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Pattern of Bupivacaine-Xylazine Anaesthesia and Behavioural Alterations Following Open Castration in Rabbits

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ABSTRACT

Castration is a routine Veterinary procedure requiring effective anaesthesia to ensure animal welfare and surgical success. Xylazine-bupivacaine is increasingly used in rabbit anaesthesia, yet its anaesthetic pattern and post-castration physiological and behavioural effects are poorly documented. This study evaluated the anaesthetic profile of xylazine-bupivacaine and associated changes following open castration in ten male Chinchilla rabbit bucks (*Oryctolagus cuniculus*) aged 8±2.0 months and weighing 1.4±0.2 kg, randomly assigned to castrated (n=5) and non-castrated control (n=5) groups. All animals received xylazine (5 mg/kg intramuscularly) five minutes before bupivacaine (5 mg/kg) scrotal infiltration. Anaesthesia onset, duration, and recovery were 8.0±1.1, 28.2±6.0, and 52.5±4.0 minutes in the castrated group, and 8.2±2.0, 20.3±2.0, and 58.8±11.0 minutes in the non-castrated group, respectively (p>0.05). Serum alanine aminotransferase rose transiently at 24 hours, declined below baseline at 48 hours, and returned to baseline by 72 hours. Creatinine decreased significantly in the castrated group at 72 hours (3.46±0.71 mg/dL; p<0.05). Vital parameters recovered to baseline within 24 hours following transient depression at 30 minutes. Significant reversible mydriasis was observed during anaesthesia (7.5±0.2 mm vs. 6.0±0.1 mm baseline; p<0.05). Mounting and thumping behaviours ceased by Day 30 and 40, respectively; vocalizing by Day 50, and cycling and grooming by Day 60 post-castration, consistent with androgen withdrawal. The xylazine-bupivacaine combination provides safe, short-duration anaesthesia adequate for rabbit castration, with transient and clinically manageable physiological effects and predictable behavioural outcomes.

Keywords: *alpha-2 agonist, amide local anaesthetic, androgen withdrawal, mydriasis, orchiectomy*

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Data Availability

Data supporting the findings are available from the corresponding author on reasonable request.

Introduction

Castration (orchidectomy or orchiectomy); the surgical excision of the testes, is performed routinely in veterinary medicine for population control, behavioural modification, prevention of unwanted breeding, and enhancement of meat quality (Gerencsér *et al.*, 2020; Faraji *et al.*, 2021). In rabbits, the procedure additionally reduces aggression, eliminates the “boar taint” in

carcasses, and supports laboratory colony management (Gerencsér *et al.*, 2020).

The rabbit presents particular anaesthetic challenges due to its delicate physiology and heightened stress response (Lichtenberger and Ko, 2011). Effective anaesthesia requires balanced sedation, analgesia, and muscle relaxation while minimising adverse effects on vital systems. Xylazine, an alpha-2 adrenergic agonist, produces dose-dependent sedation, analgesia, and

muscle relaxation through inhibition of norepinephrine release (Greene and Thurmon, 2007; Lin *et al.*, 2010). Bupivacaine, a long-acting amide local anaesthetic, provides sustained analgesia at the surgical site through reversible sodium-channel blockade (Butterworth and Strichartz, 1990; Cederholm *et al.*, 2008). Together, these agents offer complementary mechanisms of action that are reported to be effective and well-tolerated for castration in rabbit (Kumar *et al.*, 2018).

Despite clinical use of this combination, information regarding its precise anaesthetic pattern and effects on biochemical parameters, vital signs, pupillary response, and post-castration behaviour in rabbits remains limited. This study was therefore designed to: (i) determine the onset, duration, and recovery time of xylazine-bupivacaine anaesthesia; (ii) assess biochemical and haematological changes following anaesthesia and castration; (iii) evaluate pupillary diameter changes during anaesthesia; and (iv) document behavioural alterations following open castration.

Materials and Methods

Ethical Approval

Ethical approval was obtained from the Institutional Ethical Committee, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria (Reference: JOSTUM/VCM/ETHICS/2024/17). All procedures, complied with institutional guidelines for animal use and care.

Study location

The study was conducted at the Veterinary Teaching Hospital South Core, Joseph Sarwuan Tarka University, Makurdi (07°41'N, 08°37'E), Benue State, Nigeria. This is located in a tropical climate region with average annual rainfall of 1,290 mm and temperatures ranging between 26.5°C and 42°C (Okechukwu, 2013).

Animals and Experimental Design

Ten male domestic rabbit bucks (*Oryctolagus cuniculus*), Chinchilla breed, aged 8±2.0 months and weighing 1.4±0.2 kg, were purchased from a commercial farm in Benue State. Animals were randomly assigned to two (2) groups: castrated (n=5) and non-castrated control (n=5). All rabbits were individually housed under controlled conditions (temperature: 25±2°C; relative humidity: 55–65%; 12 h light/dark cycle) with *ad libitum* access to water and a balanced commercial rabbit pelleted diet (crude protein: 16–18%; digestible energy: 10–11 MJ/kg). Animals underwent two weeks of acclimatization in preparation for the study.

Anaesthetic Protocol

Animals were fasted for 12 hours pre-operatively with free access to water. Each rabbit received xylazine hydrochloride (Xylased®; 5 mg/kg intramuscularly; Biovet, Haryana, India) as premedication. Five minutes later, bupivacaine 0.5% (5 mg/kg; Marcaine®; Myungmoon Pharm. Co., Seoul, Republic of Korea) was infiltrated at the scrotal incision site. Adequacy of local analgesia was confirmed by pinprick at the scrotal site before incision.

Surgical Procedure

Open castration was performed following the method described by Jenkins (2012). The scrotal region was clipped and aseptically prepared. A longitudinal scrotal incision was made sufficient to exteriorise one testis at a time. The vaginal tunic was incised to expose the tunica albuginea of the testis and the spermatic cord. The spermatic cord and associated vessels were doubly ligated with chromic catgut size 3-0 (Johnson and Johnson®, New Brunswick, USA) and transected distal to the ligatures. The procedure was repeated for the contralateral testis. Skin was closed with nylon size 3-0 (Johnson and Johnson®, New Brunswick, USA) in a simple interrupted pattern. Meloxicam (0.5 mg/kg subcutaneously; Melocap®; Evans Therapeutics Ltd., Lagos, Nigeria) was administered once daily for three days post-operatively. The surgical site was inspected daily for swelling, discharge, or dehiscence.

Vital Parameter Monitoring

Rectal temperature obtained using a mercury thermometer, respiratory rate, and heart rate obtained using a stethoscope were recorded at baseline (0, that is, before anaesthesia), 30 minutes, 24, 48, and 72 hours after anaesthesia.

Pupillary Diameter Measurement

Pupillary diameter was measured at the widest horizontal diameter of the pupil (mid-eye region) using a calibrated millimetre ruler (Shinwa Sokutei Co., Japan) at baseline (pre-anaesthesia), during peak anaesthesia, and following full recovery from anaesthesia.

Blood Sample Collection

Blood samples (3 mL dispensed into plain bottles for serum biochemistry and 1 mL into EDTA bottles for haematology) were collected by marginal ear vein venepuncture at baseline (time 0, before anaesthetic induction) and postoperatively at 24, 48, and 72 hours.

Haematological Analysis

Red blood cell (RBC) and white blood cell (WBC) counts were determined using 1:200 and 1:20 dilutions respectively (RBC dilution fluid and Türk's solution) in an improved Neubauer haemocytometer (a double-ruled counting chamber with a depth of 0.1 mm) at ×10 and ×40 objective magnification (equivalent to 100× and 400× total magnification) respectively. Packed cell volume (PCV) was determined by the microhaematocrit method: heparinized capillary tubes were centrifuged at 12,000 rpm for 5 minutes and the buffy coat ratio read. Differential WBC counts were performed on Leishman's-stained blood films by classifying 200 cells under oil immersion. Platelet counts used a 1:20 dilution with 1% ammonium oxalate, incubated for 10–15 minutes, and counted in an improved Neubauer haemocytometer at ×40 objective magnification.

Serum Biochemical Analysis

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were measured by the kinetic IFCC spectrophotometric method, expressed as U/L. Total protein was determined by the Biuret reaction

(g/L). Albumin was quantified by bromocresol green (BCG) dye-binding at 630 nm (g/L). Creatinine was measured by the Jaffé reaction (mg/dL). Urea was determined by the urease–Berthelot colorimetric method (mg/dL). All assays were run in duplicate alongside reagent blanks, calibration standards, and low/high quality control materials. Haemolysed samples were excluded where optical interference was likely.

Behavioural Observations

Mounting, thumping, vocalizing, and cycling/grooming behaviours were assessed individually for each rabbit at baseline (Day 0) and on Days 10, 20, 30, 40, 50, and 60 post-castration during standardized 15-minute observation periods. Each behaviour was scored as present (+) or absent (–).

Statistical Analysis

Data were analysed by one-way analysis of variance (ANOVA) using IBM SPSS Statistics Version 21. Results were presented as Mean $\pm$ Standard Error of Mean (SEM) and values of $p < 0.05$ were considered statistically significant. Tukey's Honest Significant Difference (HSD) post hoc test was applied to determine differences between time points within and between groups.

Results

Anaesthetic Pattern

The onset, duration, and recovery from xylazine-bupivacaine anaesthesia in both groups are shown in Table 1. No statistically significant between-group variation was observed for any anaesthetic parameter ($p > 0.05$).

Table 1: Pattern of Xylazine–Bupivacaine Anaesthesia in Rabbits (n=5 per group)

Parameter	Group	Mean $\pm$ SEM (min)
Onset	Castrated	8.0 $\pm$ 1.1
	Non-castrated	8.2 $\pm$ 2.0
Duration	Castrated	28.2 $\pm$ 6.0
	Non-castrated	20.3 $\pm$ 2.0
Recovery	Castrated	52.5 $\pm$ 4.0
	Non-castrated	58.8 $\pm$ 11.0

Values are expressed as Mean $\pm$ SEM. SEM = Standard Error of Mean. No significant between-group differences ($p > 0.05$)

Serum Biochemical Parameters

Serum biochemical values for both groups at all time points are presented in Table 2. In the castrated group, ALT rose transiently at 24 h (24.80 $\pm$ 3.51 U/L) before declining at 72 h (21.60 $\pm$ 3.26 U/L), while AST progressively decreased from 27.20 $\pm$ 7.59 U/L (0 h) to 13.80 $\pm$ 1.83 U/L (72 h). In the non-castrated group, AST increased at 48–72 h, reaching 28.20 $\pm$ 5.19 U/L. Total protein in the castrated group rose at 24–48 h, consistent with an acute-phase response, while albumin remained stable in both groups at all time points. Creatinine was significantly lower in the castrated group at 72 h (3.46 $\pm$ 0.71 mg/dL; $p < 0.05$). Urea showed dynamic fluctuations in both groups with no statistically significant between-group variation ($p > 0.05$).

Vital Parameters

Pre-, intra-, and post-anaesthetic vital parameters are presented in Table 3. Both groups showed significant decrease in respiratory rate and heart rate at 30 minutes post-anaesthesia ($p < 0.05$), with full recovery to near-baseline values by 24 hours. Body temperature declined transiently at 30 minutes, rose above baseline at 24–48 hours (castrated peak: 40.24 $\pm$ 0.23°C), and returned toward baseline by 72 hours. No significant between-group differences were detected ($p > 0.05$).

Haematological Parameters

Haematological changes following castration are shown in Table 4. PCV, haemoglobin, and RBC counts increased slightly on Day 1 before declining on Day 3 in both groups, all remaining within physiologically acceptable reference ranges. WBC count rose in the castrated group by Day 3 (8.40 $\pm$ 1.37 $\times 10^3/\mu\text{L}$). Neutrophil, lymphocyte, and eosinophil percentages showed minor fluctuations that were not statistically significant between groups ($p > 0.05$).

Table 2: Serum Biochemical Parameters Following Open Castration in Rabbits (n=5 per group)

Parameter	Group	0 h (baseline)	24 h	48 h	72 h
ALT (U/L)	Castrated	21.60±1.86	24.80±3.51 ^a	18.20±1.43 ^b	21.60±3.26 ^a
	Non-castrated	23.00±2.59	21.10±3.33 ^b	21.40±2.16	27.80±2.40 ^a
AST (U/L)	Castrated	27.20±7.59	20.20±3.43 ^b	28.20±5.19 ^a	13.80±1.83 ^b
	Non-castrated	25.50±9.27	21.40±2.16 ^b	27.80±2.40 ^a	28.20±5.19 ^a
Total Protein (g/L)	Castrated	65.80±9.86	74.20±9.05 ^a	73.20±7.43	69.00±6.40 ^b
	Non-castrated	74.60±6.77	79.40±7.43 ^a	73.00±6.40 ^b	73.20±11.20
Albumin (g/L)	Castrated	23.00±2.35	24.00±1.90 ^a	22.60±2.46 ^b	22.40±1.32
	Non-castrated	23.20±1.32	23.40±1.40	26.60±1.50 ^a	24.00±2.97 ^b
Creatinine (mg/dL)	Castrated	6.28±2.20	6.46±1.37	2.53±0.26 ^b	3.46±0.71 ^a
	Non-castrated	6.38±1.66	4.16±1.13 ^b	6.78±2.24 ^a	3.58±1.00 ^b
Urea (mg/dL)	Castrated	144.52±18.54	136.14±15.28 ^b	67.14±14.48 ^b	133.72±34.40 ^a
	Non-castrated	115.22±29.51	78.24±15.44 ^b	102.82±37.07 ^a	153.02±6.55 ^a

Values are expressed as Mean ± SEM. SEM = Standard Error of Mean. ^a = significantly higher than the immediately preceding timepoint ($p < 0.05$); ^b = significantly lower than the immediately preceding timepoint ($p < 0.05$).

Table 3: Vital Parameters Pre-, During, and Post-Anaesthesia (n=5 per group)

Parameter	Group	0 (baseline)	30 min	24 h	48 h	72 h
Resp. Rate (bpm)	Castrated	162.4±6.3	101.6±5.0*	161.6±8.3	162.4±3.3	168.0±9.0
	Non-castrated	167.2±5.5	102.4±6.2*	165.0±4.3	164.0±4.0	162.4±6.2
Heart Rate (bpm)	Castrated	256.8±16.8	211.2±11.1*	255.2±7.5	255.2±10.4	255.2±11.1
	Non-castrated	255.2±16.4	208.8±10.4*	252.8±11.1	257.6±12.8	251.2±14.8
Temperature (°C)	Castrated	38.26±0.34	37.17±0.06	39.14±0.35	40.24±0.23 ^a	39.14±0.62
	Non-castrated	38.66±0.49	37.64±0.21	39.42±0.42	40.04±0.17 ^a	39.40±0.54

Values are expressed as Mean ± SEM. SEM = Standard Error of Mean. * = significantly lower than baseline within group ($p < 0.05$); ^a = significantly higher than baseline within group ($p < 0.05$).

Table 4: Haematological Changes Following Open Castration in Rabbits (n=5 per group)

Parameter	Group	Day 0 (baseline)	Day 1	Day 3
PCV (%)	Castrated	28.40±1.03	29.00±2.00 ^a	25.80±1.16 ^b
	Non-castrated	28.80±0.97	29.40±1.50 ^a	26.00±1.22 ^b
Haemoglobin (g/dL)	Castrated	9.46±0.34	9.68±0.66 ^a	8.74±0.35 ^b
	Non-castrated	9.64±0.31	9.80±0.51 ^a	8.58±0.41 ^b
RBC (×10 ⁶ /μL)	Castrated	4.74±0.17	4.78±0.34	3.78±0.55 ^b
	Non-castrated	4.91±0.18	4.90±0.25	4.46±0.25 ^b
WBC (×10 ³ /μL)	Castrated	7.16±0.86	6.80±0.77 ^b	8.40±1.37 ^a
	Non-castrated	7.50±0.68	8.84±1.08 ^a	6.50±0.80 ^b
Neutrophils (%)	Castrated	2.30±0.50	1.74±0.30 ^b	3.22±0.93 ^a
	Non-castrated	2.89±0.93	3.93±0.90 ^a	1.88±0.25 ^b
Lymphocytes (%)	Castrated	4.59±0.62	4.45±0.79	5.00±0.95 ^a
	Non-castrated	4.33±0.50	4.68±0.47 ^a	4.92±0.82 ^a
Eosinophils (%)	Castrated	0.30±0.22	0.27±0.14 ^b	0.11±0.08 ^b
	Non-castrated	0.27±0.15	0.23±0.17 ^b	0.12±0.08 ^b

Values are expressed as Mean ± SEM. SEM = Standard Error of Mean. ^a = significantly higher than Day 0 baseline within group ($p < 0.05$); ^b = significantly lower than Day 0 baseline within group ($p < 0.05$).

Table 5: Behavioural Changes Following Open Castration in Rabbits (n=5)

Behaviour	Day 0	Day 10	Day 20	Day 30	Day 40	Day 50	Day 60
Mounting (Castrated)	+++++	++++	++	-----	-----	-----	-----
Mounting (Non-castrated)	+++++	+++++	+++++	+++++	+++++	+++++	+++++
Thumping (Castrated)	+++++	++++	+++	+	-----	-----	-----
Thumping (Non-castrated)	+++++	+++++	+++++	+++++	+++++	+++++	+++++
Vocalizing (Castrated)	+++++	+++++	+++++	++	+	-----	-----
Vocalizing (Non-castrated)	+++++	+++++	+++++	+++++	+++++	+++++	+++++
Cycling & Grooming (Castrated)	+++++	+++++	+++++	+++++	+++++	++	-----
Cycling & Grooming (Non-cast.)	+++++	+++++	+++++	+++++	+++++	+++++	+++++

+: present; -: absent

Behavioural Observations

Post-castration behavioural changes are summarised in Table 5. In castrated rabbits, mounting was highly evident on Day 0 (+++++), moderately present on Day 10 (++++), occasional on Day 20 (++), and absent from Day 30. Thumping followed a similar trajectory,

becoming absent after Day 40. Vocalizing remained strong through Day 20 (+++++), declined at Day 30 (++), and ceased by Day 50. Cycling and grooming persisted through Day 40, decreased on Day 50 (++), and ceased by Day 60. In contrast, non-castrated rabbits retained all four behaviours at consistent levels throughout the 60-

day observation period, underscoring that the behavioural suppression observed in the castrated group was attributable to androgen withdrawal rather than habituation or environmental effects.

Pupillary Diameter

Pupillary diameter results are presented in Table 6. A significant dilation was recorded during anaesthesia in

both groups (castrated: 7.5 ± 0.2 mm; non-castrated: 7.4 ± 0.3 mm), compared to the respective pre-anaesthetic baselines (castrated: 6.0 ± 0.1 mm; non-castrated: 6.1 ± 0.1 mm; $p < 0.05$). Diameter returned fully to baseline in both groups following recovery from anaesthesia, with no significant between-group differences at any time point ($p > 0.05$).

Table 6: Pupillary Diameter During Xylazine-Bupivacaine Anaesthesia (n=5 per group)

Time Point	Castrated (mm)	Non-castrated (mm)
Pre-anaesthesia (baseline)	6.0 ± 0.1	6.1 ± 0.1
During anaesthesia	7.5 ± 0.2^a	7.4 ± 0.3^a
Post-anaesthesia (recovery)	6.0 ± 0.2	6.1 ± 0.2

Values are expressed as Mean $\pm$ SEM. ^a = significantly higher than baseline within group ($p < 0.05$).

Discussion

The xylazine-bupivacaine combination produced a clinically adequate anaesthetic profile for open castration in rabbits. The onset of approximately 8 minutes, reflecting the time to peak sedation following intramuscular xylazine administration, allows adequate time for surgical preparation. The duration of 20–28 minutes is sufficient for the procedure. These findings are consistent with Kumar *et al.* (2018), who also reported onset times of 7–9 minutes and surgical durations of 20–30 minutes using the same combination in rabbits. Greene and Thurmon (2007) similarly noted that xylazine-based sedation in rabbits produces predictable onset and recovery profiles at doses of 3–5 mg/kg IM. The prolonged duration of bupivacaine is attributable to its high lipid solubility and protein binding to alpha-1-acid glycoprotein, while xylazine enhances the overall anaesthetic profile through central alpha-2 adrenoceptor-mediated sedation and analgesia (Cederholm *et al.*, 2008; Lin *et al.*, 2010).

The transient rise in ALT following castration is consistent with the expected hepatocellular response to surgical trauma, oxidative stress, and released inflammatory mediators (Ocak *et al.*, 2009). Importantly, ALT returned to near-baseline by 72 hours in the castrated group, confirming the liver's robust regenerative capacity and indicating that the anaesthetic regimen did not cause persistent hepatotoxicity (Hu *et al.*, 2019). The divergent AST pattern—declining in castrated rabbits but rising in non-castrated animals at 48–72 hours—may reflect the hepatoprotective influence of androgens; their withdrawal after castration could prolong enzyme leakage (Yamamoto *et al.*, 2013). The acute-phase rise in total protein at 24–48 hours in the castrated group is a recognised physiological response to surgical injury, involving upregulation of fibrinogen, C-reactive protein, and serum amyloid A (Cray *et al.*, 2009). Albumin stability in both groups confirms that the liver's constitutive synthetic function was preserved throughout the perioperative period.

The significant decrease in serum creatinine in castrated rabbits at 48 hours may be attributable to reduced creatinine production following androgen-mediated muscle mass loss, or altered renal haemodynamics

following testosterone withdrawal (Harrison and Rucker, 2016; Salsabila *et al.*, 2025). Androgens are known to modulate glomerular filtration rate and tubular function, and their removal may explain both the creatinine and urea fluctuations observed. These findings warrant further investigation using more precise markers such as glomerular filtration rate and tubular function assays.

The significant transient reductions in respiratory rate and heart rate at 30 minutes are the expected cardio-respiratory depressant effects of xylazine, which acts centrally reducing sympathetic outflow (Kuusela *et al.*, 2001; Greene and Thurmon, 2007). Their rapid return to baseline by 24 hours confirms effective compensatory homeostasis and the safety of the protocol at the doses used (Lichtenberger and Ko, 2011). The mild post-operative hyperthermia at 24–48 hours is characteristic of the inflammatory thermoregulatory response to tissue injury (Maloney and Anderson, 2012). Haematological parameters remained within physiological limits; the modest WBC rise in castrated animals on Day 3 likely represents a localised wound-healing inflammatory response (Snyder and Cherry, 2015).

In this study, castrated rabbits showed complete cessation of mounting and thumping by Day 20–30, while non-castrated counterparts maintained these behaviours throughout the 60-day observation period. This contrast directly implicates testosterone withdrawal as the primary driver of behavioural change. Vocalizing and cycling/grooming, being less exclusively androgen-dependent, persisted longer and ceased by Days 50 and 60 respectively. The delayed suppression of these latter behaviours suggests that androgen-driven neural circuits require more time to fully down-regulate, consistent with the established role of testosterone-sensitive neurons in the hypothalamus and limbic system in modulating sexual and arousal-related behaviours (Brooks, 1937). The progressive behavioural timeline observed here aligns with what has been reported in other species following surgical castration, where behaviours dependent on circulating androgens decline within weeks while more complex social behaviours may persist for longer (Yamamoto *et al.*, 2013).

Significant mydriasis during anaesthesia results from xylazine-mediated sympathetic activation and inhibition of the parasympathetic sphincter pupillae, causing iris

dilation (Greene and Thurmon, 2007). Its complete reversal upon recovery confirms a pharmacodynamic mechanism and supports the use of pupillary monitoring as a practical, non-invasive indicator of the level of sedation and analgesia in the rabbit (Smith *et al.*, 2015). Regarding the small sample size, it is acknowledged that ten animals (five per group) represent a limitation of this study and may reduce statistical power. This sample size reflects the ethical minimum achievable under the institutional approval framework and is consistent with sample sizes reported in comparable rabbit anaesthesia and castration studies (Kumar *et al.*, 2018; Varga *et al.*, 2019; Benato *et al.*, 2019). Future studies with larger cohorts are recommended to improve generalizability and confirm these findings.

The administration of xylazine (5 mg/kg IM) and bupivacaine (5 mg/kg local infiltration) synergistically provides safe, predictable, and clinically balanced anaesthesia for open castration in rabbits, with onset within 8 minutes, surgical duration of 20–28 minutes, and recovery within one hour. Biochemical changes were largely transient and non-significant, except for creatinine decrease in castrated rabbits at 48 hours, suggesting androgen-mediated renal modulation. Significant reversible mydriasis during anaesthesia supports the utility of pupillary monitoring in this species. Behavioural suppression was progressive and complete by Day 30–60, consistent with androgen withdrawal. These findings provide clinically relevant baseline data for the use of this protocol in rabbit surgery, and highlight the value of routine biochemical and behavioural monitoring following castration.

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Conflicts of Interest

The authors declare no conflict of interest.

Authors' Contributions

Guse M. G.: conceptualization, methodology, data collection, writing – initial draft, writing – revisions. **Elsa T. A.:** student supervision, project leadership, writing – revisions. **Kisani A. I.:** student supervision, methodology, writing – revisions. **Ode S.:** student supervision, data analysis, writing – revisions. **Acham M. F.:** data collection, surgery. **Aliko E. U.:** data collection, surgery. **Idigbe S. U.:** data collection, surgery. **Ejeh E.:** data collection, surgery.

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