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Research Article

Evaluation of the Anesthetic Efficacy of the Medetomidine–Butorphanol–Ketamine Combination (Kitty Magic) in Cats

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ABSTRACT

This study was conducted to evaluate the anesthetic efficacy, effects on physiological stability, and postoperative analgesic efficacy of medetomidine–butorphanol–ketamine combination (Kitty Magic) in cats undergoing routine bilateral orchiectomy (castration). Twenty clinically healthy male cats of varying breeds, ages, and body weights were administered a single intramuscular injection of an equal-volume mixture of medetomidine (0.5 mg/mL), butorphanol (10 mg/mL), and ketamine (100 mg/mL) ("Kitty Magic") at 0.02–0.08 mL/kg (total mixture volume). Mean sedation duration was 4.15 ± 2.13 minutes, surgical anesthesia duration was 43.85 ± 8.78 minutes, and total anesthesia time was 59.65 ± 9.03 minutes. The time to come to the sternal position was 57.25 ± 10.89 minutes, and the time to stand was 60.85 ± 16.80 minutes. Statistically significant but clinically tolerable decreases in heart rate, respiratory rate, and body temperature were observed. No complications such as vomiting, urination, or excitation were observed. Postoperative pain assessment was performed using the Simple Descriptive Scale, and 90% of cases had a pain score of "0." Atipamezole injection administered at the end of the operation resulted in full recovery within an average of 12.11 ± 5.47 minutes.

The findings indicate that the Kitty Magic combination provides reliable anesthesia in cats, produces adequate muscle relaxation and analgesia, and maintains cardiorespiratory stability. Due to its simple administration method, cost-effectiveness, and ease of reversal with atipamezole, this protocol is a practical and safe alternative for short-term surgical procedures in shelters and clinical settings.

Keywords: *Analgesic, cyclohexanes, feline, imidazoles, morhinans*

Kedilerde Medetomidin–Butorfanol–Ketamin Kombinasyonunun (Kitty Magic) Anestezik Etkinliğinin Değerlendirilmesi

ÖZET

Bu çalışma, rutin bilateral orşiektomi (kastrasyon) operasyonu geçiren kedilerde medetomidin–butorfanol–ketamin kombinasyonunun (Kitty Magic) anestezik etkinliğini, fizyolojik stabilite üzerindeki etkilerini ve postoperatif analjezik etkinliğini değerlendirmek amacıyla gerçekleştirilmiştir. Farklı ırk, yaş ve vücut ağırlıklarına sahip klinik olarak sağlıklı yirmi erkek kediye 0.02–0.08 mL/kg dozunda tek bir intramüsküler enjeksiyon uygulanmıştır. Ortalama sedasyon süresi 4.15 ± 2.13 dakika, cerrahi anestezi süresi 43.85 ± 8.78 dakika ve toplam anestezi süresi 59.65 ± 9.03 dakika olarak belirlenmiştir. Sternala gelme süresi 57.25 ± 10.89 dakika, ayağa kalkma süresi ise 60.85 ± 16.80 dakika olarak kaydedilmiştir. Kalp atım sayısı, solunum sayısı ve vücut ısısında istatistiksel olarak anlamlı ancak klinik olarak tolere edilebilir düşüşler gözlenmiştir. Kusma, idrar yapma veya eksitasyon gibi herhangi bir komplikasyona rastlanmamıştır. Postoperatif ağrı değerlendirmesi Basit Tanımlayıcı Skala (Simple Descriptive Scale) kullanılarak yapılmış ve olguların %90'ının ağrı skoru "0" olarak kaydedilmiştir. Operasyon sonunda uygulanan atipamezol enjeksiyonu, ortalama 12.11 ± 5.47 dakika içinde tam uyanma sağlamıştır.

Elde edilen bulgular, Kitty Magic kombinasyonunun kedilerde güvenilir bir anestezi sağladığını, yeterli kas gevşemesi ve analjezi oluşturduğunu ve kardiyorespiratuvar stabiliteyi koruduğunu göstermektedir. Basit uygulama yöntemi, maliyet etkinliği ve atipamezol ile kolaylıkla geri döndürülebilmesi nedeniyle bu protokol, barınaklar ve klinik ortamlarda kısa süreli cerrahi işlemler için pratik ve güvenli bir alternatiftir.

Anahtar Kelimeler: *Analjezik, feline, imidazoller, morfinanlar, sikloheksanlar*

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Introduction

Castration is one of the most common procedures in small animal surgery and is usually performed under general anesthesia. Providing safe, adequate depth, and appropriate duration of anesthesia is crucial for surgical success and animal welfare (Koç & Sarıtaş, 2004; Ünsaldı, 2011). Ketamine is a dissociative anesthetic that produces loss of consciousness and somatic analgesia but has limited muscle relaxant effects. Therefore, it is generally used in combination with α2-adrenergic agonists and opioids in clinical practice (Topal, 2005; Baetge & Matthews, 2012).

Medetomidine, an α2-adrenergic receptor agonist, is widely preferred in small animal medicine for its potent sedative, analgesic, and muscle relaxant properties (Lemke, 2004; Granholm et al., 2006). The most important advantages of this agent are its short-term effect, reversibility with specific antagonists such as atipamezole, and safe recovery (Ünsaldı, 2011).

Butorphanol, an opioid-derived analgesic, provides effective analgesia while minimizing cardiopulmonary side effects thanks to its kappa receptor agonist and partial μ-receptor antagonist properties (Nussbaumer et al., 2008; Taylor et al., 2010). When used with ketamine, its analgesic and sedative effects are synergistically enhanced (Horn, 2017; Miller et al., 2014).

The combination of these three agents—medetomidine, butorphanol, and ketamine—is referred to as "Kitty Magic" in veterinary medicine and is used as a practical, economical, and reliable option, particularly in feline anesthesia (Schroeder & Smith, 2011).

The aim of this study was to evaluate the efficacy of a combination of medetomidine, butorphanol, and ketamine in general anesthesia in cats, and to determine anesthesia induction time, duration of surgical anesthesia, reflex loss times, physiological parameters, and potential complications. The study findings are intended to contribute to the search for effective and safe combinations for feline anesthesia.

Materials and Methods

In this study, a total of 20 cats of different breeds, ages, and sexes, which were brought to the Surgery Department Clinic of Aydin Adnan Menderes University Faculty of Veterinary Medicine for castration and determined to be clinically healthy following physical, radiological, hematological, and biochemical evaluations, were used. The cats were fasted for 12 hours prior to surgery but were allowed access to water. This research was conducted with the approval of the Aydın Adnan Menderes University Local Ethics Committee for Animal Experiments (approval no. 64583101/2019/030). Consent forms were obtained from all animal owners.

Anesthesia Protocol

For anesthesia, medetomidine hydrochloride (Domitor®, Zoetis, Türkiye), ketamine hydrochloride (Alfamine® 10%, Atafen, Türkiye), and butorphanol hydrogen tartrate (Butomidor®, Interhas, Türkiye) were mixed in equal amounts to prepare the "Kitty Magic" combination. The prepared mixture was administered intramuscularly (IM) at a dose of 0.02–0.08 ml/kg to cats scheduled for surgery. Following injection, the onset of sedation, loss of ear, tail, forelimb, and hindlimb pedal reflexes, surgical anesthesia duration, operation time, and time to regain sternal recumbency were recorded. During anesthesia, respiratory rate (R), heart rate (P), and body temperature (T) were measured every 5 minutes. At the end of the surgical procedure, the animals were kept under observation until fully recovered and monitored for possible complications (vomiting, urination, excitation, defecation, etc.).

Clinical Evaluation

Sedative efficacy was evaluated based on reflex loss times and changes in physiological parameters. The onset of sedation was defined as the first moment when the animal responded minimally to environmental stimuli after injection. Reflex loss times were determined as the time when ear, tail, forelimb, and hindlimb pedal reflexes disappeared. The duration of surgical anesthesia was defined as the period during which anesthetic depth was sufficient throughout the operation. The time to regain sternal recumbency was considered as the moment when the animal first lifted its body and returned to a normal position. Changes in heart rate (P), respiratory rate (R), and body temperature (T) parameters were monitored over time.

Pain Assessment

Postoperative pain level was evaluated using the Simple Descriptive Scale (SDS) developed by Slingsby et al. (2015) and Steagall et al. (2009). The scale classifies the degree of pain in cats from 0 to 4: 0 – No pain, 1 – Mild discomfort, 2 – Moderate pain, 3 – Severe pain, 4 – Very severe pain (marked restlessness). The animals were observed for 6 hours after surgery, and pain scores were recorded at regular intervals.

Statistical Evaluation

The data were analyzed using the SPSS 19.0 statistical software package, and values with a significance level of $P<0.05$ were considered statistically significant. For each variable, the arithmetic mean ($\bar{x}$) was calculated; for time-dependent variables, the standard error of the mean (SE) was determined, whereas for other parameters the standard deviation (SD) was used. The Shapiro–Wilk test was applied to assess the normality of data distribution. For variables exhibiting a normal distribution, differences were evaluated using the paired samples t-test. For non-normally distributed variables—specifically heart rate at 45 minutes and respiratory rate at 10 minutes—pairwise comparisons were performed using the Wilcoxon signed-rank test and the sign test.

Results

The distribution of the total 20 cats used as study material was as follows: 1 Siamese, 1 Angora, 1 Persian, and 17 Domestic Shorthair cats. The ages of the animals ranged from 1 to 4 years (mean ± SD: 1.85 ± 0.81 years), and

Table 1. Breed, age, sex, and weight distribution of the cats used as study material

Animal No	Breed	Age (y)	Body weight (g)
1	Domestic Shorthair	1	3250
2	Domestic Shorthair	2	3650
3	Domestic Shorthair	3	5200
4	Siamese	2	4150
5	Domestic Shorthair	1	3350
6	Domestic Shorthair	2	2800
7	Domestic Shorthair	2	5100
8	Domestic Shorthair	1	4300
9	Domestic Shorthair	2	4320
10	Domestic Shorthair	1	2750
11	Domestic Shorthair	1	3800
12	Angora	2	4100
13	Domestic Shorthair	2	4850
14	Persian	2	3150
15	Domestic Shorthair	1	4700
16	Domestic Shorthair	3	4120
17	Domestic Shorthair	1	3500
18	Domestic Shorthair	4	3650
19	Domestic Shorthair	2	4000
20	Domestic Shorthair	2	3400

Table 2. Mean values and ranges of anesthetic parameters recorded in cats anesthetized with the Kitty Magic protocol.

Parameter	Min/Max	Mean ± SD
Surgical anesthesia duration (min)	22 / 54	43.85 ± 8.78
Total anesthesia duration (min)	30 / 72	59.65 ± 9.03
Time to lateral recumbency (min)	1 / 9	4.15 ± 2.13
Time to loss of ear reflex (min)	1 / 14	5.65 ± 3.41
Time to loss of tail reflex (min)	1 / 15	5.75 ± 3.51
Time to loss of forelimb pedal reflex (min)	2 / 18	6.95 ± 4.81
Time to loss of hindlimb pedal reflex (min)	2 / 22	7.30 ± 5.38
Time to sternal recumbency (min)	30 / 72	57.25 ± 10.89
Time to standing position (min)	1 / 75	60.85 ± 16.80

body weights ranged from 2.75 to 5.20 kg (mean ± SD: 3.91 ± 0.71 kg) (Table 1).

Following the Kitty Magic injection, sedative effect was observed to develop within an average of 4.15 ± 2.13 minutes, after which the cats assumed a lateral position. The duration of surgical anesthesia was determined as 43.85 ± 8.78 minutes, while the total anesthesia duration was 59.65 ± 9.03 minutes. The time for the cats to regain sternal recumbency was 57.25 ± 10.89 minutes, and recovery of the standing reflex took 60.85 ± 16.80 minutes. The operation durations were recorded separately for each cat, and the arithmetic mean of these values was calculated as 6.7 ± 1.3 minutes. Detailed information on anesthesia durations is presented in Table 2.

The Kitty Magic combination was administered as a single injection. During and after sedation, no complications such as vomiting, urination, excitation, or defecation were observed in any of the cats.

At the 45th minute following sedation, atipamezole was administered to all subjects. After atipamezole injection, the time for the cats to regain sternal recumbency was measured and found to be 12.11 ± 5.47 minutes on average. One of the cats in the study showed signs of awakening at the 28th minute following injection; therefore, atipamezole was administered at the 31st minute.

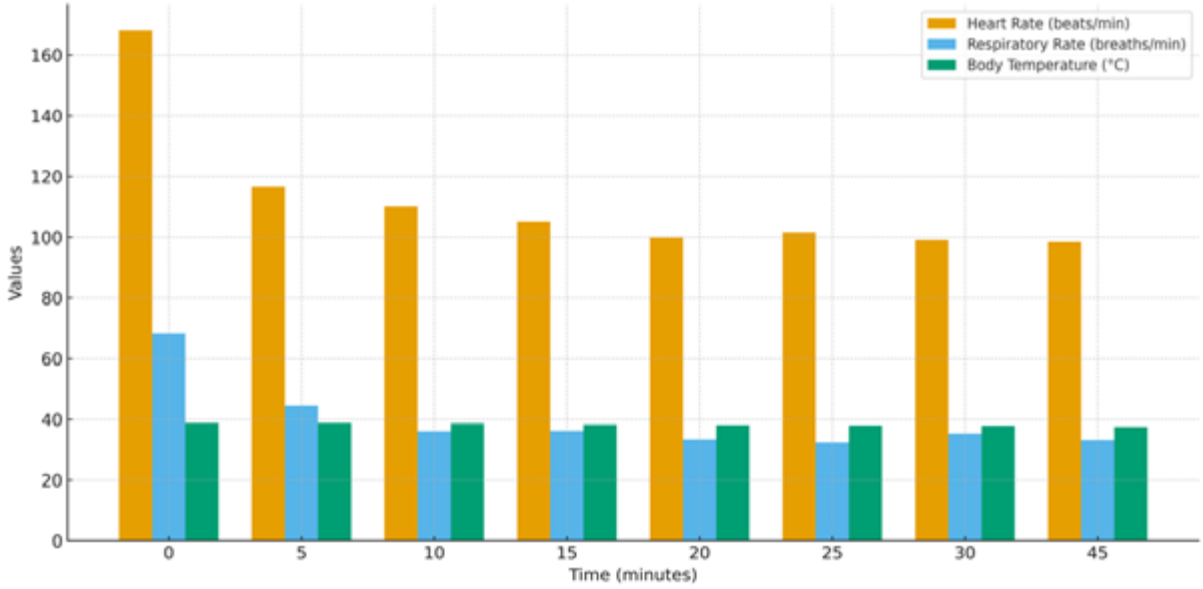

Figure 1. Mean values of heart rate (beats/min), respiratory rate (breaths/min), and body temperature (°C) recorded at 0, 5, 10, 15, 20, 25, 30, and 45 minutes during Kitty Magic anesthesia in cats. Heart rate and respiratory rate showed a significant decrease compared to baseline values ($P<0.05$), while body temperature demonstrated a gradual decline remaining within physiological limits. Error bars represent standard deviations.

Among the cats anesthetized with the Kitty Magic combination, 3 moved their hind limbs during scrotal incision, apnea was observed in 4 cases, and arrhythmia in 5 cases. Additionally, one cat required an additional dose of anesthetic agent 16 minutes after injection, while two others required it after 14 minutes.

Reflex Parameters

In the anesthetized animals, ear, tail, forelimb, and hindlimb pedal reflexes were evaluated. The loss of ear and tail reflexes occurred at an average of 5.65 ± 3.41 and 5.75 ± 3.51 minutes, respectively, while the loss of forelimb and hindlimb pedal reflexes occurred at 6.95 ± 4.81 and 7.30 ± 5.38 minutes, respectively (Table 2).

Physiological Parameters

During Kitty Magic anesthesia, heart rate, respiratory rate, and body temperature were recorded at 0, 5, 10, 15, 20, 25, 30, and 45 minutes. The heart rates were 168.20 ± 8.33, 116.80 ± 7.25, 110.30 ± 4.97, 105.00 ± 5.21, 99.80 ± 5.79, 101.60 ± 6.03, 99.00 ± 5.14, and 98.42 ± 6.62 beats/min, respectively. The respiratory rates were 68.35 ± 5.98, 44.70 ± 4.02, 36.10 ± 2.81, 36.20 ± 2.71, 33.30 ± 2.68, 32.30 ± 2.82, 35.30 ± 3.16, and 33.05 ± 2.29 breaths/min, respectively. Body temperature values were recorded as 38.77 ± 0.11, 38.79 ± 0.12, 38.61 ± 0.13, 38.32 ± 0.13, 38.13 ± 0.14, 38.04 ± 0.15, 37.93 ± 0.16, and 37.53 ± 0.14 °C, respectively (Table 3, Figure 1).

Statistical evaluations revealed a statistically significant difference ($P < 0.05$) among the heart rate values when compared minute by minute. When the mean respiratory rates were compared minute by minute, a statistically significant difference was found between 0, 5, 10, 20, 25, and 30 minutes ($P < 0.05$); however, no statistically significant difference was detected between 10 and 15 minutes or between 20 and 45 minutes ($P > 0.05$) (Table 3).

Discussion

This study was conducted to evaluate the effects of the frequently used medetomidine–butorphanol–ketamine combination (Kitty Magic) in cat orchiectomy operations on anesthetic efficacy, cardiorespiratory responses, and postoperative analgesia. Compared with similar studies reported in the existing literature, the study demonstrates that the medetomidine–butorphanol–ketamine protocol is a suitable, stable, and easily reversible anesthetic for short-duration surgical procedures.

Similar results have been obtained in recent studies. Robertson et al. (2018) reported that combinations of α2-agonist + opioid + dissociative are predictable, safe, and practical in cats for short-term elective surgeries, as per the AAFP Feline Anesthesia Guidelines. These protocols

Table 3. Mean (±SE) values of heart rate (P), respiratory rate (R), and body temperature (T) measured at different time points following administration of the Kitty Magic protocol (medetomidine–ketamine–butorphanol) in cats.

Parameter	0 min	5 min	10 min	15 min	20 min	25 min	30 min	45 min
P (beats/min)	168.20±8.33^{a}	116.80±7.25^{b}	110.30±4.97^{c}	105.00±5.21^{d}	99.80±5.79^{e}	101.60±6.03^{f}	99.00±5.14^{g}	98.42±6.62^{h}
R (breaths/min)	68.35±5.98^{a}	44.70 ± 4.02^{b}	36.10 ± 2.81^{c}	36.20 ± 2.71^{c}	33.30± 2.68^{d}	32.30±2.82^{e}	35.30±3.16^{f}	33.05±2.29^{d}
T (°C)	38.77±0.11	38.79±0.12	38.61±0.13	38.32±0.13	38.13±0.14	38.04±0.15	37.93±0.16	37.53±0.14

Different superscript letters within the same row indicate statistically significant differences ($P < 0.05$).

Table 4. Postoperative Pain Assessment Scores

	Pain Score										
Case No	0	1	2	3	4	Case No	0	1	2	3	4
1		✓				11	✓				
2	✓					12	✓				
3	✓					13	✓				
4	✓					14	✓				
5	✓					15	✓				
6		✓				16		✓			
7	✓					17	✓				
8	✓					18	✓				
9	✓					19	✓				
10	✓					20	✓				

SDS pain score definitions: 0 = no pain; 1 = mild discomfort; 2 = moderate pain; 3 = severe pain; 4 = very severe pain (marked restlessness). Pain was assessed during the first 6 h postoperatively at predetermined intervals; the table reports the maximum score observed for each case.

are recommended as a reliable alternative, particularly in low-volume clinics where inhalation anesthesia infrastructure is not available.

In this study, the mean duration of anesthesia was 59.65±9.03 minutes, and the duration of surgical anesthesia was 43.85±8.78 minutes; these values were consistent with the results of Bruniges et al. (2016) and Kim et al. (2015). More recently, Imboden et al. (2023) similarly reported that combinations containing medetomidine provided high stability from induction to recovery, and that the medetomidine-butorphanol combination, in particular, had limited effects on cardiac parameters.

The decrease in heart and respiratory rates was attributed to the physiological effects of medetomidine and paralleled findings in the literature. Hedenqvist et al. (2021) stated that ketamine and α2-agonist combinations may cause mild bradycardia and hypoventilation, but these effects are generally clinically insignificant. Although the cardiorespiratory changes in the present study were statistically significant, their being clinically tolerable supports the reliability of the combination.

In postoperative analgesia assessment, the mean pain score obtained with the Kitty Magic protocol was 0.1, which was lower than those reported by Fernandez-Parra et al. (2017) and Polson et al. (2012). This may be explained by the partial μ-opioid receptor agonist effect of butorphanol. Similarly, Corona et al. (2020) reported that short-acting protocols containing opioids provided minimal pain and high-quality recovery in cats. Furthermore, Cremer and Riccó (2017) emphasized that the combination of opioids with α2-agonists enhances not only analgesia but also antinociceptive effects, thereby improving postoperative behavioral comfort.

In the present study, minimal movement in response to surgical stimulation was observed in three cats, requiring additional doses. This finding aligns with the supplemental analgesic requirements reported by Slingsby et al. (2015) and did not affect the overall effectiveness of the protocol. Moser et al. (2020) similarly noted that, in a comparison of dexmedetomidine–alfaxalone combinations with buprenorphine and butorphanol, butorphanol provided sufficient anesthetic quality, though additional inhalation support was occasionally required.

The time-dependent decrease in respiratory rate observed in this study was consistent with the reports of Khenissi et al. (2017) and Lee et al. (2015), indicating that α2-agonist–induced respiratory depression remained within physiological limits. Van Nimwegen et al. (2019) also emphasized that sedative combinations may vary individually in cats and dogs but that the medetomidine–butorphanol–ketamine trio is among the safest in terms of hemodynamic stability.

The mean recovery time after atipamezole administration was recorded as 12 minutes, which is parallel to the 10–15 minute recovery times reported by Granholm et al. (2006). Imboden et al. (2023) similarly reported that atipamezole can be used safely as an effective reversal agent in medetomidine-based protocols, although early administration may slightly increase postoperative pain scores.

No complications such as salivation, vomiting, vocalization, or excitation were observed during surgery in cats anesthetized with the Kitty Magic protocol. This finding is consistent with the reports of Bruniges et al. (2016) and Wiese & Muir (2006). More recently, Cremer and Riccó (2017) confirmed that the antiemetic and sedative effects of α2-agonists reduce the incidence of such complications.

The four short-term apnea cases observed in this study correspond with the transient respiratory arrests repor-

ted by Harrison et al. (2011) for similar combinations and did not cause clinical issues after recovery. Considering the findings of Biermann et al. (2012), which indicated that cardiovascular changes could be more pronounced in dexmedetomidine-based protocols, the balanced dosing ratios in the Kitty Magic combination appear to minimize this effect.

In conclusion, the medetomidine-butorphanol-ketamine combination (Kitty Magic) stands out as a safe, predictable, and economical anesthetic option for short-term feline orchiectomies. This combination offers the advantages of rapid induction, adequate surgical depth, minimal cardiorespiratory depression, and controlled recovery with atipamezole. Furthermore, recent multicenter studies reported in the literature (Robertson et al., 2018; Moser et al., 2020; Imboden et al., 2023) also support the widespread use of this protocol in clinical practice and its high safety profile.

Conclusion

This study evaluated the anesthetic effects, cardiorespiratory responses, and postoperative analgesia of the medetomidine–butorphanol–ketamine (Kitty Magic) combination administered during orchiectomy operations in cats. Following the combination, reflexes disappeared within an average of 6.95 ± 4.81 minutes, surgical anesthesia was achieved for 43.85 ± 8.78 minutes, and was easily reversed within 12.11 ± 5.47 minutes following atipamezole injection. While statistically significant decreases were observed in respiratory and heart rates, and body temperature, these changes were found to remain within physiological limits and did not pose a clinical risk. No complications such as vomiting, urination, excitation, or defecation were observed during the study. The findings demonstrate that the Kitty Magic protocol is a reliable, practical, and balanced option for feline anesthesia, providing effective surgical anesthesia in a short time, providing adequate muscle relaxation and analgesia during the operation, exhibiting a low complication rate, and being easily reversible with atipamezole. Furthermore, it was concluded that this combination offers an economical, feasible, and safe alternative even in situations where inhalation anesthesia equipment is not available.

Based on these results, it is recommended that the Kitty Magic protocol can be safely used by veterinarians in castration and ovariohysterectomy operations performed in shelters and clinical settings. Furthermore, further studies to determine the effects of variables such as different dose levels, age, sex, and health status on the duration of anesthesia and physiological responses would be beneficial. Furthermore, combining this protocol with nonsteroidal anti-inflammatory drugs or multimodal analgesic approaches in the postoperative period may further improve pain management and the quality of recovery in cats.

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Conflict of Interest

The authors declare that they have no conflict of interest related to this manuscript.

Author Contribution Statement

G.Y.G. contributed to data collection, investigation, formal analysis, and drafting of the manuscript. E.Ç. contributed to the conception and design of the study, supervision, methodology, data interpretation, critical revision of the manuscript, and correspondence. B.K. contributed to data collection, literature review, and manuscript editing. A.B. contributed to the conception of the study, supervision, methodology, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

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