 months, 61−96 months, >96 months) and weight (16−25 kg, 25−34 kg, ≥35 kg). For models where the interaction term was not statistically significant, that model was rebuilt after dropping the respective term. In order to account for the bias between the results for sAP obtained by two different methods, the statistical analysis was not based on the absolute figures, but instead looked at the relative differences in sAP. Model Δ1 compared measurements between point t_1 (skin incision) and t_2 (osteotomy of the tibia), and model Δ2 measurements between t_2 and t_3 (end of skin closure). In the second model, dogs that had received rescue analgesia were omitted from the analysis. For measurement of associations between groups (FSO, FSP) and rescue analgesia (binary variable coded 0 or 1), we used cross tables and a multivariable binary logistic regression approach with rescue analgesia as the dependent variable and treatment group as the main effect. Parameter estimates were adjusted for the influence of sex, weight and age. Subject was included as a random effect to account for the inclusion of 12 dogs with surgery on both stifles. Results were expressed as adjusted odds ratios with 95% confidence intervals and Wald *p* values. The threshold level of statistical significance (alpha) for all analyses was set to 0.05.

Table 2 The *p* values derived from multivariable general linear models for systolic (SAP), diastolic (DAP) and mean arterial pressure (MAP) and heart rate (HR) measurements during 100 tibial plateau levelling osteotomy stifle surgeries in 88 dogs. Independent factors were group (divided in group FSO: femoral, sciatic nerve blocks with obturator nerve block; group FSP: femoral, sciatic nerve blocks with a placebo nerve block), time (two time points) and the group*time interaction. Subject (animal ID) was included as a random effect to account for the repetition of time within subject. The model was adjusted for the influence of sex, age and weight. Model Δ1 describes the difference between measuring point t_1 (skin incision) and t_2 (osteotomy of the tibia), and model Δ2 the difference between t_2 and t_3 (end of skin closure; only those 86 cases not requiring rescue analgesia). Observed means are presented in Fig. 2. All non-significant results (n.s.) had *p* values > 0.09

	Model Δ1 (time 1-2)			Model Δ2 (time 2-3)		
Factor	Group	Time	Interaction[†]	Group	Time	Interaction[†]
SAP	0.008	n.s.	n.s.	n.s.	<0.001	n.s.
DAP	0.028	n.s.	n.s.	n.s.	<0.001	n.s.
MAP	0.018	n.s.	n.s.	n.s.	<0.001	n.s.
HR	n.s.	n.s.	n.s.	n.s.	0.012	n.s.

n.s., non-significant.
[†]Group*time interactions were tested and, when not statistically significant ($p > 0.05$), excluded from the final model. Displayed *p* values relate to the final model without the interaction term.

Results

Descriptive analysis

A total of 96 client-owned dogs were initially enrolled in the study; however, four dogs were excluded from the study, two because of skin infections and one each owing to coagulopathy and a splenic mass. Another four dogs were later excluded from statistical analyses, three due to intraoperative hypotension unresponsive to a fluid bolus and one as a result of apparent obturator block nerve block failure. In this study, 12 dogs had surgery on both pelvic limbs on two separate sessions with a minimum of 4 weeks between interventions leading to a total number of 88 dogs and 100 TPLO procedures. Of the 88 participating dogs, 34 were male and 54 were female. The age at surgery ranged from 6 to 164 months (median, 80 months). The weight at surgery ranged between 16 and 60 kg (median, 30 kg) (Table 1). The ratio of dogs with invasive to noninvasive blood pressure was 41:9 in group FSO and 37:13 in group FSP. At t_1 and t_2, mean values of all variables did not change, whereas between t_2 and t_3 all sAP increased visibly while HR remained relatively constant (Table 2; Fig. 3a−d). Rescue analgesia was administered to 14 dogs, seven dogs each in both groups. In group FSO, the nociceptive stimulus occurred in five cases during plate fixation and two times during skin closure. In group FSP, rescue analgesia was administered twice during stifle distraction and in the remaining five cases, once during each of the following steps of the surgery: medial arthrotomy, application of the rotation pin, closure of the fascia, plate fixation and skin closure. Of the 14 dogs that required rescue analgesia, two needed a second injection of fentanyl before the end of surgery, both from group FSP. In only one of the two dogs could a nociceptive stimulus have been transmitted via the obturator nerve since the sympathetic reaction occurred during stifle distraction. The differences between groups regarding the total number of fentanyl boluses were considered negligible.

Postoperatively, all dogs of group FSP showed a marked hyperadduction of the limb as a sign of adductor muscle action unopposed by abduction forces of the biceps femoris and gluteus medius muscles due to the proximal sciatic nerve block. One dog in group FSO which showed hyperadduction of the limb postrecovery was excluded from the study. Evaluation of the dermatomes regularly produced false-negative results on the contralateral limb. It was therefore decided to assume a similar incidence of failure of the femoral and sciatic nerve blocks in both groups and not to exclude animals based on postoperative femoral and sciatic nerve block evaluation.

Inferential analysis

The multivariable linear models, after adjustment for the influence of sex, age, and weight, indicated statistically significant differences in sAP between groups FSO and FSP from t_1 to t_2. Individuals from group FSP showed sAP that were on average

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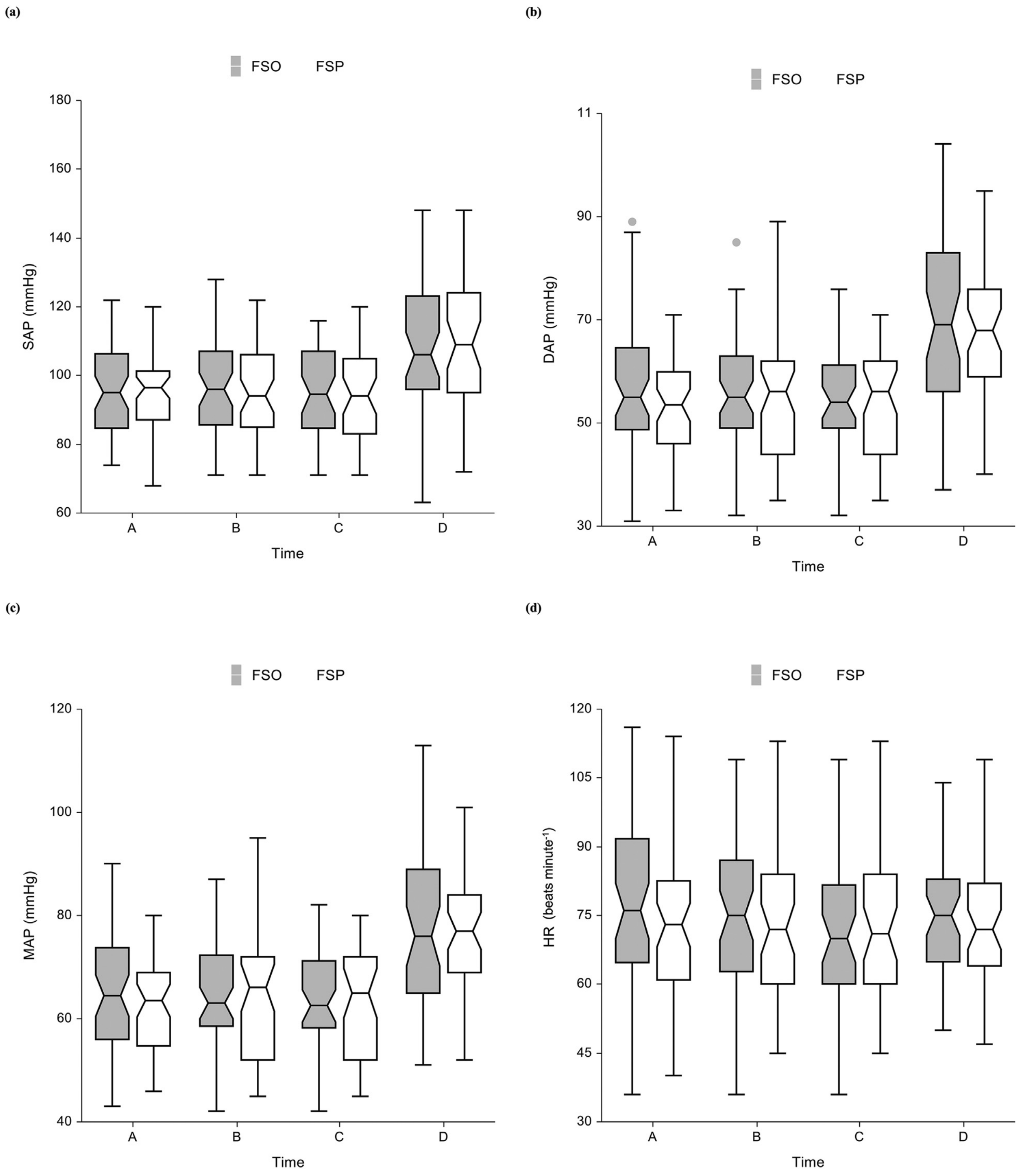

Figure 3 Box and whisker plots of (a) systolic arterial pressure (SAP), (b) diastolic arterial pressure (DAP), (c) mean arterial pressure (MAP) and (d) heart rate (HR) for groups FSO (with femoral, sciatic and obturator nerve blocks) and FSP (with femoral, sciatic and a placebo nerve block) measured during 100 tibial plateau levelling osteotomy stifle surgeries in 88 dogs. Values are presented for four sets of measurements: (A) skin incision (t_1), (B) osteotomy of the tibia (t_2), (C) osteotomy of the tibia (t_2) after exclusion of values of those animals requiring rescue analgesia and (D) end of skin closure (t_3). The median is the line within the box, 95% confidence interval of the median (notch), interquartile range (box), upper and lower quartile (upper and lower limit of box), range of values outside the interquartile range limited to a maximum of 1.5 × interquartile range (whiskers). Dots above and below the whiskers represent moderate outliers.

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Table 3 Multivariable binary logistic regression analysis of the relationship between rescue analgesia (coded 0, 1) and the independent variables group (FSO: femoral, sciatic and obturator nerve blocks; FSP: femoral, sciatic nerve blocks without obturator nerve block), sex (male, female), weight (16–25 kg, 25–34 kg, ≥35 kg) and age (≤60 months, 61–96 months, >96 months) for 100 completed tibial plateau levelling osteotomy surgeries in 88 dogs

Risk factor	Category	Adjusted odds ratio	LCL	UCL	*p*
Group	FSO	Reference			
	FSP	1.434	0.406	5.067	0.576
Sex	Male	Reference			
	Female	0.557	0.165	1.876	0.345
Age	≤60	Reference			
(months)	61–96	0.638	0.107	3.793	0.621
	>96	3.078	0.728	13.019	0.126
Weight	≤25	Reference			
(kg)	25–34	3.015	0.481	18.890	0.239
	≥35	9.656	1.591	58.605	**0.014**

LCL, lower limit of the 95% confidence interval for the adjusted odds ratio; UCL, upper limit of the 95% confidence interval for the adjusted odds ratio.
Bold signifies *p*-values < 0.05.

4–5 mmHg lower than animals from group FSO. Although statistically significant, this finding was considered clinically irrelevant. From t_2 to t_3, after exclusion of animals that were administered rescue analgesia before t_2, a steady increase in all sAP, but no significant differences between groups, were observed. Group*time interactions were included in the initial multivariable linear models but were not retained since none were statistically significant (Table 2; Fig. 3a–d). In the multivariable binary logistic regression, a higher body weight significantly increased the adjusted odds (chance) for rescue analgesia [odds ratios 3.02 (25–34 kg) and 9.66 (≥35 kg)]. Whether the greater body weight was related to dogs of a larger breed or because they were overweight is unknown (Table 3).

Discussion

In this study, no clinically significant differences were observed between group FSO and control FSP group regarding intraoperative cardiopulmonary values or the need for rescue analgesia. The study therefore failed to demonstrate a positive effect of an additional obturator nerve block on intraoperative nociception, unlike similar studies in humans undergoing major knee surgery. Apart from the differences in anatomy between humans and dogs, this could be attributed to the different surgical techniques used in these species.

The choice of the nerve block techniques employed in this study included the parasacral approach to the sciatic nerve described by Portela et al. (2010), because it allows to block the sciatic and the obturator nerve through a combined approach. Also, by blocking all abductor muscle function, it was possible to identify failure of the obturator nerve block more easily. The distal site for the femoral nerve block (Campoy et al. 2010) was chosen in order to avoid the inadvertent blockade of the obturator nerve. The use of more distal blocking techniques using US guidance such as the caudal sciatic nerve block (Campoy et al. 2010) and the saphenous nerve block (Portela et al. 2018) may have reduced the possibility of a concomitant obturator nerve block even further, maximizing the success rate at the same time. Nevertheless, the possibility of accidental obturator nerve block caused by a parasacral sciatic nerve block was considered low, mainly because both nerves are separated by the pelvic fascia and therefore do not share the same anatomical compartment (Jochum et al. 2004). The results of the inferential analysis showed a higher chance for nerve block failure in dogs weighing >34 kg. Whether this was due to insufficient spread of the injectate or other reasons is unknown. Using US guidance for all blocks may have minimized this effect.

The lack of a reliable, postoperative evaluation of block efficacy is a limitation of this study. Specifically, the identification of incomplete blocks of the femoral and sciatic nerves were somewhat inconsistent, and the result of this evaluation was therefore not used as an exclusion criterion. Instead, it was assumed that the incidence of femoral and sciatic nerve block failure would be statistically similar in both groups. Block failure in this context is defined as any incomplete nerve block that allows nociceptive transmission leading to the need for rescue analgesia as defined by Caniglia et al. (2012). Following this assumption, the difference in the percentage of animals requiring rescue analgesia owing to nociception via the obturator nerve would be the same in both groups independent of the absolute value for femoral/sciatic block failure. The limitation of postoperative block evaluation due to false-positive results has been reported by Portela et al. (2010). Similarly, false-negative results might be a limiting factor. During this study, dogs would regularly show no reaction to pinching the

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skin of the contralateral, unblocked limb with haemostats. This might have been caused either by postoperative excitement, multimodal analgesia, individual or breed-specific reasons for a relatively low skin sensitivity, or any combination of these factors. A further limitation of the study was the failure to record the animals' body condition scores. This makes it impossible to discriminate between large *versus* overweight dogs, which could be of considerable clinical significance.

Although a pilot cadaver study was performed by the authors (unpublished data) to evaluate the reliability of a modified parasacral approach to the obturator nerve, the nerve could be blocked routinely and effectively using this approach. Block efficacy of the obturator nerve block could easily be identified postoperatively, as dogs administered the placebo injection exhibited hyperadduction of the pelvic limb. As a result, dogs would have to jump over their own leg in order to move forward. This observation could give rise to the argument that an obturator nerve block could have its merit when a proximal sciatic nerve block is used, in order to facilitate early mobilization in the immediate postoperative period while the animal is still limited to a tripodal gait. Only one dog from group FSO was excluded after showing hyperadduction of the limb as a sign of obturator nerve block failure, suggesting a high success rate of this block.

The study does not provide evidence for the role of obturator nerve involvement in stifle nociception *per se*. One reason is the inability to identify from the outset those individuals in which sensory fibres of the obturator nerve supply the area of the medial stifle. It also can be challenging to clearly distinguish intraoperative nociception occurring via the obturator nerve, as there is no surgical manoeuvre during TPLO surgery that would solely trigger a nociceptive obturator nerve response without also affecting the femoral or the sciatic nerve. Additionally, the multimodal analgesia could account for a confounding bias by centrally suppressing the sympathetic response to nociceptive stimuli transmitted via the obturator nerve. Nevertheless, the results suggest that there is no significant influence of an additional obturator nerve block on HR or sAP and on the need for rescue analgesia in dogs undergoing TPLO surgery under the conditions of the current study.

Conclusions and clinical relevance

This study does not support the routine use of an obturator nerve block for TPLO surgery in dogs. Future studies require a more refined and standardized evaluation of block efficacy using a composite assessment protocol including opioid and anaesthetic gas consumption as well as postoperative reflexes, muscle function and dermatome sensitivity. The obturator nerve block may have a role when used in combination with proximal sciatic nerve blocking techniques in order to enable unhindered tripodal gait in the immediate postoperative period.

Authors' contributions

GP: study design and conduction, data collection and interpretation, writing of the manuscript and approval of the final version for publication. VD and MD: statistical analysis and data interpretation, writing of the manuscript and approval of the final version for publication.

Conflict of interest statement

Authors declare no conflict of interest.

References

Abrahams MS, Aziz MF, Fu RF, Horn JL (2009) Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: a systemic review and meta-analysis of randomized controlled trials. Br J Anaesth 102, 408−417.

Adami C, Casoni D, Noussitou F et al. (2016) Addition of magnesium sulphate to ropivacaine for spinal analgesia in dogs undergoing tibial plateau levelling osteotomy. Vet J 209, 163−168.

Bartel AKG, Campoy L, Martin-Flores M et al. (2016) Comparison of bupivacaine and dexmedetomidine femoral and sciatic nerve blocks with bupivacaine and buprenorphine epidural injection for stifle arthroplasty in dogs. Vet Anaesth Analg 43, 435−443.

Ben-David B, Schmalenberger K, Chelly JE (2004) Analgesia after total knee arthroplasty: is continuous sciatic blockade needed in addition to continuous femoral blockade? Anesth Analg 98, 747−749.

Boscan P, Wennogle S (2016) Evaluating femoral-sciatic nerve blocks, epidural analgesia, and no use of regional analgesia in dogs undergoing tibia-plateau-leveling-osteotomy. J Am Anim Hosp Assoc 52, 102−108.

Campoy L (2006) Fundamentals of regional anesthesia using nerve stimulation in the dog. In: Recent advances in veterinary anesthesia and analgesia: companion animals. Gleed RD, Ludders JW (eds). International Veterinary Information Service, Ithaca, NY.

Campoy L, Bezuidenhout AJ, Gleed RD et al. (2010) Ultrasound-guided approach for axillary brachial plexus, femoral nerve, and sciatic nerve blocks in dogs. Vet Anaesth Analg 37, 144−153.

Campoy L, Martin-Flores M, Ludders JW, Gleed RD (2012a) Procedural sedation combined with locoregional anesthesia for orthopedic surgery of the pelvic limb in 10 dogs: a case series. Vet Anaesth Analg 39, 436−440.

Campoy L, Martin-Flores M, Ludders JW et al. (2012b) Comparison of bupivacaine femoral and sciatic nerve block versus bupivacaine and morphine epidural for stifle surgery in dogs. Vet Anaesth Analg 39, 91−98.

Caniglia AM, Driessen B, Puerto DA et al. (2012) Intraoperative antinociception and postoperative analgesia following epidural anesthesia versus femoral and sciatic nerve blockade in dogs undergoing stifle joint surgery. J Am Vet Med Assoc 241, 1605−1612.

Gurney MA, Leece EA (2014) Analgesia for pelvic limb surgery. A review of peripheral nerve blocks and the extradural technique. Vet Anaesth Analg 41, 445−458.

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Hayashi K, Manley PA, Muir P (2004) Cranial cruciate ligament pathophysiology in dogs with cruciate disease: a review. J Am Anim Hosp Assoc 40, 385−390.

Jaggy A (2007) Atlas und Lehrbuch der Kleintierneurologie (2nd edn). Schlütersche Verlagsgesellschaft mbH, Hannover, Germany. pp. 27−29.

Jochum D, Iohom G, Choquet O et al. (2004) Adding a selective obturator nerve block to the parasacral sciatic nerve block: an evaluation. Anesth Analg 99, 1544−1549.

Kim SE, Pozzi A, Kowaleski MP, Lewis DD (2008) Tibial osteotomies for cranial cruciate ligament insufficiency in dogs. Vet Surg 37, 111−125.

Macalou D, Trueck S, Meuret P et al. (2004) Postoperative analgesia after total knee replacement: the effect of an obturator nerve block added to the femoral 3-in-1 nerve block. Anesth Analg 99, 251−254.

Mogicato G, Layssol-Lamour C, Mahler S et al. (2015) Anatomical and ultrasonographic study of the femoral nerves within the iliopsoas muscle in beagle dogs and cats. Vet Anaesth Analg 42, 425−432.

O'Connor BL, Woodbury P (1982) The primary articular nerves to the dog knee. J Anat 134, 563−572.

Portela DA, Otero PE, Taragona L et al. (2010) Combined paravertebral plexus block and parasacral sciatic block in healthy dogs. Vet Anaesth Analg 37, 531−541.

Portela DA, Verdier N, Otero PE (2018) Regional anesthetic techniques for the pelvic limb and abdominal wall in small animals: A review of the literature and technique description. Vet J 238, 27−40.

Sakura S, Hara K, Ota J, Tadenuma S (2010) Ultrasound-guided peripheral nerve blocks for anterior cruciate ligament reconstruction: effect of obturator nerve block during and after surgery. J Anesth 24, 411−417.

Schulz KF, Altman DG, Moher D (2010) CONSORT 2010 Statement; updated guidelines for reporting parallel group randomised trials. Ann Int Med 152, 2010.

Shimada S, Shimizu M, Kishimoto M (2017) Ultrasound-guided femoral nerve block using a ventral suprainguinal approach in healthy dogs. Vet Anaesth Analg 44, 1208−1215.

Singer D (2006) Size relationship of metabolic rate: oxygen availability as the "missing link" between structure and function? Thermochimica Acta 446, 20−28.

Slocum B, Slocum TD (1993) Tibial plateau leveling osteotomy for repair of cranial cruciate ligament rupture in the canine. Vet Clin North Am Small Anim Pract 23, 777−795.

Tayari H, Tazioli G, Breghi G, Briganti A (2017) Ultrasound-guided femoral and obturator nerves block in the psoas compartment in dogs: anatomical and randomized clinical study. Vet Anaesth Analg 44, 1216−1226.

Zoetis, NJ, USA Canine dexmedetomidine dosing chart. https://www.zoetisus.com/products/cats/dexdomitor/doc/Canine_Dosing_Chart.pdf. (Accessed 18 January 2022).

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