



*Clinical Report*

**Immobilization and Anesthesia of African lion  
(*Panthera leo*) 5 Cases**

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**Abstract**

**Case Description-** Five lions (one female and 4 male) were presented for diagnostic and surgical treatment (wound management, castration and radiography). Immobilization or anesthesia was necessary to complete the procedure.

**Treatment and Outcome -** Immobilization was induced using intramuscular injection of various drug combinations (xylazine, diazepam or midazolam in combination with ketamine). Inhalation anesthesia (halothane) was used to maintain anesthesia in an adult lion suffering from upper lip laceration. Castration was performed under field anesthesia. Opioid analgesic (morphine) was used to provide postoperative analgesia in surgical cases. No adverse effects or complications were observed during anesthesia and recovery period.

**Clinical Relevance-** Chemical immobilization has been accepted as a routine procedure for non-domestic animals. Intramuscular agents are used for immobilization and anesthesia for short procedures. Following immobilization, inhalation anesthetics are used to maintain anesthesia in most species with excellent results. As with domestic animals, monitoring and supportive care should be provided during general anesthesia in wild animals.

**Key words:** immobilization, anesthesia, lion, ketamine, xylazine

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## Introduction

Many procedures, routinely accomplished in domestic animals with minimal restraint, require anesthesia for the welfare and safety of both the zoo animal and veterinarian. Chemical immobilization of wild and exotic animals is essentially a form of veterinary anesthesia conducted under the most difficult circumstances.<sup>1</sup> Wild felids respond to anesthetic agents in a manner similar to that of domestic cats.<sup>2</sup> Although physiological responses during maintenance of anesthesia are not different in domestic and wild felids, successful induction and recovery require significantly more knowledge and skills.<sup>3</sup> The aim of this article is to provide specific information regarding effective chemical immobilization and anesthetic techniques for captive lions.

**Case 1-** A 5-yr-old male lion (*Panthera leo*) with a laceration of the upper lip was presented for surgical management of the wound. The lion was starved for 12 hours before anesthesia. A mixture of xylazine (20 mg/ml, Alfasan, Woerden, Holland), (0.5 mg/kg, 100 mg total.), diazepam (5 mg/ml, Phoenix Pharma LTD., Gloucester, UK), (0.05 mg/kg, 10 mg total) and ketamine (100 mg/ml, Aesculaap, Boxtel, Holland), (5 mg/kg, 1000 mg total) was injected in the same syringe into the gluteal muscles. The dose of these drugs was determined based on estimated body weight of the lion ( $\approx$  200 kg). Following anesthesia, the cephalic vein was catheterized for subsequent fluid administration. Lidocaine spray (Xylocaine 10%, ASTRA, Sweden) was used to desensitize the larynx prior to tracheal intubation.

Following intubation using a 20 mm large animal endotracheal tube, the lion was connected to a rebreathing anesthetic system and anesthesia was maintained with halothane (Halothane Liquid, Rhodia Organique Fine LTD, Bristol, UK)(1-1.5%) in oxygen (6 L/min). The lion received 1.5 liter of dextrose-saline and 1.5 liter of lactated Ringer's solution during anesthesia (approximately 7 ml/kg/hr). Continuous ECG was used to monitor heart rate and rhythm. During anesthesia, the heart and respiratory rates remained stable at approximately 60-70 beats/min and 12-14 breaths/min, respectively. During anesthesia, the eyes were lubricated with saline solution to minimize the risk of corneal dryness. The duration of surgery and anesthesia were approximately 50 and 110 minutes, respectively. The lion received 20 mg morphine (Morphine sulfate, 10 mg/ml, Darou Pakhsh CO., Iran) IM (approximately 0.1 mg/kg) before discontinuation of halothane anesthesia. Following reappearance of swallowing reflex, extubation of the trachea was performed and the lion was transferred to its cage. No adverse effects (excitement, cyanosis, vomiting) were observed during induction of anesthesia. The recovery was smooth without any excitatory phase.

**Case 2-** A 4-yr-old male lion weighing approximately 180 kg was anesthetized for open castration in a local zoo. Anesthesia was induced with a combination of midazolam (Midazolam, Dormicum, 5 mg/ml, Hoffman-La Roche Ltd, Basel, Switzerland), (0.11 mg/kg, 20 mg total) and ketamine (5.5 mg/kg, 1000 mg total) mixed before use and injected intramuscularly into gluteal muscles. The animal became recumbent within 8 minutes.

The immobilized lion was placed in lateral recumbency with extended head and neck to maintain open airway. An intratesticular injection of 15 mL lidocaine (Lidocaine, 20 mg/ml, Farvet, Bladel, Holland) (2%) in each testicle was made following induction of anesthesia to provide additional analgesia. The cephalic vein was catheterized for subsequent drug administration. No fluid was administered during anesthesia. In order to maintain anesthesia, the lion received 10 mg diazepam (0.06 mg/kg), 60 mg xylazine (0.33 mg/kg) and 600 mg ketamine (3.33 mg/kg), intravenously during surgery. The duration of anesthesia was

approximately 50 minutes. At the end of surgery, 20 mg morphine was given IM to provide postoperative analgesia. The recovery was smooth and no complication was observed.

**Case 3-** Radiographic examination of a 3.5-yr-old male lion suffering from hind limb lameness was performed under general anesthesia using a portable radiograph in a local zoo. The lion, weighing approximately 170 kg, was anesthetized with a mixture of xylazine (1 mg/kg, 170 mg total.) and ketamine (5.9 mg/kg, 1000 mg total) administered intramuscularly. Lateral recumbency occurred within 10 minutes and clinical and radiographic examinations were performed. The recovery was uneventful.

**Cases 4 and 5-** Two 9-month-old lion cubs (one male and one female) suffering from hind limb weakness were immobilized to perform radiographic examination of spinal column under light general anesthesia. The male cub (weighing 32.5 kg) received xylazine-ketamine (1 and 5 mg/kg, respectively) and the female cub (weighing 25 kg) was given diazepam-ketamine combination (0.4 and 5 mg/kg, respectively). All drugs were mixed in the same syringe and injected intramuscularly.

Immobilization occurred within 5 minutes with both combinations. Although the lion cub given xylazine-ketamine reached deeper level of anesthesia, muscle relaxation was adequate for radiography with both combinations. Heart and respiratory rates tended to be lower with xylazine-ketamine compared to diazepam-ketamine (80-90 vs. 100-110 beats/min and 20-22 vs. 25-28 breaths/min). Lion cubs remained sedated for about 50 minutes. No side-effects or complications were encountered.

## Discussion

Cyclohexamines (ketamine and tiletamine) are the main drugs used for immobilization of wide variety of carnivores.<sup>2</sup> Ketamine produces rapid dissociative anesthesia, analgesia and immobilization following IM administration in treated animal. Normal protective reflexes (laryngeal, palpebral and corneal reflexes) are usually retained.<sup>1,4</sup> Ketamine has a relatively wide margin of safety allowing for general estimation of body weight.<sup>1,5</sup> It is available in 50 and 100 mg/mL aqueous solutions. The 50 mg/mL solution is too dilute to be useful in wildlife immobilization.

High doses of ketamine alone may be used for immobilization of nondomesticated cats; however, salivation, muscle rigidity, convulsion and respiratory depression often occur.<sup>6</sup> Many of these side-effects can be prevented by adding a suitable sedative or tranquilizer. Sedatives are usually mixed with anesthetic drugs in the same syringe and given as a single IM injection. A combination of xylazine (2-3 mg/kg, IM) and ketamine (7-10 mg/kg, IM) can be used to induce short period of anesthesia (i.e., 5-20 minutes) in lion. Additional doses can be given when necessary to deepen or extend anesthesia.<sup>1,6,7,8</sup> No reversal agent is available for ketamine; therefore, additional ketamine should be given IV at 0.5-2 mg/kg to avoid the prolonged recoveries that may result from high IM doses. Excessive salivation is not a problem in lion due to the larger diameter airways compared to domestic cats.<sup>6</sup>

Xylazine, an  $\alpha_2$ -adrenergic agonist, is a potent CNS depressant with sedative, muscle relaxant and some analgesic properties. It has mostly been used in combination with ketamine for immobilization of wild animals.  $\alpha_2$ -adrenergic agonists should not be used as the sole immobilizing agent in dangerous carnivores because they may appear sedated but can respond aggressively when stimulated.<sup>3,6</sup> Side-effects of xylazine may include respiratory and circulatory depression, vomiting, bradycardia, hypotension, atrioventricular block and

impaired thermoregulation.<sup>6</sup> As in domestic cats, vomiting or retching may occur prior to immobilization in some lions and is minimized by pre-anesthetic starvation.<sup>8</sup> Administration of metoclopramide has been recommended to reduce emesis in felids.<sup>2</sup>

The availability of specific antagonists (yohimbine, tolazoline and atipamezole) has increased the usefulness of the  $\alpha_2$ -adrenergic agonists in wild animals.<sup>1,6</sup> When used in combination with ketamine, the xylazine effects should not be reversed before the animal has metabolized ketamine.<sup>3</sup> Xylazine is available in 20 mg/mL aqueous solutions in Iran. In other countries the 100 mg/mL solution is also available.

Benzodiazepines, diazepam or midazolam, were used in three cases in order to improve muscle relaxation and prolong anesthesia duration. The benzodiazepines (diazepam, midazolam and zolazepam) have anti-convulsant activity and produce sedation and muscle relaxation in treated animals.<sup>7</sup> Diazepam has minimal effects on the cardiopulmonary system. Injectable diazepam is supplied as a propylene glycol formulation. This formulation has several disadvantages, including: slow absorption following intramuscular (IM) or subcutaneous (SC) administration, precipitation when mixed with other anesthetics or fluids (except ketamine), cardiac arrhythmias, and pain on injection. Diazepam can be combined in the same syringe with ketamine as a single IM injection. In order to reduce the incidence of ketamine-induced convulsion, it is advised that the lion is given diazepam (5-10 mg, IV) as soon as it is safely immobilized.<sup>2,3</sup> As benzodiazepines produce minimal cardiopulmonary depression, diazepam-ketamine combination may be preferred to xylazine-ketamine for immobilization or induction of anesthesia in lion cubs or debilitated animals.<sup>3</sup>

Unlike diazepam, midazolam is in a water-soluble solution and provides rapid absorption following IM or SC administration with no precipitation, minimal irritation and cardiac arrhythmias following IV administration.<sup>3,7</sup> Zolazepam is only available in combination with tiletamine as Telazol. The effects of benzodiazepines may be reversed by flumazenil.

Other acceptable anesthetic combinations for lion immobilization are medetomidine (0.04-0.1 mg/kg) with ketamine (2.5-3 mg/kg) or Telazol (tiletamine-zolazepam, 2-5 mg/kg).<sup>1,6,9</sup>

Medetomidine, a potent  $\alpha_2$ -agonist, markedly reduces ketamine requirement, allowing the use of very low total drug volume. In excited or aggressive lions higher dose should be used to ensure safe immobilization and smooth induction of anesthesia. Propofol (1 mg/kg) has been recently used for short-term prolongation of anesthesia following induction with ketamine.<sup>10</sup>

Whenever possible, inhalation anesthesia is preferred for invasive or prolonged procedures in large felids; because it provides accurate control of the depth of anesthesia and more rapid recoveries than with incremental injectable drugs.<sup>2,3,7</sup> In lion, tracheal intubation is easily performed under direct vision using an 18-24 mm-id endotracheal tube. Large animal ET tubes, while they are the right diameter, are generally too long for lions so an appropriate length should be used to avoid endobronchial intubation.<sup>3</sup> It is suggested that the larynx be sprayed with lidocaine before endotracheal intubation, in order to decrease the possibility of laryngeal spasm.<sup>7</sup>

The immobilized lion should be approached with great caution. Ensure that the animal is appropriately immobilized, and if not, additional drugs should be given.<sup>1</sup> The immobilized lion should be kept in lateral recumbency with extended head and neck and pulling the tongue forward in order to maintain open airways.<sup>3</sup>

The principles of anesthetic monitoring in lions are the same as for domestic cats. Following immobilization, it is necessary to assess the depth of anesthesia before any procedures are carried out. As in domestic cat, animal's vital signs (heart & respiratory rates, color of mucous membranes and capillary refill time) should be recorded at 5-minute intervals during immobilization period.<sup>1,2,7</sup> Portable monitoring equipment such as pulse oximetry is available

for field situations. Normal heart and respiratory rates for adult lions are in the range of 55-65 beats/min and 10-15 breaths/min, respectively.<sup>1</sup> Heart and respiratory rates will tend to increase as anesthetic depth decreases, providing reliable signs of recovery.<sup>10</sup>

Temperature monitoring is important during prolonged anesthesia, especially when working in extremely high or low ambient temperature.<sup>3</sup> The eyes should be protected from direct sunlight which may result in retinal damage in ketamine-anesthetized animals.<sup>3,4</sup> In order to prevent corneal drying, the eyes are lubricated with a plain eye ointment.

Intravenous catheterization and fluid administration are important especially during long procedures and will provide a ready venous access for repeated drug administration. Prophylactic fluid therapy, using lactated Ringer's solution (5-10 ml/kg/hr), is desirable to maintain extracellular fluid volume during prolonged anesthesia. The cephalic or femoral vein can be catheterized for intravenous drugs and fluid injection. The cephalic vein is covered by very thick skin and cut-down may be necessary before catheterization of the vein.<sup>3</sup>

In the lion undergoing castration, intratesticular administration of lidocaine was performed in order to provide intra- and post-operative analgesia.<sup>7</sup> Local anesthetics should be employed as an adjunct to general anesthesia, whenever possible, to avoid large doses of general anesthetic in large undomesticated felids.<sup>3</sup>

Effective postoperative analgesia should be provided whenever invasive painful surgeries are performed. Various opioids (butorphanol, buprenorphine and morphine) and non-steroidal anti-inflammatory drugs (flunixin meglumine, phenylbutazone and ketoprofen) can be used to alleviate acute postoperative pain in lions. Single injection of morphine (0.1 mg/kg, IM) will provide effective analgesia for 4-6 hrs.<sup>3</sup> Flunixin (1 mg/kg, daily) and phenylbutazone (10 mg/kg, daily, oral) have been used in lion up to 7 days with no adverse effects. Due to increased risk of toxicity, NSAID's should not be used for prolonged time or in dehydrated animals.<sup>11</sup>

Human safety should be given a high priority when anesthetizing any dangerous wild species. It is the responsibility of the anesthetist to ensure effective and safe immobilization before approaching the animal. It is highly recommended to have an extra dose of ketamine available in case the animal awakens.<sup>2</sup> Once all procedures are completed and all monitoring equipment is removed the animal should be transferred to a quiet, dim, safe area for recovery. Lions should be continuously observed until they are able to maintain sternal recumbency.

Basically lions will react in a similar manner to domestic cats to anesthetic drugs. Many factors influence the animal's response to anesthetic drugs, including age, sex, stage of reproductive cycle, general nutritional status and mental state before drug administration. An excited animal usually requires more drugs for induction of anesthesia and once anesthetized, has a greater tendency for respiratory depression, hyperthermia and acidosis. When anesthesia must be prolonged, inhalation anesthetics such as halothane or isoflurane can be used for maintenance. Induction and recovery of wild animals requires special attention to details to prevent injury to personnel or animal.

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## مقیدسازی و بیهوشی در شیر آفریقایی (۵ مورد)

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**توصیف بیماران و یافته‌های بالینی:** ۵ قلاده شیر باغ وحش برای انجام اقدامات تشخیصی و درمانی (پارگی لب، عمل اخته و رادیوگرافی) ارجاع داده شدند که همگی به مقیدسازی شیمیایی یا بیهوشی عمومی نیاز داشتند.

**درمان و نتیجه آن:** القاء بیهوشی با استفاده از تزریق عضلانی ترکیبات دارویی مختلف انجام شد. یک قلاده شیر تحت بیهوشی استنشاقی قرار گرفت اما بیهوشی برای عمل اخته به صورت صحرائی انجام شد. به منظور کنترل درد بعد از عمل از داروی مرفین استفاده شد. هیچگونه عارضه جانبی در حین بیهوشی یا بعد از بازگشت از بیهوشی بروز نکرد. جزییات داروهای مورد استفاده و مراقبت‌های حین بیهوشی در این مقاله ارائه شده است.

**کاربرد بالینی:** مقیدسازی شیمیایی به عنوان یک روش معمول برای مهار حیوانات غیر اهلی پذیرفته شده است. تجویز دارو بصورت عضلانی برای مقیدسازی و بیهوشی برای جراحی‌های کوتاه مدت انجام می‌گیرد. بطور کلی برای ادامه بیهوشی در گونه‌های مختلف استفاده از داروهای استنشاقی توصیه می‌شود. همانند حیوانات اهلی، مراقبت و انجام اقدامات حمایتی در حین بیهوشی بسیار حائز اهمیت است.

**کلید واژگان:** مقیدسازی - بیهوشی - شیر - کتامین - زابلازین