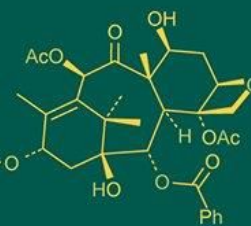
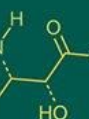
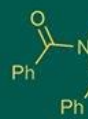
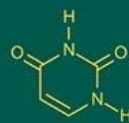


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; SP-9(6): 502-505
www.biochemjournal.com
Received: 19-03-2025
Accepted: 21-04-2025

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Chemical restraint and vasectomy in two captive Indian leopards (*Panthera pardus fusca*): Clinical observations and preliminary outcomes

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DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i6Sg.4667>

Abstract

This study documents the surgical and anaesthetic protocol for elective vasectomy in two adult male Indian leopards (*Panthera pardus fusca*) housed at Gadag Zoo, Gadag, Karnataka, as a means of population management. Chemical restraint was achieved using a combination of Xylazine (1 mg/kg body wt.) and Ketamine (3 mg/kg body wt.), administered via blow pipe. Anaesthetic depth was maintained using intermittent intravenous ketamine boluses, and both animals showed smooth recovery following reversal with Yohimbine. Detailed health assessment, morphometric, haematological, and biochemical evaluations were conducted. Vasectomy was performed via bilateral 0.5 cm skin incisions near the prepuce. The vas deferens was isolated using ringed clamps and incised through the tunica vaginalis. Occlusion was achieved by ligation (3-0 polypropylene) and cauterization followed by excision of the vas segment. No intraoperative or postoperative complications were observed. This technique demonstrates that vasectomy under Xylazine-Ketamine anaesthesia is a safe, effective, and minimally invasive contraceptive method in leopards. While short-term outcomes were favourable, further studies are required to assess long-term reproductive, behavioural, and social implications in captive leopard populations.

Keywords: Leopard, Xylazine-ketamine, vasectomy, haemato-biochemical, physiological parameters, morphometry

Introduction

The Indian leopard (*Panthera pardus fusca*) exhibits a social structure that is both intriguing and adaptable. Although solitary by nature, these felids can peacefully coexist in social groups when sufficient space and food resources are available. However, in captive environments where space is limited and population increases due to successful breeding or the intake of rescued individuals, leopards are often housed in artificial groupings such as single-sex enclosures to control reproduction (Mallapur & Chellam, 2002; Mallapur *et al.*, 2002) [11, 12]. Such arrangements may influence their behaviour, particularly when individuals attempt to establish territories within confined exhibits (Metz *et al.*, 2017) [14]. Conversely, housing leopards in small, compatible mixed-sex groups has been shown to reduce aggressive interactions, encourage affiliative behaviours and enhance overall enrichment in captivity (Pastorino *et al.*, 2021) [15].

To ensure animal welfare by compatible social grouping and facilitate population management, effective birth control methods are essential. Vasectomy is one of the contraceptives that does not alter the natural behaviours or sexual dimorphism. Importantly, vasectomy is reversible, with restored fertility reported in several species, including bush dogs, chimpanzees, gorillas, Sika deer, Przewalski's horses, and lions (Silber *et al.*, 2013; Marconi *et al.*, 2020) [18, 13].

Materials and Methods

Two adult male Indian leopards (*Panthera pardus fusca*), aged six and seven years, housed at Gadag Zoo, Gadag, Karnataka, were selected for vasectomy under chemical restraint as part of a population management strategy. For identification and record-keeping, they were designated as Leopard 1 and Leopard 2, respectively. Both individuals were deemed clinically healthy upon preoperative observations, with an estimated body weight of 70 kg.

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The leopards were isolated from the group and fasted the day prior to surgery.

Anaesthesia was induced using a combination of Xylazine (1 mg/kg body weight) and Ketamine (3 mg/kg body weight) administered via blow pipe. Additional doses of anaesthetics were given intramuscularly or intravenously as needed to maintain adequate anaesthetic depth. Vital parameters were monitored and recorded throughout the procedure at regular intervals.

Once adequately immobilized, the animals were blindfolded and transferred to a makeshift operation site. Actual body weight was recorded using an electronic platform scale (Fig 1), and morphometric measurements were taken using a measuring tape.



Fig 1: Anaesthetised leopard placed on weighing platform for morphometry

A thorough physical examination was conducted after positioning the leopards on the operating table. An intravenous catheter was placed in the saphenous vein to facilitate blood sampling and fluid therapy. Collected blood samples were sent for laboratory analysis within two hours. Preoperatively, Meloxicam (0.1 mg/kg IM) and long-acting Enrofloxacin (5 mg/kg IM) were administered.

For the vasectomy, the animals were placed in left lateral recumbency with the right hindlimb abducted. The surgical site around the scrotum and prepuce was aseptically prepared. Spermatid cords were palpated cranial to the scrotum, and 1 mL of 2% Lignocaine was infiltrated subcutaneously over each cord. Beginning with the left side, the spermatid cord was elevated, and the vas deferens was isolated manually. A small (0.5 cm) skin incision was made, and the vas deferens was grasped using ringed clamps through the tunica vaginalis, which was then incised and bluntly dissected.

The vas deferens was occluded at two points approximately 4 cm apart using 3-0 polypropylene suture material. The lumen near the ligatures was pierced and lumen was cauterised with thermocautery. The segment between ligatures was excised and preserved in formalin for histopathological confirmation. The cut ends were returned into the spermatid cord, and the skin incision was closed with a single interrupted suture using 2-0 polyglactin 910. Antiseptic ointment and fly repellent spray were applied to the surgical site (Fig 2).

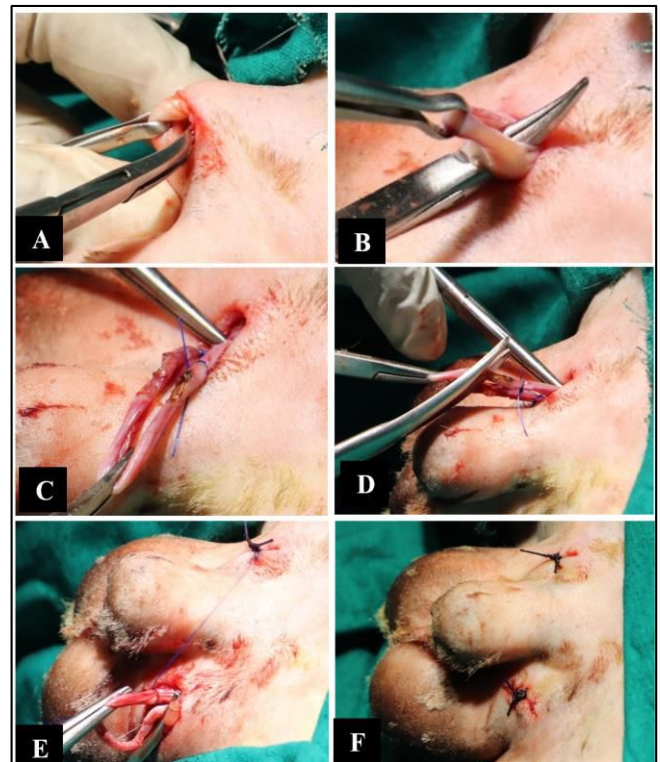


Fig 2: Vasectomy procedure in leopard. (A) Isolation of vas deference using ringed clamp after skin incision, (B) Exteriorisation of vas deference, (C) Occlusion of vas deference by ligation and cauterization, (D) Excision of vas deference segment between ligatures, (E) Repeating the procedure on other side and (F) Closure of skin incision.

Following surgery, both leopards were shifted to individual enclosures. Yohimbine (10 mg IV) was administered to reverse the anaesthetic effects. The animals were closely monitored for six days in isolation before being reintroduced to their group.

Results and Discussions

The use of Xylazine and Ketamine for chemical restraint in leopards is well established and widely applied in both captive and free-ranging individuals (Belsare & Athreya, 2010; Deka *et al.*, 2012) [3, 8]. In this study, Table 1 summarizes the doses and anaesthetic durations of the Xylazine-Ketamine combination used in two adult captive male leopards undergoing elective vasectomy. The induction dose was calculated based on estimated body weight. Induction time was defined as the period from darting to complete immobilization, which was achieved within 11 minutes in Leopard 1. In Leopard 2, catatonia and head movement persisted until 20 minutes post-darting, though immobilization was sufficient to allow manual administration of supplemental anaesthetic to achieve safe restraint.

Anaesthetic depth was maintained using intermittent IV boluses of Ketamine (50 mg), guided by reflex assessments. The duration of anaesthesia encompassed physical restraint, transfer to the makeshift surgical area, clinical examination, surgical intervention, post-operative relocation to the enclosure, and administration of the reversal agent Yohimbine. Leopard 2 exhibited slightly prolonged induction and recovery times compared to Leopard 1, likely due to a marginally inadequate induction dose necessitating additional anaesthetic administration to achieve the desired effect. Both animals recovered smoothly from anaesthesia.

Opportunistic physical examination during anaesthetic restraint is essential in wild animals for baseline health assessments and data collection. Both animals were in good

body condition, adequately hydrated, and free of external wounds. Morphometric parameters of the leopards are shown in AI-generated images (Fig 3).

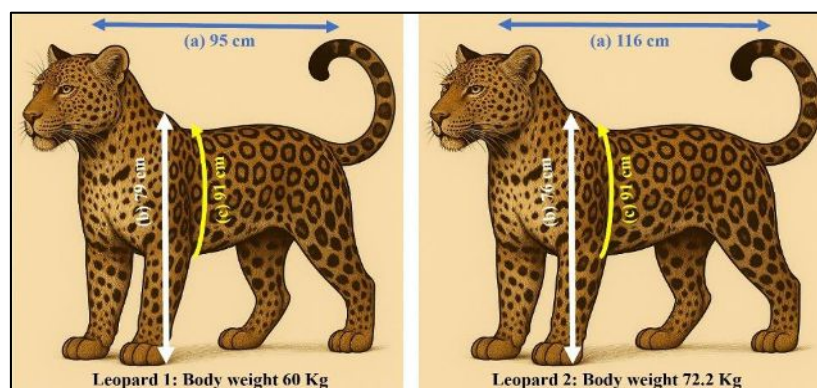


Fig 3: Morphometry of two Indian Leopards illustrated on AI-generated images. (a) Body length from head to base of tail, (b) Shoulder height and (c) Chest girth

Haematological results revealed inter-individual variation in WBC and differential leukocyte counts, while RBC indices and platelet values were comparable (Table 2). Serum biochemical values were largely similar between the two leopards, except for ALT, AST, and GGT, which showed marked variation (Table 3). Physiological parameters were marginally elevated in Leopard 2, possibly due to prolonged

induction and associated excitation (Fig 4). Various factors like handling, environment, physiological status, management practices etc., contribute to variations in physiological parameters and our findings were within the range documented for captive leopards by Srivastav *et al.*, 2016 [17] and Shanmugam *et al.*, 2017 [16].

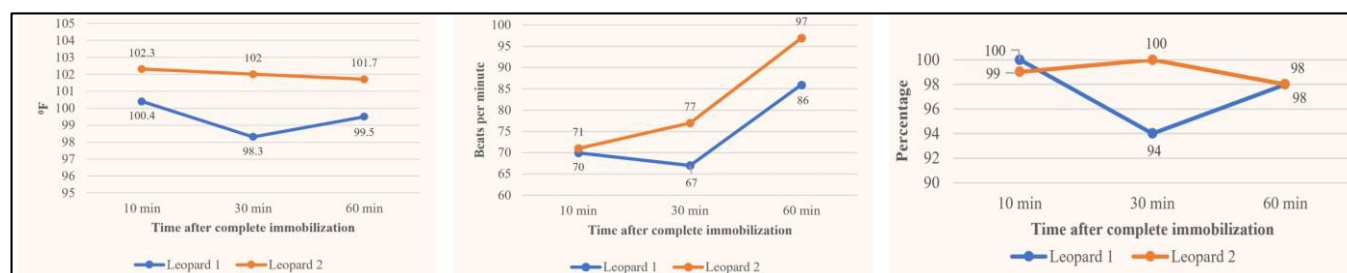


Fig 4: Physiological parameters during Xylazine-Ketamine anaesthesia in leopards.

During surgery, the vas deferens within the spermatic cords was readily palpable on both sides of the prepuce. However, extracutaneous fixation using ringed clamps was difficult due to thick skin, necessitating small skin incisions to exteriorize the vas deferens. Ringed clamps proved effective for selective isolation of the vas through limited dissection. After exteriorization of vas deference, effective occlusion is critical for vasectomy success. In human studies, cautery of the vas with fascial interposition has demonstrated lower failure rates than simple clipping and excision techniques (Barone *et al.*, 2004; Labrecque *et al.*, 2002) [2, 10]. Given the near similar anatomy of the vas deferens across species (Dean *et al.*, 2011) [6], surgical techniques employed in humans may be applied in animals either to reduce the risk of spontaneous recanalization or to enable future reversal via microsurgical anastomosis (Marconi *et al.*, 2020) [13]. Vasectomy remains a more accessible, rapid, safe, and cost-effective contraceptive option compared to hormonal or chemical alternatives (Gazendam *et al.*, 2023) [9].

No post-operative complications such as swelling, infection, or hematoma were observed in either leopard, and no significant behavioural changes were noted. However, potential complications may include procedural failure or post-operative issues such as pseudopregnancy in females due to continued mating and copulation-induced ovulation.

Such pseudopregnancies may result in elevated progesterone exposure, with potential risks of pyometra and infertility in females (DeMatteo *et al.*, 2006) [7]. Further investigations are required to assess these dynamics in leopard populations.

Conclusion

The Xylazine-Ketamine combination provided effective and safe anaesthetic restraint for adult male leopards undergoing physical examination and minor surgical intervention. Vasectomy can be performed through small bilateral incisions on either side of prepuce with no immediate complications. Long-term studies are necessary to evaluate the reproductive, social, and welfare outcomes of vasectomy in captive leopard populations.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Acknowledgement

The authors wish to express their sincere gratitude to the authorities and supporting staff for their invaluable contributions to the successful and uneventful execution of the surgical procedure. Their dedication to wildlife conservation is deeply appreciated.

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