European Association of Zoo and Wildlife Veterinarians

Surgery and Anaesthesia Session

Scroll down to view documents

European Association of Zoo- and Wildlife Veterinarians (EAZWV)
4th scientific meeting,
joint with the
annual meeting of the European Wildlife Disease Association (EWDA)

May 8-12, 2002, Heidelberg, Germany.

This manuscript is reproduced in the IVIS website with the permission of EAZWV
www.eazwv.org
XENOGENEIC SKIN GRAFTS USING PORCINE SMALL INTESTINAL SUBMUCOSA IN TWO BARN OWLS (Tyto alba), AN UMBRELLA COCKATOO (Cacatua alba), AND AN COMMON AMERICAN CROW (Corvus brachyhyynchos)

S. J. HERNANDEZ-DIVERS and S. M. HERNANDEZ-DIVERS

Affiliation:
Exotic Animal, Wildlife and Zoo Animal Medicine, Department of Small Animal Medicine, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602-7390, USA.

Abstract

Skin trauma in the keel region of psittacines is often associated with feather plucking, automutilation, and crash injuries of feather-clipped individuals (1, 2, 3). In addition, keel damage was also one of the most commonly observed traumas in captive bustards (Buteo buteo) in the United Arab Emirates (4). Many of these keel injuries become chronic necrotic and granulomatous lesions, and some can involve the underlying keel bone. Trauma to the skin and underlying soft tissues of the tarsometatarsus from poorly fitted or damaged jesses has been reported in raptors, with similar presentations seen in psittacines with tight legbands (1, 4).

Current techniques for the repair of keel injuries include conservative care and surgery. Various skin grafting techniques have been utilised in birds with large skin deficits. Cutaneous autografts have been successfully employed in the ostrich (Struthio camelus), ring-necked pheasant (Phasianus colchicus), rock dove (Columba livia) and red-tailed hawk (Buteo jamaicensis) (5, 6). Allografts have been performed frequently in chickens (to determine inbreeding coefficients) with graft survival positively correlated to genetic homogeneity (7). There are no published reports of xenogeneic skin grafts in birds. Vet Biosist (Cook Veterinary Products Inc, 501N Rogers Street, Bloomington, Indiana 47405, USA) is derived from porcine small intestinal submucosa (SIS) that has been dehydrated and sterilised (8). This presentation describes the successful use of porcine small intestinal submucosa (SIS) as xenogeneic grafts for the repair of serious skin deficits in two barn owls (Tyto alba), an umbrella cockatoo (Cacatua alba), and a common American crow (Corvus brachyhyynchos).

Zusammenfassung

Hautbeschädigungen im Brustbereich bei Papageien werden oft mit Feder picken, Selbstverstümmelung und Sturzverletzungen bei flügelgestuzten Individuen in Zusammenhang gebracht (1, 2, 3). Dazu kommt, das Brustverletzungen, bei Gefangenschaft gehaltenen Trappen (Buteo buteo) in den Vereinigten Arabischen Emiraten zu den am häufigsten vorkommenden Verletzungen gehören (4). Viele dieser Brustverletzungen werden zu chronisch necrotisierenden und granulomatösen Läsionen, manchmal wird auch das darunterliegende Brustbein mit einbezogen. Verletzungen der Haut und des darunterliegenden Bindegewebes des Tarsometatarsus durch schlecht sitzende oder beschädigte Fußringe wurde bei Greifvögeln beschrieben, ähnlich wie bei eng beringten Papageien (1, 4). Die übliche Behandlungsverfahren bei Brustverletzungen besteht aus conservativer Pflege und einer Operation. Verschiedene Hauttransplantationsmethoden wurden bei Vögeln mit großen Hautdefiziten bereits angewandt. Eigenhauttransplantate wurden erfolgreich eingesetzt bei Straußen (Struthio camelus), bei Halsbandfasanen (Phasianus colchicus), bei Tauben (Columba livia) und bei Rotschwanzhabichten (Buteo jamaicensis) (5, 6). Fremdhauttransplantate wurden regelmässig bei Hühnern eingesetzt (um den Inzucht Koeffizient zu bestimmen), wobei das Überleben nach der Transplantation positiv mit der genetischen Homogenität korreliert ist (7). Es gibt keine veröffentlichten Berichte über xenogenetische Hauttransplantate bei Vögeln. Vet Biosist (Cook Veterinary Products Inc, 501 N Rogers Street, Bloomington, Indiana 47405, USA) wurde gewonnen aus der Submucosa des Dünndarms von Schweinen, welche dehydriert und sterilisiert wurde (8). In dieser Präsentation werden erfolgreiche Einsätze der Schweinedünndarmsubmucosa (SIS) als xenogenetische Transplantate zur Behandlung von ernsten Hautverletzungen bei zwei Scheuneneulern (Tyto alba), einem Weissenkakadu (Cacatua alba), und bei einer gemeinen Amerikanische Krähe (Corvus brachyhyynchos).

Résumé

Les traumatisms cutanés dans la région du bréchet des psittacidés sont souvent associés à du picage et de l’automutilation, ainsi que des traumatisms de chute chez les animaux aux plumes rognées. De plus, les dommages au bréchet sont aussi parmi les traumatisms les plus fréquents chez les buses (Buteo buteo) captives dans les Emirats Arabes Unis (4). Dans de nombreux cas, ces lésions deviennent granulomateuses ou
évolutent vers la nécrose chronique, et peuvent également toucher l’os sous-jacent. Des traumatismes de la peau et des tissus mous sous-jacents du tarsométatarse causées par des jets mal adaptés ou abîmés ont été rapportés chez les rapaces, et sont similaires aux lésions observées chez les psittacidés portant des bandages trop serré autour des pattes. Les techniques usuelles pour le traitement des traumatismes du bréchet comprennent l’intervention chirurgicale et les soins. Différentes techniques de greffe cutanée ont été utilisées chez des oiseaux présentant de larges déficits cutanés. Les autogreffes cutanées le pigeon biset *(Columba liva)* et la buse à queue rousse *(Buteo jamaicensis)* (5,6). Des allogreffes sont fréquemment faites sur des poulets (afin de déterminer des coefficients de consanguinité), et la survie du greffon est positivement corrélée à l’homogénéité génétique (7). Aucun rapport de xénogreffe cutanée chez les oiseaux n’est connu à ce jour. Vet Biosist (Cook Veterinary Products Inc, 501N Rogers Street, Bloomington, Indiana 47405, USA) est dérivé de la sous-muqueuse de l’intestin grêle du porc (SIS), déshydratée et stérilisée (8). Cette présentation décrit l’utilisation réussie de la SIS en tant que xénogreffe pour la réparation de déficits cutanés importants chez deux chouettes effraies *(Tyto alba)*, un cacatoès *(Cacatua alba)*, et un corbeau *(Corvus brachyhyhyncho)*.

**Key words:** barn owl, *Tyto alba*, umbrella cockatoo, *Cacatua alba*, common crow, *Corvus brachyhyynchos*, small intestinal submucosa, skin graft

**References**

AVIAN ORTHOPEDICS - BASICS OF MINIMALOSTEOSYNTHESIS DEMONSTRATED ON A FRACTURED FEMUR CONDYLUS

M. LIERZ

Affiliation:
Institute for Poultry Diseases, Free University of Berlin, Koserstrasse 21, 14195 Berlin, Germany.

Abstract

A juvenile Gy- Peregrine Falcon Hybrid (Falco rusticolus * Falco peregrinus) was presented with an acute lameness of the left pelvic limb caused by a fractured condylus medialis shown during the radiological examination. As all ligaments within the joints were stable a minimal osteosynthesis using a lag screw and a kirschner- wire as fixation was successfully tried. The surgery is described and different methods and principles of possible osteosynthesis techniques are discussed.

Extended abstract:

Successful management of the avian orthopaedic patient requires not only the application of sound orthopaedic principles, but also careful management of the bird, especially the rehabilitation process after surgery. Before surgery the bird needs a detailed evaluation to determine if the outcome of the surgery meets the purpose for the bird afterwards, e.g. a wild bird should not be treated if there are no chances for full return to function after a fracture (4).

Fracture healing in birds is similar to mammal's (6) but the structure of the avian bone is different. The cortex is thinner but stronger, and splinters more easily into fragments resulting in comminuted fractures. The long bones have a relatively large medullary cavity and may be pneumatised. The rate of healing is very rapid and scar tissue or callus can form within 7 - 10 days. Most fractures are caused by trauma but can also be caused by metabolic diseases, infections and neoplasia (3).

When planning fracture fixation, the following points should be taken into account. It is always an advantage if primary bone healing can be achieved. This direct primary healing is fast and strong...
but there is no large visible callus. This type of healing will only be possible if there is rigid stabilisation with a perfect alignment of the fracture ends. In addition the compression of the fracture ends is important. Compression of the fracture prevents fracture end resorption, which means that the implants stay stable longer (2). In cases were primary healing is not possible (the majority of avian fractures) secondary healing, with the formation of callus, is necessary. The formation of the callus is influenced by the movement of the fracture ends and the functional stress on the fracture gap, as in mammals too much movement causes the formation of a false joint. Finally the vascularisation of the bone should be considered as bone healing is only possible with a sufficient blood supply to the fracture ends. The perfect fixation method is a rigid fixation to eliminate forces (axial compression, bending, and torsion) on the fracture, compression of the fracture ends, and a good blood supply. Bandage fixation on its own is not a sufficient fixation and should only be used for short-term support, e.g. during transport to the veterinarian. Surgical methods can be divided into internal and external techniques as well as the combination of both. Internal fixation methods are screws, wires, intramedullary pins and bone plates. Screws should only be used in trochea fractures and are of high importance in minimal osteosynthesis. Mostly, screws are used in combination with other methods to hold a single splint in place during rebuilding a fractured bone. Cerkage wires should never be used alone. They do not have any stability against torsion and axial compression and they have a high reduction of blood supply. They might be of use in fixation of single fragments. Intramedullary pins are used very often, as they are easy and quick to apply. In some cases they are the method of choice but often this method is insufficient. Low stability against torsion and axial compression are the biggest disadvantages. An infected fracture is usually a contraindication for the intramedullary pin as the infection can be introduced into the bone (8). Bone plates, in particular dynamic compression plates, have an excellent stability against the described forces of the fracture including a good reposition of the fracture, except in comminuted fractures.

Unfortunately they are usually too heavy for smaller birds, are expensive, and have a risk of reduction of the blood supply to the fracture. In most of the orthopaedic cases seen in avian veterinary practice, external fixation is the method of choice because it is quick and easy to apply and can be applied with the fracture site closed so that a good blood supply remains at the fracture ends. It also allows repositioning of the bone during surgery. Finally removal without a second invasive surgery is also an advantage. Correctly applied external fixation provides good stability against torsion and axial compression. By including an intramedullary pin into the external fixation the stability against bending can be increased; it also maintains the correct alignment of the bone (1,7). Apart from the above-mentioned general considerations, the orthopaedic surgical techniques need adjustment with regard to the type of fracture and its location. Some orthopaedic cases, such as a false joint, need additional surgical intervention apart from the fracture treatment (5). As mentioned before screws are the method of choice in fractured trochea and joints. A juvenile Gyr-Peregrine Falcon Hybrid (Falco rusticolus * Falco peregrinus) was presented with an acute lameness of the left pelvic limb caused by a fractured condylus medialis shown during the radiological examination. The fracture line was located within the sulcus intercondylaris at the border of the sulcus patellaris. Because of the acute fracture a surgical fracture repair was performed immediately. The bird was anaesthetised with a isoflurane- inhalation anaesthesia, premedicated with prednisolon, atropine and fluids. The surgical entrance was chosen from medial between the m. femorotibialis externus et medius and m. femorotibialis internus. Care was taken of the n. cutaneous femoralis medialis and the v. tibialis medialis. After demonstration of the fracture line (within the joint) it was recognised that all ligaments were functional. During reposition of the fracture a step within the joint has to be avoided as this would lead to a malformation of the joint later on. The fragment was fixed with a lag screw directed from medial to lateral. To improve the stability of the fixation against torsion a short kirschner- wire was placed in the fragment too. To gain more stability of the joint the fascia was sutured with pressure. The skin was closed with single interrupted sutures. Three weeks after surgery the fracture line was not visible on x-ray any more. First the kirschner- wire was removed to get more forces on the fracture and the screw. This should improve the force induced healing process. Ten days later the screw was removed too. During clinical and radiological examination the bird did not show any problems of the left knee joint. The case demonstrate the successful use of minimal-osteosynthesis in joint fractures.
References

5. Lierz M and Lierz U; Brunnberg, L. Surgical management of a pseudarthrosis in a white-tailed- sea eagle (Haliaeetus albicilla). Proc. 40th International Symposium on Diseases of Zoo and Wild Animals, Rotterdam, Netherlands, 2001; 295-7
7. Redig PT. The use of an external skeletal fixator - intramedullary pin tie-in (ESF-IM) for treatment of long bone fractures in raptors. In: Lumeij, JT; Remple, JD; Redig, PT; Lierz, M; Cooper, JE. eds. Raptor Biomedicine III. Florida, USA: Zoological Education Network, 2000; 239- 53

This manuscript is reproduced in the IVIS website with the permission of EAZWV www.eazwv.org
TAPE BANDAGE TO SUPPORT THE HEALING PROCESS OF TENDON- AND LIGAMENT-INJURIES IN BIRDS

M. WEHRLE

Affiliation:
Natur- und Tierpark Goldau, Parkstrasse 40, CH-6410 Goldau Germany

Abstract

In two cases of rupture of the Achilles-Tendon, one combined with a rupture of the medial tarsal-ligament, the healing of the tendons and ligament were supported by partial immobilisation of the tarsal joint by taping after surgical adaptation. Taping is a procedure of non-rigid immobilisation to provide a controlled stress after surgery and to increase bearing weight adapted to the kind of injury and to the grade of healing. The target is to build up strength and functional tissue.

Zusammenfassung


Résumé

Dans deux cas de rupture du talon d’Achille, dont un associé à une rupture du ligament médial tarsal, la guérison des tendons et du ligament a été facilitée par immobilisation partielle de l’articulation tarsale, grâce à un bandage après adaptation chirurgicale. Le bandage est une technique d’immobilisation non-rigide qui permet de contrôler le stress post-chirurgical et d’accroître le poids portant selon le type de traumatisme et le stade de guérison. La finalité est de rétablir la force et la fonctionnalité du tissu.

Key words: bird, taping, tendon, ligament, injury

Introduction

The healing of joint injuries is a special problem in birds, which walk much, especially if they are able to fly. If we immobilise a leg by a cast or a fixateur extern we have a total immobilisation with all its problems of muscle atrophy, cartilage integrity, enormous handicap and stress of the wild animal and stiffness after removing the immobilisation. Also the healing of the injury is delayed and there is no functional tissue built up during the healing period because of the poor supply of these structures especially if they are not moving (1). In human medicine this disadvantage has been recognised and an alternative procedure of non-rigid immobilisation has been discovered. The target of this kind of rehabilitation was to adapt weight bearing to the kind of injury and to the level of the recovery. That means the patient is allowed to do some controlled movements without stretching the repaired structure (2).

Taping achieves 3 targets in the healing of joint injuries in wild animals:
• Immobilisation of an injured tendon or ligament that it can not be stretched, but it is necessary to increase partially putting weight on the structures during the healing period to achieve a high
physical resistance of the new tissue. Under bearing partial weight the body is building up a functional tissue, which is stronger after recovery than tissue that is built up without bearing any weight on.

- Minimisation of muscle atrophy.
- A bandage should handicap a wild animal as little as possible to reduce the stress to a minimum level.

### Technique of tape bandage

Material: Leukotape® is a very strong non-elastic adhesive tape, which glues well on the skin and makes very little irritation. It is also resistant to water. Rolls are available in different width (1.5cm, 3cm) and at a length of 5 meters.

Method: *showed in pictures at the presentation* (3, 4)

### Case reports

**Demoiselle crane (Anthropoides virgo)** found with injury of the left leg.

Clinical examination: Penetrated injury from caudal through skin, Achilles tendon and capsule of the tarsal joint with contamination.

Diagnosis: Achilles tendon torn and infection of the tarsal joint.

<table>
<thead>
<tr>
<th>Day</th>
<th>Therapeutical Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4</td>
<td>Tarsal joint washed out with NaCl; Splint-bandage with plastic-halfpipe to avoid</td>
</tr>
<tr>
<td></td>
<td>stretching the Achilles tendon; Amoxicillin LA 150mg/kg i.m.; Meloxicam 0.1</td>
</tr>
<tr>
<td></td>
<td>mg/kg i.m.</td>
</tr>
<tr>
<td>6</td>
<td>Surgery under Anaesthesia (medetomidin-ketamin): approach from medial; tarsal joint</td>
</tr>
<tr>
<td></td>
<td>closed by Vicryl 4-0 and 2 U-stitches to adapt the Achilles tendon by PDS 3-0. Skin:</td>
</tr>
<tr>
<td></td>
<td>Prolene 4-0. Splint-bandage with plastic-halfpipe. Amoxicillin LA 150</td>
</tr>
<tr>
<td></td>
<td>mg/kg i.m.; Meloxicam 0.2 mg/kg i.m.</td>
</tr>
<tr>
<td>7 – 14</td>
<td>Change the bandage every 3 days. Day 14: Skin stitches removed. Amoxicillin LA 150</td>
</tr>
<tr>
<td></td>
<td>mg/kg i.m.; Meloxicam 0.2mg/kg i.m.</td>
</tr>
<tr>
<td>14 – 42</td>
<td>Taping to allow flexion approximate 0 - 10 degrees.</td>
</tr>
<tr>
<td></td>
<td>Change the tape every 7 days.</td>
</tr>
<tr>
<td>42 – 56</td>
<td>Taping to allow flexion approximate 0 - 20 degrees.</td>
</tr>
<tr>
<td>56 – 94</td>
<td>Taping to allow flexion approximate 0 - 40 degrees.</td>
</tr>
<tr>
<td>94 – 108</td>
<td>Taping to allow flexion approximate 0 - 80 degrees.</td>
</tr>
<tr>
<td>108 - 122</td>
<td>Taping to allow flexion approximate 0 - 80 degrees.</td>
</tr>
<tr>
<td>122</td>
<td>Tape removed.</td>
</tr>
<tr>
<td>After 130</td>
<td>Unrestricted use of the leg.</td>
</tr>
</tbody>
</table>

**Red-breasted goose (Branta rubicollis)** found having caught its leg between 2 rocks and could not escape itself.

Clinical examination: Lateral hypermobility in the tarsal joint, hyperflexion (approximate 180 degrees) of the mediotarsus and loss of sensibility in the foot, loss of proprioception and no activity in the foot.

Diagnosis: Injury of the medial ligament and Achilles tendon partial torn; injury of the nerves by strangulation.
Day | Therapeutical procedure.
---|---
0  | Splint-bandage. Meloxicam 0.2 mg/kg i.m.
3  | Clinical examination shows sensibility in the foot and spontaneous movement. Surgery: approach from medial; 2 Sultan-diagonal-stitches with 3-0 PDS over the medial ligaments without opening the capsule of the tarsal joint; 2 U-stitches to adapt the Achilles tendon. Skin: Prolene 4-0. Tape bandage to avoid stretching of the Achilles tendon. Amoxicillin LA 150 mg/kg i.m.; Meloxicam 0.2 mg/kg i.m.
5; 7; 10; | Change part of the bandage on the wound. Amoxicillin LA 150 mg/kg i.m.; Meloxicam 0.2 mg/kg i.m.
14 | Skin stitches removed. Tape bandage to allow flexion approximately 0 - 10 degrees.
14 – 42 | Tape-bandage to allow flexion approximately 0 - 10 degrees.
42 - 56 | Tape-bandage to allow flexion approximately 0 - 40 degrees.
56 - 70 | Tape-bandage to allow flexion approximately 0 - 80 degrees.
70 – 94 | Tape-bandage to allow flexion approximately 0 - 100 degrees.
After 100 | Unrestricted use of the leg.

Discussion

In these 2 cases taping was successfully used to support the healing process of tendon- and ligament injuries after surgery. The same material and technique was used, but in the crane-case taping came in use after day 14 because of the caudal skin injury. Due to the crane’s long legs, which gave a big leverage, the time period of little flexion (10-20 degrees) was longer than the similar period in the goose-case. The advantages in comparison to the cast, soft cast and other techniques are:

- Partial bearing weight and controlled movements which strengthen the new tissue and shortens the period of recovery.
- Minimum of muscle atrophy.
- Minimum handicap for the animal.
- Easy application and modification of the bandage.
- Almost unlimited functionality (mobility, strength) of the injured leg after recovery.

In comparison to other animals taping is more suitable in birds legs because of very little subcutaneous tissue. Due to the tight junction between skin and deeper structures, taping achieves good stability.

References

3. The basic principles of athletic taping Mueller Chemical Co. 1979.
MEDEOTOMIDINE-KETAMINE-REMOTE ANAESTHESIA OF THE EURASIAN LYNX
(Lynx lynx Linné, 1758) AND ITS EFFECTS ON ANAESTHETIC DEPTH,
RESPIRATION, CIRCULATION AND METABOLISM

J. SCHÖNE\textsuperscript{1}, Ch. HACKENBROICH\textsuperscript{1}, K. H. BONATH\textsuperscript{2} and M. BÖER\textsuperscript{1}

Affiliation:
1. Fachgebiet Tiergartenbiologie und Zootiermedizin, Tierärztliche Hochschule Hannover und Serengeti
   Safaripark, Hodenhagen (Zool. Direktor: PD Dr. M. Böer)
2. Abteilung für Allgemeine und Experimentelle Chirurgie, Chirurgische Veterinärklinik, Justus-Liebig-
   Universität Giessen (Leiter: Prof. Dr. K. H. Bonath)

Abstract

A modern anaesthesia and immobilisation procedure was developed for the Eurasian Lynx (Lynx lynx). Data
supported by statistical analysis of a comprehensive anaesthesia monitoring are presented for the first time for
this feline species. In order to avoid undue harm to the 17 subjects, non or minimally invasive monitoring
techniques were used, which are suitable for use both in clinical environment and under field conditions. Based
on observations of reflex activity, pain sensitivity, muscle relaxation, respiratory, circulatory and metabolic
functions, the clinical suitability and veterinary practicability of the medetomidine/ketamine anaesthesia were
demonstrated.

After estimating the body weight of the subject, 0,03 mg/kg BW medetomidine and 3 mg/kg BW ketamine were
injected from a distance (actual dosages were found to be 0,0319 ± 0,0031 mg/kg BW medetomidine and 3,19 ±
0,31 mg/kg BW ketamine after weighing the subjects). All experimental remote immobilisations were carried out
in conjunction with diagnostic and/or therapeutic measures. Induction phase, tolerance phase and recovery
phase were recorded.

The tolerance period showed a very good anaesthetic depth with pronounced peripheral analgesia and complete
muscle relaxation. Capnography, pulse oximetry, indirect blood pressure measurement, electrocardiography
and mobile blood gas analysis proved to be reliable non or minimally invasive methods for anaesthesia
monitoring under field conditions. The i.m. application of atipamezol at 5 times the dosage of the administered
medetomidine proved to be a suitable method of antagonising the medetomidine effect quickly and effectively.

The results show that systemic and organ-specific effects of the medetomidine/ketamine anaesthesia were
compensated by endogenous regulatory mechanisms of the lynxes and did not cause clinical complications in
healthy animals. In the dosages described above, the combination of the \textalpha{}-agonist medetomidine and the
dissociative anaesthetic ketamine leads to a secure, effective and antagonisable immobilisation, which is
suitable for minor surgical and management procedures for the Eurasian Lynx.

Zusammenfassung

Für den Eurasischen Luchs (Lynx lynx) wurde ein modernes, tierart- und tierschutzgerechtes Anästhesie- und
Immobilisationsverfahren erarbeitet. Erstmals werden statistisch gesicherte Daten einer nahezu vollständigen
Anästhesieüberwachung bei dieser Felidenart vorgestellt. Zur Schonung der 17 Probanden fand ein praxisnahes
und unter Feldbedingungen einsetzbares nicht bzw. minimal invasives Monitoring Verwendung. Anhand der
Überwachung von Reflexerregbarkeit, Schmerzempfinden, Muskelrelaxation, Atem-, Kreislauf- und
Stoffwechselfunktionen wurden die klinische Eignung und die veterinärmedizinische Praktikabilität einer
Medetomidin/Ketamin-Anästhesie beim Luchs überprüft.

Es wurden – nach geschätztem Körpergewicht – 0,03 mg/kg KGW Medetomidin und 3 mg/kg KGW Ketamin auf
Distanz injiziert (0,0319 ± 0,0031 mg/kg KGW Medetomidin und 3,19 ± 0,31 mg/kg KGW Ketamin absolut). Alle
experimentell-anästhesiologischen Immobilisationen wurden mit diagnostischen und/oder therapeutischen
Maßnahmen verbunden. Einleitungs, Toleranz- und Aufwachphasen wurden dokumentiert.

Die Toleranzphase wies eine sehr gute Anästhesieteile mit deutlicher peripherer Analgesie und vollständiger
Muskelrelaxation auf. Kapnometrie, Pulsoximetrie, indirekte Blutdruckmessung, Elektrokardiographie und
mobile Blutgasanalyse erwiesen sich als zuverlässig, nicht bzw. minimal invasive Methoden zur
Anästhesieüberwachung unter Feldbedingungen. Die i.m. Gabe von Atipamezol in der 5fachen Dosis des
verabreichten Medetomidin erwies sich bei dieser Felidenart als geeignet, den Medetomidinan teil rasch und
effektiv aufzuheben.

Résumé
Un procédé d’anesthésie et d’immobilisation moderne a été mis au point pour le lynx eurasien (Lynx lynx Linné, 1758). Il est adapté à cette espèce animale et conforme à la protection des animaux. Pour la première fois, des données confirmées par des statistiques sur pratiquement l’ensemble de la surveillance anesthésique ont pu être présentées pour ce type de félin. Pour protéger les 17 animaux testés, un système de surveillance par écran inaperçu ou discret a été utilisé dans des conditions de champ. La surveillance des capacités réflexes, de la douleur, de la relaxation musculaire, des fonctions respiratoires, cardiovasculaires et métaboliques ont permis de tester l’aptitude clinique et les possibilités médicovétérinaires d’une anesthésie avec médétomidine-kétamine. En prenant appui sur la masse corporelle, 0,03 mg/kg PV de médétomidine et 3 mg/kg PV de kétamine ont été injectées à distance (0,0319 ± 0,0031 mg/kg PV de médétomidine et 3,19 ± 0,31 mg/kg PV de kétamine absolue). Les immobilisations expérimentales-anesthésiologiques ont été combinées avec des mesures diagnostiques et/ou thérapeutiques. Les phases d’introduction, de tolérance et de réveil ont été documentées. La phase de tolérance a présenté une très bonne profondeur anesthésique avec une nette analgésie périphérique et une relaxation musculaire totale. La capnométrie, pulsoximétrie, la mesure indirecte de la tension sanguine et l’analyse mobile des gaz du sang se sont avérées être des méthodes de surveillance anesthésique non ou peu gênantes dans des conditions de champ. L’atipamézole injectée en respectant un dosage de 5x la médétomidine introduite a permis d’éliminer rapidement et efficacement la part de médétomidine. Les données obtenues prouvent que les influences caractéristiques de l’anesthésie médétomidine/kétamine et spécifiques aux organes ont été compensées rapidement par des mécanismes de régulation des lynx, avec le dosage utilisé, sans provoquer de complications cliniques. Pour le dosage utilisé, la combinaison de médétomidine avec l’agoniste α2 et l’anesthésique dissociable kétamine ont permis d’obtenir chez le lynx une immobilisation sûre, efficace et antagonisable qui convient aux petites opérations chirurgicales et aux mesures de management.

Key words: Eurasian Lynx, Lynx lynx, medetomidine, ketamine, atipamezole, remote anaesthesia, anaesthesia monitoring

Introduction
In the Autumn of 1999 the Ministry for Nutrition, Agriculture and Forestry of the Federal State of Lower Saxony, Ministry for Environmental Affairs of Lower Saxony, Hunting Association of Lower Saxony and Harz National Park jointly decided to reintroduce the Eurasian Lynx into the Harz area. A safe, effective and reversible anaesthetic regime is equally important for successful release of Lynxes into the wild, as it is for zoological gardens and wildlife parks in which these popular predators are kept. Anaesthetic studies of indigenous and exotic pets as well as of captive and wild animals confirm a medetomidine/ketamine combination to be both safe and effective (2,3,4,5,7,10,11,12,13,14,15,16,17,21,22,23,24,25,26,27,28). The aim of this study was to test clinical suitability and veterinary practicability of a medetomidine/ketamine anaesthetic combination on the Eurasian lynx.

Material and methods
The experiment was carried out on 17 healthy animals in predominantly standardised conditions. Gender, as well as different age and weight classes were taken into consideration. Ages of the 10 male (1 castrated male) and 7 female lynxes varied from 3 to almost 14 ½ years with body weights ranging from 16,8 kg to 35 kg. All experimental remote immobilisations were carried out in conjunction with diagnostic and/or therapeutical measures. After estimating the body weight of the subject, 0,03 mg/kg BW medetomidine (Domitor®, Pfizer GmbH, Karlsruhe) and 3 mg/kg BW ketamine (Hostaket®, Hoechst Roussel Vet Vertriebs GmbH,
Unterschleißheim) were injected i.m. using either a blowpipe or tranquilliser gun (actual dosages were found to be 0.0319 ± 0.0031 mg/kg BW medetomidine and 3.19 ± 0.31 mg/kg BW ketamine after weighing the subjects).

Reflex activity, pain sensitivity, muscle tone, respiratory rate, end-tidal carbon dioxide concentration (capnography), peripheral oxygen saturation (pulse oximetry), heart rate, indirect blood pressure measurement, capillary refill time, mucous membrane colour and thermoregulation were recorded every 5 minutes (15 min-45 min after injection) in a specially created anaesthesia protocol. Data from the electrocardiograph and venous blood gas analysis (inclusive of acid-base-state) were recorded every 10 minutes (15/20 min-45/50 min after injection).

After carrying the patients back to their enclosure the α₂-antagonist atipamezol (Antisedan®, Pfizer GmbH, Karlsruhe) was injected i.m. into the hindquarters at 5 times the dosage of the administered medetomidine.

The stages of anaesthesia were defined – according to BONATH (6) – as follows: Induction phase is the time from application to lateral recumbency, tolerance phase is the time from first contact with the animal until first signs of reawakening and recovery time is the time from first signs of reawakening until the animal was completely awake.

Palpebral reflex, corneal reflex, pupillary light reflex, interdigital reflex and sphincter reflex as well as muscle tone and capillary refill time of the oral mucosa were measured semi-quantitatively. To test for pain sensitivity pressure was applied to a toe using an arterial clamp. 12 second long electrocardiograms (I., II. and III. derivations according to Einthoven) were produced using a Hellige Multiscriptor EK43 (25/50 mm/s, 1 cm/mV). Indirect blood pressure readings (cuff size of about 40% of limb diameter) were taken oscillometrically from the lower left forelimb (Vet Bp™ 6000, Sensor Devices Inc.). The peripheral oxygen saturation (S₂O₂) was measured with a pulse oximeter (Satelite Plus, Datex) and a lingually attached Sensorclip. Respiratory rate and end-tidal carbon dioxide concentration (ETCO₂) were measured continuously with a capnograph (Capnomac II, Datex) attached to a tracheal tubus (Size 7.5 to 8.5). Blood samples for obtaining a blood gas analysis and establishing the acid/base status were taken from the V. cephalica. The following parameters were monitored with a Critical Care Analyser (OPTI3, AVL): oxygen partial pressure = pO₂, carbon dioxide partial pressure = pCO₂, pH, bicarbonate = HCO₃⁻, base excess = BE. The core temperature was continuously registered by a digital thermometer (DTL60, Unitherm GmbH).

The statistical evaluation was done with the aid of the BMDP/Dynamic programme, Release 7.0 (8).

To test statistical significance over time by a corrected standard distribution of characteristics a monofactorial variance analysis with repeated measurements was carried out with the programme BMDP5V using the factor „time“. Due to missing data during the course of observation the „Wald-test“ was used, which uses the maximum-likelihood-approximation principle. Results of p=0.05 were seen as statistically significant. In addition the exact p-value is quoted.

Results

Using the ketamine/medetomidine dosages described above 17 lynxes were successfully anaesthetised. The induction phase ran smoothly and without excitation. Mean induction time lasted 10.35 ± 3.43 [min], mean tolerance time 50.45 ± 8.7 [min] and mean recovery time 13.93 ± 7.89 [min]. The tolerance phase showed a very good anaesthetic depth with pronounced peripheral analgesia and complete muscle relaxation.

Excitability of the pupillary light reflex (p=0.0031), end-tidal carbon dioxide levels (p=0.0002), peripheral oxygen saturation (p=0.0098), venous oxygen partial pressure (p=0.0026) and venous carbon dioxide partial pressure (p=0.0030) increased significantly in the course of anaesthesia from minute 15 to minute 45. Excitability of the corneal reflex (p=0.0063), heart rate (p<0.0001), diastolic blood pressure (p=0.0216) and body temperature (p<0.0001) decreased significantly in the same period. All other parameters remained unchanged during anaesthesia or the changes were statistically nonsignificant.

Electrocardiograms were obtained for 16 animals with the following results: no suspected type I AV-blocks, no type II AV-blocks were observed, 13 animals showed a respiratory sinus arrhythmia, and one animal temporarily did not display a p-wave. The latter was replaced in the first interval with a fibrillating f-wave, which hinted at an atrial fibrillation. Later a normal sinus rhythm resumed.
Atipamezol given at 5 times the dosage of the administered medetomidine antagonised the former anaesthetic effects rapidly and effectively. All animal passed through the recovery stage calmly and without excitation.

Complete data of anaesthetic amounts, length of anaesthesia phases and all monitored parameters are listed in Tab. 1-3.

Table 1: Dosages of medetomidine, ketamine and atipamezole as well as length of anaesthesia stages of 17 anaesthetised Eurasian Lynxes (mean value (\(\bar{x}\)), standard deviation (s), minimum (\(x_{\text{min}}\)), maximum (\(x_{\text{max}}\))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(\bar{x} \pm s)</th>
<th>(x_{\text{min}})</th>
<th>(x_{\text{max}})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medetomidine [(\mu g/kg)]</td>
<td>31.9 ± 3.1</td>
<td>28.4</td>
<td>38.3</td>
</tr>
<tr>
<td>Ketamine [mg/kg]</td>
<td>3.19 ± 0.31</td>
<td>2.84</td>
<td>3.83</td>
</tr>
<tr>
<td>Atipamezole [(\mu g/kg)]</td>
<td>159.5 ± 15.5</td>
<td>142</td>
<td>191.5</td>
</tr>
<tr>
<td>Induction phase [min]</td>
<td>10.35 ± 3.43</td>
<td>5.97</td>
<td>20.5</td>
</tr>
<tr>
<td>Tolerance phase [min]</td>
<td>50.45 ± 8.7</td>
<td>28.5</td>
<td>63.17</td>
</tr>
<tr>
<td>Recovery phase [min]</td>
<td>13.93 ± 7.89</td>
<td>1.67</td>
<td>30.5</td>
</tr>
</tbody>
</table>

Table 2: Cardiovascular, respiratory and metabolic parameters: HR = heart rate, SBP = systolic blood pressure, DBP = diastolic blood pressure, RR = respiratory rate, \(S_aO_2\) = peripheral oxygen saturation, \(ETCO_2\) = end-tidal carbon dioxide, BT = body temperature (mean value (\(\bar{x}\)) ± standard deviation (s), number of animals (n))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>15 min</th>
<th>20 min</th>
<th>25 min</th>
<th>30 min</th>
<th>35 min</th>
<th>40 min</th>
<th>45 min</th>
<th>Wald-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR/min</td>
<td>93.75 ± 7.23</td>
<td>92.13 ± 9.72</td>
<td>91.87 ± 10.33</td>
<td>90.24 ± 10.77</td>
<td>89.06 ± 9.81</td>
<td>87.00 ± 11.01</td>
<td>85.00 ± 10.26</td>
<td>p &lt; 0.0001</td>
</tr>
<tr>
<td>SBP [mmHg]</td>
<td>210.00 ± 16.42</td>
<td>195.43 ± 43.55</td>
<td>199.20 ± 27.59</td>
<td>198.50 ± 28.25</td>
<td>192.73 ± 27.97</td>
<td>198.33 ± 22.87</td>
<td>196.13 ± 18.17</td>
<td>p = 0.1327</td>
</tr>
<tr>
<td>DBP [mmHg]</td>
<td>164.20 ± 13.05</td>
<td>151.14 ± 34.67</td>
<td>155.10 ± 26.45</td>
<td>153.40 ± 26.17</td>
<td>148.73 ± 24.13</td>
<td>152.00 ± 18.38</td>
<td>151.50 ± 17.30</td>
<td>p = 0.0216</td>
</tr>
<tr>
<td>RR/min</td>
<td>15.30 ± 6.67</td>
<td>14.21 ± 3.49</td>
<td>16.88 ± 4.70</td>
<td>16.25 ± 3.79</td>
<td>16.00 ± 4.91</td>
<td>15.86 ± 3.71</td>
<td>16.42 ± 3.99</td>
<td>p = 0.3283</td>
</tr>
<tr>
<td>(S_aO_2) [%]</td>
<td>95.82 ± 2.56</td>
<td>96.19 ± 2.93</td>
<td>96.94 ± 2.43</td>
<td>96.88 ± 2.80</td>
<td>97.24 ± 2.02</td>
<td>97.86 ± 1.88</td>
<td>98.67 ± 1.15</td>
<td>p = 0.0098</td>
</tr>
<tr>
<td>(ETCO_2) [%]</td>
<td>4.63 ± 0.39</td>
<td>4.79 ± 0.45</td>
<td>4.95 ± 0.38</td>
<td>4.88 ± 0.42</td>
<td>4.98 ± 0.36</td>
<td>4.91 ± 0.34</td>
<td>4.86 ± 0.34</td>
<td>p = 0.0002</td>
</tr>
<tr>
<td>BT [°C]</td>
<td>38.54 ± 0.76</td>
<td>38.46 ± 0.75</td>
<td>38.49 ± 0.80</td>
<td>38.45 ± 0.67</td>
<td>38.36 ± 0.67</td>
<td>38.18 ± 0.83</td>
<td>37.99 ± 0.81</td>
<td>p &lt; 0.0001</td>
</tr>
</tbody>
</table>
Tab. 3: More cardiovascular and metabolic parameters: \( pO_2 \) = oxygen partial pressure, \( pCO_2 \) = carbon dioxide partial pressure, \( HCO_3^- \) = bicarbonate, \( BE \) = base excess (mean value (\( \bar{x} \)) ± standard deviation (s), number of animals (n))

<table>
<thead>
<tr>
<th>Time post injection/Parameter</th>
<th>15/20 min</th>
<th>25/30 min</th>
<th>35/40 min</th>
<th>45/50 min</th>
<th>Wald-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous ( pO_2 ) [mmHg]</td>
<td>40,62 ± 4,59 (13)</td>
<td>43,67 ± 5,46 (15)</td>
<td>45,15 ± 5,81 (13)</td>
<td>48,56 ± 5,36 (9)</td>
<td>( p = 0,0026 )</td>
</tr>
<tr>
<td>Venous ( pCO_2 ) [mmHg]</td>
<td>39,15 ± 4,34 (13)</td>
<td>42,73 ± 3,71 (15)</td>
<td>42,00 ± 3,61 (13)</td>
<td>42,56 ± 3,57 (9)</td>
<td>( p = 0,0030 )</td>
</tr>
<tr>
<td>Venous pH</td>
<td>7,33 ± 0,04 (14)</td>
<td>7,33 ± 0,05 (16)</td>
<td>7,32 ± 0,04 (13)</td>
<td>7,31 ± 0,03 (9)</td>
<td>( p = 0,5339 )</td>
</tr>
<tr>
<td>Venous ( HCO_3^- ) [mmol/l]</td>
<td>20,8 ± 1,57 (14)</td>
<td>20,67 ± 2,01 (16)</td>
<td>20,75 ± 1,39 (13)</td>
<td>20,76 ± 1,18 (9)</td>
<td>( p = 0,3928 )</td>
</tr>
<tr>
<td>Venous BE [mmol/l]</td>
<td>-4,98 ± 1,57 (14)</td>
<td>-4,86 ± 1,28 (15)</td>
<td>-4,78 ± 1,65 (13)</td>
<td>-4,82 ± 1,21 (9)</td>
<td>( p = 0,8799 )</td>
</tr>
</tbody>
</table>

Discussion

Separation of the anaesthetic stages into induction, tolerance and recovery phases proved to be realistic in our experience.

Complete muscle relaxation and absence of peripheral pain sensitivity were good indicators for evaluation of anaesthetic depth, however the large variability of the reflexes was not.

Respiratory depressive qualities of the anaesthetic combination were responsible for the minor drop in respiratory frequency. Breaths were frequent and deep enough to ensure sufficient ventilation of the lungs. This was shown by the capnometric readings: normal level of ETCO\(_2\) in small mammals is between 4-5 vol.-% (1) and despite a significant rise the mean did not exceed these levels.

The mean of obtained pulse oximetry values rose significantly from 96% to almost 99%. Norm SaO\(_2\) value for an animal breathing atmospheric air is 92% or more (20), i.e. the already high values improved.

Standard levels for venous blood gasses in domestic cats are 39 ± 11 mm Hg for \( pO_2\) and 41,8 ± 9,12 mm Hg for \( pCO_2\) (19). Despite significant rises neither parameter deviated from these levels, i.e. they show sufficient oxygen supply of blood and tissues.

The initially high heart rate can probably be attributed to excitation of the animals and a linked rise in the sympathetic tonus.

The commonly observed respiratory sinus arrhythmia of the lynx was probably due to their relatively large body mass in relation to that of domestic cats. The cause of atrial fibrillation in one case was attributed to the anaesthetic, this returned to normal by minute 35 however. This temporary reduction in the effectiveness of the atria remained a solitary exception.

Both systolic and diastolic blood pressure were raised, probably due to the effects of ketamine (18) and the stress induced rise in the sympathetic tonus.

Hypertension over a relatively short period of time is generally preferable to hypotension. In general terms animals should not be subjected to systolic pressures of over 250 mm Hg over longer periods (9). This hypothetical value was never exceeded. For this study absolute values were not in the forefront of the investigation but rather featured trends during the course of the anaesthesia (1).

The norm levels for the venous acid/base status in domestic cats are 7,300 ± 0,087 for \( pH \), -5,7 ± 4,6 mmol/l for \( BE \), and 19,4 ± 4,0 mmol/l for \( HCO_3^- \) (19). Again the means for the lynxes laid in these limits.

At no time did a dangerous hypo- or hyperthermia occur.

This manuscript is reproduced in the IVIS website with the permission of EAZWV www.eazwv.org
Conclusion

The current studies show that medetomidine and ketamine are especially suited for anaesthesia of Eurasian lynxes. As a result of the data of this study the medetomidine/ketamine combination can be reckoned to have most of the important attributes of an "ideal" anaesthetic for the immobilisation of wild animals over distance (29):

- good solubility at high concentration in small volumes
- speedy absorption and effect onset
- sedation, muscle relaxation, analgesia
- a sufficiently long effect
- it does not cause excitement during onset or recovery
- it lacks life endangering side effects
- it is antagonizable and has a short recovery stage

The combination of medetomidine and ketamine and their subsequent, partial antagonisation with atipamezol can be recommended as an appropriate and secure method for distance immobilisation of Eurasian lynxes.

Acknowledgements

We thank the Ministry for Nutrition, Agriculture and Forestry of the Federal State of Lower Saxony and Discovery Channel, Germany, for financial support. We thank the students Lara Fichtel, Matthias Peppmüller, Svenja Schenk, Vanessa Klippel and Peter Robert Bowen for their indispensable help, Norbert Tietz and Ralph Neumann (Wildpark Lüneburger Heide), Dr. Hartmut Müller (Wildpark Schwarze Berge), Ute Radestock (Heimatnatu rgarten Weissenfels), Dr. Florian Brandes (Tierpark Essehof) and Joachim Hennig (Wisentgehege Springe) for their trust in our work.

References

EFFECT OF CLIMATE CONDITIONS OF MIDDLE EAST ON CHEMICAL IMMOBILISATION OF ARABIAN AND AFRICAN UNGULATES

L. MOLNAR\textsuperscript{1} and P. MCKINNEY\textsuperscript{2}

Affiliation:
1. Abu Dhabi Falcon Hospital, Abu Dhabi, United Arab Emirates
2. Wildlife Protection Office, Dubai, United Arab Emirates

Abstract

Experience with 48 cases of a chemical immobilisation of Arabian oryx (\textit{Oryx leucoryx}) and Arabian gazelles species are presented by authors. Immobilisation was carried out in conditions almost identical with a free-ranging habitat and a climate condition of desert in Middle East. In 18 cases of chemical immobilisation etorphine (Immobilon, 1.8-2.2 ml/animal) mixed with azaperon (Stresnil, 30 mg/animal) was used. This combination of anaesthetic was reversed by equal dose of diprenorphine (Reviron). Capture myopathy, hyperthermia and aspiration pneumonia was observed in 30\% of darted animals. By authors experience of animal capture in desert conditions, when summer temperature reaches 48\textdegree C and animals are free-ranging, the preferred drug of choice is a mixture of ketamine (0.8-1.5 mg/kg) and xylazine (0.5-1.2 mg/kg). Anaesthesia can be successfully reversed with atipamezole (Antisedan, 0.5-0.9 mg/kg).

Zusammenfassung

Die Autoren präsentieren ihre Erfahrung über bei der chemischen Immobilisierung in 48 Fällen bei arabischen Spieszböcken (Oryx leucoryx) und arabischen Gazellenarten. Die Immobilisierung wurde durchgeführt bei ähnlichen Verhältnissen wie bei einer Freihaltung und bei einem Wüstenklima in dem mittleren Osten. In 18 Fällen der chemischen Immobilisierung wurde Etorphine (Immobilon, 1.8-2.2 ml/Tier) kombiniert mit Azperon (Stresnil, 30 mg/Tier). Diese Kombination des Anästhetikums wurde wieder aufgehoben mit der gleichen Dosierung Diprenorphine (Reviron). Fangmyopathie, Hyperthermie und Aspirationspneumonieen wurden in 30\% der betäubten Tiere gefunden. Nach den Erfahrungen der Autoren beim Einfangen der Tiere bei Wüstenklima, wo die Temperaturen im Sommer 48\textdegree C erreichen, und die Tiere frei gehalten werden, wird eine Kombination von Ketamine (0.8-1.5 mg/kg) und Xylazine (0.5-1.2 mg/kg) bevorzugt. Diese Anästhesie kann erfolgreich aufgehoben werden mit Atipamezole (Antisedan, 0.5-0.9 mg/kg).

Résumé

48 Cas d’immobilisation chimique d’oryx d’arabie (\textit{Oryx leucoryx}) et de gazelle d’arabie sont présentés. Toutes les immobilisations ont été réalisées dans des conditions quasi identiques avec des animaux en liberté et les conditions climatiques du désert au moyen orient. Dans 18 cas, un mélange d’Etorphine (Immobilon: 1,8-2,2 ml par animal) et d’azapéron (Stesnil: 30mg par animal) était utilisé. Cette combinaison d’anesthésiants était antagonisée par une dose égale de diprénorphine (Reviron). Des myopathies de capture, de l’hyperthermie et des pneumonies d’inspiration ont été observés chez 30\% des animaux fléchés. D’après l’expérience des auteurs en capture d’animaux dans des conditions désertiques, la meilleure anesthésie est un mélange de kétabine (0,8-1,5 mg/Kg) et xylazine (0,5-1,2 mg/Kg), lorsque les températures estivales atteignent 48\textdegree C et que les animaux sont en liberté. L’anesthésie peut facilement être antagonisée par de l’atipamézole (antisédant (0,5-0,9 mg/Kg).

Key words: immobilisation, Immobilon, azaperon, ketamine, xylazine, Arabian oryx, \textit{Oryx leucoryx}, gazelles

Introduction

During a three years of veterinary service and management of a population of 150 Arabian oryxes (\textit{Oryx leucoryx}) and 200 gazelles, goitred gazelles (\textit{Gazella subgutterosa}) and Arabian mountain...
gazelles (*Gazella gazella*), the chemical immobilisation and animal capture was performed in 48 cases of Arabian oryxes and 83 cases of gazelles. They were kept in a 25 km² of fenced desert ecosystem, which was a part of ecotourist resort. Large areas of sand dunes and extremely hot daily temperatures made animal capture very difficult in many aspects. Animals were free-ranging, forming different size family groups (5-25 individuals). Traumatic injuries as a result of fighting near water and food sources were the main reasons of immobilisation and medical treatment. Adult females, especially during a calving period, often injured other group members. Translocation of injured and aggressive animals was the second most common veterinary procedure at the site. Body weight of anaesthetised animals ranged between 40-150 kg.

**Methods**

For a chemical immobilisation and animal capture a dart gun and 3 ml darts were used. Darted animals could be approached at the feeding spots or near shaded places by vehicles. In 18 cases of Arabian oryx capture a combination of etorphine (Immobilon, 1.8-2.2 ml/animal) and azaperon (Stresnil, 30 mg/animal) was used. This combination resulted in a good anaesthesia and analgesia in all darted animals. Minor surgical procedures could be performed in field conditions. There were negative effects observed using the combination of these drugs. Hyperthermia, capture myopathy and aspiration pneumonia mainly in a higher doses were the reason to switch to different drugs, especially during a hot summer time. Combination of ketamine-xylazine reversed with atipamezole was used to immobilise oryxes. Following doses were used: ketamine (0.8-1.5 mg/kg)-xylazine (0.5-1.2 mg/kg) and atipamezole (Antisedan, 0.5-0.9 mg/kg). Atipamezole was administered minimum 30 min postdarting, half dose i.v., half dose i.m. Immobilisations of gazelle species were also performed by the combination of ketamine-xylazine and reversed by atipamezole. Two species of gazelles were present at the site, Arabian goitred gazelle (*Gazella subgutterosa*) and Dorcas gazelle (*Gazelle dorcas*). Ketamine (7 mg/kg) and xylazine (12-16 mg/kg) were used for Dorcas gazelle. Drug dose at Arabian gazelle was half of dose used for Dorcas gazelle. 20-25 min postdarting 0.8-1.0 ml of atipamezole was administered, half dose i.v. and half dose i.m. Rapid and complete reverse of intramuscular ketamine-xylazine was achieved. No adverse effects were observed.

**Results and discussion**

Immobilisation of 18 Arabian oryxes was performed by using a combination of etorphine (Immobilon, 1.8-2.2 ml/animal) and azaperon (Stresnil, 30 mg/animal). Darted animals shortly after darting usually tend to run until become exhausted. This resulted in capture myopathy, especially if animal was surrounded with soft sand dunes. Increased dose of immobilon was used to prevent this effect by shortening the induction time. Hyperthermia and regurgitation of a rumen content were observed with an increased immobilon dose. During a hot summer time hyperthermia was a cause of death of 3 Arabian oryxes. Aggression of subadult male towards a dominant male was recorded in 90% of cases using immobilon. Aggressive behaviour of the dominant male towards darted individuals of the same family group was common when darted animal became recumbent. These effects were the reason to use the combination of ketamine (0.8-1.5 mg/kg) and xylazine (0.5-1.2 mg/kg) reversed with atipamezole (Antisedan, 0.5-0.9 mg/kg). A good results with atipamezole reversing xylazine in Arabian oryx were reported by other authors as well (Ancrenaz, 1994). Ketamine-medetomidine combination was successfully used in gemsbok (*Oryx gazella*) (Grobler et al., 2001) and sika deer (Tsuruga et al., 1999) and ketamine-xylazine in gazelle species (Foster,1999). Higher drug dose requirements in Dorcas gazelle were confirmed by the same author. Atipamezole has an antagonistic effect on xylazine induced sedation, bradycardia and ruminal atony (Thompson et al., 1991). Idazoxan (RX781094) is another alternative drug to reverse xylazine and medetomidine in different wild ruminants (Haviernick et al., 1998; Doherty and Tweedie, 1989; Jorgenson et al., 1990). In our clinical practice in Middle East the chemical immobilisation with ketamine-xylazine and the antagonistic effect of atipamezole offers a good drug combination for a field veterinary work in desert conditions.
Both drugs combination etorphine-azaperon and ketamine-xylazine can be used for chemical capture and minor surgical procedures in Arabian oryx and gazelle species. Using immobilon in the extremely hot climate conditions and in animals in a free-ranging environment brings a much higher risk of occurrence of the negative effects and fatalities. Ketamine-xylazine is a relatively safe and cheap alternative to the ultrapotent narcotics.

References

IMMOBILISATION OF GIRAFFE WITH MEDETOMIDINE AND KETAMINE FOLLOWED BY GASEOUS ANAESTHESIA

E.J.FLACH1, P.M.TAYLOR2, A.W.SAINSBURY1, J.DODDS1, R.A.F. LINTON3, K.BAKER2 and R.EASTWOOD2

Affiliation:
1. Veterinary Science Unit, Institute of Zoology, Whipsnade Wild Animal Park, Dunstable, Beds. LU6 2LF (Flach, Dodds) and Regent’s Park, London NW1A 4RY (Sainsbury)
2. Dept.Clinical Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge CB3 0ES
3. The Rayne Institute, St.Thomas’ Hospital, London, SE1 7EH

Abstract

Between 1998 and 2001 five giraffe (Giraffa camelopardalis) have been immobilised on a total of nine occasions at the Zoological Society of London’s two animal collections. Induction was achieved with approximate doses (based on estimated body-weights) of 50-73µg/kg body-weight (BW) medetomidine and 1.3-3.3mg/kg BW ketamine, following pre-medication with 20mg haloperidol for the adult animals. Anaesthesia was maintained with halothane or isoflurane and oxygen for between 57 and 160 minutes. A mild acidosis was seen in most procedures, but oxygenation was good. Recovery, following administration of RX821002-A (40-62µg/kg BW) or atipamezole (0.25-0.3mg/kg BW), was rapid in the calf and slow, but calm, in the adults. The adults made one or more attempts to stand before succeeding, but when the adult male was given atipamezole partially intravenously and partially intramuscularly he attempted to stand very soon after, fell backwards, suffered injuries to his head and body, and later died. Apart from this death, all other procedures were successful and none of the common problems of giraffe anaesthesia, such as excited inductions and regurgitation, were encountered.

Zusammenfassung

In der Periode zwischen 1998 und 2001 wurden fünf Giraffen (Giraffa camelopardalis) bei neun Gelegenheiten immobilisiert. Eingeleitet wurde jeweils mit einer angepassten Dosis (basiert auf das geschätzte Körpergewicht) von 50-73 µg/kg Körpergewicht (KW) Medetomidine und 1.3-3.3mg/kg KG Ketamine gefolgt durch eine Prämédication mit 20mg Haloperidol bei den ausgewachsenen Tieren. Die Anästhesie wurde erreicht mit Halothan oder Isofluran und Sauerstoff für einen Zeitraum von 57-160 Minuten. In den meisten Fällen trat eine leichte Azidose, aber die Sauerstoffsättigung war gut. Das Erwachen, nach verabreichen von RX821002-A (40-62 µg/kg BW) oder Atipamezole (0.25-0.3 mg/kg KG), war schnell bei Kälbern und langsam, aber ruhig, bei ausgewachsenen Tieren. Die Ausgewachsenen brauchten einen oder mehrere Versuche, um auf zu stehen. Nachdem einem männlichen ausgewachsenen Tier Atipamezole teilweise intravenös und teilweise intramuskulär gegeben worden war, versuchte es kurz danach auf zu stehen, fiel rückwärts, verletzte sich an Kopf und Körper und starb wenig später. Mit Ausnahme dieses Todesfalles verliehen alle Prozeduren erfolgreich und keines der üblichen Probleme bei der Anästhesie von Giraffen, wie Erregung bei der Einleitung und Regurgitation, wurden wahrgenommen.

Résumé

Entre 1998 et 2001, sur 5 girafes (Giraffa camelopardalis) appartenant aux deux collections de la Zoological Society of London, ont été réalisées au total 9 anesthésies. Les animaux ont été induits avec des dose approximatives ( a partir de poids corporels estimés) de 50-73 µg/Kg de médétomidine et de 1,3-3,3 mg/Kg de ketamine avec une prémédication de 20 mg d’halopéridol pour les adultes. L’anesthésie était ensuite entretenu avec de l’halothane ou de l’isoflurane et de l’oxygène durant 57 à 160 minutes. Une acidose mineure a été observée dans la plupart des cas, mais l’oxygénation restait bonne. Le réveil, après administration de RX821002-1 (40-62 µg/Kg), ou d’atipamézole (0.25-0.3 mg/Kg) était rapide chez les jeunes et lent, mais paisible chez les adultes. Les adultes faisaient une ou plusieurs tentatives avant de réussir à se lever, mais quand le mâle adulte a
reçu l’atipamézone partiellement en IV et partiellement en IM, il a essayé de se lever très rapidement, est tombé en arrière et s’est ainsi blessé à la tête et au corps, puis il est décédé. Excepté cette mort, toute les autres anesthésies ont été réussies, et aucun des problèmes classiques rencontrés lors de l’anesthésie d’une girafe (induction tumultueuse et régurgitation) n’ont été constatées.

Key words: Giraffa camelopardalis, anaesthesia, anaesthetic monitoring

Introduction

Giraffe are difficult animals to restrain physically and are also a high-risk species for chemical immobilisation (2), thereby making clinical examination and treatment problematic. Traditionally the opiates etorphine and carfentanil have been used in combination with sedatives such as acepromazine and xylazine to immobilise giraffe, but these combinations cause excitement and respiratory depression. Other complications of the use of these agents include regurgitation with secondary inhalation pneumonia and physical injury when giraffe become recumbent at the start of the procedure and subsequently when they get up (2). Mortality rates as high as 25-35% have been reported (5), although others have recorded mortalities below 15% (1). This paper describes the use of medetomidine and ketamine to induce anaesthesia; a combination which gave smooth inductions in five captive giraffe at Rotterdam zoo (9) and 23 free-ranging giraffe in South Africa (3, 4), and maintenance with halothane or isoflurane in oxygen.

Materials and methods

Three adult giraffe at Whipsnade Wild Animal Park were immobilised in 1998 and 2000 for hoof trimming. A four-month-old calf required two anaesthetics in 1998 for treatment of an umbilical abscess, and a six-year-old female at London zoo was anaesthetised twice in 2001 for the repair of a mandibular fracture (Table 1). Specially prepared yards were used for the procedures to ensure optimal conditions for induction and recovery. Cushioning was provided by straw bales attached to metal fences to a height of 2.5 metres and a deep-litter bed, at least 10cm deep, was provided so that the giraffe could obtain a good footing. The prepared yards measured between approximately 4m x 3m and 5m x 3.5m.

The adults were fasted for 48 hours and water was withheld for 12 hours prior to the procedure. They were darted with 20mg haloperidol (Serenace, Searle Pharmaceuticals) one hour before the anaesthetic agents were administered. The calf was separated from his mother and food and water for just 12 hours and was calm enough without the need for premedication. Each giraffe was darted with medetomidine (Zalopine, Orion Co.) at an approximate dose-rate (based on estimated body-weights) of 0.05mg/kg body-weight, plus ketamine (Vetalar V, Pharmacia & Upjohn) at between 1.3 and 2.5mg/kg (Table 1) either immediately, combined in one syringe, (Steffi) or 5 minutes after the medetomidine.

When recumbent the animals were moved into the centre of the yard and the head and neck raised on straw bales until the head was 1m above the ground to avoid excessive cerebral blood pressure and minimise the risk of regurgitation. The legs of the adults Wilhelm, Josie and Elley were tied and arranged for hoof trimming. The calf was positioned in right lateral recumbency with the left hindleg raised to allow access to the umbilicus and Steffi was placed in sternal recumbency for access to both sides of the mandible during the first procedure, and in half-lateral recumbency on the second occasion. During the procedures the animals' necks and limbs were massaged continuously by two or three people. Orotracheal intubation was performed blindly by palpation in all cases, using a 22mm or 25mm cuffed endotracheal tube for the adults and a 12mm tube for the calf. Anaesthesia was maintained with either halothane (Halothane-RM, Rhone Merieux) or isoflurane (Isoflurane-Vet, Merial) in oxygen, administered by a closed to-and-fro field anaesthetic machine with 35L bag (John Bowring, Conrob Consultants Ltd.) for all cases except Steffi, for whom a large animal circle circuit was used. A catheter was placed in the jugular vein and Hartmanns solution administered at 5-10mL/kg/hr. The rectal temperature, pulse and respiratory rates of the giraffe were monitored throughout
each procedure. Additional measurements included end tidal carbon dioxide (Kontron, Herts), arterial blood pressure, using an aneroid manometer (Pressurveil, Xomed) or an electronic system (Kontron) connected to a catheter placed in an auricular artery, arterial blood gas analysis (i-Stat, Heska Ltd.). For four of the procedures, cardiac output was measured using a lithium dilution technique (8).

At the end of the anaesthetic the giraffe were allowed to breath 100% oxygen for at least two minutes, and then the medetomidine sedation was reversed with either RX821002-A (Pierre Fabre), an alpha-2 antagonist related to idazoxan (7) or atipamezole (Antisedan, Pfizer) (Table 1). All were given prophylactic antibiotics, normally 15mg/kg amoxycillin trihydrate (Clamoxyl LA, Pfizer), a non-steroidal anti-inflammatory drug (either 1.1mg/kg flunixin meglumine, Finadyne, Schering-Plough, or 1.4mg/kg carprofen, Rimadyl, Pfizer) and a vitamin E and selenium supplement (Dystosel, Intervet).

Results

The adult giraffe given haloperidol were calm at the time of induction and showed reduced responses to external stimuli, such as noise and movements of people and vehicles. In all animals progressive sedation and ataxia developed after the medetomidine, with ptosis and salivation in evidence. Ataxia increased after ketamine administration until the animals stumbled and then fell into sternal, followed by lateral, recumbency. However, the initial doses were insufficient to produce recumbency in three cases and top-up doses (between 0.67 and 1.8mg/kg ketamine plus, in two cases, 0.013mg/kg medetomidine) were required. Induction time to recumbency was between 8 and 19 minutes for single dose inductions. No significant injuries appeared to be sustained by any of the giraffe during this phase, but Wilhelm fell heavily and awkwardly when he was anaesthetised in 2000.

The results of anaesthetic monitoring are summarised in Table 2. Rectal temperature remained within narrow limits, and only fell below 36.4°C in one animal. The pulse and respiratory rates were typically high when first recorded, fell after the introduction of anaesthetic gas, and then the pulse slowly rose whilst the respiratory rate normally fell. Wilhelm was apnoeic briefly after recumbency, probably due to the supplementary medetomidine and ketamine, but quickly restarted breathing after intubation and temporary manual intermittent positive-pressure ventilation. All animals were mildly acidotic, but only three animals had an arterial pH of less than 7.2. The first time that Wilhelm was anaesthetised, in 1998, he developed respiratory acidosis in conjunction with a mild metabolic acidosis, but the respiratory component of the acidosis resolved once excessive dead space was removed from the circuit. He was also given an intravenous infusion of 500mL of 4.2% sodium bicarbonate (Polyfusor, Fresnius Kabi Ltd.).

The partial pressures of carbon dioxide and oxygen were acceptable, and indeed most animals were well oxygenated, with percentage oxygen saturations in the 90s. The base excess was negative for part of the time on several occasions, indicating a degree of metabolic acidosis, as mentioned earlier. The mean arterial blood pressure was normal, but cardiac outputs appeared low; only 20 and 21 litres per minute in the two animals given halothane during anaesthesia, and 21 rising to 33-34 in the two given isoflurane.

After injection of the reversal drugs it took between two and 22 minutes for the animals to support their heads. They remained incoordinated, and made half-hearted attempts to rise, before successfully sitting up. In all cases, except when the male died, they then rested before attempting to stand. The calf stood at the first attempt on both occasions, between seven and nine minutes after supporting its head, but the adults made one or two unsuccessful attempts before getting to their feet 12 to 34 minutes after supporting their heads. None were harmed during this process.

When the adult male, Wilhelm, was reversed with both intravenous and intramuscular doses of atipamezole after his second anaesthesia, in 2000, he attempted to stand as soon as he was released from being held. He rose well on his forelegs, but his hindlegs failed to extend fully and support his weight, and he fell over backwards, hitting his head. Thereafter he made half-hearted attempts to rise and was assisted when it was safe to do so. An arterial blood sample was acidotic (pH 7.03, compared to 7.18-7.25 during the procedure), so sodium bicarbonate
(4 litres of 4.2%) was administered intra-venously, followed by 6 litres of Hartmanns and 400ml 50% dextrose. In addition he was given further atipamezole (50mg) and flunixin meglumine (2g). The acidosis was successfully resolved, but the animal became progressively weaker and dyspnoeic, and died nine hours after reversal. Necropsy findings included widespread, acute muscle damage, haemorrhages of the left thoracic wall and of the left side of the cranium, plus damage to the left hip. There was evidence of chronic kidney damage, although insufficient to cause elevations of urea or creatinine, and terminal visceral congestion and pulmonary oedema. Routine haematological and biochemical parameters were similar to three previous samples from the same animal, including mild normocytic and normochromic anaemia (Red blood cell count 10.4x10¹²/l), mild neutrophilia (13.4x10⁹/l) and high blood copper concentration (27.4µmol/l). But in addition both sodium (138mmol/l) and calcium (2.08mmol/l) were lower than on previous occasions.

On all other occasions the animals became steadily stronger and less ataxic once they were standing, but they were kept isolated and under observation for 24 hours before re-joining the herd. In one animal a clear improvement in alertness was observed 12 hours after the start of the procedure, and this was thought to be due to the effect of the haloperidol waning.

**Discussion**

These nine anaesthetic procedures indicate that the combination of medetomidine and ketamine is useful for immobilisation of giraffe and should be considered a preferred alternative to etorphine. There was a calm and smooth induction in each case with no significant injuries and no regurgitation. Endotracheal intubation was done blindly and by palpation, as in the cow, because of the limited degree of jaw opening, but once performed it allowed maintenance of a patent airway, addition of oxygen with and without volatile anaesthetic drugs, and direct measurement of end-tidal carbon dioxide. The effects of medetomidine were completely reversed by the antagonist RX821002-A, as noted in other species by Kock *et al* (7) and Schaftenaar (9), but atipamezole, was used latterly because it is the specific, and commercially available, antagonist. It was similarly effective, but when given to the male in divided doses intra-venously and intra-muscularly he attempted to stand too soon, and fell over backwards. In contrast, the whole dose of atipamezole was injected intra-muscularly into the six-year-old female and her recovery was slow, but when she attempted to rise she was strong enough and sufficiently co-ordinated to stand, even though she fell over during recovery from her first anaesthetic. Bush and colleagues (4) also found that atipamezole was best given intra-muscularly. The padded walls and well-bedded substrate of the yards were essential for the recovery phase because all of the adults made several attempts before successfully standing, and despite padding the adult male sustained traumatic injuries when he fell over.

The doses of medetomidine were lower than, but those of ketamine were similar to, doses required for immobilisation of free ranging giraffe (3). Unfortunately because shoulder heights were not recorded it is not possible to compare with the larger study of wild giraffe (4). The respiratory pulse rates were lower in our animals than in these two studies, but arterial blood pressure was higher. Mean blood pressure in conscious, standing giraffe ranged from 205 to 325mm Hg, and was 215 in an anaesthetised, recumbent animal (6). Therefore, most of our animals (90-222mm Hg) were hypotensive, but less so than the free-ranging animals reported by Bush *et al* (4). We saw similar, but less severe, acidosis, but much higher oxygen concentrations and saturation (4).

Cardiac output was measured on four occasions. The typical value seen in horses and humans is 70ml/kg/min (8), which would equate to approximately 52.5l/min for Wilhelm and Elley, and 45.5l/min for Josie. However, the observed outputs were between 20 and 211/min during two procedures with halothane anaesthesia, and 211/min rising to 33-34l/min in the two animals given isofluorane. The full significance of these low values is not clear, but isofluorane would appear to be a safer anaesthetic than halothane, which is known to lower cardiac output in other species (8). Obviously, given the history of anaesthetic complications in giraffe, it is important that the maximum data on respiratory and cardiovascular effects of anaesthesia are collected and collated whenever animals have to be immobilised.
Conclusions

Medetomidine and ketamine provided good induction in all cases, and halothane and isoflurane gave safe and controllable gaseous anaesthesia, although the cardiac outputs of animals anaesthetised with isoflurane were superior to halothane. Giraffe anaesthesia remains a high-risk procedure, and the loss of one animal during recovery underlines the need to continually improve methods and protocols, and to find alternatives whenever possible.

Acknowledgements

These procedures were successful because of the hard work and dedication of many people, for whom we are extremely grateful: the keeping staff of Whipsnade Wild Animal Park and London zoo, the Senior Curator of the Zoological Society of London, Nick Lindsay, members of the veterinary staff at Whipsnade and London, especially Sue Thornton, Tai Strike, Stefano Di Concetto, Ilona Furrokh, Gill Bell and Caroline Coe. Charlotte Langton, Marcus Clausss, Andy Hartley, Carol Nyaoke, Samuel Bila, Martin Hosegood, Nick Linton and Graham Bilbrough assisted with individual procedures.

References

Table 1 Giraffe Immobilisations 1998-2001  Summary of procedures and drug doses

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Sex</th>
<th>Date</th>
<th>Age</th>
<th>Est.Wt</th>
<th>Induction</th>
<th>Maintenance</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hpd (mg)</td>
<td>Med (mg)</td>
<td>Ket (mg)</td>
</tr>
<tr>
<td>1</td>
<td>Wilhelm M</td>
<td>29.7.98</td>
<td>10y</td>
<td>750³</td>
<td>20</td>
<td>45</td>
<td>1200</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>Wilhelm M</td>
<td>30.8.00</td>
<td>12y</td>
<td>750³</td>
<td>20</td>
<td>45</td>
<td>1600</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Marcus M</td>
<td>12.8.98</td>
<td>4m</td>
<td>150</td>
<td>7.5</td>
<td>195</td>
<td>19</td>
<td>0.25-2</td>
</tr>
<tr>
<td>4</td>
<td>Marcus M</td>
<td>26.8.98</td>
<td>4.5m</td>
<td>150</td>
<td>7.5</td>
<td>225</td>
<td>8</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>Josie F</td>
<td>22.10.98</td>
<td>10y</td>
<td>650</td>
<td>20</td>
<td>40</td>
<td>2000⁴</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Josie F</td>
<td>7.7.00</td>
<td>12y</td>
<td>650</td>
<td>20</td>
<td>40</td>
<td>1600</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>Elley F</td>
<td>25.5.00</td>
<td>15y</td>
<td>750</td>
<td>20</td>
<td>40</td>
<td>1100</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Steffi F</td>
<td>13.9.01</td>
<td>6y</td>
<td>600</td>
<td>20</td>
<td>30</td>
<td>1200</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Steffi F</td>
<td>19.12.01</td>
<td>6y</td>
<td>600</td>
<td>20</td>
<td>30</td>
<td>1200</td>
<td>5</td>
</tr>
</tbody>
</table>

Drugs:  
Hpd = haloperidol  
Med = medetomidine  
Ket = ketamine  
Med2/Ket2 = supplemental doses  
Halo = halothane  
Iso = isofluorane  
RX = RX821002-A (methoxy-idazoxan)  
Atip = atipamezole

Times:  
T-rec = time to recumbency (from 1st dose of ketamine)  
T-proc = time of procedure (from recumbency to reversal)  
T-head = time to holding head up (from dose of reversal agent)  
T-stand = time to standing (from dose of reversal agent)

1. RX 821002-A administered 1/v, except cases 6 and 7 when 20mg given i/v, 10mg i/m  
2. Atipamezole given i/m, except case 2 when 150mg given i/v, 75mg i/m  
3. Approx. weight based on dry carcass weight (705kg) post mortem. Weight used for dose calculation was 900kg  
4. Approx. total induction dose, one dart partial injected

This manuscript is reproduced in the IVIS website with the permission of EAZWV www.eazwv.org
**Table 2. Giraffe immobilisations 1998 – 2001: Anaesthetic monitoring**

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Temp °C</th>
<th>Pulse min⁻¹</th>
<th>Resp min⁻¹</th>
<th>ET CO₂ mm Hg</th>
<th>Art pH</th>
<th>PaCO₂ mm Hg</th>
<th>PaO₂ mm Hg</th>
<th>O₂ sat %</th>
<th>HCO₃⁻ mmol/l</th>
<th>AdjBE</th>
<th>BP mm Hg</th>
<th>CO l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wilhelm</td>
<td>37.3 – 37.9</td>
<td>22 - 36</td>
<td>36 - 86</td>
<td>50 - 90</td>
<td>7.1</td>
<td>73</td>
<td>71</td>
<td>87</td>
<td>22</td>
<td>-10</td>
<td>160 – 170</td>
<td>NR</td>
</tr>
<tr>
<td>2</td>
<td>Wilhelm</td>
<td>36.4 – 37.1</td>
<td>26 - 37</td>
<td>0 - 62</td>
<td>NR</td>
<td>7.2</td>
<td>53 - 74</td>
<td>75 - 93</td>
<td>92 -94</td>
<td>23 - 28</td>
<td>(4) - 0</td>
<td>168 – 188</td>
<td>21 - 33</td>
</tr>
<tr>
<td>3</td>
<td>Marcus</td>
<td>NR</td>
<td>30 - 70</td>
<td>40 - 64</td>
<td>47 - 67</td>
<td>7.2 – 7.3</td>
<td>20* - 79</td>
<td>143 - 222</td>
<td>89 -96</td>
<td>8* - 32</td>
<td>NR</td>
<td>90 – 122</td>
<td>NR</td>
</tr>
<tr>
<td>4</td>
<td>Marcus</td>
<td>37.0</td>
<td>31 - 37</td>
<td>16 - 60</td>
<td>NR</td>
<td>7.2</td>
<td>NR</td>
<td>NR</td>
<td>90 – 96</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Josie</td>
<td>37.6 – 37.8</td>
<td>31 - 62</td>
<td>12 - 80</td>
<td>NR</td>
<td>7.2</td>
<td>NR</td>
<td>90 - 168</td>
<td>222</td>
<td>89 - 100</td>
<td>24 - 32</td>
<td>(4) - 4</td>
<td>200</td>
</tr>
<tr>
<td>8</td>
<td>Steffi</td>
<td>36.4 – 37.4</td>
<td>32 - 42</td>
<td>16 - 40</td>
<td>38 - 49</td>
<td>7.2 – 7.3</td>
<td>59 - 78</td>
<td>290 - 456</td>
<td>100</td>
<td>24 - 37</td>
<td>(4) - 10</td>
<td>186 – 222</td>
<td>NR</td>
</tr>
<tr>
<td>9</td>
<td>Steffi</td>
<td>NR</td>
<td>24 - 40</td>
<td>8 - 56</td>
<td>38 - 57</td>
<td>7.2 – 7.3</td>
<td>50 - 55</td>
<td>38 - 59</td>
<td>64 - 86</td>
<td>23 - 26</td>
<td>(3) – (1)</td>
<td>?</td>
<td>NR</td>
</tr>
</tbody>
</table>

ETCO₂ = end-tidal CO₂  
O₂ sat = oxygen saturation  
HCO₃⁻ = bicarbonate  
AdjBE = adjusted base excess  
BP = mean arterial blood pressure  
CO = cardiac output  
NR = not recorded

- unusual figures recorded 15 minutes after the onset of monitoring, thought to be due to air in the arterial blood sample
CAPTURE MYOPATHY SYNDROME

F. KARBE¹, U. HETZEL², and G. von HEGEL¹

Affiliation:
1. Karlsruhe Zoo, Germany.
2. Institute of Veterinary Pathology, University of Giessen, Germany.

Abstract

Capture myopathy is a disease associated with capture stress, seen mainly in artiodactylids, but also in many other wild vertebrates. The underlying pathogenesis is complex and the clinical picture varies greatly. An imbalance of the sympathetic and adrenal systems, hyperthermia and acidosis, lead to cell necrosis, primarily of skeletal muscles and kidneys. Although knowledge of the animals’ history makes the diagnosis of capture myopathy fairly easy, animals are often lost due to the difficulty of treatment. Optimising animal capture and transport is the only efficient way of minimising the occurrence of capture myopathy.

Zusammenfassung


Résumé

La myopathie de capture est une maladie associée au stress de capture, connu chez de nombreux artiodactyles, mais aussi chez d’autres vertébrés sauvages. La pathogenèse est complexe et le tableau clinique est variable. Un déséquilibre du système nerveux sympathique et du système adrénergique, l’hyperthermie et l’acidose menant à la nécrose cellulaire principalement dans les muscles et les reins, sont en cause. Bien que la connaissance de l’histoire de l’animal rende le diagnostic de la myopathie de capture assez aisé, le traitement est difficile et les animaux sont souvent perdus. Le seul moyen efficace de minimiser l’apparition de myopathies de capture est d’optimiser les conditions de capture et de transport.

Key words: capture myopathy, artiodactylids, capture-related deaths, peracute capture shock, hyperthermia, acidosis, myoglobinuria, rhabdomyolysis

Extended abstract

Capture myopathy is a syndrome associated with the capture and transport of wild animals. It is induced by excessive anaerobic muscular activity, usually following exertion; and characterised by lesions of skeletal - and to a lesser extent - cardiac muscles. In zoos this problem is mainly seen in artiodactylids, although it occasionally occurs in other mammals, birds, and reptiles as well. In the 1960’s and 1970’s this disease was one of the mayor causes of capture-related deaths in wild animals (3). While rarely seen with today’s modern and more humane methods of animal restraint,
its clinical appearance is often a precursor of the animals’ death. Apart from white muscle disease (WMD), capture myopathy (CM) is the only other relevant myopathy in zoo animals. The pathogenesis of the nutritional myopathy WMD is well known and related to an absolute or relative deficiency of Vitamin E and the mineral selenium. CM is an exertional myopathy with a complex pathogenesis and various clinical forms. The combination of perceived fear, muscular activity, and the activation, exhaustion, and failure of sympathetic and adrenal systems contribute to the development of this syndrome. In many cases these biological systems, which are responsible for maintaining homeostasis in a crisis, do not recover and lead to various forms of shock, killing the animal. Prolonged maximal muscular activity under warm environmental conditions causes hyperthermia and acidosis, predisposing the development of CM (2, 4, 5, 6).

Clinical signs vary enormously and depend mainly on how long the animal has lived with the disease. The peracute form of capture shock quickly becomes, or is identical to, circulatory shock. Affected animals exhibit elevated serum muscle enzymes (AST, CPK, LDH) and usually die within six hours after capture. If the animals survive the first hours, they usually develop the so-called ataxic myoglobinuric syndrome (5). Patients seem deeply depressed, show accelerated and laboured respiration and a reluctance to stand. Hyperthermia is typical, while myoglobinuria is less common (2). Being the continuation of the acute form, muscle and renal lesions due to hypoxia and intracellular acidosis become more prominent. Animals have elevated serum BUN values and muscle enzymes. The degree of cellular necrosis determines whether the animal has a chance to recover or will die of renal failure, azotemia, and/or acidosis. Delayed complications of CM can kill healthy looking animals, even after several days. Massive necrosis of skeletal muscles can lead to toxaemia or the sudden rupture of large muscles, if forced to bear weight. Sudden stress may cause ventricular fibrillation in a delayed peracute form (5).

Pathological findings increase with the duration of the disease. Peracute capture shock involves only a marked congestion and oedema of the lungs, intestine and liver. Hypoxia, ATP deficiency, and intracellular acidosis destroy enzyme systems and cellular functions, leading to renal tubular necrosis and rhabdomyolysis within a few hours. Myocytes exhibit findings typical of degeneration and necrosis. The loss of cross and vertical striations of affected muscle fibers follow initial cloudy swelling and granulation of the sarcoplasm. Macroscopically, skeletal muscles appear pale and dry, with chalky white streaks, resembling the changes in WMD. Myocardial changes are less prominent. As the pathological process continues, hyaline (ZENKER) degeneration develops and often leads to necrosis, with or without dystrophic mineralization (1, 5). Further changes include adrenal swelling, atrophy of the cortex, and brownish urine in the bladder (3).

Treatment of CM is difficult and often unsuccessful. Animals exhibiting moderate-to-severe signs of the disease usually die. The main objectives are to save the patient from the vicious cycle of shock and to prevent further cell necrosis, toxaemia and renal failure. Infusion therapy can be used to treat shock-related hypovolaemia, azotemia, and acidosis. Since CM has such a poor prognosis, its prevention is essential. The most effective way to spare the animal is to optimise the method of restraint. Negative capture conditions, such as hot weather and excessive stress, must be avoided if possible. After capture and transport, animals should not be stressed again during the following days, to avoid causing delayed peracute CM. It must be kept in mind that - even with a trained team and well organised capture - the occurrence of CM, especially in artiodactylids, can never be completely ruled out.

References