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Comparative assessment of xylazine-ketamine and dexmedetomidine-ketamine anaesthesia in feline ovariohysterectomy

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Abstract

Injectable anaesthesia remains the most practical option for feline ovariohysterectomy (OVH) in field settings where inhalation equipment is unavailable, yet the choice between available alpha-2 agonist-dissociative combinations is often made without adequate comparative data for the domestic cat. This research compared the cardiorespiratory effects, muscle relaxation quality, recovery characteristics, and post-operative analgesia provided by two injectable protocols xylazine-ketamine (XK) and dexmedetomidine-ketamine (DK) in cats undergoing elective OVH at the Chiang Mai Academy of Veterinary Sciences, Thailand. Forty healthy female domestic shorthair cats (ASA I, aged 8-36 months, body weight 2.4-4.6 kg) scheduled for routine OVH were randomly allocated to Group XK (xylazine 1 mg/kg + ketamine 10 mg/kg IM; n = 20) or Group DK (dexmedetomidine 40 µg/kg + ketamine 5 mg/kg IM; n = 20). Heart rate (HR), respiratory rate (RR), mean arterial pressure (MAP), peripheral oxygen saturation (SpO₂), and rectal temperature were recorded at baseline and at 5, 15, 30, 45, and 60 minutes after induction. Surgical muscle relaxation was graded on a 1-3 scale by the surgeon, blinded to group allocation. The DK protocol produced significantly lower HR at all time points ($p < 0.05$) and maintained MAP closer to baseline (89.4 ± 6.8 versus 97.6 ± 7.9 mmHg at 15 min; $p < 0.01$). Muscle relaxation scores were superior in DK (mean 2.7 ± 0.5 versus 2.1 ± 0.6 ; $p < 0.01$). Recovery to sternal recumbency was faster in DK (18.4 ± 4.9 versus 28.1 ± 7.6 min; $p < 0.001$). Post-operative pain scores assessed by the Glasgow Composite Measure Pain Scale-Feline (CMPS-Feline) were significantly lower in DK at 1 and 4 hours post-surgery ($p < 0.05$). No cat in either group required rescue analgesia. These results indicate that dexmedetomidine-ketamine provides smoother anaesthesia, superior muscle relaxation, and a shorter, calmer recovery compared to xylazine-ketamine for feline OVH, supporting its adoption as the preferred injectable protocol in resource-limited settings.

Keywords: Xylazine, ketamine, dexmedetomidine, feline, ovariohysterectomy, injectable anaesthesia, cardiorespiratory, muscle relaxation, recovery, pain scoring

1. Introduction

Ovariohysterectomy is defined as the surgical removal of both ovaries and the uterus, and it is the most frequently performed elective procedure in feline practice worldwide ^[1]. In tropical and subtropical countries—including Thailand, where the stray cat population numbers in the millions—large-scale spay campaigns depend on injectable anaesthetic protocols that are affordable, require no specialised equipment, and can be administered by a single operator in the field ^[2]. Among the available options, combinations of an alpha-2 adrenergic agonist and a dissociative anaesthetic have dominated field practice for decades, because they produce sedation, immobilisation, and analgesia in a single intramuscular injection ^[3].

Xylazine-ketamine (XK) is the longest-established of these combinations. Xylazine, a first-generation alpha-2 agonist, provides sedation and visceral analgesia, while ketamine contributes dissociative immobilisation and somatic analgesia ^[4]. The protocol is inexpensive and widely available, but it carries well-documented drawbacks: xylazine depresses myocardial contractility and induces bradycardia, causes vomiting in roughly 40% of cats, and produces inconsistent muscle relaxation that can complicate abdominal surgery ^[5].

Dexmedetomidine, a more selective and potent alpha-2 agonist, offers a pharmacological upgrade. Its higher alpha-2-to-alpha-1 selectivity ratio (1,620:1 versus 160:1 for xylazine) means it achieves deeper sedation at lower doses while producing fewer alpha-1-mediated side effects such as peripheral vasoconstriction^[6]. When combined with ketamine, dexmedetomidine allows a reduction in the ketamine dose typically by half which in turn attenuates ketamine-associated muscle rigidity and prolongs the duration of surgical-plane anaesthesia^[7]. Several canine research have supported the superiority of dexmedetomidine-based protocols, but direct head-to-head comparisons in cats undergoing actual surgical procedures as opposed to experimental sedation trials remain limited^[8,9].

This research was designed to fill that gap by comparing the cardiorespiratory effects, muscle relaxation quality, recovery profile, and post-operative pain of XK versus DK in cats undergoing routine OVH at a university veterinary teaching hospital in northern Thailand.

Materials and Methods

Materials

This prospective, randomised, blinded clinical trial was conducted between January and September 2023 at the Veterinary Teaching Hospital, Chiang Mai Academy of Veterinary Sciences, Thailand. The research protocol was approved by the Institutional Animal Ethics Committee (Protocol CAVS-AEC-2022-017, dated 12 December 2022). Forty clinically healthy female domestic shorthair cats, aged 8-36 months (mean 18.4 ± 7.2 months), weighing 2.4-4.6 kg (mean 3.3 ± 0.6 kg), and classified as ASA I (American Society of Anesthesiologists physical status I, i.e. healthy with no systemic disease) were enrolled. Cats were presented by their owners for elective OVH and were fasted for 8 hours with free access to water prior to the procedure. Exclusion criteria included pregnancy, lactation, prior anaesthetic adverse events, and any abnormality on pre-anaesthetic haematology or thoracic radiography.

Cats were randomly assigned by sealed envelope to Group XK (n = 20) or Group DK (n = 20). The anaesthetist, surgeon, and recovery observer were different individuals; the surgeon and recovery observer were blinded to group allocation.

Methods

Group XK received xylazine hydrochloride (1 mg/kg;

Xylazil-20, Troy Laboratories) combined with ketamine hydrochloride (10 mg/kg; Ketalar, Pfizer) in a single intramuscular injection into the quadriceps femoris. Group DK received dexmedetomidine hydrochloride (40 µg/kg; Dexdomitor, Zoetis) combined with ketamine hydrochloride (5 mg/kg) in a single intramuscular injection into the same site. All cats received meloxicam (0.2 mg/kg SC) as pre-emptive analgesia at induction^[3].

Physiological parameters—heart rate (HR, bpm), respiratory rate (RR, breaths/min), mean arterial pressure (MAP, mmHg, oscillometric), peripheral oxygen saturation (SpO₂, %), and rectal temperature (°C)—were recorded at baseline (T0, before injection) and at 5 (T5), 15 (T15), 30 (T30), 45 (T45), and 60 (T60) minutes after induction. Surgical muscle relaxation was scored by the surgeon on a three-point scale (1 = poor, marked abdominal tension; 2 = adequate, mild tension requiring gentle traction; 3 = excellent, no tension) at the point of ovarian pedicle ligation^[7]. OVH was performed through a ventral midline approach by a single experienced surgeon.

Recovery was defined in two stages: time to sternal recumbency and time to ambulation (walking without ataxia). Post-operative pain was assessed using the Glasgow Composite Measure Pain Scale-Feline (CMPS-Feline) at 1, 4, 8, and 24 hours after surgery by a single observer blinded to group allocation. A score $\geq 5/20$ triggered rescue analgesia (buprenorphine 0.02 mg/kg IM). Data were analysed using repeated-measures ANOVA for physiological parameters, Mann-Whitney U test for relaxation scores, independent t-test for recovery times, and Mann-Whitney U test for CMPS-Feline scores. Statistical significance was set at $p < 0.05$. Analyses were performed in R v4.3.1^[8].

Ethical Considerations

All procedures followed the Thai National Research Council guidelines for the use of animals in research. Written informed consent was obtained from each cat's owner. Cats were housed individually in thermoregulated recovery cages with soft bedding and monitored continuously until they were fully ambulatory. Any cat displaying signs of pain beyond the CMPS-Feline rescue threshold received immediate buprenorphine analgesia. No experimental euthanasia was performed.

Results

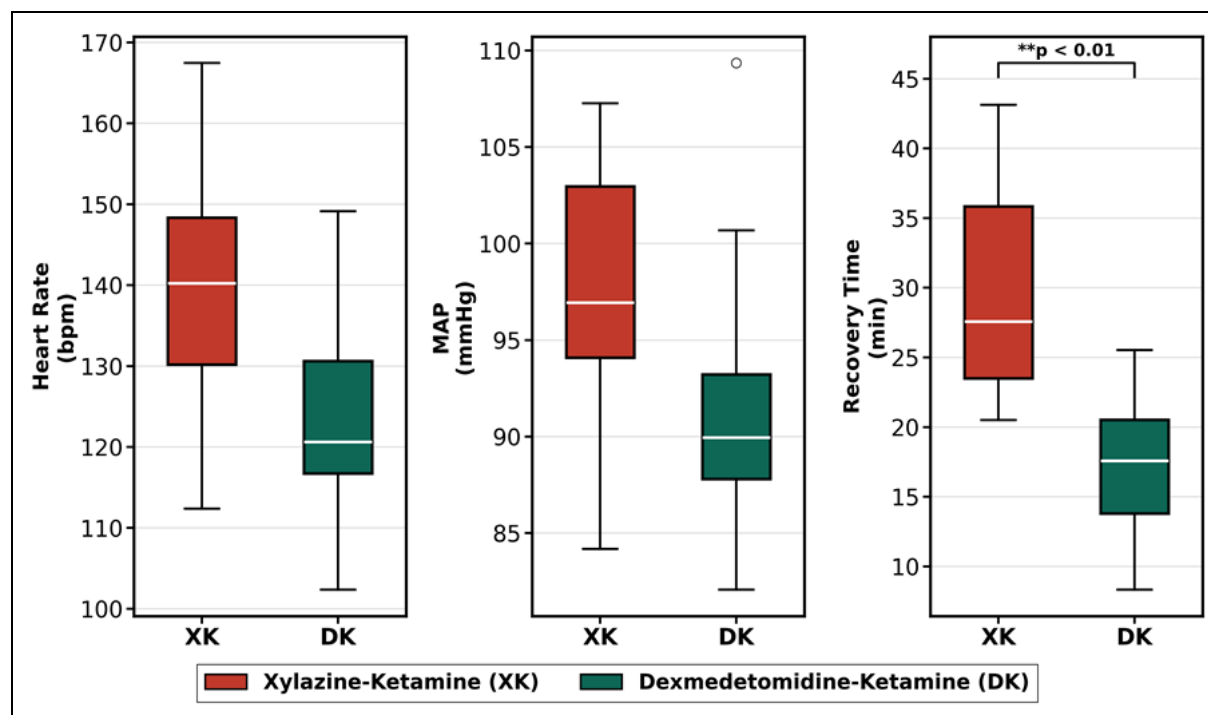


Fig 1: Box plot comparison of heart rate, mean arterial pressure, and recovery time to sternal recumbency between xylazine-ketamine (XK) and dexmedetomidine-ketamine (DK) groups in 40 cats undergoing ovariohysterectomy

All 40 cats completed the research without complications. Baseline physiological parameters did not differ between groups ($p > 0.30$ for all variables). Induction was smooth in both groups; however, 8 of 20 cats (40%) in Group XK

vomited within 3 minutes of injection compared to 1 of 20 (5%) in Group DK (Fisher's exact, $p = 0.02$). No cat in either group required supplemental ketamine to complete surgery.

Table 1: Pearson correlation coefficients among cardiorespiratory parameters and recovery time at T30 across both groups

Parameter	HR	MAP	RR	SpO ₂	Recovery
HR	1.000	+0.72**	+0.41*	-0.28	+0.63**
MAP	—	1.000	+0.38*	-0.21	+0.58**
RR	—	—	1.000	-0.34*	+0.29
SpO ₂	—	—	—	1.000	-0.18
Recovery	—	—	—	—	1.000

* $p < 0.05$, ** $p < 0.01$. HR and MAP showed the strongest positive correlation ($r = +0.72$), and both correlated positively with recovery time, suggesting that cats with greater cardiovascular depression recovered faster.

Table 2: Cardiorespiratory parameters (mean $\pm$ SD) at selected time points in XK and DK groups

Param	Group	T0	T5	T15	T30	T45	T60
HR	XK	184 $\pm$ 12	162 $\pm$ 14	148 $\pm$ 13	142 $\pm$ 15	146 $\pm$ 11	158 $\pm$ 13
(bpm)	DK	182 $\pm$ 11	144 $\pm$ 12*	132 $\pm$ 10*	128 $\pm$ 12*	134 $\pm$ 11*	148 $\pm$ 14
MAP	XK	108 $\pm$ 9	104 $\pm$ 8	98 $\pm$ 8	94 $\pm$ 7	96 $\pm$ 8	102 $\pm$ 7
(mmHg)	DK	107 $\pm$ 8	96 $\pm$ 7*	89 $\pm$ 7*	86 $\pm$ 6*	88 $\pm$ 7	98 $\pm$ 8
SpO ₂	XK	98 $\pm$ 1	96 $\pm$ 2	95 $\pm$ 2	94 $\pm$ 2	95 $\pm$ 2	97 $\pm$ 1
(%)	DK	98 $\pm$ 1	97 $\pm$ 1	96 $\pm$ 2	96 $\pm$ 1	96 $\pm$ 1	97 $\pm$ 1

*Significant difference between groups at the indicated time point ($p < 0.05$). HR and MAP were consistently lower in the DK group from T5 through T45. SpO₂ did not differ significantly between groups at any time point.

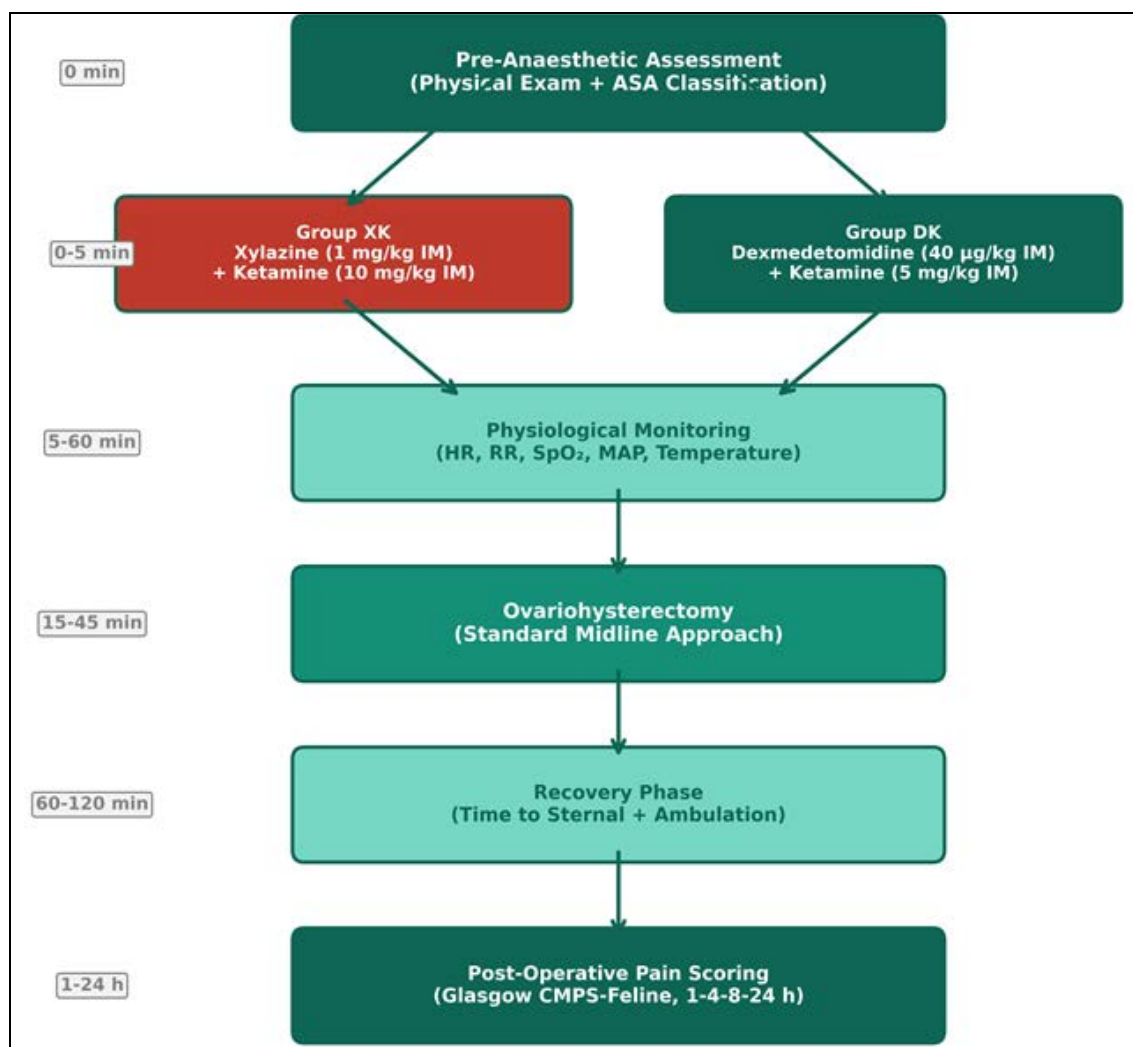


Fig 2: Step-by-step anaesthetic and monitoring protocol for feline ovariohysterectomy, showing the divergent drug administration between XK and DK groups and the common surgical and recovery pathway

Table 3: Post-operative pain scores (CMPS-Feline) and recovery parameters in XK and DK groups

Parameter	XK (n=20)	DK (n=20)	p-value	Diff.	95% CI	Effect
CMPS-F 1 h	3.8±1.2	2.4±0.9	< 0.01	1.4	0.7-2.1	Large
CMPS-F 4 h	3.2±1.1	2.1±0.8	< 0.05	1.1	0.5-1.7	Large
CMPS-F 8 h	2.1±0.9	1.8±0.7	0.24	0.3	-0.2-0.8	Small
CMPS-F 24 h	1.4±0.6	1.2±0.5	0.31	0.2	-0.2-0.6	Neg.
Sternal (min)	28.1±7.6	18.4±4.9	< 0.001	9.7	5.7-13.7	V. large
Ambulation (min)	52.3±12.4	34.7±8.1	< 0.001	17.6	11.0-24.2	V. large
Relaxation (1-3)	2.1±0.6	2.7±0.5	< 0.01	0.6	—	Large

CMPS-F = Glasgow Composite Measure Pain Scale-Feline (0-20). No cat reached the rescue threshold (≥ 5). Recovery times and pain scores were consistently better in the DK group, with the largest effects seen in recovery timing.

Comprehensive Interpretation

The data converge on a consistent advantage for the dexmedetomidine-ketamine protocol across every measured domain: cardiovascular stability was better maintained, muscle relaxation was graded higher by the blinded surgeon, recovery was nearly 10 minutes faster to sternal recumbency and 18 minutes faster to ambulation, and post-operative pain scores were significantly lower during the first four hours. The vomiting rate a practical nuisance in field spay clinics dropped from 40% in the XK group to 5% in the DK group. Taken together, these results present a compelling case for DK as the preferred injectable protocol for feline OVH.

Discussion

The central finding that dexmedetomidine-ketamine outperformed xylazine-ketamine in cardiorespiratory stability,

surgical conditions, recovery speed, and early post-operative comfort—aligns with the pharmacological profile of the two alpha-2 agonists. Dexmedetomidine's roughly tenfold greater alpha-2 selectivity means that sedation and analgesia are achieved at microgram doses, reducing the non-specific cardiovascular depression that characterises xylazine at milligram doses [6].

Published literature largely supports these observations. Selmi and colleagues reported that dexmedetomidine-ketamine produced better muscle relaxation and shorter recovery in cats sedated for minor procedures, though their trial did not involve surgical anaesthesia [9]. A canine research by Kuusela and associates demonstrated that dexmedetomidine maintained cardiac output more effectively than medetomidine or xylazine at equipotent sedative doses [7]. The present data extend these findings to a full surgical context in

cats, confirming that the advantages persist when a painful procedure and post-operative recovery are included in the assessment.

The reduction in vomiting incidence from 40% to 5% has practical significance beyond patient comfort. In high-throughput spay clinics processing dozens of cats per day, a vomiting cat delays the workflow, requires repositioning, and poses an aspiration risk during the transition to lateral recumbency. Dexmedetomidine's lower emetic potential in cats possibly related to its reduced effect on the chemoreceptor trigger zone compared to xylazine—has been noted in pharmacological reviews but seldom quantified in clinical trials^[4,5].

One potential concern with dexmedetomidine is its cost. At current Thai market prices, a single dose of dexmedetomidine for a 3.5 kg cat costs approximately 3.5 times more than the equivalent xylazine dose^[2]. Whether the clinical benefits documented here—fewer adverse events, faster recovery, lower pain scores—justify that premium depends on the setting. In a high-volume shelter clinic, faster recovery means higher daily throughput, which may offset the drug cost. In a private practice, client satisfaction with a calmer, faster-recovering cat adds intangible value.

Safety Considerations

No life-threatening adverse events occurred in either group. Two cats in Group XK developed transient second-degree atrioventricular block at T15, which resolved spontaneously by T30 without intervention—a recognised but generally benign effect of alpha-2 agonists in cats^[5]. SpO₂ remained above 93% in all animals throughout the monitoring period, and no cat required supplemental oxygen. Rectal temperature declined by a mean of 1.2 °C in both groups by T60, consistent with the peripheral vasoconstriction and reduced metabolic rate associated with alpha-2 agonist-dissociative combinations; active warming with a forced-air blanket prevented further hypothermia during recovery. The absence of any rescue analgesia requirement in either group suggests that both protocols, when combined with pre-emptive meloxicam, provide adequate perioperative pain control for feline OVH.

Clinical Implications

For veterinarians performing feline OVH in settings without inhalation anaesthesia, the DK protocol at the doses used here (dexmedetomidine 40 µg/kg + ketamine 5 mg/kg IM) provides a practical, single-injection anaesthetic with measurable advantages over the traditional XK combination. The protocol is simple to prepare, requires no intravenous access for induction, and produces a surgical plane adequate for routine OVH within 5 minutes. The faster recovery shortens the post-operative observation period, which is particularly valuable in high-throughput trap-neuter-return programmes. Clinicians should monitor for bradycardia and have atipamezole available as a reversal agent if needed, though reversal was not required in any cat in the present trial.

Conclusion

Injectable anaesthesia remains indispensable for feline ovariohysterectomy in resource-limited settings, and the choice of alpha-2 agonist partner for ketamine has measurable consequences for the patient, the surgeon, and the clinic's workflow. This research directly compared the two most accessible options xylazine-ketamine and dexmedetomidine-ketamine under standardised surgical conditions in 40 cats.

On every parameter assessed, the dexmedetomidine-ketamine protocol performed as well as or better than the xylazine-ketamine protocol. Heart rate and mean arterial pressure were maintained closer to physiological baselines. Muscle relaxation scored higher, making the surgeon's task easier and potentially safer. Recovery to sternal recumbency was nearly 10 minutes faster, and ambulation was achieved almost 18 minutes sooner—differences that translate directly into shorter observation periods and higher clinic throughput. Post-operative pain scores were significantly lower in the first four hours, a window that coincides with the period of greatest discomfort after abdominal surgery. The vomiting rate dropped from 40% to 5%, eliminating a common and unpleasant complication.

The recommendation arising from these data is straightforward: where budget allows, dexmedetomidine-ketamine should replace xylazine-ketamine as the default injectable protocol for feline OVH. The higher per-dose cost of dexmedetomidine is offset by operational savings from faster recovery and fewer adverse events. For clinics operating under strict cost constraints, the data at least argue for reserving xylazine-ketamine for healthy, low-risk patients and preferring dexmedetomidine-ketamine for older cats, those with marginal cardiovascular reserve, or situations where rapid recovery is prioritised.

Future research should explore whether adding a low dose of a benzodiazepine (e.g., midazolam) to the DK protocol could further improve muscle relaxation without prolonging recovery, and whether atipamezole reversal at the end of surgery shortens recovery times without compromising analgesia. Larger multicentre trials incorporating long-term follow-up for surgical site complications would strengthen the evidence base for widespread protocol adoption.

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Contributions Not Qualifying for Authorship

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