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Comparison of incisional, transverse abdominis plane, and rectus sheath blocks in dogs undergoing ovariohysterectomy

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OBJECTIVE
To compare the analgesia provided by incisional (Incisional), transverse abdominis plane (TAP), and rectus sheath (RS) blocks in dogs submitted for ovariohysterectomy (OHE).

ANIMALS
22 female mixed-breed dogs were allocated into 3 treatments of Incisional (n = 7), TAP (n = 7), and RS (n = 8) and underwent OHE from April 4 to December 6, 2022.

PROCEDURES
After premedication with acepromazine (0.05 mg/kg) and morphine (0.5 mg/kg), anesthesia was induced (6 mg/kg) and maintained (0.4 mg/kg/min) with propofol. Each dog randomly received either an incisional (blind technique), TAP, or RS (ultrasound-guided) block. Intraoperative analgesia was assessed using cardiorespiratory variables. Postoperative analgesia was evaluated up to 6 hours after the operation with a Short Form of Glasgow Pain Scale (SF-GCPS) and Visual Analog Scale (VAS). Fentanyl was administered as a rescue analgesic when needed.

RESULT
During surgery, all data remained within normal limits without any significant differences. Fentanyl was administered to 1 dog in the Incisional and 1 in the TAP. Post-operatively, a single dose of fentanyl was given to 1 dog in the TAP and 1 in the RS. Four dogs in the Incisional and 3 in the RS received both doses of fentanyl. There was no significant difference regarding postoperative rescue analgesia among treatments.

CLINICAL RELEVANCE
All 3 techniques demonstrated acceptable intra- and post-operative analgesia efficacy in dogs undergoing OHE. Further studies are warranted to confirm these findings.

Keywords: ultrasound-guided, incisional block, transverse abdominis plane block, rectus sheath block, ovariohysterectomy

Various methods have been proposed to provide adequate perioperative analgesia for ventral midline incisions in celiotomies. Direct injection of local anesthetic drugs at the incision line (incisional block) has been assessed as effective in reducing pain at the surgery site.[1,2] However, this approach can be accompanied by considerable complications such as high inflammation, spleen puncture, and hernia. Even saline injection has been reported to produce postoperative edema and erythema.[3] Moreover, the analgesia results produced by this method were contradictory and, in some cases, insufficient to provide clinical significance.[4,5]

The transverse abdominis plane (TAP) block was used to reduce pain, opioid requirements, and patient discomfort after surgery in human patients.[6] It is a relatively new regional anesthesia technique rapidly expanding, providing good analgesia after abdominal surgeries. This method involves injecting a local anesthetic bolus in the space between the internal oblique and transverse abdominis muscles.[7] In veterinary medicine, several studies have suggested that this technique can be used with satisfactory results.[6,8,9]

Rectus abdominis sheath (RS) block is another method used for the analgesia of the abdominal incisional line. This technique has recently been mentioned in humans and proposed as an alternative to TAP block.[10] In this method, ventral branches of spinal nerves are desensitized at the entrance to the posterior rectus sheath and before entering the rectus abdominis muscle. In 2019, James et al described the RS block in dog cadavers suggesting this method's potential use in clinical practice.[10]

To the authors' knowledge, no study has yet compared the level and quality of analgesia produced by incisional, TAP, and RS blocks in dogs. Therefore, the objective of the current study was to evaluate analgesia provided by incisional, TAP, and RS blocks in the perioperative period in dogs submitted for ovariohysterectomy (OHE).

Materials and Methods

Animal and procedures

A prospective experimental blinded study was designed for the current study. The study was performed from April 4 to December 6, 2022. Twenty-two indigenous dogs with the American Society of Anesthesiologists' physical status I–II were used. The dogs were transferred to the Veterinary Hospital at least 2 weeks before the study and kept in individual cages. A thorough physical examination, CBC, and TP measurements confirmed the animal's health status. The dogs were fed twice a day and had access to water ad libitum, given 12 hours of fasting and 2 hours of water limitation before each experiment. The Ethics Committee of our university approved this study (EE/1401.24.3.88374/SCU.ac.ir).

On the day of the experiment, dogs were premedicated with acepromazine (0.05 mg/kg; Neurotranq; Alfasan) and morphine (0.5 mg/kg; Morphine Sulfate; Darou Pakhsh) intramuscularly. After 20 minutes, a 20 gauge intravenous catheter was aseptically inserted into the left saphenous vein, and a lactated ringer's solution infusion at the rate of 5 mL/kg/h was initiated. Approximately 20 minutes later, anesthesia was induced with propofol (6 mg/kg; Pofol; Dong Kook Pharm) intravenously (IV) titrated to effect. After tracheal intubation, all dogs were connected to a circuit system and received 100% oxygen, first at the rate of 30 mL/kg/min for 10 minutes and 10 mL/kg/min, then.

Anesthesia was maintained with a constant rate infusion (CRI) of propofol (0.4 mg/kg/min) using a syringe pump (Daiwha, Medifusion). During anesthesia, heart rate (HR), non-invasive systolic, diastolic, and mean blood pressure (SBP, DBP, and MBP), Lead II electrocardiography (ECG), respiratory rate (f_R), rectal temperature (RT), end-tidal carbon dioxide ($ETCO_2$, Capnograph, Respironics), and peripheral arterial oxygen saturation (SPO_2) were monitored using a multiparameter monitor (Vitapia 7000k, Trismed). The variables taken 5 minutes before the start of the surgery were recorded as the baseline values. Dogs were breathing spontaneously, but when $ETCO_2$ exceeded the reference values (ie, 35–45 mmHg), manual ventilation was used to restore it to the normal range. It was also attempted to maintain the rectal temperature around 37–38 °C; a heating pad and warm water were used.

Then, dogs randomly (www.randomization.com) received 1 of the 3 treatments of incisional (Incisional, n = 7), TAP (TAP, n = 7), and RS (RS, n = 8) blocks. For all blocks, dogs were positioned in dorsal recumbency. The skin from the pubis to the xiphoid and laterally to 10 cm on either side of the ventral midline was clipped and aseptically prepared.

For the incisional line block, a 22-gauge, 2-inch needle was inserted caudal to the umbilicus subcutaneously and in deeper tissues. A 1 mg/kg of 0.25% bupivacaine (Bupivacaine HCl 0.5%; Myungmoon Pharm) diluted to 0.8 mL/kg[3] with normal saline was injected in an 8 cm straight line at the predicted incision line.

For the TAP block, abdominal layers were imaged with an ultrasound (US) apparatus (Landwind, Wellkang tech). Approximately 5 centimeters lateral to the midline, midway between the iliac crest and the caudal aspect of the rib cage, a linear array probe of 10 MHz (Landwind) was positioned transversely. Three layers of the abdominal wall were identified as the external abdominal oblique, internal abdominal oblique, and transversus abdominis. A 22-gauge 90-mm spinal needle (Disposable spinal needle, Dr. Japan), attached to an extension set, was then passed perpendicular to the skin through the external and internal oblique muscle layers. The needle was inserted between the ultrasound beam's long axis, enabling an in-plane approach to visualize the needle penetrating the abdominal layers. To confirm the correct placement of the drug, 1 mL of the drug was injected when the plane was considered reached. The needle was re-adjusted if the hydrodissection was in an incorrect site. Once the needle had been positioned in the intended plane, the 0.25% bupivacaine solution (1 mg/kg, diluted to 20 mL with normal saline) was injected **(Figure 1)**. The procedure was repeated similarly on both sides of the abdomen (10 mL for each side).

For the RS block, a linear array US transducer was placed at the abdominal midline and initially oriented in a transverse orientation to observe the linea alba. A hyperechoic "double line" representing the internal rectus sheath, composed of the aponeurosis of the transversus abdominis muscle, transversalis fascia, and peritoneum, was identified by sliding the probe laterally to view the lateral extent of the rectus abdominis (RA) muscle. After acquiring the optimal double-line image, the spinal needle (22 gauge, 90 mm) was inserted lateral to the probe and directed dorsomedially with an in-plane approach. The needle was inserted between the lateral edge and midpoint of the RA muscle, passing through the external rectus sheath, then the muscle until reaching the plane between the internal rectus sheath and the RA muscle. A test dose (1 mL of normal saline) was administered to confirm the correct placement. When there was a mismatch between the test dose

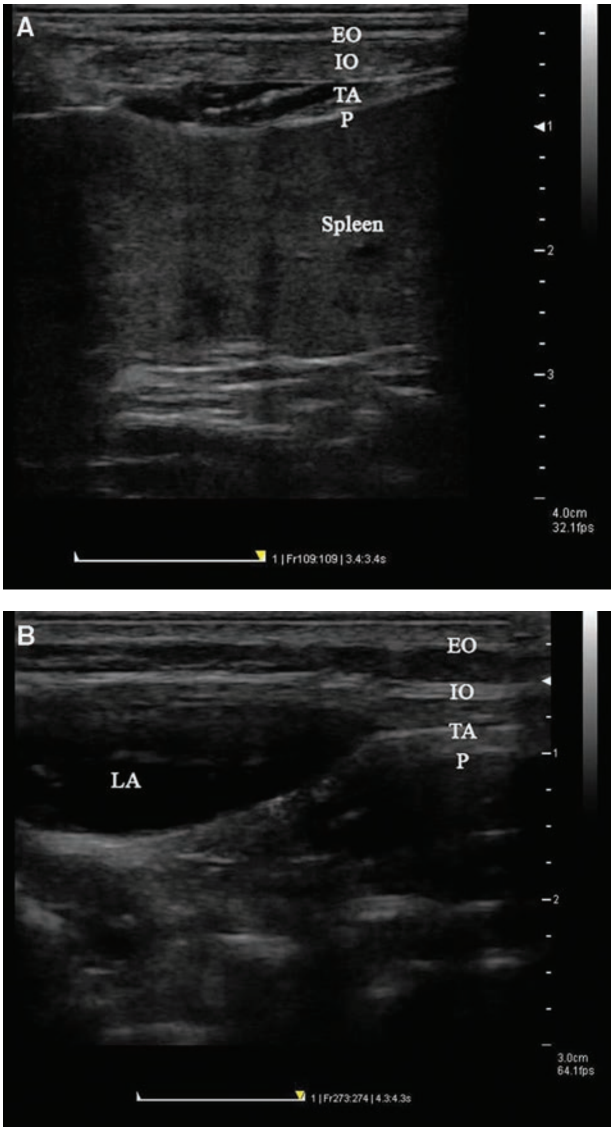

Figure 1—Ultrasound (US) images of the abdominal wall for transverse abdominis plane (TAP) block (A) Image of the correct placement of the needle in the TAP. The external abdominal oblique, internal abdominal oblique, and transversus abdominis were the 3 layers of the abdominal wall identified. To visualize the needle as it penetrated these layers, an in-plane approach was used by inserting it between the long axis of the ultrasound beam. A 1 mL dose was administered upon reaching the plane to ensure the accurate placement of the drug. (B) Post-injection image of the local anesthetics into the TAP. After confirmation that the needle was correctly positioned in the intended plane, the 0.25% bupivacaine (1 mg/kg, diluted to 20 mL with normal saline) was injected. The procedure was repeated similarly on both sides of the abdomen (10 mL for each side). EO = External abdominal oblique muscle. IO = Internal abdominal oblique muscle. LA = local anesthetic. P = peritoneum. TA = transverse abdominis muscle.

and the target site, the needle was re-adjusted, and the procedure was repeated. When the correct target site was reached, a 0.25% bupivacaine (0.5 mL/kg; half of the volume for each side) was administered slowly **(Figure 2)**.

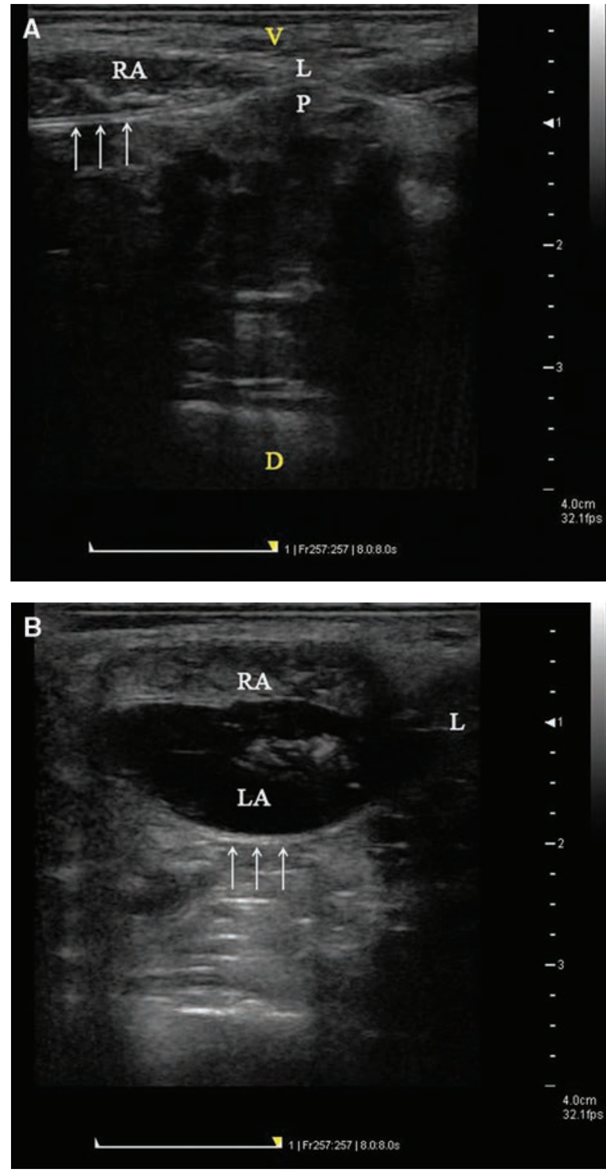

Figure 2—Ultrasound (US) images of the abdominal wall for rectus sheath (RS) block. (A) Pre-injection image of the RS block. To view the linea alba, a linear array US transducer was positioned along the midline of the abdomen and angled transversely. By shifting the probe to get a better look at the lateral section of the rectus abdominis muscle, a hyperechoic "double line" was detected, which represents the internal rectus sheath made up of the aponeurosis of the transversus abdominis muscle, transversalis fascia, and peritoneum. (B) Post-injection image of the local anesthetics into the RS. The needle was introduced through the external rectus sheath, traversing the RA muscle between its midpoint and lateral edge until it reached the region between the internal rectus sheath and the muscle. After confirming the accuracy of the placement, the 0.25% bupivacaine (0.5 mL/kg, split equally between both sides) was administered when the correct target site was identified. Arrows indicate the double-line sign. D = dorsa. L = linea alba. LA = local anesthetic. P = peritoneum. RA = rectus abdominis. V = ventral.

After 15 minutes, the surgical site was prepared aseptically. Ovariohysterectomy was performed routinely with an 8 cm incision line.[11] If limb movement was observed during the operation, propofol (1 mg/kg) was administered. If the HR or MBP increased to 20% or more compared with the baseline values, 1 mcg/kg fentanyl (Fentanyl citrate, Caspian Tamin Pharmaceutical) was administered IV (2 doses at most). If the variables did not improve, 0.5 mcg/kg/hr fentanyl was infused.

Assessments

1. Volume of injected solutions and duration of injection (the time from the insertion of the needle to the skin [for incisional block] and probe placement [for TAP and RS block] till the end of injections), the duration of general anesthesia (since induction to standing after surgery) and duration of surgery (since skin incision to the last suture knot of skin) were recorded.
2. The US image quality was scored concerning landmark and needle visualization. Scores for landmark quality were as 1 = excellent: easily distinguishing muscle layers, 2 = good: identifiable muscle and peritoneum, and 3 = poor: landmarks could not be identified. Scores for the quality of the image of the needle were as excellent: 1 = the entire needle shaft and the tip could be visualized, 2 = good: only the tip was visualized, and 3 = poor: needle tip was only identified after the test dose injection.
3. Heart rate, SBP, DBP, MBP, f_R, and RT were recorded 5 minutes before the surgery as baseline (T0). During the anesthesia session, the SPO_2 and $ETCO_2$ were recorded in addition to the mentioned variables at the time of skin incision (T1), muscle dissection (T2), ovarian pedicle ligation (T3), and skin suture (T4).
4. Assessment of analgesia during surgery was done by measuring HR, blood pressure, and frequency of injected fentanyl.
5. A Short Form of the Glasgow Composite Measuring Pain Scale (SF-GCPS) and a Visual Analog Scale (VAS, 10 cm from 0: no pain to 10: the worst possible pain) were used to assess postoperative analgesia at 30 minutes and every hour till 6 hours after the end of the operation. If the pain score was 5/20 or 6/24 in the SF-GCPS or higher than 3 in the VAS, fentanyl was administered IV (1 mcg/kg). Each animal was allowed to be injected 2 times at most. If any dog required more than 2 rescue analgesics, the dog was not evaluated for the remained time points, and a ketoprofen (1.1 mg/kg; Rooyan Daroo) was administered intramuscularly.

All the animals, except those injected already, received ketoprofen (1.1 mg/kg) 6 hours after surgery. The injections were all administered by 1 individual (H.I.R.). An experienced veterinarian performed all surgeries. The data were recorded and measured by the same investigator (M.K.). Two individuals blind to the treatment independently scored the pain (M.K. and M.E.G.). In case of disagreement, the higher score was included.

Statistical Analysis

GraphPad Prism (Version 9.0.0, GraphPad Software, LLC) was used for statistical assessments. The normal distribution of the data was evaluated by the Shapiro-Wilk test. For data with normal distribution, 1-way analysis of variance (ANOVA) was used for inter-treatment comparison, and repeated measures for the ANOVA and Bonferroni post hoc tests were used for intra-treatment comparison. For nonparametric data, the Mann-Whitney test was used to compare 2 sets of data (ie, image qualities between the TAP and RS treatments); the Kruskal-Wallis and Dunn's post hoc tests were used to compare 3 sets of data, and the Friedman and Dunn's post hoc tests were used for intra-treatment comparison. Agreement between researchers for given pain scores was checked using the Weighted κ coefficient. The correlation was evaluated based on Altman's model[12] as very good (κ = 0.81–1.00), good (κ = 0.61–0.80), moderate (κ = 0.41–0.60), relatively weak (κ = 0.21–0.40), and weak (κ < 0.20). Fisher's exact test was used to compare rescue analgesia requirements between treatments. Data with normal distribution were displayed as mean ± standard deviation, and data with non-normal distribution were expressed as median (minimum–maximum); $P < .05$ was considered as the significant level.

Results

All the animals tolerated the analgesia, anesthesia, and surgery procedures well and completed the study. The body condition score (using a 1–9 scale), weight, and age of the animals were 3–6, 19.3 ± 2.7 kg, and 1.5–2.5 years, respectively. The amount of propofol consumed for maintenance and the duration of local anesthetic injection was significantly higher in the TAP treatment than in the Incisional (*P* = .008 and .021, respectively; **Table 1**). Intraoperative evaluation of cardiorespiratory changes showed that all evaluated data at the predetermined time points were in the normal range without significant differences within and between treatments ($P > .05$, **Supplementary Table S1**). The evaluation of ECGs obtained during surgery showed no arrhythmia other than sinus arrhythmia in 1 dog.

Table 2 provides the results of pain scores after the operation. The inter-rater agreement among the observers was very good (κ = 0.92). Comparison of pain scores within each treatment showed that with the SF-GCPS, the scores at 4, 5, and 6 hours after surgery in the Incisional were higher than the baseline (*P* = .026, .002, and .001, respectively). Pain scores at 4, 5, and 6 hours after surgery in the RS were also significantly higher than the baseline (*P* = .011, .000, and .000, respectively). The TAP treatment's pain score at 5 and 6 hours after surgery was significantly higher than the baseline (*P* = .009 for both time points). With the VAS method, the pain score was significantly higher in the Incisional at 4, 5, and 6 hours compared with the baseline (*P* = .039, .006, and .004, respectively). Also,

Table 1—Mean ± standard deviation (when indicated) of weight, amount of propofol used for induction and maintenance, duration of anesthesia and surgery, injection volume, duration of injection, and the median quality of ultrasound images in dogs undergoing ovariohysterectomy induced and maintained with propofol receiving incisional (Incisional, n = 7), or ultrasound-guided transverse abdominal plane (TAP, n = 7) or rectus sheath (RS, n = 8) blocks randomly.

	Treatments			
Variable	**Incisional**	**TAP**	**RS**	***P* value**
Weight (kg)	17.6 ± 2.0	20.5 ± 1.9	16.6 ± 7.4	.155
Propofol (induction; mL)	5.5 ± 0.5	6.9 ± 0.7	6.1 ± 1.3	.081
Propofol (maintenance; mL)	44.5 ± 6.0	63.7 ± 12.3[a]	56.7 ± 6.6	.008
Duration of anesthesia (min)	76.8 ± 14.8	89.0 ± 15.6	93.0 ± 7.9	.080
Duration of surgery (min)	56.6 ± 5.3	57.9 ± 9.1	51.4 ± 15.5	.549
Bupivacaine total dose (mg/kg)	1.0	1.0	1.2 ± 0.1[b]	< .000
Final injected volume (mL/kg)	0.8	0.93 ± 015	0.5[b]	< .000
Duration of injection (min)	2.6 ± 1.2	10.0 ± 3.9[a]	8.8 ± 5.8	.016
Landmarks' image quality	—	1 (1–3)	1 (1–1)	.200
Needle's image quality	—	1 (1–2)	1 (1–2)	> .999

[a]Significant difference from the Incisional treatment ($P < .05$). [b]Significant difference from the other treatments ($P < .05$).

Table 2—Median (maximum–minimum) of scores for the Glasgow Composite Measuring Pain Scale (SF-GCPS) and a Visual Analog Scale (VAS, 10 cm from 0: no pain to 10: the worst possible pain) and the number of dogs that required rescue analgesia at baseline (before surgery) and up to 6 hours after surgery undergoing ovariohysterectomy induced and maintained with propofol receiving incisional (Incisional, n = 7), ultrasound-guided transverse abdominal plane (TAP, n = 7), or rectus sheath (RS, n = 8) blocks randomly.

Variables	**Treatments**	**Baseline**	**30 min**	**1 h**	**2 h**	**3 h**	**4 h**	**5 h**	**6 h**	***P* value**
SF- GCPS	Incisional	0 (0–5)	1 (0–7)	1 (0–7)	3 (2–10)	6 (3–11)	6 (3–11)[a]	6 (5–11)[a]	6 (5–11)[a,b]	> .000
	TAP	0 (0–3)	1 (0–4)	1 (0–7)	1 (0–8)	3 (0–4)	3 (0–4)	4 (1–5)[a]	4 (1–6)[a]	.007
	RS	0 (0–2)	1.5 (0–4)	1.5 (0–6)	2 (1–6)	3.5 (1–8)	4 (0–11)[a]	5 (1–11)[a]	5.5 (3–11)[a]	> .000
	P value	.699	.933	.926	.337	.580	.122	.092	.028	
VAS	Incisional	1 (0–3)	1 (0–4)	1 (0–4)	2 (1–4)	2.5 (1–4)	3 (2–5)[a]	4 (3–5)[a,b]	4 (3–5)[a,b]	< .000
	TAP	0 (0–3)	1 (0–3)	1 (1–4)	1 (1–2)	2 (1–3)	2 (0–3)	2 (1–3)	2 (1–3)	.066
	RS	0 (0–1)	1 (0–3)	1.5 (1–3)	2 (1–4)	2.5 (1–3)[a]	3 (0–4)[a]	3 (0–4)[a]	3.5 (2–4)[a]	< .000
	P value	.305	.983	.916	.256	.466	.183	.013	.003	
Number of dogs required rescue analgesia	Incisional	–	1 out of 7	1 out of 7	1 out of 6	1 out of 6	1 out of 5	2 out of 5	1 out of 4	–
	TAP	–	0 out of 7	1 out of 7	0 out of 7	0 out of 7	0 out of 7	0 out of 7	0 out of 7	–
	RS	–	0 out of 8	1 out of 8	0 out of 8	0 out of 8	3 out of 8	2 out of 7	1 out of 5	–

[a]Significant difference with the baseline ($P < .05$). [b]Significant difference with the TAP treatment ($P < .05$).

the pain score in the RS was higher than the baseline at 3, 4, 5, and 6 hours after surgery (P = .041, .022, .004, and .000, respectively).

Comparison of pain scores among treatments showed that with the SF-GCPS, the pain score at 6 hours after surgery was significantly higher in the incisional treatment than in the TAP (P = .006). With the VAS, the pain scores at 5 and 6 hours after surgery in the Incisional were significantly higher than in the TAP (P = .014 and .007, respectively).

One out of 7 dogs in the Incisional treatment and 1 out of 8 in the TAP received fentanyl during surgery. In the post-operative period, 4 out of 7 dogs in the Incisional received both doses of fentanyl as rescue analgesia. Also, in the TAP, 1 dog required a single dose of fentanyl. In the RS treatment, 3 out of 8 dogs received both doses of fentanyl, and 1 received 1 dose. There was no significant difference regarding the requirement for rescue analgesia among treatments intra- and post-operatively (P > .467 and > .267, respectively).

The duration of analgesia (calculated as the time to administer the first rescue analgesic) was 4 ± 2, 6 ± 1, and 5 ± 1 hours for Incisional, TAP, and RS, respectively (P = .075). Based on the previous studies,[13] the duration of analgesia was considered the primary outcome and used for power analysis. The power was calculated as 89%, assuming alpha as 0.05 (G*Power Version 3.1.9.7; Franz Faul, Germany).

Discussion

The current study showed that incisional, TAP, and RS blocks could be relatively easily performed in dogs. These techniques are free of major complications and provide adequate analgesia during OHE under the study's circumstances. TAP block was associated with lower pain scores than incisional block at 6 hours of evaluation after surgery.

In this study, the location of drug placement and anatomical landmarks in the incisional block was via blind technique, while the sites for the TAP and the

RS blocks were determined using a 10 MHz linear probe, and the quality of all images was assessed as good to excellent. Schroeder et al[8] used a linear probe with a frequency of 6–13 MHz for TAP block in dogs. Other investigators used linear 12–15 MHz probes.[9,13] Because of the shallowness of the plane and sheath for TAP and RS block, the higher the frequency of the probe, the more quality of the image to distinct muscle layers will be achieved. However, for us, a 10 MHz transducer was adequate for visualization and distinction of structures to ensure correct solution placement.

The dose rate of bupivacaine was 1 mg/kg for the Incisional and TAP treatments and 1.21 ± 0.1 mg/kg for the RS. The total volumes of injectates were 0.8 and 0.5 mL/kg for the Incisional and RS treatments and about 0.93 mL/kg for the TAP. However, the total dose of bupivacaine (mg/kg) was higher in the RS compared with other treatments, and the final volume of injected solutions was lower in the RS than in the Incisional and TAP. The dose rate chosen for the incisional method was half the dose selected by Fitzpatrick et al[3]; however, the final volume was similar. The dose was selected to be in range with the total bupivacaine dose of other methods. The dose rates and final volumes for the TAP and the RS were also chosen based on some modifications from previous studies in dogs.[8,10] Although the final volume was adjusted to body mass in the Incisional and RS treatments, fixed volume was used for the TAP. Both adjusted (0.8 mL/kg)[13] and fixed volumes (10 mL per hemiabdominal wall)[8] were used for TAP block in dogs. The final volume of the administered solution for the TAP in the current study was about 0.93 mL/kg, which was not significantly different from the volume of 0.8 mL/kg used in the Incisional treatment.

Cardiorespiratory variables evaluated during surgery were not significantly different among treatments. However, 1 dog in the Incisional and 1 in the TAP received a bolus of fentanyl during the operation. Both required rescue analgesia at the time of incisional closure. Expectedly, these 2 dogs were administered fentanyl in the postoperative period as well. Portela et al[9] and Covaco et al[14] also reported the need for rescue analgesia after TAP application during abdominal surgeries in dogs. In contrast, Skouropoulou et al[15] noted the lack of cardiorespiratory changes during the ovariectomy procedure after TAP block in cats. Although TAP block may also diminish visceral pain,[16,17] it has been anecdotally accepted that it is adequate for somatic and not visceral pain. Campoy et al[13] doubted this belief and attributed it primarily to the lack of a comprehensive understanding of the fascial anatomy and solution migration. In our study, the contribution of morphine in providing intraoperative analgesia makes it difficult to argue about the influence of TAP block on visceral pain.

The SF-GCPS is a modified and simplified form of the Glasgow Composite Measuring Pain Scale (GCPS), introduced by Reid et al.[18] This method is a scale considered the gold standard pain scale in dogs. It has also been stated that the GCPS has a very good ability to differentiate between mild, moderate, and severe pain in both soft and hard tissues.[19] The VAS is also a simple subjective method for evaluating pain and uses a 10-cm or 100-mm long line marked to the level of pain the animal is exerting.[20] In various investigations, 1,[9,13] 2,[3,5,14,21], or 3,[22] pain scoring scales were used. In the present study, we used 2 systems to improve the robustness of pain evaluation. However, the current study's authors cannot state that using VAS and SF-GCPS for pain evaluation is superior to using SF-GCPS alone, especially when only SF-GCPS could detect pain in the TAP treatment and VAS was not. However, the VAS noticed pain earlier in the RS treatment more effectively than the SF-GCPS. The authors are aware that a modified version of VAS (dynamic and interactive VAS; DIVAS) has been introduced and may be more practical and accurate for pain evaluation,[23] mainly when it includes palpation of the incision. However, we used the traditional VAS in the current investigation. It should also be mentioned that using other pain assessment methods, such as mechanical nociceptive thresholds[22] or pinching the skin, or exerting abdominal wall pressure,[13] have been used and might have provided extra information. However, these methods were not used in the current study, which is a potential limitation of our work.

Incisional administration of local anesthetics can be pre- and post-incisional, and the solution can be administered in subcutaneous (SC) or SC plus deeper tissues. Preoperative bupivacaine infiltration at the incision site was more effective in dogs undergoing celiotomy than post-operative injection.[2] In another study on dogs, pre- and post-incisional bupivacaine provided analgesia in the post-operative period with no significant difference.[3] Campagnol et al[5] found no benefit of post-operative subcutaneous incisional administration of bupivacaine over saline injection for pain reduction after OHE in dogs. In the current study, in the Incisional treatment, 4 out of 7 dogs received rescue analgesia; all required both doses. We administered the solution preincisionally and in the SC and deeper tissues. In the authors' experience, drug exit from the allocated site when the tissues were incised and the non-uniformity of drug distribution in superficial and deep tissues were the main reasons for the ineffectiveness of this method.

The ability of the TAP block to reduce postoperative pain has been corroborated in humans[24,25] and veterinary medicine[8,9,13] studies. In the present paper, only 1 dog received a single dose of rescue analgesia in the TAP treatment, possibly due to technical failure. According to our results, the block can last at least 6 hours post-operation. Campoy et al[13] stated that analgesia after the TAP might diminish after 6 hours. It has been noted that although the reason for the prolonged TAP anesthesia is not apparent, it may be due to the lack of blood vessels in the area, which causes the clearance time of the drug to be prolonged. We did not assess dogs for pain expression beyond 6 hours which is 1 limitation of the current study.

Two approaches for TAP block have been reported in dogs: single and 2 injections. Schroeder et al[8] showed that a single injection in the middle of the distance between the iliac crest and the last rib in each abdominal half of dogs could acceptably block the T12, L1, and L2 nerves. Still, there is less chance for T11 and L3 nerves to be blocked satisfactorily. Portela et al[9] performed 2 injection techniques in the caudal and cranial midline of the abdomen to increase the possibility of T11 and L3 nerve blocks. Also, during a study on dogs, Romano et al[26] stated that a TAP block with 2 injection sites at central and terminal points of the midline of the abdomen could affect more nerve branches. In a recent study, Campoy et al[13] reported that a single injection technique in dogs submitted to OHE provided sufficient analgesia for at least 8 hours. In the present study, a single injection technique was used because, in our experience, a single injection would reduce the injection time and is more practical for clinical use.

Rectus sheath block has successfully reduced pain in several studies in humans;[27–30] however, Manassero et al[31] have recommended that the RS block should be supplemented with anesthesia at the incision site in human patients referred for hernial repair. James et al[10] have reported the first use of the RS block in veterinary medicine with the rationale of the advantage of the RS block compared with TAP, which is easier to perform and gives a more achievable image of landmarks in ultrasound that subsequently reduce the risk of drug injection in the wrong site. In a recent study on cats, the RS block offered little benefit during surgery and was associated with higher pain scores after OHE. In the current investigation, 3 dogs received 2 doses of rescue analgesic in the RS treatment, and 1 was administered 1 dose of rescue analgesia; however, except for 1 dog, others received fentanyl at least 4 hours after surgery. It should also be mentioned that, however, the total dose of bupivacaine was the same; the final volume used in the RS was about half of the 2 other treatments. This could considerably affect the solution's spread and make the results different. It is, in fact, another limitation of our study.

Conclusion

In conclusion, Incisional, TAP, and RS blocks appeared to provide adequate intraoperative analgesia in dogs undergoing OHE who received CRI of propofol. Moreover, although more dogs received rescue analgesia in the Incisional and RS, no significant difference was found among the 3 treatments. Ultrasound-guided TAP and RS blocks can be efficient options for perioperative analgesia in canine ovariohysterectomy. Further studies should evaluate the efficacy of TAP and RS blocks with a greater number of dogs using various volumes of local anesthetic solutions and in longer duration.

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The authors have no conflict of interest to declare.

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Supplementary Materials

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