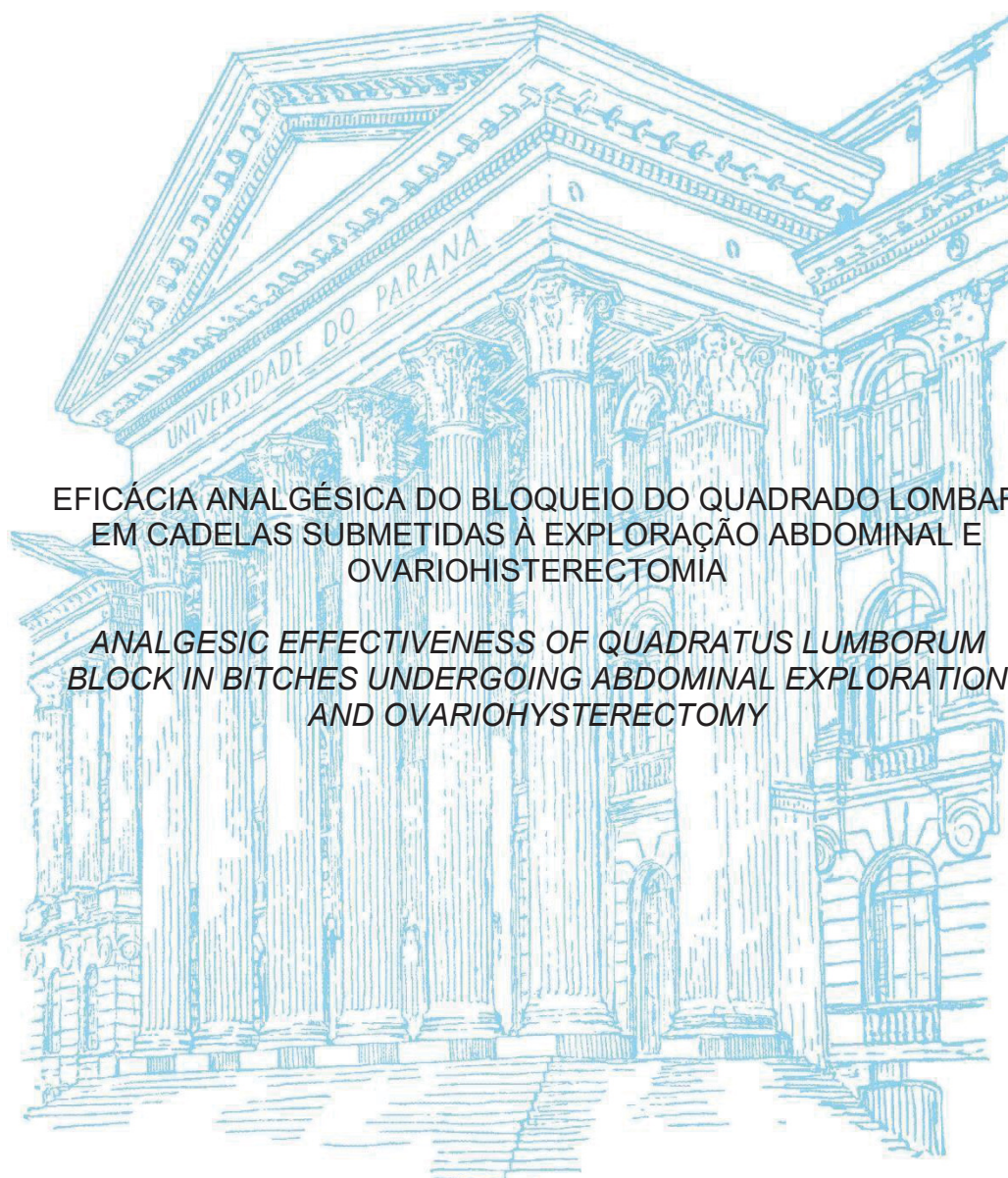


UNIVERSIDADE FEDERAL DO PARANÁ

LETTYCIA DEMCZUK THOMAS



EFICÁCIA ANALGÉSICA DO BLOQUEIO DO QUADRADO LOMBAR
EM CADELAS SUBMETIDAS À EXPLORAÇÃO ABDOMINAL E
OVARIOHISTERECTOMIA

*ANALGESIC EFFECTIVENESS OF QUADRATUS LUMBORUM
BLOCK IN BITCHES UNDERGOING ABDOMINAL EXPLORATION
AND OVARIOHYSTERECTOMY*

PALOTINA 2022

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CADELAS SUBMETIDAS À EXPLORAÇÃO ABDOMINAL E
OVARIOHISTERECTOMIA

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RESUMO

Os bloqueios interfasciais podem constituir protocolos de analgesia multimodal pré-operatória. Dentre eles, o bloqueio do quadrado lombar (QL-*block*) promove analgesia e dessensibilização visceral e da parede abdominal em cães e gatos, porém ainda requer estudos clínicos para comprovação da sua eficácia. O presente estudo objetivou avaliar a eficácia analgésica do QL-*block* com bupivacaína em cadelas submetidas a exploração abdominal e ovariectomia, durante os pontos de estímulo nociceptivo trans-operatório e nas 24 horas após extubação. Para tanto, 16 cadelas sem raça definida ($12,0 \pm 3,0$ kg, $1,5 \pm 0,9$ anos) foram submetidas à anestesia geral com isoflurano (ETIso 1,4%, VPPI). Realizou-se QL-*block* (0,3 mL/kg) bilateralmente com bupivacaína 0,25% (BUPI) ou salina (CONTROL). Antes da pré-medicação avaliou-se FC, PAS, Glasgow, DIVAS, glicose e corticosterona e após estabilização do plano cirúrgico (TBas) e nos momentos incisão de pele (TSki), manipulação de rim direito (TRk), rim esquerdo (TLk), omento (TOM), intestino (TInt), tração e ligadura de ovário direito (TROv), ovário esquerdo (TLOv), corno uterino (TUTE) e celiorrafia (TCel), registrou-se FC e PAS. Instituiu-se remifentanil ($10\text{--}20$ µg/kg/h) como resgate analgésico quando FC ou PAS > 20%. No pós-operatório avaliou-se FC, PAS, DIVAS e Glasgow nos momentos 0,5; 1; 2; 3; 4; 6; 8; 12; 24 horas após extubação. Resgate analgésico foi feito com metadona (0,2 mg/kg IM) caso DIVAS ≥ 3 ou Glasgow > 6. Avaliou-se ainda glicose e corticosterona em 0,5; 2; 4 h pós-extubação. O requerimento analgésico e retorno ao apetite foram registrados. No trans-operatório, não houve diferença ao longo do tempo ou entre os grupos para FC. A PAS foi menor em BUPI em TIsk, TRk, TLk, TOM e TROv; a dose total de remifentanil e o número total de resgates foi menor em BUPI ($n = 1,6 \pm 1,9$ versus $n = 10,6 \pm 4,4$ µg/kg, $p = 0,0001$). A percentagem de cães que receberam resgate após extubação foi menor em BUPI (0% versus 63%, $p = 0,0256$) e o retorno ao apetite foi mais precoce em BUPI ($p = 0,0125$). Os escores de Glasgow foram menores em BUPI em T2 e T3 e menores escores de DIVAS foram observados em BUPI em T0,5 e T3 ($p = 0,0303$ e $p = 0,0310$). O QL-*block* promove menor consumo de opioides no período trans e pós-operatório, menores escores de dor e retorno precoce do apetite em cadelas submetidas à exploração abdominal e ovariectomia.

Palavras-chave: QL-Block, bloqueios interfasciais, analgesia, bupivacaína

ABSTRACT

Interfascial nerve blocks may be used as part of preoperative multimodal analgesia protocols. Among them, the quadratus lumborum block (QL-Block) promotes analgesia and desensitization of viscera and abdominal wall in dogs and cats, but clinical studies are still required to prove its efficacy. The present study aimed to evaluate the analgesic efficacy of QL-Block with bupivacaine in bitches submitted to abdominal exploration and ovariohysterectomy, during the intraoperative nociceptive stimulus points and at the 24 hours after extubation. Sixteen mixed breed bitches (12.0 ± 3.0 kg, 1.5 ± 0.9 years) were submitted to general anesthesia with isoflurane (ETIso 1.4%, VPPI) and the QL-Block (0.3 mL kg^{-1}) was performed bilaterally with 0.25% bupivacaine (BUPI) or saline (CONTROL). Before premedication, we evaluated HR, SAP, DIVAS, GCMPS, glucose and corticosterone. After stabilization of the surgical plane (TBas) and at skin incision (TSki), manipulation of the right kidney (TRk), left kidney (TLk), omentum (TOM), intestine (TInt) traction of the right ovary (TRov), left ovary (TLOv), uterine horn (TUte) and celiorraphy (TCel), it was recorded HR and SAP. Remifentanyl ($10\text{--}20 \text{ }\mu\text{g kg}^{-1} \text{ hour}^{-1}$ IV) was instituted as analgesic rescue HR or SAP $> 20\%$. In the postoperative period, HR, SAP, DIVAS and GCMPS were evaluated at 0.5; 1; 2; 3; 4; 6; 8; 12; 24 hours after extubation. Methadone (0.2 mg kg^{-1} IM) was used as rescue analgesia when DIVAS ≥ 3 or GCMPS > 6 . Glucose and corticosterone were evaluated at 0.5; 2; 4 h after extubation. Analgesic requirement and return to appetite were recorded. There were no differences over time or between groups for HR. SAP was lower in BUPI at TIsk, TRk, TLk, TOM and TRov; the total dose of remifentanyl and the total number of rescues was lower in BUPI ($n = 1.6 \pm 1.9$ versus $n = 10.6 \pm 4.4 \text{ }\mu\text{g kg}^{-1}$, $p = 0.0001$). The percentage of dogs that received rescue after extubation was lower in BUPI (0% versus 63%, $p = 0.0256$) and the return to appetite was earlier in BUPI ($p = 0.0125$). GCMPS scores were lower in BUPI at T2 and T3 and lower DIVAS values were observed in BUPI at T0.5 and T3 ($p = 0.0303$ and $p = 0.0310$). The QL-Block with 0.25% bupivacaine reduces autonomic response, pain scores, and opioid consumption in the intraoperative and postoperative periods, and promotes early return of appetite in bitches submitted to abdominal exploration and ovariohysterectomy.

Key-words: QL-Block, interfascial blocks, analgesia, bupivacaine

SUMÁRIO

1. INTRODUÇÃO GERAL.....	9
2. OBJETIVOS.....	11
3. REVISÃO BIBLIOGRÁFICA.....	12
3.1. BLOQUEIOS LOCORREGIONAIS ECOGUIADOS.....	12
3.2. MECANISMO DE AÇÃO DOS ANESTÉSICOS LOCAIS E FISIOPATOLOGIA DO BLOQUEIO NERVOSO.....	13
3.3. DESCRIÇÃO ANATÔMICA DO SÍTIO DE REALIZAÇÃO DO BLOQUEIO.....	15
3.4. BLOQUEIO DO QUADRADO LOMBAR (<i>QL BLOCK</i>).....	18
REFERÊNCIAS.....	22
4. ANALGESIC EFFECTIVENESS OF <i>QUADRATUS LUMBORUM</i> BLOCK IN BITCHES UNDERGOING ABDOMINAL EXPLORATION AND OVARIOHYSTERECTOMY.....	28
Abstract	28
Introduction.....	29
Materials and methods	31
Results	36
Discussion	39
Conclusions.....	44
References	44

1. INTRODUÇÃO GERAL

Os bloqueios locorregionais fazem parte dos protocolos de analgesia multimodal pré-operatória, já que a dessensibilização de uma área específica reduz o número de resgates analgésicos no trans e pós-operatório de cirurgias invasivas, e permite retorno precoce do apetite devido ao baixo requerimento de opioides (PORTELA et al., 2021). Nesse cenário, a ultrassonografia se tornou uma ferramenta imprescindível para elevar a acurácia das técnicas de bloqueio. Sua superioridade comparada a outras ferramentas de neurolocalização tem sido discutida há mais de uma década, pois a correta inserção e visualização da agulha reduz os riscos inerentes da técnica (HOPKINS, 2007; THOMSON et al., 2021).

Dentre os bloqueios anestésicos, os bloqueios interfasciais têm se destacado em relação às técnicas convencionais. O sítio alvo geralmente é mais superficial e de visualização mais fácil, e após a deposição e dispersão do anestésico local, há bloqueio de um ou mais alvos neurais (ELSHARKAWY et al., 2018; MACHI & JOSHI, 2019).

Apesar da facilidade de execução, os bloqueios fasciais requerem comprovação da sua eficácia em relação à analgesia padrão-ouro, como a produzida pela anestesia espinal (MARHOFER et al., 2020). Assim, torna-se imprescindível a realização de estudos clínicos para avaliar a dispersão anestésica e assim padronizar doses e volumes dos fármacos utilizados nos bloqueios fasciais (HOTTA, 2019).

Para analgesia abdominal, algumas técnicas de bloqueio locorregional são descritas, dentre elas se destaca o bloqueio do quadrado lombar (*QL-block*). O *QL-block* é um bloqueio abdominal ecoguiado, derivado do bloqueio do músculo transversso abdominal (*TAP-Block*), que promove analgesia de maior número de dermatômos, sendo eficiente para analgesia trans e pós-operatória para diferentes procedimentos cirúrgicos abdominais e ortopédicos em humanos (BLANCO et al., 2015; MUROUCHI et al., 2016; YOUSEF, 2018; KUKREJA et al., 2019; ALANSARY et al., 2020). A literatura sugere que o *QL-block* promove analgesia e dessensibilização visceral e da parede abdominal em cães e gatos, podendo ser superior a outras técnicas analgésicas (ARGUS et al., 2020; GARBIN et al., 2020a). Contudo, apesar de estudos cadavéricos em cães apontarem para o potencial

analgésico do QL-*block* e a analgesia visceral ser documentada em humanos, há uma carência de estudos clínicos controlados para confirmar essa hipótese em cães (GARBIN, et al., 2020a).

2. OBJETIVOS

Objetivo geral: Avaliar a eficácia analgésica do bloqueio do quadrado lombar com bupivacaína em cadelas submetidas a exploração abdominal e ovariectomia.

Objetivo específico 1: Avaliar o potencial analgésico do bloqueio do quadrado lombar durante a manipulação de rins, omento, duodeno, ovários e útero durante exploração abdominal e ovariectomia de cadelas.

Objetivo específico 2: Avaliar o potencial analgésico do bloqueio do quadrado lombar no pós-operatório de cadelas submetidas à exploração abdominal e ovariectomia.

3. REVISÃO BIBLIOGRÁFICA

3.1. BLOQUEIOS LOCORREGIONAIS ECOGUIADOS

A deposição de um fármaco anestésico próximo a um nervo periférico é definida como anestesia regional. Ela promove dessensibilização, cursando com bloqueio sensitivo e/ou bloqueio motor de uma região por um período de tempo ao impedir a geração e propagação do estímulo elétrico (CAMPOY & SCHOEDER, 2013). Por esse motivo, a anestesia locorregional reduz o requerimento de resgates analgésicos e fornece analgesia de melhor qualidade e de duração superior no pós-operatório, em relação a procedimentos em que os bloqueios locorregionais são dispensados (BARTEL et al., 2016; ROMANO et al., 2016). Diversos bloqueios locorregionais alternativos à anestesia do neuroeixo vêm sendo propostos, pois promovem dessensibilização mais seletiva associada a menores taxas de complicações como hipotensão secundária ao bloqueio de fibras simpáticas (VETTORATO et al., 2012, GARCIA-PEREIRA, 2018).

O ultrassom tem se tornado uma ferramenta cada vez mais popular para realização de bloqueios locorregionais. A ultrassonografia baseia-se na interação entre feixes sonoros e os tecidos, sendo que a obtenção da imagem é o resultado da reflexão desses feixes, emitidos e captados pelo transdutor (KOSSOFF, 2000). A utilização do ultrassom na anestesia locorregional permite acurácia na deposição do fármaco anestésico na proximidade de nervos periféricos (MUNIRAMA & MCLEOD, 2015). Apesar de demandar boa coordenação visual e motora, a ultrassonografia permite a visualização do trajeto da agulha entre os tecidos adjacentes, aumentando a segurança e sucesso da técnica, em comparação à técnica convencional de estimulação nervosa (KIM et al., 2013). Para a execução do bloqueio ecoguiado, podem ser utilizadas as técnicas “fora do plano” ou “em plano”, sendo que a última pode ser realizada ao longo ou através do eixo visual. Entretanto, o agulhamento “em plano” é geralmente preferido pois a agulha é inserida alinhada ao transdutor, desta forma é possível avaliar o seu trajeto até o ponto de deposição (FRANCO et al., 2021).

Um dos pontos-chave para a padronização de uma técnica de bloqueio locorregional ecoguiado é o estabelecimento de marcos anatômicos e ultrassonográficos, que devem ser consistentes entre os animais e permitir a

localização eficiente do ponto de punção (MOGICATO et al., 2015). Na medicina veterinária há discrepâncias anatômicas entre espécies e até mesmo raças, como diferenças na profundidade ou espessura de tecidos, o que torna o uso da ultrassonografia imprescindível para amenizar os erros de punção (SCHROEDER et al., 2011). Ademais, o uso da ultrassonografia como ferramenta na execução de bloqueios locorregionais está associado à redução de risco de toxicidade sistêmica dos anestésicos locais e injeção intravascular acidental, pois as técnicas ecoguiadas permitem a redução de volume do anestésico local para a efetividade do bloqueio (RENES, et al., 2010; BARRINGTON & KLUGER, 2013; MUNIRAMA & MCLEOD, 2015).

Há aproximadamente 15 anos, novas técnicas de bloqueios locorregionais ecoguiados vêm sendo aprimoradas na medicina humana, e o sucesso na performance dos bloqueios correlaciona-se à curva de aprendizado dos profissionais anestesistas (MARHOFER et al., 2005). Na medicina veterinária, a literatura aponta há mais de uma década o benefício na utilização da ultrassonografia para realização de bloqueios de membro pélvico em cães (SHILO et al., 2010; COSTA-FARRÉ, et al., 2011), contudo ainda são escassos os estudos de bloqueios relacionados a cavidade abdominal, principalmente estudos clínicos para comprovação da eficácia analgésica.

3.2. MECANISMO DE AÇÃO DOS ANESTÉSICOS LOCAIS E FISIOPATOLOGIA DO BLOQUEIO NERVOSO

Os neurônios são unidades estruturais funcionais do sistema nervoso, capazes de gerar e propagar impulsos elétricos, que são captados por nociceptores - terminações nervosas de neurônios sensoriais primários (MCKUNE et al., 2015; DRUKARCH et al., 2018). As fibras nociceptivas aferentes de primeira ordem podem ser de dois tipos: fibras A-delta, mielinizadas, que transmitem informação de alta intensidade e curta duração (dor aguda); e fibras C, não mielinizadas, que propagam informação lenta, possuindo limiares mais altos (ALMEIDA et al., 2004; MCKUNE et al., 2015). As fibras de segunda ordem projetam-se para os centros cerebrais por meio de tratos, e após o processamento e integração dos impulsos ocorre a percepção (MCKUNE et al., 2015).

Dois pares de raízes nervosas emergem de cada nível da coluna vertebral,

sendo que as raízes dorsais levam informações aferentes para a medula e as ventrais fornecem informações eferentes para órgãos-alvo. Cada área inervada por uma raiz isolada é definida como dermatomo (CAMPOY & SCHROEDER, 2013).

A célula nervosa em estado não estimulado, apresenta acúmulo de íons K^+ em seu interior (potencial de repouso), sendo que este íon é capaz de se mover livremente através de canais para K^+ na membrana. Os canais para K^+ são proteínas de membrana responsáveis pelo controle dos potenciais de ação, sendo alguns subtipos voltagem-dependentes, regulados por transmissores ou pelo aumento de Ca^{2+} citoplasmático (WANN, 1993; TETZLAFF, 2000). O sódio se move através de canais iônicos específicos que se abrem na propagação do potencial de ação, permitindo o influxo de Na^+ (TETZLAFF, 2000). Os anestésicos locais bloqueiam principalmente os canais para sódio voltagem-dependente, além de canais para potássio, cálcio e receptores acoplados a proteína G, o que impossibilita o influxo de íons Na^+ , impede a despolarização neuronal e a geração e propagação do estímulo nervoso (BECKER et al., 2006; GARCIA, 2015; TAYLOR & MCLEOD, 2020).

O bloqueio nervoso promovido pelo anestésico local é dependente da concentração do anestésico, já que a maior concentração do anestésico atenua de forma mais efetiva a condução do impulso, prolongando o período refratário (TAYLOR & MCLEOD, 2020). A duração do efeito também é determinada pelo grau de ligação proteica; a bupivacaína, por exemplo, possui tempo de duração prolongado por apresentar alta taxa de ligação proteica, e devido à essa característica permanece relacionada à membrana das células nervosas por maior tempo (TETZLAFF, 2000; TAYLOR & MCLEOD, 2020). Deve-se sempre levar em conta a capacidade de ligação proteica dos anestésicos locais, uma vez que a fração livre é farmacologicamente ativa (GARCIA, 2015).

Ao contrário do bloqueio local, que almeja a localização de um único alvo neural e causa um bloqueio previsível, os bloqueios interfasciais requerem o conhecimento anatômico de planos formados por fáscias musculares, sendo a dispersão do anestésico local imprevisível, assim como a complexidade da extensão do bloqueio (ELSHARKAWY et al., 2018).

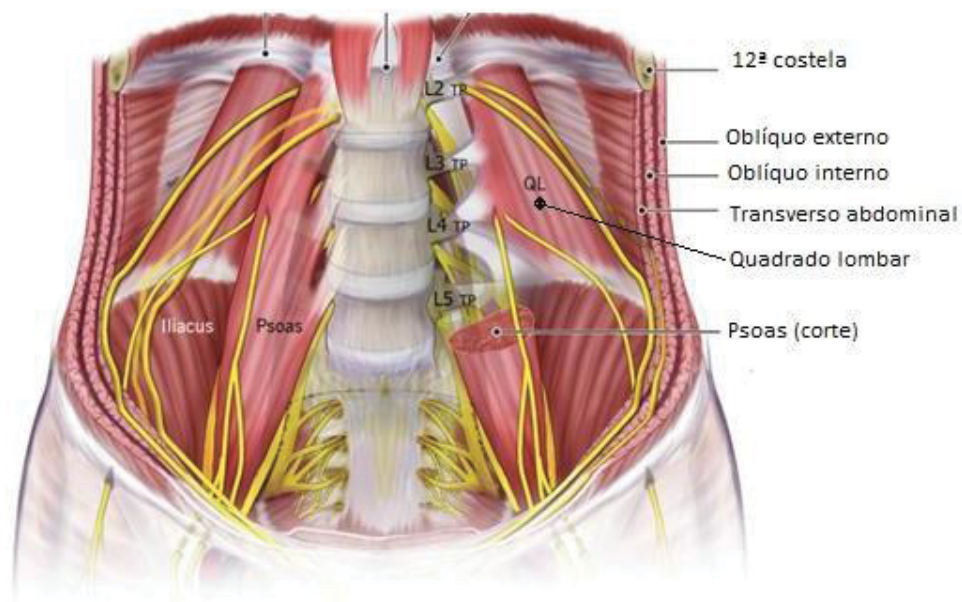
Os anestésicos locais da classe amida utilizados para a realização de bloqueios interfasciais são empregados com relativa segurança na rotina em diversas espécies (KLAUMANN et al., 2013; PORTELA et al., 2018). A ropivacaína ganhou

popularidade nessa classe de bloqueios, que geralmente requer maiores volumes, sendo menos cardiotoxica em comparação à bupivacaína, apesar de apresentar bloqueio sensorial relativamente mais curto (ENG et al., 2014; GARCIA, 2015). Os dados em relação à duração analgésica são controversos, pois o uso de bupivacaína a 0,25% no QL-*block* para cirurgias renais abertas promove analgesia satisfatória com duração de sete horas após o término do procedimento (ALANSARY et al., 2020). Enquanto em cirurgias renais laparoscópicas, de menor estímulo doloroso, o mesmo bloqueio com ropivacaína a 0,375% promove conforto analgésico sem requerimento de resgates por até 16 horas no pós operatório (VENKATRAMAN, et al., 2020).

3.3. DESCRIÇÃO ANATÔMICA DO SÍTIO DE REALIZAÇÃO DO BLOQUEIO

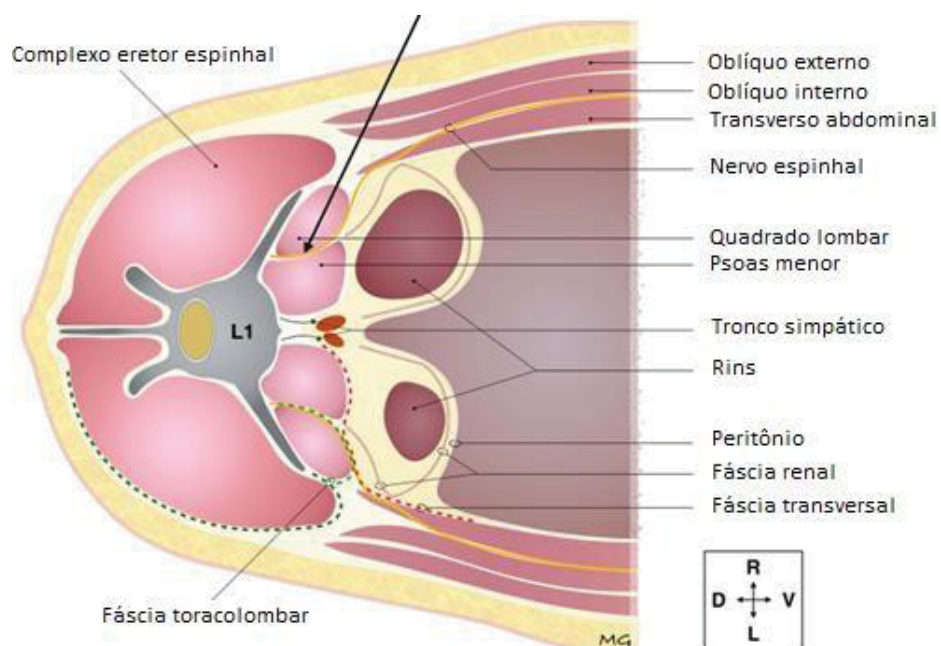
O músculo quadrado lombar (QL) localiza-se ventralmente à coluna vertebral, sendo o músculo hipaxial lombar mais dorsal. Ele se estende desde a altura do corpo das três últimas vértebras torácicas até os processos transversos das vértebras lombares, onde se fixam (FIGURA 1). Ventral ao músculo quadrado lombar, na sua porção cranial, localiza-se o músculo psoas menor e na porção caudal, o músculo psoas maior. O músculo QL é revestido pela folha ventral da fáscia toracolombar, criando uma divisão física entre os músculos QL e psoas, a fáscia consiste de uma lâmina tubular complexa de aponerose e forma planos potenciais para a deposição e propagação de anestésicos locais (FIGURA 2) (EL-BOGHADLY et al., 2016; GARBIN et al., 2020a; 2020b).

FIGURA 1 – Vista frontal do músculo quadrado lombar (QL) em humano. Corte do músculo psoas para visualização dos ramos ventrais das raízes nervosas espinhais. TP – processo transversal.



Fonte: ELSHARKAWY, 2017.

FIGURA 2 - Ilustração esquemática de corte transversal ao nível da primeira vértebra lombar (L1) mostrando a musculatura abdominal com as camadas da fáscia toracolombar ao redor do músculo quadrado lombar (QL) em cão. A seta preta representa a inserção da agulha para realizar a injeção do plano QL guiado por ultrassom entre os músculos QL e psoas. A linha tracejada verde-escuro representa a fáscia toracolombar.



FONTE: GARBIN et al., 2020a.

A fáscia toracolombar é a estrutura mais importante para a execução do QL-*block* (UESHIMA et al., 2017; AKERMAN et al., 2018). Suas características anatômico-fisiológicas, como a presença de neurônios simpáticos e nociceptores, compõe parte da explicação da analgesia promovida pelo bloqueio (BLANCO, 2016; AKERMAN et al., 2018). Autores apontam a presença de grandes fibras mielinizadas com terminações encapsuladas entremeadas às camadas da fáscia toracolombar, sendo que vários músculos de várias dimensões se ligam a esse tecido (WILLARD et al., 2012).

Nos cães, a parede abdominal, a pele e o peritônio são inervados pelos ramos ventrais dos nervos espinhais torácicos e lombares (T9-L2) (EVANS & LAHUNTA, 2013). Essas raízes nervosas estão localizadas no plano entre os músculos QL e psoas, sendo coradas a partir da deposição de contraste pela técnica de QL-*block*, conforme estudo cadavérico em humanos (DAM et al., 2017). Em estudo cadavérico em cães, após a deposição de contraste no volume de 0,3 mL/kg por ponto, os autores verificaram impregnação dos músculos quadrado lombar, psoas menor e uma dispersão que variou entre as raízes nervosas de T13 à L6, sendo que as raízes de L1 e L2 foram coradas na totalidade das amostras (QUINAGLIA, 2019).

A inervação dos órgãos abdominais se dá através de ramos simpáticos dos troncos torácico e abdominal, sendo que os nervos esplâncnicos possuem papel importante na inervação simpática abdominal (LEEK, 1977; DYCE et al., 2010; EVANS & LAHUNTA, 2013). As fibras pré-ganglionares do sistema simpático localizam-se paralelamente à medula espinhal na região toracolombar, enquanto as fibras pós ganglionares formam plexos emaranhados, que correm juntamente às artérias viscerais de onde obtém sua nomenclatura (DYCE et al., 2010). A inervação ovariana nos cães se dá pelas fibras nervosas sensoriais dos gânglios da raiz dorsal do segmento T10 a L4, com sua maior parte localizada entre T13 a L2 (CHIEN et al., 1991). As fibras pré-ganglionares simpáticas oriundas do plexo aórtico abdominal e mesentérico caudal se enovelam juntamente aos nervos lombares esplâncnicos e as fibras pré-ganglionares parassimpáticas, formando o plexo ovárico, enquanto os cornos uterinos recebem inervação simpática do nervo hipogástrico (CONSTANTINESCU, 2005). Em cães, os ramos ventrais dos dois últimos nervos espinhais torácicos (T12-T13) e dos três nervos espinhais lombares (L1-L3) percorrem entre os feixes dos músculos QL e psoas, sendo que os três primeiros nervos lombares e os nervos esplâncnicos foram corados em estudo cadavérico de

QL-*block* em cães (GARBIN et al., 2020a).

Próximo ao local de punção do QL-*block* correm os ramos abdominais das artérias lombares, que se originam na aorta abdominal. A fáscia toracolombar também promove uma separação física entre o complexo eretor espinhal, músculo quadrado lombar e psoas menor do espaço retroperitoneal (ELSHARKAWY et al., 2019).

3.4. BLOQUEIO DO QUADRADO LOMBAR (QL BLOCK)

Descrito pela primeira vez na medicina em 2007 com intuito de promover analgesia abdominal, o QL-*block* é a extensão mais dorsal do TAP-*Block*. O anestésico é depositado em maior proximidade com o espaço paravertebral, promovendo analgesia visceral, além da analgesia somática (BLANCO, 2007; KADAM et al., 2013), porém a teoria de que a analgesia possa ser resultante de propagação do anestésico para o espaço paravertebral é inconclusiva (CARLINE et al., 2016; TAMURA et al., 2018).

Na medicina humana existem pelo menos três abordagens para realização do QL-*block* documentadas (CARLINE et al., 2016; BALOCCO et al., 2021), sendo que os autores correlacionam a abordagem com a área bloqueada, com foco abdominal ou lombar a depender da técnica empregada (LA COLLA & BEN-DAVID, 2017, TAMURA et al., 2018). A eficácia analgésica das diferentes abordagens foi documentada em procedimentos cirúrgicos de quadril (KUKREJA et al., 2019), nefrolitotomia (DAM et al., 2019), histerectomia e cesariana (BLANCO et al., 2015; YOUSEF, 2018).

A abordagem transmuscular do QL-*block* foi descrita na medicina em 2013 com o intuito de promover analgesia abdominal e para procedimentos retroperitoneais (BORGLUM et al., 2013; DAM et al., 2017). Trata-se de um bloqueio relativamente mais profundo em que o agulhamento permite a visualização do trajeto da agulha através do músculo QL até o ponto desejado, o epimísio da parte anterior do músculo QL, sendo este o plano formado entre os músculos QL e psoas (BORGLUM et al., 2013; DAM et al., 2019).

Na medicina veterinária, duas abordagens para a realização do QL-*block* foram inicialmente descritas em estudos cadavéricos, e consistem na deposição do anestésico entre os músculos QL e psoas (plano QL ou transmuscular), ou no plano

fascial na face lateral do músculo QL e medial à fáscia toracolombar (superficial ou lateral) (GARBIN et al., 2020a; 2020b). Mais recentemente, uma terceira abordagem (posterior) foi documentada na medicina veterinária em estudo cadavérico, e consiste em uma abordagem ao aspecto dorsal do músculo QL (ALAMAN et al., 2022). Apesar das três descrições, apenas a abordagem do plano QL possui relato clínico (ARGUS et al., 2020). Para a realização dessa abordagem, os marcos anatômicos ultrassonográficos devem ser identificados: o plano QL formado entre os músculos QL e psoas menor, tomando como referência o processo transversal da primeira vértebra lombar (GARBIN et al., 2020a).

Atualmente, ainda não há estudos que comparem a eficácia dos bloqueios interfasciais entre si e em relação à anestesia multimodal com opioides, porém os dados sugerem superioridade de analgesia visceral promovida pelo QL-*block* (JONES & ALDWINCKLE, 2020; LIU et al., 2020). Na medicina, em um estudo recente comparando as técnicas de TAP-*Block* e QL-*block* em cirurgias abdominais, este último promoveu analgesia mais prolongada com menor requerimento de opioides (LIU et al., 2020). Contudo, devem sempre ser considerados os fatores limitantes para sua realização, como risco elevado de sangramento ou visualização ultrassonográfica pobre das estruturas anatômicas (JONES & ALDWINCKLE, 2020).

Na medicina veterinária, o QL-*block* no plano formado entre o músculo QL e psoas menor foi aplicado em um gato, e reduziu o requerimento anestésico em cistotomia. Entretanto, estudos clínicos controlados ainda são necessários para comprovar sua eficácia. Para a realização do bloqueio, os autores utilizaram probe linear posicionada paralela às costelas na altura do processo transversal da segunda vértebra lombar, seguido de agulhamento “em plano” em sentido dorsoventral (ARGUS et al., 2020). Em contrapartida, em estudo cadavérico em cães, o agulhamento padronizado foi em orientação ventrolateral a dorsomedial (GARBIN et al., 2020a).

Em pequenos animais, o volume indicado de anestésico para o QL-*block* é de 0,2 a 0,3 mL/kg por ponto, realizado bilateralmente (PORTELA et al., 2018), mas volumes maiores podem ser necessários para o bloqueio de fibras nervosas torácicas (T12-T13) (GARBIN et al., 2020b). O volume de 0,4 mL/kg por ponto promoveu dispersão de corante de T13 a L3 em cadáveres de cabras, sugerindo potencial analgesia de flanco (HARTNACK et al., 2019). Na abordagem posterior, um volume maior de 0,5 mL/kg por ponto proporcionou dispersão com coloração

mais consistente das fibras toracolombares, permanecendo a necessidade de comprovação em estudo clínico (ALAMAN et al., 2022),

Apesar das diversas descrições em cadáveres, a realização de estudos clínicos *in vivo* é imprescindível para a implementação do QL-*block* na rotina anestésica em pequenos animais, pois os modelos cadavéricos não traduzem com exatidão a dispersão do fármaco anestésico, por características como contração muscular e circulação sanguínea estarem fora de cenário (SONDEKOPPAM & TSUI, 2019). As alterações bioquímicas no tecido conjuntivo fascial no *post mortem* resultam em menor resistência para a dispersão do contraste, mascarando a real difusão do fármaco anestésico *in vivo* (BEHR et al., 2020). Mas no espaço peridural, a propagação de bupivacaína foi maior em cães vivos que em cadáveres, sugerindo precaução ao extrapolar volumes de estudos cadavéricos (CIMA et al., 2020).

Os principais anestésicos locais utilizados para a realização do QL-*block* são a bupivacaína, a ropivacaína e a levobupivacaína (PORTELA et al., 2018). Entretanto, na medicina, o uso de coadjuvantes somados ao anestésico ganhou popularidade na execução da técnica. Em cirurgias renais, melhores resultados foram evidenciados com a associação de dexmedetomidina no bloqueio em comparação à sua administração pela via intravenosa, ou uso de bupivacaína isolada (ABDELLATIF et al., 2020; ALANSARY et al., 2020). O uso de dexametasona também é recomendado, com justificativa na potencialização e duração da analgesia (AKERMAN et al., 2018). Já a adição de epinefrina à ropivacaína tende a aumentar a segurança da técnica realizada em parturientes, ao reduzir a concentração plasmática do anestésico (ZANFINI et al., 2019).

Até o momento, na medicina, o volume ideal de anestésico e o tempo exato de analgesia do QL-*block* permanecem indefinidos, apesar de já ser descrita a implantação de cateter no plano transmuscular do QL para infusão contínua do anestésico (WARUSAWITHARANA, 2017; SÁ et al., 2018).

Apesar da proposta de promover analgesia visceral e da parede abdominal, o anestesista deve se manter atento às potenciais complicações, sendo estas relacionadas à performance do bloqueio, como hematomas e até mesmo repercussões hemodinâmicas (SÁ et al., 2018; VISOIU & PAN, 2019). O aumento no volume ou na concentração do anestésico utilizado pode elevar o risco de simpatólise. Essa pode levar à bradicardia ou a episódios hipotensivos, especialmente considerando a propagação do anestésico no espaço paravertebral;

estudos são necessários para avaliar possível propagação peridural (SÁ et al., 2016; DAM et al., 2017).

Enquanto na medicina a técnica é vastamente empregada, ainda com que a dose e volume do anestésico e a duração do *QL-block* não estejam totalmente definidos, na medicina veterinária a experiência com o bloqueio é pequena, e as informações são extrapoladas da aplicação humana e estudos cadavéricos (PORTELA et al., 2018).

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4. ANALGESIC EFFECTIVENESS OF *QUADRATUS LUMBORUM* BLOCK IN BITCHES UNDERGOING ABDOMINAL EXPLORATION AND OVARIOHYSTERECTOMY

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Abstract

Objective to evaluate the analgesic efficacy of the QL-Block with bupivacaine in bitches submitted to abdominal exploration and ovariohysterectomy.

Study design Randomized, double-blinded, controlled experimental study.

Animals Sixteen mixed-breed healthy adults bitches.

Methods Under general anesthesia with isoflurane, QL-Block (0.3 mL kg^{-1}) was performed bilaterally with bupivacaine 0.25% (BUPI) or saline (CONTROL). HR, SAP, GCMPs, DIVAS, glucose, and corticosterone were evaluated before premedication and HR and SAP after stabilization (T_{Bas}) and at the moments: skin incision (T_{Ski}), renal manipulation (T_{Rk} and T_{Lk}), omentum (T_{Om}) and intestine traction (T_{Int}) and traction of the right and left ovaries (T_{Rov} and T_{Lov}) and uterine horn (T_{Ute}), and celiorrhaphy (T_{Cel}). Rescue analgesia was provided with remifentanyl infusion when HR or SAP > 20%. In the postoperative period, HR, SAP, DIVAS, and GCMPs were evaluated at 0.5; 1; 2; 3; 4; 6; 8; 12; 24 hours after extubation (0.2 mg kg^{-1} IM methadone as rescue analgesic when DIVAS ≥ 3 or GCMPs > 6). Glucose and

corticosterone were evaluated at 0.5; 2; 4 h after extubation. Analgesic requirement and return to appetite were recorded.

Results There were no differences over time or between groups for HR. SAP was lower in BUPI at T1sk, TRk, TLk, T0m, and TRov; the total dose of remifentanyl and the number of doses of rescue analgesia was lower in BUPI ($p = 0.0001$). The number of dogs that received rescue analgesia after extubation was lower in BUPI ($p = 0.0256$), and appetite was restored earlier in BUPI ($p = 0.0125$). The GCMPs was lower in BUPI at T2 and T3 and lower DIVAS scores were observed in BUPI at T0.5 and T3 ($p = 0.0303$ and $p = 0.0310$).

Conclusions and clinical relevance The QL-Block promotes lower opioid consumption in the intraoperative and postoperative periods, lower pain scores and early return of appetite in bitches submitted to abdominal exploration and ovariohysterectomy.

Keywords QL-Block, interfascial blocks, analgesia, bupivacaine.

Introduction

Interfascial blocks are a recent group of techniques of the modern regional anesthesia. The target site of these blocking techniques is usually more superficial, making them less invasive, and after the deposition and dispersion of the local anesthetic, there is blockage of one or more neural targets (Machi & Joshi 2019). The superiority of ultrasound-guided blocks over other nerve localization tools has been discussed for more than a decade, as precise injection and needle visualization reduce the risks related to the blocking techniques (Hopkins 2007; Thomson et al. 2021). Despite the benefits, the development of a new interfascial blocking technique

requires clinical study to prove its effectiveness in relation to gold standard analgesia, for instance, that produced by spinal anesthesia (Marhofer et al. 2020).

Quadratus lumborum block (QL-Block) was first described in humans. The anesthetic is injected in a greater proximity to the paravertebral space, promoting visceral and somatic analgesia (Blanco 2007; Kadam et al. 2013). In veterinary medicine, three QL-Block approaches were described in canine cadavers: the QL plane, in which the anesthetic is deposited between the QL and psoas muscles; the superficial block in the fascial plane, when the anesthetic is injected in the lateral side of the QL muscle and medial to the thoracolumbar fascia (Garbin et al. 2020a, b), and a dorsal QL approach (Alaman et al. 2022). The standardization of this blocking technique was also carried out on goats and cats (Hartnack et al. 2019; Santos et al. 2021). Unfortunately, the cadaveric models do not accurately reflect the local anesthetic dispersion, due to characteristics such as the absence of muscle contraction and blood circulation added to the biochemical changes in the fascial connective tissue, resulting in less resistance to the dispersion of the contrast (Sondekoppam & Tsui 2019; Behr et al. 2019), also not ruling out the change in intraabdominal pressure due to respiratory movements (Romano et al. 2020). So far, only the QL plane approach has a clinical report (Argus et al. 2020), and there is only one clinical study that assessed the analgesic efficacy of this potential block for ovariohysterectomy in dogs (Viscasillas et al. 2021).

In dogs, the abdominal wall, as well as the skin and the peritoneum, are innervated by the ventral branches of the thoracic and lumbar spinal nerves (T9-L2) (Evans & Lahunta 2013). It is known that the ventral branches of the last two thoracic spinal nerves (T12-T13) and the three lumbar spinal nerves (L1-L3) run between the bundles of the QL and psoas muscles (Garbin et al. 2020a). Therefore, it is speculated that

the QL-Block promotes satisfactory analgesia for abdominal procedures in small animals.

Thus, we aimed to evaluate the analgesic efficacy of the QL-Block through the QL plane approach, with bupivacaine in dogs, during an exploratory laparotomy and ovariohysterectomy, and 24 hours postoperatively.

Materials and methods

Animals

Sixteen mixed-breed healthy bitches were used in this study. Informed owner consent was obtained, and preoperative examinations were performed [blood count and a serum biochemistry profile (urea, creatinine, alanine aminotransferase, alkaline phosphatase and albumin)]. Exclusion criteria were based on animals that did not fulfil the following characteristics: intact females, body condition score ranging from 4 to 6, on a scale of 9 (LaFlamme 1997), docile behavior and otherwise healthy [American Society of Anesthesiologists (ASA) physical status classification 1].

Animals were enrolled in a randomized, double-blinded, controlled study and randomly assigned to one of two groups. After admission to the hospital, which took place 48 hours prior to the procedure, the dogs were fed commercially available dog food and had free access to water.

Anesthetic management

Food but not water was withheld for 8 hours prior to anesthesia. Baseline awake heart rate (HR), respiratory rate (fR), and doppler systolic arterial pressure (SAP) (cuff size 40- 50% limb circumference) were assessed before premedication. Sedation score

(Gurney et al. 2009), dynamic interactive visual analog score (DIVAS), and modified Glasgow pain score (GCMPS) were also evaluated before premedication. Subsequently, 3 mL of venous (cephalic) blood was withdrawn to evaluate baseline plasma glucose and corticosterone. Acepromazine [0.03 mg kg⁻¹; Acepran[®] 0,2%; Vetnil; SP, Brazil] was administered intramuscularly as premedication, and 15 minutes later, we performed venoclysis of the cephalic vein, and anesthesia was induced with propofol (Propovan[®]; Cristália, Brazil) intravenously (IV) to effect, followed by tracheal intubation with a cuffed endotracheal tube. Anesthesia was maintained with isoflurane (Isoflurano; Instituto BioChimico, Brazil) in 0.6 oxygen through a rebreathing circuit. Initially, a flow of 100 mL kg⁻¹ minute⁻¹ was used and the vaporizer was adjusted to reach an expired isoflurane fraction (PE'ISO) of 1.3%, assessed by a gas analyzer. Volume-controlled mechanical ventilation using a tidal volume (V_T) of 10 mL kg⁻¹ and a fR of 12 was initially instituted and adjusted to maintain normocapnia [partial pressure of end-tidal carbon dioxide (PE'CO₂) at 35-45 mmHg]. Monitoring included HR, electrocardiogram, fR, PE'CO₂, peripheral hemoglobin oxygen saturation (SpO₂), esophageal temperature (T) (LifeWindow LW9xVet; DIGICARE[®]), and SAP (vascular doppler). After 10 minutes of stabilization, anesthetic baseline values of HR, fR, SAP were obtained. Throughout the procedure, lactate ringer was infused at 5 mL kg⁻¹ hour⁻¹.

Study design

Bilateral QL-Block was performed by the same researcher, with a standard volume of 0.3 mL kg⁻¹ per point (total 0.6 mL kg⁻¹). The dogs were randomly assigned to one of two groups (eight dogs in each group): BUPI [QL-Block performed with 0.25% bupivacaine (Neocaína[®]; Cristália, Brazil)] and CONTROL (was assigned QL-Block

with 0.9% saline). After 10 minutes of induction and baseline evaluation, the animals were positioned in left lateral recumbency, and the QL-Block was performed on the right side (Fig.1). A linear ultrasound (US) probe (SonoAce[®]/VetR3; 5-12 MHz linear transducer) in fundamental image format was positioned caudal and parallel to the last rib, transversally to the spine, with the cranial marking pointing towards the dorsal region. The identified ultrasonographic landmarks were: the first lumbar vertebra (the hyperechoic structure that produced acoustic shading) and the transverse process of the respective vertebra, to the left of the display. The QL muscle was identified immediately medial to the transverse process as a hypoechoic structure and its fasciae, as a hyperechoic structure. The psoas minor (PM) muscle was located medially to the QL muscle, with US aspect similar to the QL muscle. The injection site was defined as the space between the medial fascia of the QL muscle and the lateral fascia of the PM muscle (Fig. 2). The quality of US scanning was graded as excellent, good, or poor (adapted from OTERO et al., 2020).

A 21G X 100 mm echogenic needle (SonoPlex[®]; PAJUNK, USA) was introduced in-plane in a ventro-lateral to dorsomedial direction. After the needle aspiration produced negative pressure, 0.2 mL of saline (NaCl 0.9%; Eurofarma, Brazil) was injected in the QL fascia to confirm the needle position. After confirmation of the correct position, the treatment solution was injected. The quality of the needle visualization was graded (OTERO et al. 2020) and the time required to perform the QL-Block (from scanning to injection) were recorded. After 5 minutes, the patient was positioned in right lateral recumbency and the same procedure was performed on the left side. After 5 minutes of the second block, the patient was positioned in dorsal recumbency, and a 15-minute interval was standardized for the beginning of the procedure.

The surgical procedure was performed by the same experienced surgeon and an assistant, and included: celiotomy, digital pressure of the right and left kidneys, traction of the omentum, traction of the small intestine at the height of the ileocolic valve, traction of the right and left ovaries and uterine horn, followed by ovariectomy and celiorrhaphy. The manipulation of the organs always followed the same order, with pressure being applied by the same surgeon for 60 seconds. If HR and/or SAP increased more than 20% above the anesthetic baseline (increase in only one variable was characterized as a nociceptive response), the stimulus was interrupted and rescue analgesia was provided with remifentanyl infusion ($10\text{--}20\ \mu\text{g kg}^{-1}\ \text{hour}^{-1}$; Cloridrato de remifentanila; Cristália, Brazil). The remifentanyl solution was prepared at a concentration of $10\ \mu\text{g mL}^{-1}$. Remifentanyl was discontinued when HR and SAP returned to baseline, and a 3-minute washout period was allowed to drug clearance. The right ovarian pedicle was first stretched for 60 seconds, and ligated thereafter. If a nociceptive response was observed, traction was interrupted, and remifentanyl was infused until the ovarian pedicle ligatures were applied. The technique was repeated in the left ovarian pedicle and uterine body. All variables were recorded every 10 minutes until the end of the surgery. Time points for statistical analysis were: TBas, before start of surgery (baseline); TSki, skin incision; TRk, digital pressure to the right kidney; TLk, digital pressure to the left kidney; TOm, traction of the omentum; TInt, traction of the small intestine; TRov, traction of the right ovarian pedicle; TLov, traction of the left ovarian pedicle; TUte, traction of the uterine horn and TCel, celiorrhaphy.

The degree of ovarian exposure was assessed using a simple descriptive scale (1, ovary cannot be exposed out of the abdominal cavity; 2, ovary can be exposed after moderate to intense applied traction; 3, ovary can be easily exposed with little

traction). The total dose of remifentanyl required were recorded. Meloxicam (0.2 mg kg^{-1} ; Maxicam 0.2%; Ouro Fino, Brazil) was administered IV at the first skin suture.

Postoperative Evaluation

Isoflurane was discontinued at the end of surgery. After extubation, dogs were transferred to the recovery ward. Sedation score was assessed at 0.5, 1, and 2 hours after extubation. HR, SAP, and pain scores were assessed at 0.5, 1, 2, 3, 4, 6, 8, 12, and 24 hours after extubation. At the same time points, dogs were encouraged to walk and eat, and standard dry and wet commercial food were offered. Time to first return of ambulation and appetite were registered. The number of rescues, incidence of ataxia, nausea, and vomit episodes were recorded. Two pain assessment systems were used: the dynamic interactive visual analog scale (DIVAS involved three phases: visual observation only, interaction with the observer and palpation 5 cm around the incision area) and the Glasgow composite pain scale – short form (GCMPS, ranging from 0 to 24). Methadone (0.2 mg kg^{-1} IM; Mytedom[®]; Cristália, Brazil) was administered as rescue analgesia when DIVAS ≥ 3 or GCMPS > 6 . When rescue analgesia was necessary, a new evaluation was performed after 30 minutes and supplemental methadone (0.1 mg kg^{-1} IM) was administered if needed. Pain and sedation assessments were performed by the same two researchers, who were unaware of the treatment, and the medians of the scores were used in the statistical analyses. Blood samples were held at 0.5, 2 and 4 h after extubation to evaluate blood glucose and corticosterone: 3 mL of venous blood was collected from the cephalic vein (with the least restraint and discomfort for the animal) in sodium fluoride + ethylenediaminetetraacetic acid tubes. The samples were centrifuged at 1529 g for 5 min, and plasma was stored at -30°C . Plasma glucose and corticosterone were

evaluated through enzymatic colorimetric technique and enzyme immunoassay (ELISA), respectively.

Statistical analysis

All statistical analyses were performed with GraphPad Prism 5 (GraphPad Software, San Diego, California USA). D'Agostino test was applied to check for normality. Body weight; total time to perform the QL-Block; total dose of remifentanyl; propofol requirement; duration of surgery; HR; SAP; time to extubation; time to ambulation; corticosterone and plasma glucose were compared by unpaired t test. Quality of US scan, needle imaging; degree of ovarian exposure and appetite were compared by Mann-Whitney test. HR; SAP; corticosterone and plasma glucose were subjected to one-way ANOVA followed by Dunnett's Multiple Comparison Test to compare within group. The sedation and pain scores were compared by Mann-Whitney test (between groups) and Kruskal-Wallis (within group). Fisher's exact test was used to compare frequency of body score, incidence of ataxia, salivation, and vomiting. Significance was considered if $p < 0.05$. Normally distributed data are presented as mean $\pm$ standard deviation and data without normal distribution as median (range).

Results

Preoperative and intraoperative variables

During surgery, PE'ISO values were $1.36 \pm 0.06\%$ in BUPI and $1.36 \pm 0.05\%$ in CONTROL. In order to maintain PE'CO₂ at 35-45 mmHg, the fR values were 17.4 ± 4.9 in BUPI and 23.4 ± 8.5 in CONTROL respectively. There were no differences between groups for body weight, body score and total dose of propofol. The duration

of surgery was longer in the CONTROL group compared to BUPI ($p < 0.0001$) (Table 1).

As for the execution of the QL-Block, the time required to complete the injection was similar in CONTROL and BUPI [3.11 ± 0.94 and 3.34 ± 1.38 minutes, respectively for the right side ($p = 0.7062$) and 2.99 ± 1.51 and 3.56 ± 0.92 for the left side ($p = 0.3761$)].

No differences between groups were observed regarding the quality of scanning ($p = 0.5431$ for the right side and $p = 0.2104$ for the left side) and needle visualization ($p = 0.4452$ for the right and $p = 0.6084$ for the left side). Considering bilateral injection in each animal (total of 32 punctures), the quality of scanning was rated as excellent in 28.1% of the cases, good in 50%, and poor in 21.9%. The needle visualization was rated as excellent in 50% of the cases, good in 43.8%, and poor in 6.2%.

There were no differences over time or between groups for HR. SAP was higher in CONTROL than in BUPI at T1sk, TRk, TLk, TOm, and TRov. In CONTROL, SAP differed from baseline from T1sk to TUTE (Table 2).

The total dose of remifentanyl was higher in CONTROL, compared to BUPI (Table 1). In CONTROL, all animals required transoperative rescue analgesia, and five of them received remifentanyl at all evaluation points. In BUPI, 5 animals required rescue analgesia: 3 animals received remifentanyl at only one evaluation point (right ovary or uterine horn) and 2 animals received rescue analgesia at 4 points (manipulation of the right ovary until the end of surgery).

Regarding the degree of ovarian exposure, BUPI showed better exposure bilaterally ($p = 0.0126$ for left ovary and $p = 0.0101$ for right ovary). In BUPI, one animal showed poor quality of ovary exposure bilaterally: the right ovary could not be exposed out of the abdominal cavity (grade 1) and the left ovary was exposed after moderate traction

(grade 2); the same animal required analgesic rescue at all evaluation points from TRov. In the remaining seven dogs, exposure was considered satisfactory (grade 3). In CONTROL, only one animal obtained satisfactory exposure (grade 3) of both ovaries, in the other animals, one presented satisfactory exposure (grade 3) in the left ovary and median exposure in the right ovary (grade 2) and the others presented only median to poor quality of ovary exposure.

Postoperative variables

There were no differences between groups for time to extubation ($p = 0.2448$) and time to ambulation ($p = 0.2143$) (Table 1). HR did not differ between groups, but in CONTROL, HR differed from baseline along time, at T0.5 and T3. SAP was lower in BUPI compared to CONTROL at T2 and T4 ($p = 0.0326$ and $p = 0.0435$) (Table 3). The number of dogs that received rescue analgesia after extubation was lower in BUPI ($n=0$) than in CONTROL ($n=5$) ($p = 0.0256$), and appetite was restored earlier in BUPI compared to CONTROL ($p = 0.0125$) (Table 1).

Ataxia was observed in four dogs in BUPI and in one dog in the CONTROL up to one hour after extubation. Nausea was observed in two dogs in BUPI and five dogs in CONTROL, and vomiting occurred in one dog in BUPI and one in CONTROL. However, there was no significant difference between groups.

The sedation score was not significantly different between groups ($p > 0.05$) (Table 4). None of the animals showed signs of sedation at T2. GCMPS significantly increased from baseline at T0.5 in both groups and at T1 in CONTROL ($p < 0.0001$) (Table 4). The GCMPS was lower in BUPI than CONTROL in T2 and T3 ($p = 0.0435$ and $p = 0.0277$, respectively). DIVAS significantly increased from baseline at T0.5 and T1 in both groups and at T2 and T3 hours in CONTROL ($p < 0.05$). Lower DIVAS

scores were observed in BUPI at T0.5 and T3 ($p = 0.0303$ and $p = 0.0310$), compared to CONTROL.

There were no differences between groups for glucose and corticosterone. Both variables remained above baseline for up to 4 hours postoperatively in CONTROL, but in BUPI the values returned to baseline at T0.5 hours for corticosterone and T2 for glucose.

Discussion

The study evaluated the analgesic efficacy of the QL-Block performed in bitches undergoing laparotomy followed by ovariohysterectomy, and it is the second clinical study to evaluate the extent of the QL-Block in the Veterinary Medicine. QL-Block with bupivacaine was associated with a reduction in the intraoperative and postoperative opioid consumption, early return of appetite, and better ovarian exposure.

Surgical time was longer in CONTROL because when rescue analgesia was required, surgery was interrupted, remifentanil was infused until hemodynamic variables returned to baseline, and a 3-minute washout period was allowed before the next surgical stimulus was applied. However, it is known that surgical time alone does not influence pain-related behaviors in the perioperative evaluation (Wagner et al. 2008).

In the present study, traction of specific organs followed by ovariohysterectomy were used as a nociceptive model to identify the extension of the QL-Block in the abdominal cavity. The QL plane approach in dog cadavers successfully stained the first three lumbar spinal nerves, the thirteenth thoracic spinal nerve, the sympathetic trunk, and the splanchnic nerves (Garbin et al. 2020a). Therefore, in the present study, satisfactory analgesia of the abdominal wall, kidneys, gastrointestinal and genital system were expected.

Gastrointestinal innervation occurs through afferent sympathetic fibers, which cell bodies are in the lower thoracic and upper lumbar dorsal root ganglia. As for renal innervation, afferent fibers from the last thoracic and first lumbar segments reach the kidney via the lumbar splanchnic nerves and the celiac plexus (Cervero 1994). Stimulation of the ovaries and ovarian ligaments is a standardized visceral pain model even for MAC studies in dogs (Boscan et al. 2011). It is known that the ovaries in dogs are innervated by the sensory nerve fibers from the dorsal root ganglia of T10 to L4 segment (Chien et al. 1991). In human medicine, the indications for the use of QL-Block are mainly based on case reports. Blockade varies from T7 to L2, and is effective for abdominal and hip surgeries, depending on the approach (La Colla & Ben-David 2017; Elsharkawy et al. 2019; Balocco et al. 2021).

Nociceptive response (more than 20% increase above the anesthetic baseline in HR and/or SAP) was observed in both groups at TRov (right ovary), TUte (uterine horn), and TCel (celiorrhaphy), suggesting that 0.3 mL.kg⁻¹ through the QL plane approach does not block as far as T10 to L4. It is emphasized that the right ovary is anatomically more cranial in relation to the left ovary in dogs (MacPhail 2015). This would justify the nociceptive response observed in the present study only in the right ovary. The present study is the first to demonstrate that QL-Block with bupivacaine in dogs can provide adequate analgesia for celiotomy; renal, intestinal, and omentum manipulation; but partial analgesia for ovariohysterectomy and celiorrhaphy. Urinary bladder was not manipulated in the present study, but analgesia for cystotomy has been already documented in an isolated case report in a cat (Argus et al. 2020).

In the first published clinical study of QL-Block in dogs, the authors evaluated the dispersion (total volume of 0.4 ml kg⁻¹ of bupivacaine and iomeprol) by tomography and the analgesia during ovariohysterectomy (Viscasillas et al. 2021). One of the

animals also required analgesic rescue in the manipulation of the first ovary, corroborating the present study. The authors found a contrast dispersion similar to cadaveric studies, covering the extension of 3 vertebrae, but they point out that there may be a discrepancy between the migration of the local anesthetic versus the contrast, even when both are administered in the same solution (Viscasillas et al. 2021).

The question arises as to whether a larger volume of local anesthetic would promote a greater extent of QL-Block analgesia, however, in humans extrapolation of anesthetic volume or concentration may increase the risk of sympatholysis (Sá et al. 2016). In the Veterinary Medicine, taking into account the TAP-Block, a study on cadavers showed that the number of stained ventral nerve branches was not higher when the volume was increased (Freitag et al. 2021).

The thoracolumbar fascia, which forms the QL plane, between the QL and PM muscles is composed of a complex tubular lamina of aponeuroses and forms potential planes for the deposition and propagation of local anesthetics (El-Boghdadly et al. 2016; Garbin et al. 2020a, 2020b). Its anatomical-physiological characteristics, such as the presence of sympathetic neurons and nociceptors, as well as the presence of large, myelinated fibers with endings intermingled with the layers of the fascia, make it the most important structure for the performance of the QL-Block, which is part of the explanation for the achieved analgesia (Willard et al. 2012; Blanco 2016; Ueshima et al. 2017; Akerman et al. 2018).

In the present study, remifentanyl was chosen as a transoperative rescue analgesic because it has a rapid onset of action, and is predominantly metabolized by plasma esterases, characterized by a 50% decrease in plasma concentration after 3 to 4 min of drug withdrawn (Burkle et al. 1996; Panzer et al. 2011). Thus, remifentanyl has

minimal interference in the evaluation of the following surgical stimulus, even when transoperative rescue was required.

In the present study, meloxicam was administered at the end of the surgical procedure to all dogs. Despite the possibility of its analgesic potential affecting pain assessment, the anesthetic protocol was lacking in analgesia, making it mandatory to use a postoperative drug to comply with ethics in the use of animals in clinical studies.

The maintenance of HR observed during surgery in the present study is in agreement with other studies of surgical and anesthetic methods for neutering female dogs, that the blood pressure changed rapidly during the different phases of the surgery, however, the HR remained unchanged (Shih et al. 2008; Hoglund et al. 2010). The authors relate the maintenance of HR to the baroreceptor reflex (Hoglund et al. 2010). Two pain assessment scales were used, and two evaluators were chosen to improve the reliability of evaluating postoperative pain. Pain scores were higher in the first 3 hours after extubation in both groups, but GCMPS and DIVAS scores were lower in BUPI during this period. Postoperative rescue analgesia was only required in the CONTROL animals, suggesting that QL-Block analgesia is effective for postoperative pain after abdominal exploration surgery and ovariohysterectomy in bitches lasting at least 3-4 hours, since in the present study there was a difference between the groups up to that time. In a study comparing two protocols for the use of bupivacaine for ovariohysterectomy in dogs, rescue analgesia was required within 24 hours after surgery (Campagnol et al. 2012).

The low pain scores observed in the present study after 6 hours of evaluation, may be related to the QL-block efficacy in BUPI and the effective management of analgesic rescue when this was necessary.

No anesthetic complications were observed. Studies evaluating different techniques in relation to QL-Block are necessary, since in relation to neuraxial anesthesia, locoregional anesthesia has the advantage of promoting more selective desensitization with lower complication rates (Vettorato et al. 2012; Garcia-Pereira 2018), such as hypotension, observed in a clinical study that evaluated neuroaxis anesthesia for ovariohysterectomy (Nejamkin et al. 2020). Although there was no difference, ataxia was evidenced in 4 animals of BUPI in the postoperative period, being observed up to 2 hours of evaluation. Even the contrast impregnation in the lumbar plexus (L4-L7) not being evidenced in cadaveric study in dogs (Garbin et al. 2020a), in medicine it is still considered a disadvantage of the technique (Elsharkawy et al. 2019). Therefore, ataxia may also be a complicating factor of the technique in dogs.

The assessment of glucose and corticosterone occurred up to 4 hours after surgery, these markers are used to assess analgesic efficacy through attenuation of the neuroendocrine responses to pain (Desborough 2000; Martins et al. 2010). The methodology was based on other studies, which showed an increase in glucocorticoids and glucose levels up to 4 hours of surgical recovery (Martins et al. 2010; Imagawa et al. 2011; Kim et al. 2012; Gutiérrez-Bautista et al. 2018).

For both glucose and corticosterone concentrations, the CONTROL group showed an increase from the baseline value and the concentrations remained significantly elevated and did not return to near-baseline concentrations until the 4 h time. In other words, the amplitude of the neuroendocrine response in BUPI was smaller compared to CONTROL, since in BUPI the values returned to baseline values at T2. As for glucose concentration, although there was no difference between groups, only in CONTROL the mean at T0.5 exceeded the reference for the species (65-118 mg/dL).

We can assume that the neuroendocrine response to surgical stress was more attenuated in BUPI. The study started at the same time in the morning, to standardize the collection times, mainly for the evaluation of the neuroendocrine response.

This study has some limitations: continuous measurement of invasive blood pressure was not performed. Scan quality has a direct impact on technique accuracy, new ultrasound models can improve performance, and better degree of scanning and needling can be achieved. The number of dogs used for the study was small, and a larger number of animals could determine greater difference and analgesic superiority of BUPI group compared to CONTROL. The size of the animals included in the present study was standardized for the execution and comparison of the technique, but the quality of the injection can be changed considering the anatomical discrepancy related to different animal sizes. Future clinical studies should assess whether other QL-Block approach can provide complete desensitization for ovariohysterectomy and manipulation of other abdominal viscera.

Conclusions

The QL-Block through the QL plane approach performed with a 0.3 mL kg⁻¹ volume per point with 0.25% bupivacaine reduces opioid consumption in intraoperative and postoperative periods, decreases pain scores, reduces the amplitude of neuroendocrine response, and promotes early return of appetite in bitches submitted to abdominal exploration and ovariohysterectomy.

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Figure 1 Patient positioning in left lateral recumbency and ultrasound-guided performance of the *quadratus lumborum* block at the QL plane approach.

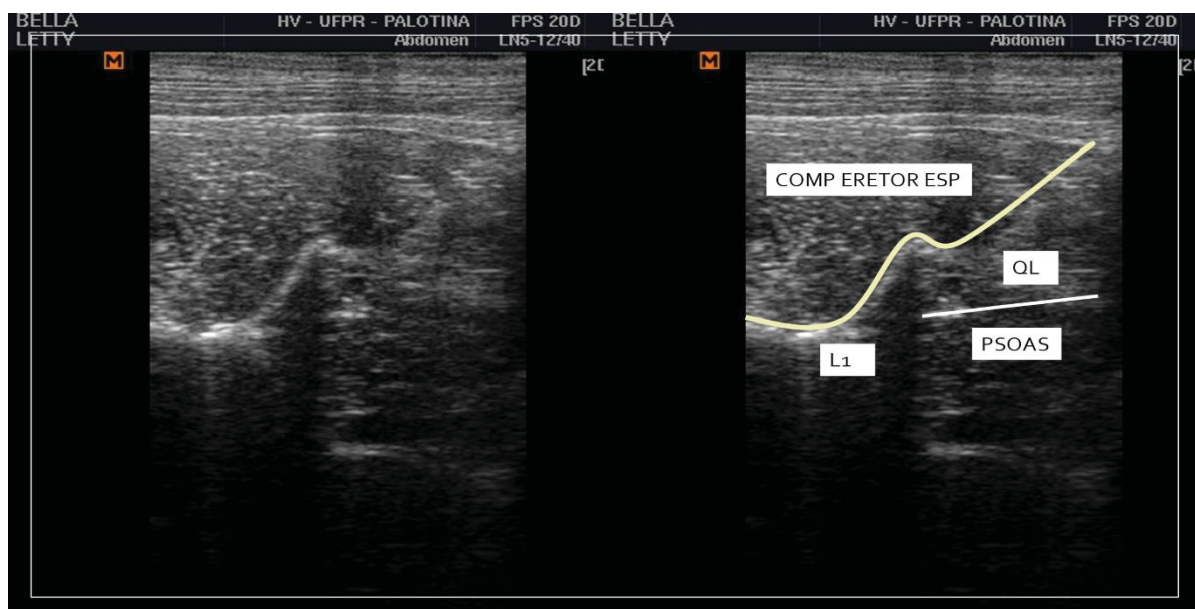


Figure 2 Sonoanatomy of the landmarks to perform the QL plane approach of *quadratus lumborum* block in dogs.

Table 1. Mean $\pm$ SD body weight, total dose of propofol, duration of the procedure, total dose of remifentanyl, number of rescue analgesia, extubation time, time to ambulation, return of appetite; median (range) body score and incidence of ataxia, salivation and vomiting in bitches undergoing exploratory laparotomy and ovari hysterectomy after *Quadratus lumborum* block (QL-Block) with bupivacaine (BUI) or saline (CONTROL).

VARIABLES	GROUPS		P
	CONTROL	BUI	
Body weight (kg)	11.1 $\pm$ 2.7	13.3 $\pm$ 2.3	p = 0.0897
Body score	5 (5-5)	5 (5-6)	p = 0.4667
Total dose of propofol (mg kg ⁻¹)	4.7 $\pm$ 0.5	4.9 $\pm$ 0.8	p = 0.5863
Duration of surgery (minutes)	89.3 $\pm$ 16.4	48.5 $\pm$ 12.2 *	p < 0.0001
Total dose remifentanyl (μ g kg ⁻¹)	10.6 $\pm$ 4.4	1.6 $\pm$ 1.9 *	p = 0.0001
Extubation time (minutes)	3.0 $\pm$ 1.1	4.0 $\pm$ 2.1	p = 0.2448
Time to ambulation (minutes)	14.3 $\pm$ 8.7	21.0 $\pm$ 11.8	p = 0.2143
Return of appetite (minutes)	502.5 $\pm$ 592.0	48.8 $\pm$ 53.0 *	p = 0.0125
Frequency of rescue analgesia	63%	0 *	p = 0.0256
Incidence of ataxia	1/8	4/8	p = 0.2821
Incidence of salivation (nausea)	5/8	2/8	p = 0.3147
Incidence of vomiting	1/8	1/8	p = 1.0000

* Significantly different from group CONTROL (p < 0.05).

Table 2. Mean value and standard deviation of vital parameters evaluated to predict nociceptive response in bitches undergoing exploratory laparotomy and ovari hysterectomy after *Quadratus lumborum* block (QL-Block) with bupivacaine (BUPi) or saline (CONTROL).

INTRAOPERATIVE VARIABLES	GROUPS	TIME POINTS									
		TBas	TIsk	TRk	TLk	TOm	TInt	TRov	TLov	TUte	TCel
Systolic arterial pressure (mmHg)	CONTROL	107.5 ± 9.5	122.8 ± 21.2	137.5 ± 18.0 *	139.5 ± 16.6 *	141.4 ± 18.9 *	147.0 ± 20.9 *	144.1 ± 23.0 *	144.8 ± 20.9 *	143.0 ± 21.1 *	136.8 ± 4.8*
	BUPi	113.5 ± 10.0	105.0 ± 17.3	109.5 ± 11.3 †	116.3 ± 9.9 †	115.5 ± 13.0 †	118.0 ± 11.1 †	128.0 ± 18.2 *	121.8 ± 11.0 †	126.5 ± 12.3 *	123.9 ± 15.0
Heart rate (beats minute ⁻¹)	CONTROL	92.4 ± 11.3	105.9 ± 17.5	93.0 ± 12.7	100.4 ± 13.1	105.3 ± 24.3	102.1 ± 31.2	109.0 ± 24.9	95.8 ± 16.8	97.8 ± 16.6	105.4 ± 22.1
	BUPi	102.8 ± 14.6	96.5 ± 10.8	93.1 ± 23.6	96.4 ± 26.8	98.9 ± 26.6	94.9 ± 26.2	94.0 ± 20.0	92.0 ± 21.3	102.1 ± 16.7	116.6 ± 14.8

†Significantly different from group CONTROL at the same time point

* Significantly different from TBas within a treatment

Evaluation time points: TBas, after stabilization of the surgical plane; TSki, during skin incision; TRk, manipulation of the right kidney; TLk, manipulation of the left kidney; TOm, traction of omentum; TInt, traction of intestine; TRov, traction of the right ovary; TLov, Traction of the left ovary; TUte, traction of the uterine horn; TCel, celiorraphy.

Table 3. Mean value and standard deviation of vital parameters evaluated postoperatively in bitches submitted to exploratory laparotomy and ovariectomy after *Quadratus lumborum* block (QL-Block) with bupivacaine (BUPI) or saline (CONTROL).

POSTOPERATIVE VARIABLES	GROUPS	TIME POINTS											
		TB	T0.5	T1	T2	T3	T4	T6	T8	T12	T24		
Systolic arterial pressure (mmHg)	CONTROL	154.5 ± 15.6	173.5 ± 21.5	175.3 ± 36.2	170.0 ± 18.0	161.3 ± 21.3	172.0 ± 11.8	169.9 ± 11.3	174.3 ± 9.5	162.3 ± 19.2	159.0 ± 17.3		
	BUPI	148.6 ± 26.2	159.3 ± 15.8	161.8 ± 23.7	149.0 ± 17.4 †	166.0 ± 20.5	160.8 ± 8.1 †	162.5 ± 16.0	163.6 ± 26.7	155.3 ± 20.3	154.0 ± 22.0		
Heart rate (beats minute ⁻¹)	CONTROL	126.0 ± 15.6	151.0 ± 24.4 *	131.0 ± 25.8	106.5 ± 20.9	101.0 ± 16.5 *	108.0 ± 19.7	106.5 ± 11.7	109.0 ± 18.5	106.0 ± 17.2	108.0 ± 13.5		
	BUPI	126.4 ± 25.0	132.0 ± 29.5	126.0 ± 22.3	118.5 ± 16.8	121.0 ± 30.8	124.3 ± 26.6	118.5 ± 29.5	121.0 ± 31.1	121.5 ± 27.2	117.1 ± 22.1		

† Significantly different from group CONTROL at the same time point

* Significantly different from TB within a treatment

Post-operative evaluation time points: TB, baseline; T0.5, half an hour after extubation; and T1, T2, T3, T4, T6, T8, T12, T24 represented 1, 2, 3, 4, 6, 8, 12, and 24 hours after extubation.

Table 4. Median (range) sedation score, dynamic interactive visual analog score (DIVAS) and modified Glasgow pain score (GCMPS), Mean value and standard deviation of plasma glucose and corticosterone evaluated in bitches submitted to exploratory laparotomy and ovariohysterectomy after *Quadratus lumborum* block (QL-Block) with bupivacaine (BUPI) or saline (CONTROL).

POSTOPERATIVE VARIABLES	GROUPS	TIME POINTS										
		TB	T0.5	T1	T2	T3	T4	T6	T8	T12	T24	
SEDATION SCORE	CONTROL	0 (0-1)	4 (3-8) *	4.8 (2.5-9) *	0							
	BUPI	0	4.3 (2-5) *	3.8 (2-5) *	0							
GCMPS	CONTROL	1 (0-3)	4.8 (2-10) *	3.3 (2-9) *	2.8 (1-5)	2 (1-4)	1.3 (1-4)	1 (1-3)	1.3 (0-3)	0.3 (0-4)	0 (0-3)	
	BUPI	1 (0-2)	4.3 (2-6) *	3 (2-6)	1.5 (1-4) †	1 (0-2) †	1 (0-2.5)	1 (0-4)	1 (0-6.5)	0.5 (0-5)	0.76 (0-2)	
DIVAS	CONTROL	0	2.2 (1-2.8) *	1.7 (0.8-3) *	1.1 (0.3-1.6) *	0.8 (0.5-1.6) *	0.5 (0.3-1.5)	0.4 (0.2-0.6)	0.2 (0-0.4)	0 (0-0.2)	0	
	BUPI	0	1.1 (0.2-2.2)†*	0.9 (0.5-1.8) *	0.8 (0.2-1.1)	0.4 (0.1-0.9)†	0.2 (0.1-2.2)	0 (0-1.4)	0 (0-2)	0 (0-1.2)	0	
GLUCOSE (mg dL ⁻¹)	CONTROL	92.3 ± 7.1	127.4 ± 22.0*		113.3 ± 13.2*		112.3 ± 6.2*					
	BUPI	93.9 ± 10.2	109.4 ± 11.8		105.5 ± 11.5		111.9 ± 22.8					
CORTICOSTERONE (nmol L ⁻¹)	CONTROL	22.8 ± 20.6	97.7 ± 48.1*		82.5 ± 76.5*		50.9 ± 46.3*					
	BUPI	32.2 ± 35.2	74.7 ± 28.2*		55.0 ± 50.6		30.7 ± 30.1					

† Significantly different from group CONTROL at the same time point

* Significantly different from TB within a treatment

Post-operative evaluation time points: TB, baseline; T0.5, half an hour after extubation; and T1, T2, T3, T4, T6, T8, T12, T24 represented 1, 2, 3, 4, 6, 8, 12, and 24 hours after extubation.

ANEXO 1 – COMITÊ DE ÉTICA NO USO DE ANIMAIS

Ministério da Educação
Universidade Federal do Paraná
Setor Palotina
Comissão de Ética no Uso de Animais



Certificado

Certificamos que o **Protocolo nº 35/2019** referente ao projeto de pesquisa **Descrição do bloqueio do Quadrado Lombar em cadáveres caninos e avaliação da eficácia analgésica trans e pós-anestésica em cadelas submetidas a ovariectomia eletiva**, sob responsabilidade da **Profa Fabíola Bono Fukushima**, está de acordo com os Princípios Éticos da Experimentação Animal, adotado pelo Conselho Nacional de Controle de Experimentação Animal (CONCEA) e foi **APROVADO** pela Comissão de Ética no Uso de Animais do Setor Palotina da UFPR (CEUA/Palotina) em **04/10/2019**.

O Docente responsável pelo envio do formulário deve estar ciente de que deve:

- informar qualquer intercorrência, efeitos adversos ou fatos relevantes que alterem o curso normal do estudo;
- informar sobre a necessidade de modificações ou emendas ao protocolo que foi descrito e aprovado, identificando a parte do protocolo a ser modificada e apresentando justificativas claras

Palotina, 04 de outubro de 2019.

Certificate

Certify that the **Protocol n. 35/2019** regarding the research project **Description of quadratus lumborum block in dogs cadavers and evaluation of the efficacy of trans and post-anesthetic analgesia in dogs submitted to elective ovariectomy of Fabíola Bono Fukushima** is according to the Ethical Principles of Animal Experimentation adopted by the National Council for Animal Experiments Control (CONCEA) and was **APPROVED** by the Ethics Committee on Animal Use of the UFPR – Setor Palotina (CEUA / Palotina) in **October 04, 2019**.

Palotina, October 04, 2019.

Prof. Geraldo Camilo Alberton
Coordenador/Coordinator
CEUA/Palotina - UFPR