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Case study **OPEN ACCESS**

Multidisciplinary management of an undifferentiated sarcoma in an obese captive Andean bear: a case report

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Abstract

Background: The Andean bear (*Tremarctos ornatus*) is a vulnerable ursid endemic to the Tropical Andes.
Objective: This report details the clinical management and multidisciplinary diagnostic approach of an undifferentiated sarcoma in an individual with a history of consanguinity and severe obesity.
Case description: A captive specimen presented with lameness, lethargy, and abdominal discomfort. Clinical evaluation revealed a critical body condition score (BCS 9/9).
Examination and diagnosis: Imaging assessments identified a splenic mass, confirmed through histopathology as an undifferentiated sarcoma.
Treatment/therapies: Management involved a restrictive dietary protocol for weight reduction and surgical intervention. Post-operative care included behavioral monitoring and the administration of psychotropic medication to mitigate stereotypic behaviors triggered during recovery.
Conclusion: This case highlights the clinical impact of multidisciplinary management on captive ursid health and the necessity of addressing secondary behavioral pathologies during surgical recovery.

Keywords Andean bear | bear conservation | wild animals medicine | ex-situ management | neoplasia

Introduction

Andean bears (*Tremarctos ornatus*) are the only extant species of the Ursidae family in South America, distributed across the tropical Andes from Venezuela to the Bolivia-Argentina border. Due to habitat fragmentation, land occupation, and hunting, the species is currently classified as vulnerable (VU) by the IUCN (Velez-Liendo & García-Rangel, 2017; Rodríguez *et al.*, 2019). A key strategy for the conservation of this species involves maintaining *ex situ* populations in zoos to mediate education programs and research regarding captive breeding (Velez-Liendo *et al.*, 2020). However, as these captive populations age, the emergence of complex chronic diseases—particularly neoplasia—presents a significant and underreported challenge to their clinical management and longevity.

Neoplasia is a critical clinical concern in captive ursids, with previous reports indicating a high prevalence of hepatobiliary and gastrointestinal tumors in other species (Stagni *et al.*, 2023). Despite this, documentation specifically regarding *Tremarctos ornatus* remains scarce, establishing a

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clear knowledge gap in the specialized literature. Most available reports in bears focus on *post-mortem* findings or independent tumors likely associated with age-related degenerative disorders (Fortin & Benoit-Biancamano, 2014), leaving a notable lack of integrated protocols that combine successful surgical intervention with metabolic and ethological stabilization.

In Brazil, the captive population consists of only 13 specimens (six males and seven females). One of these, an 18-year-old male, is under the care of Dr. Fábio Barreto Zoo in Ribeirão Preto, Brazil. This individual is genetically related to the remaining spectacled bears in the country, as the importation of additional specimens into Brazil ended in 1990 (Authors' personal communication). During its 17 years of captivity, this bear had not been subjected to anesthesia for clinical, biological, or nutritional evaluation. This case report addresses the aforementioned knowledge gap by presenting a multidisciplinary analysis and intervention in an Andean bear diagnosed with an undifferentiated sarcoma, emphasizing the integration of surgical treatment with metabolic and behavioral management in a patient with a history of consanguinity and high body weight.

Methods

Case report

A spectacled bear male born in captivity on 13th July 2007 at Parque Ecológico de São Carlos Zoo located in São Carlos City, São Paulo State, Brazil, named Renan, was transferred to Dr. Fabio Barreto Zoo in Ribeirão Preto, São Paulo State, Brazil, at one year old. After 17 years, in captivity, the staff of the Zoo has changed and the protocol regarding animal welfare was improved. First, the diets were prescribed based on the Daily Energy Requirement (DER) according to Carciofi *et al.* (2007) and the equation models for placental mammals provided by Kleiber (1947). In parallel, an operant conditioning protocol was incorporated in the bear's routine.

The operant conditioning was crucial to better evaluate animal behavior and clinics as the animal presented, on 22nd June 2025, claudication alternate with mobility issues, lethargy, and difficult to climb the playground part of the enclosure design. Specific commands were taken to approximate the individual to keepers and technicians for preliminary behavioral, and physical analysis and medication for pain control. After careful evaluation, it was agreed that chemical restraint was needed for a meticulous clinical checkup.

Thus, this study demonstrates the integrated evaluation of the spectacled bear across two stages: (i) **prior to surgical intervention**, referred to here as the **exploratory evaluation**, during which a battery of imaging and laboratory tests, biometry, and clinical examinations were performed and detected a tumoral mass in the spleen, alongside the establishment of a weight reduction protocol aimed at reaching a weight range compatible with the species to enhance the animal welfare; and (ii) **after the surgical intervention**, referred here as **surgical phase**, during which weight loss monitoring was maintained and complementary exams were conducted to evaluate the tumor mass detected in the spleen following the initial exploratory evaluation.

Anaesthetic protocol

On 18th July 2025, the individual was anesthetized according to the following protocol: (i) pre-anaesthetic medication (PAM) composed by tiletamine/zolazepam (2.5 mg/kg), dexmedetomidine (0,01 mg/kg) and midazolam (0.08 mg/kg) through intramuscular inoculation using anaesthetic darts released by a blowpipe for dissociation; and (ii) anaesthetic maintaining (AM) with the use of intravenous propofol (5 mg/h/kg) and inhalator isoflurane (1 MAC - Minimal Alveolar Concentration) as soon intubation. The individual was monitored during the trans-anaesthetic phase, using a multiparametric monitor (Phillips, Intellevue Anesthesia Monitor MP20, Germany) to describe electrocardiogram, oximetry, temperature, and non-invasive arterial pressure.

Checkup and biological samples collection

Checkup started with a survey of vital parameters registered by the multiparametric monitor and semiology assessment. Biological samples from the ears were collected using sterile swabs. Blood samples were taken from cephalic and dorsal venous arch veins according to Ruzhanova-Gospodinova *et al.* (2022). Feces were collected directly from the enclosure environment since the rectal ampoule was empty. Urine samples were collected using 08 FR size urethral probe. Finally, in alopecic areas, the collection of hair samples was performed.

Laboratory analysis

Hemogram with complete blood count was performed using automated methods (Hemabio III, Biotécnica, Minas Gerais, Brazil) conjugated with cytological blood smear analysis. Biochemical tests were performed by a third-party laboratory to measure glycosylated hemoglobin, amylase, uric acid, bilirubin, calcium, chlorine, total cholesterol (TC), creatin phosphokinase (CPK), alkaline phosphatase, phosphorus, gamma–glutamyl transferase (GGT), lactate desidrogenase (LDH), potassium, total protein and fractions, sodium, aspartate aminotransferase (AST), alanine aminotransferase (ALT), triglycerides by colorimetric and kinetic methods.

Testosterone, thyroid-stimulating hormone (TSH), free thyroxine (T4), total thyroxine, and B12 vitamin amounts were determined by chemiluminescence. Urinalysis was performed to evaluate the urinary filtrate from the perspective of physical, chemical, and sedimentoscopy analysis.

Gram staining (Laborclin, Paraná, Brazil) was conducted on the ear smears to look for *Malassezia pachydermatis* yeast. Trichogramma was performed in alopecic areas to assess ectoparasites and fungal dermatophytes.

Imaging diagnosis

Imaging diagnosis encompassed a multimodal evaluation composed of radiography, endoscopy and colonoscopy, and ultrasonography. Radiographic examination of the skull and pelvic limbs was performed using laterolateral, mediolateral,

and ventrodorsal projections, whilst ultrasonography comprised complete abdominal evaluation.

Ophthalmologic survey

The initial ophthalmic evaluation included the inspection of ocular structures using a slit lamp (Zumax SL 200), followed by the Schirmer Tear Test (Tear Touch) for tear quantification. The neuro-ophthalmic and pupillary reflex evaluations were performed using a cPLR device (Eickmeyer), while corneal sensitivity was assessed via esthesiometry (Cochet-Bonnet).

For ocular surface and pressure analysis, fluorescein dye (Leedsay S/A) was applied for TFBUT measurement, and applanation tonometry (Tono-Pen AVIA Vet) was performed. The posterior segment was examined via fundoscopy (ClearView Veterinary Optical Imager). Additionally, ocular ultrasonography and ultrasound biomicroscopy (UltraView XL) were conducted for biometric and ocular chamber assessments.

Finally, the OSA-VET system (SBM Sistemi) was used to perform interferometry, meniscometry, Placido disc topography, N.I.B.U.T., and meibography to analyze the morphology and function of the tear film and Meibomian glands.

Cytopathologic and histopathologic analysis

The nutritional strategy aimed to achieve a target body weight (BW) of 170 kg by targeting a steady weekly reduction of 1.0% (range 0.5–2.0%), following safety thresholds for ursid welfare (Lisi *et al.*, 2013). Initial Daily Energy Requirements (DER) were calculated based on allometric scaling for placental mammals (DER = 2.0 x 70 x (BW)0.75; Carciofi *et al.*, 2007) and subsequently restricted to 62% of maintenance levels. The diet comprised commercial adult dog food, fruits, vegetables, leafy greens, eggs, and yogurt (**Table 1**).

Due to insufficient initial weight loss, a second phase was implemented, further restricting the DER to 58% of maintenance. This adjustment included the introduction of specialized veterinary diets for canine obesity and a redistribution of food groups—increasing leafy greens (13%) and eggs (12%) while reducing vegetable proportions (**Table 1**). These modifications aimed to enhance caloric restriction and dietary variety, ensuring a progressive reduction in body mass without compromising nutritional quality or animal welfare.

Welfare assessment methodology

The welfare assessment followed the methodology proposed by Maher *et al.* (2021) for captive bear species. In summary, the protocol was slightly modified to accommodate only the visual, physical, and behavioural aspects of that work. The visual inspection composed the evaluation of eyes, nose, teeth, skin, haircoat, claws, footpads, injuries/wounds, and body weight (kg). The body weight was determined by weighing the specimen using a training protocol based on operant conditioning as described before. The physical survey was composed of the mobility hindlimb assessment and Cincinnati gait assessment scores proposed by the authors. Finally, for behavioural analysis, some behavioural categories were defined and latter grouped in as 'positive' or 'negative' displays. Shortly, positive behaviours included the following categories: foraging, climbing, and playing with objects. Negative behaviours instead included aggression and abnormal behaviour/stereotypy. The full descriptions of these behavioural categories are included in Maher *et al.* (2021).

A scoring system was applied according to Maher *et al.* (2021), with a few adaptations to improve data visualization. Shortly, the indicator categories of "aggression", "climbing", "foraging", "gait", "mobility", "playing", and "stereotypy" were scored in a scale of 1-3, analogously to worst, good, excellent qualitative attributes. Other categories, such as "claws",

Table 1 Composition of foods for daily energy requirements maintenance and weight loss

Item	(kcal/g)	Quantity-1st (g)	Energy-1st (kcal)	Quantity-2nd (g)	Energy-2nd (kcal)
Commercial Adult Dog Pellet	3.56	550	1,958.00	500	1,780
Apple	0.59	300	177	130	76.7
Watermelon	0.29	700	203	700	203
Italy Grape	0.57	70	39.9	70	30.9
Raw Carrot	0.31	900	279	700	217
Cooked Sweet Potato	1.18	900	1,062.00	300	354
Cooked Beet	0.46	900	414	700	414
Cooked Pumpkin	0.16	-	-	350	56
Cooked Corn	1.38	200	27	200	27
Chicory	0.2	800	160	1,900	323
Kale	0.28	800	224	1,900	532.0
Whole Egg	1.25	250	312.5	350	437.5
Commercial Obese Dog Pellet	3.00	-	-	190	570
Yogurt	0.74	150	111	150	111.0
Total intake/energy		5,720	5,056.40	6,050	4,405.1

"footpads", "eyes", "hair", "skin", "nose", "teeth", and "wounds" were measured in a binomial scale (health and no health). This approach allows an unbiased evaluation of behaviour and a measurable metric to estimate animal welfare.

This protocol was implemented as soon as the specimen was weighed during the first checkup round (exploratory analysis) and was used to monitor weight loss and welfare throughout the entire process of nutritional management and preparation for the surgical procedure.

Descriptive statistics

Statistical descriptive analyses were conducted using R software (version 4.3.2) within the RStudio environment. Data processing, cleaning, and organization were performed using the Tidyverse collection of packages (Wickham *et al.*, 2019), ensuring workflow reproducibility. For the temporal (monthly) follow-up data were chronologically categorized from July 2025 to January 2026.

Post-surgical follow-up

As soon as the chirurgical intervention was finished, it was followed by the initial phase of therapeutic conduct, and atipamezole (0.4 mg/kg) reverser was administered IM. Daily therapeutic conduct was based on antibiotics prescription cephalexin (30 mg/kg) BID/7 days PO associated with benzoylmetronidazole (20 mg/kg) BID/7 days PO. Analgesia and anti-inflammatory protocol were based on the prescription of morphine (0.2 mg/kg) TID/5 days PO and meloxicam (0.2 mg/kg) CID/7 days PO.

Besides, lesion inspection was performed using the operant conditioning protocol explained above. Briefly, when the bear stood up, it was possible to visualize the suture site and it possible to apply topical medication, such as rifamycin and neomycin BID/10 days in alternating shifts. Subsequently, a topical insect repellent was applied over the suture site to prevent oviposition.

Regarding the extraction of teeth 23 and 24, the diet was modified so that only soft foods were consumed to avoid suture dehiscence. To this end, wet food, cooked sweet potato, cooked beetroot, cooked egg, cooked carrot, banana, natural yogurt, honey, and papaya were administered according to the DER. Moreover, the specimen was confined in a dedicated enclosure to avoid excessive movements and to preserve internal and external suture points to reduce the chance of haemorrhage.

Finally, for the purpose of overcoming stress-related anxiety and aggressive behaviours during the lockdown for chirurgical recovering, it was administered clonazepam (from 0.03 mg/kg up to 0.05 mg/kg). Medication was administered only during episodes of abnormal behaviour. The decision to prescribe this medication at this dosage range was based on the limited literature available regarding the suggested posology for this species. After a careful evaluation of some research tools such as Google Scholar using the keywords "Clonazepam and Andean Bear", "Clonazepam prescription for Andean Bear", and "Clonazepam prescription for bears". So, the prescription was fully based on the safe allowed dosage for Canidae (Al-Tahan *et al.*, 1984) as this taxon is the most phylogenetically related to bear divergence (Maclellan & Reiner, 1994) and placed in the same order, Caniformia.

Results

Guedel's plan was successfully achieved during surgery

Figure 1 compares the anesthetic plan during the exploratory analysis (referred to as first phase) and during surgery for teeth extraction and splenectomy (referred to as second phase). Only the heart rate (bpm) and temperature (ºC) presented significant differences between first and second phases (**Figure 1**). The monitoring showed that the specimen was stable during both interventions, even with discrete variation probably related to a nociception response to automatic physiological pain at anesthesia. Since the eyes could not rotate during the exploratory intervention due to the need for a fixed eye position for ophthalmologic examination, the Guedel's plan was maintained in the first stage of plan three (reviewed by Siddiqui & Kim, 2023).

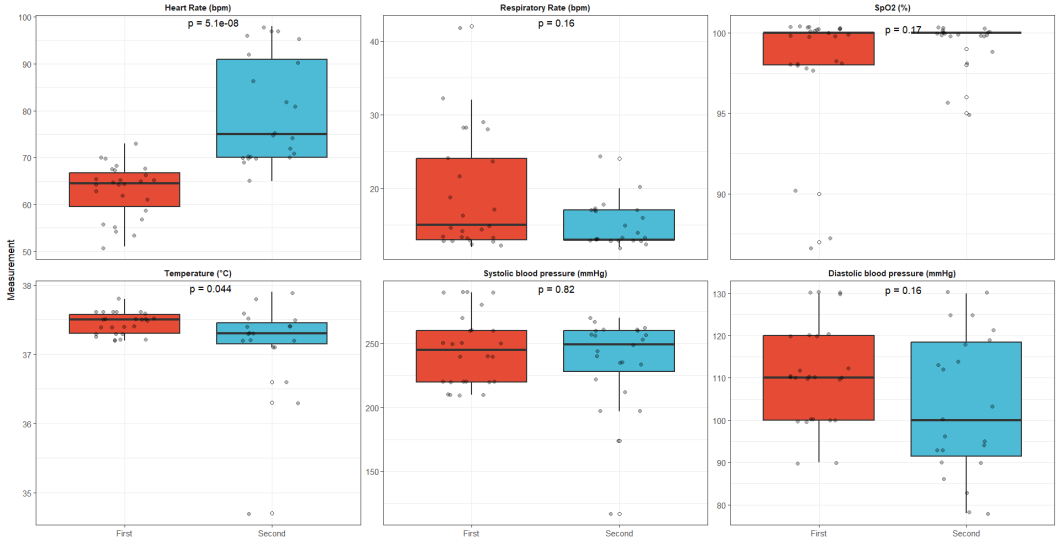


Figure 1 Anesthetic parameters measured during the exploratory analysis (first) and during surgery for teeth extraction and splenectomy (second).

Ophthalmic evaluation

Initial ophthalmic examination of both eyes (OU) revealed physiologically normal eyelids and eyelashes, though palpebral reflexes were slightly modified by analgesia. The conjunctiva was normochromic with discrete perilimbal pigmentation (at 9 o'clock in OD and 3 o'clock in OS), while the corneas remained transparent and fluorescein-negative. The anterior chambers were well-formed with serrated pupillary margins. In the lens, mild leukocoria was observed, suggestive of nuclear sclerosis (**Figure 2A**). Baseline metrics included an IOP of 13 mmHg (OD) and 12 mmHg (OS), and corneal sensitivity at 4 cm (OD) and 4.5 cm (OS). Schirmer Tear Test (STT) values were 9 mm/min in OD and 23 mm/min in OS, though these may have been influenced by anesthesia and positioning.

Fundoscopic evaluation showed normal vascular patterns, with straight cilioretinal venules and curvilinear arteries of standard caliber (**Figure 2B**). The tapetum lucidum exhibited greenish reflectivity and a normal transition zone, while the non-tapetal area showed healthy pigmentation. The oval-shaped optic discs were located within the tapetal area, featuring normal peripheral myelin deposition, physiological optic cups, and a holangiotic retinal vascularization pattern (**Figure 2B**).

Ultrasonographic evaluation (20 MHz) confirmed normal ocular biometry, with axial lengths of 14.4 mm (OD) and 14.53 mm (OS). The cornea, anterior chamber, and uveal structures (iris and ciliary body) presented preserved anatomical contours. While the lens showed regular capsules and anechoic content, the vitreous chamber presented scattered, fine hypoechoic punctate echoes, consistent with senile asteroid hyalosis. Retrobulbar structures and the intraorbital portion of the optic nerve displayed normal echogenicity and thickness. These findings were further supported by ultrasound biomicroscopy (UBM - 35 MHz), which detected no abnormalities in the anterior or posterior chambers and confirmed an open iridocorneal angle in the right eye.

Advanced ocular surface assessment (OSA-VET) indicated tear film instability, as the NIBUT was below the 10-second threshold in both eyes (2.5s in OD; 8.1s in OS). Interferometry confirmed a lipid layer deficiency in the right eye (<15 nm), and meniscometry showed a reduced tear meniscus height (0.16 mm in OD; 0.21 mm in OS). Despite these functional deficiencies, meibography revealed that Meibomian gland loss remained within physiological limits, measured at 16% in the right eye (**Figure 2C**) and 10% in the left eye (**Figure 2D**).

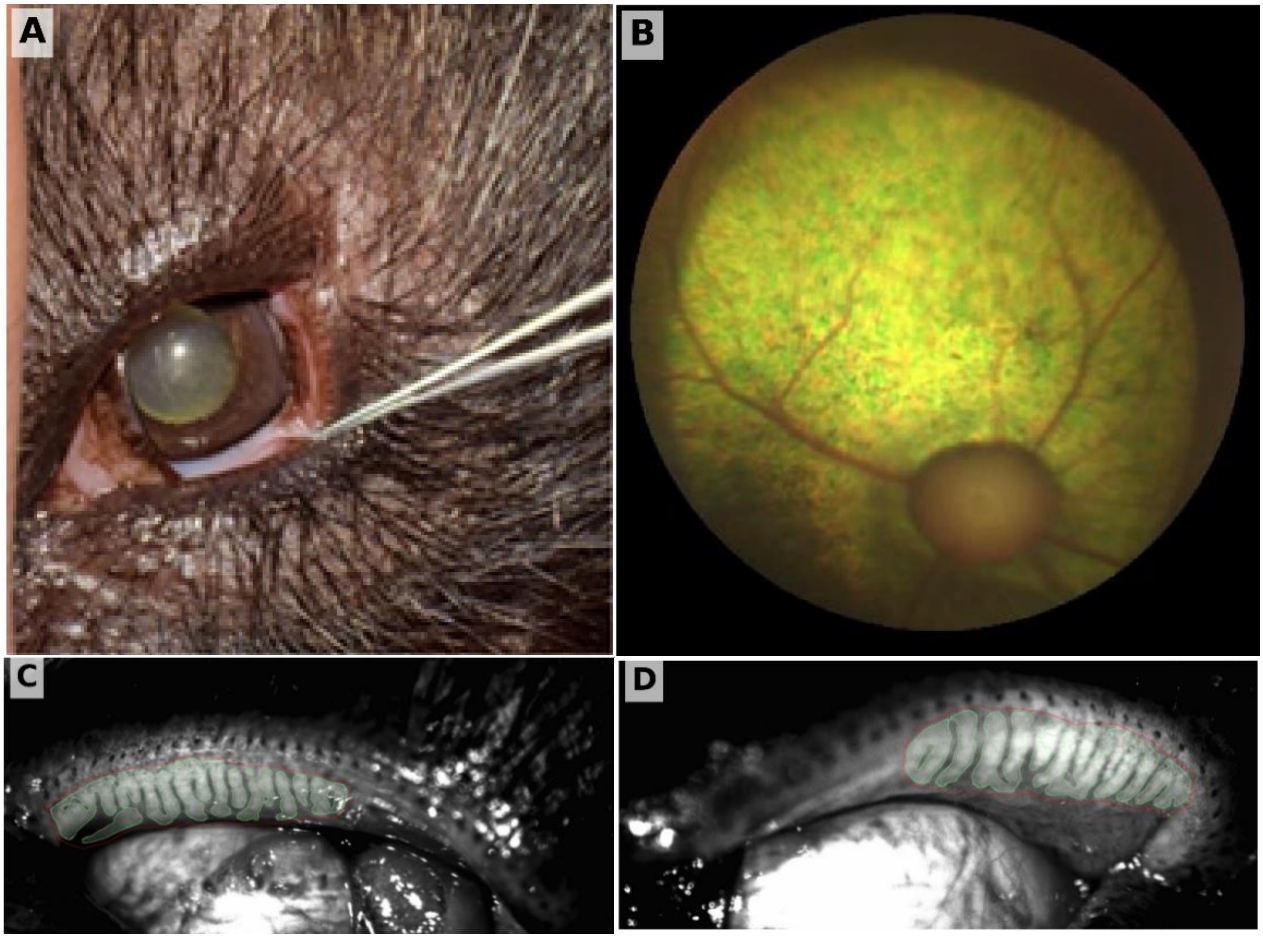


Figure 2 Ophthalmic evaluation. (A) Formed anterior chamber with a serrated pupillary margin; lens exhibiting mild leukocoria, suggestive of nuclear sclerosis; (B) Fundoscopy of the right eye, for illustrative purposes, demonstrating an optic cup within normal limits, with no alterations in coloration or diameter, and an attached retina; the retinal vascularization pattern is holangiotic; (C) Meibography revealed a 10% loss in the left eye and (D) a 16% loss of Meibomian glands in the right eye.

Laboratory exams

Hematological analysis (**Table 2**) showed the absence of anemia, but discrete hypochromia as MCH values were slightly lower than the minimal preconized reference amount determined by Castellanos et al. (2010). MCH completed approximately 93% of the minimal hemoglobin distribution in erythrocytes. Regarding infection, there was no evidence suggestive of infectious disease, as the differential leukocyte count revealed normal ranges in granulocytic and agranulocytic white blood cell populations. However, lymphopenia was observed in the initial hemogram done during the exploratory evaluation and in the second one performed before surgery (**Table 2**).

Most biochemical parameters remained within the reference intervals previously established for the species (**Table 3**). However, two clinically relevant deviations were identified: a mild hypocalcemia (5.5 mg/dL), which fell below the minimum limits proposed by Castellanos *et al.* (2010) and Cubas *et al.* (2014), and a slight elevation in the biliary profile. Specifically, direct (0.19 mg/dL) and indirect bilirubin (0.12 mg/dL) concentrations exceeded the standard reference range (0–0.1 mg/dL). While triglycerides appeared high in absolute terms (906.8 mg/dL), they remained within the upper limits described by Castellanos *et al.* (2010). Other markers of renal (urea and creatinine) and hepatic function (AST and ALT) showed no significant variations.

In relation to alopecic areas, trichotomy revealed absence of ectothrix and endothrix dermatophytes caused by parasitism of hair, as well as absence of other ectoparasites. Ear cytology evidenced the presence of *Malassezia pachydermatis* for both ears, but at lower levels (≤6 yeast cells per microscopic field) at exploratory analysis. Before surgery, it was observed right ear presented *Malassezia pachydermatis* (>12 yeast cells/field), while the left ear did not exhibit any fungal agent. However, the specimen did not exhibit any signal of discomfort or itchy for the right ear.

Urinalysis was conducted during the exploratory evaluation, although sample collection proved challenging due to significant adipose tissue obscuring the bladder. Access was eventually achieved through urethral catheterization using a 0.8 mm probe. Physical analysis of the amber-yellow urine revealed no abnormalities in turbidity, density, or odor.

Chemical assessment and sedimentoscopy were largely unremarkable, showing no evidence of cylinders, crystals, or pathogens. While discrete proteinuria was detected, it was likely associated with the high concentration of spermatozoa observed across all microscopic fields. Additionally, coprological exams and integumentary cytology confirmed the absence of endo- and ectoparasites.

Table 2 Hemogram and comparative results obtained during exploratory evaluation and pior the surgery

Parameters	Exploratory evaluation	Before surgery	Literature reference
			Castellanos *et al.* (2010)
Erythrocytes (10^6/mm³)	11.18	10.69	4.82 - 10.58
Haemoglobin (g/dL)	13.1	12.4	10.2 – 19.4
PCV (%)	50.5	47.6	33 – 55
MCV (fL)	45.2	44.5	32 – 86
MCH (pg)	11.8	11.6	12.7 – 26.3
MCHC(g/dL)	26.0	26.1	24.3 – 53
TPP (g/dL)	9.2	9.2	6 – 11.4
Leucocytes (10^3/mm³)	4.41	7.07	3.20 – 16
Segmented neutrophils (%)	94.1	94.8	-
Segmented neutrophils (10^3/mm³)	4.15	6.71	4.28 – 8.11
Lymphocytes (%)	3.3	4.0	-
Lymphocytes (10^3/mm³)	0.15	0.28	0.91 – 4.01
Monocytes (%)	0.6	1.2	-
Monocytes (10^3/mm³)	0.03	0.08	0 – 0.55
Eosinophils (%)	2	0	-
Eosinophils (10^3/mm³)	0.08	0	0 – 0.82
Basophils (%)	0	0	-
Basophils (10^3/mm³)	0	0	0 – 0.27
PLT (10^3/mm³)	564	685	-

Table 3 Biochemical and endocrine testing

Parameters	Results	Literature reference	
		Castellanos *et al.* (2010)	Cubas *et al.* (2014)
Glycosylated haemoglobin (%)	2.0	-	-
Uric acid (mg/dL)	0.8	-	-
Amylase (UI/L)	1.143,0	-	-
Total Bilirubin (mg/dL)	0.31	-	0 – 0.6
Direct bilirubin (mg/dL)	0.19	-	0 – 0.1
Indirect bilirubin (mg/dL)	0.12	-	0 – 0.1
Calcium (mg/dL)	5.5	5.61 – 10.34	7.6 – 11
Chlorine (mmol/L)	96.28	-	-
Total Cholesterol (mg/dL)	402.4	126.379 – 443.85	198 – 545
CPK (UI/L)	80.0	-	-
Creatinine (mg/dL)	0.80	-	0.6 – 2.6
Alkaline phosphatase (UI/L)	51.0	16 – 239	10 – 213
Phosphorus (mg/dL)	3.7	1.49 – 9.97	2.4 – 9.4
Gama GT (UI/L)	12.0	-	-
Glucose (mg/dL)	131.1	20 – 138	40 – 224
LDH (UI/L)	717.0	-	-
Lipase (UI/L)	27.0	-	-
Potassium (mmol/L)	3.84	-	3.2 – 5.4
Albumin (g/dL)	3.6	-	2.9 – 4.9
Globulin(g/dL)	2.7	-	1.9 – 5.2
Albumin/Globulin	1.3333	-	2.9 – 4.9
Sodium (mmol/L)	132.1	-	126 – 150
AST/GOT (UI/L)	58.0	3 – 108	10 – 121
ALT/TGP (UI/L)	34.0	3 – 79	10 – 72
Triglycerides (mg/dL)	906.8	427 – 952	-
Urea (mg/dL)	32.0	16.52 - 122.24	3 – 39
B12 (pg/mL)	502.0	-	-
Free T4 (ng/dL)	0.61	-	-
Total T4 (mcg/dL)	<5.00	-	-
Testosterone (ng/dL)	<20.0	-	-
TSH (ng/dL)	0.03	-	-

Image-based diagnosis and tumor characterization

Since the integrated evaluation started with a complaint of claudication according to information received from the zookeepers, the bear was anesthetized for the exploratory evaluation for checkup, including image-based diagnosis. The set of images included ultrasonography of the entire abdomen and radiographies of skull and pelvic limbs. Abdominal ultrasonography revealed that the bladder and urethra exhibited anatomical integrity, with adequate luminal repletion by anechoic content and walls of preserved thickness and echogenicity, showing no evidence of obstructive processes. Ultrasonographic evaluation revealed significant renal parenchymal alterations, including irregular contours, a heterogeneous and hypoechoic parenchyma, and a loss of corticomedullary differentiation. These findings are highly suggestive of chronic degenerative changes or nephropathy.

In the splenic compartment, moderate splenomegaly with rounded margins was observed. Although the parenchyma was predominantly homogeneous, a vascularized, hypoechoic nodular lesion was identified in the splenic body, measuring 5.59 x 3.52 cm (**Figure 3A**). Doppler study confirmed the presence of peripheral vascular flow around the lesion. Adjacent to the spleen, a small amount of anechoic free fluid was observed between the parietal margin and the peritoneum. The liver also presented moderately increased dimensions and rounded margins, with a homogeneous but moderately hyperechoic parenchyma—suggestive of diffuse infiltration or alteration—while hepatic and portal vascular pathways remained preserved.

Regarding the biliary system, the presence of cholelithiasis was noted; however, the absence of biliary duct dilation or significant elevations in liver enzymes (ALT/AST) suggests that these findings were clinically silent at the time of examination. The left kidney measured 9.07 cm in length, while the right kidney measured 10.17 cm. In addition to the anechoic content, a rounded, hyperechoic structure measuring 1.84 cm was identified within the lumen, producing a posterior acoustic shadow consistent with cholelithiasis (**Figure 3B**). The pancreas was partially visualized, with the left lobe showing a typical appearance and a thickness of 4.10 cm. The gastrointestinal tracts (stomach and intestinal loops) maintained five-layered wall stratification and preserved peristalsis, with moderate gastric gaseous repletion.

Cytological analysis of the splenic mass (FNAB) revealed a population of non-aggregated spindle cells of mesenchymal origin. These cells exhibited marked criteria of malignancy, including an irregular nuclear-to-cytoplasmic ratio, pleomorphism, anisokaryosis and prominent multiple nucleoli (**Figure 3C–D**). Although features of nuclear degeneration such as pyknosis and karyorrhexis were noted, likely exacerbated by the hemorrhagic background, the degree of cellular atypia pointed toward a neoplastic process.

Figure 4 shows the histopathological survey conducted on the excised splenic mass (5.59 x 3.52 cm). Due to the extensive hemorrhage and friability of the bear's splenic tissue, which precluded the collection of a viable healthy architectural sample, and the lack of available ursid samples in accessible biobanks, **Figure 4A** and **Figure 4B** feature a healthy spleen sample from a *Rattus norvegicus* (Twister rat) for comparative purposes. This control highlights the preserved capsule (thin black arrow) and lymphoid follicles (short black arrow) of the white pulp (curved arrow).

Microscopic evaluation of the splenic mass (**Figure 4C–F**) revealed a highly cellular mesenchymal proliferation characterized by a solid, disorganized growth pattern that completely effaced the normal splenic parenchyma. The lesion was composed of moderately to poorly differentiated spindle cells arranged in short, irregular fascicles. These neoplastic cells exhibited marked pleomorphism, featuring elongated to fusiform nuclei with coarsely clumped chromatin and one to three prominent nucleoli, resulting in a notably increased nuclear-to-cytoplasmic ratio.

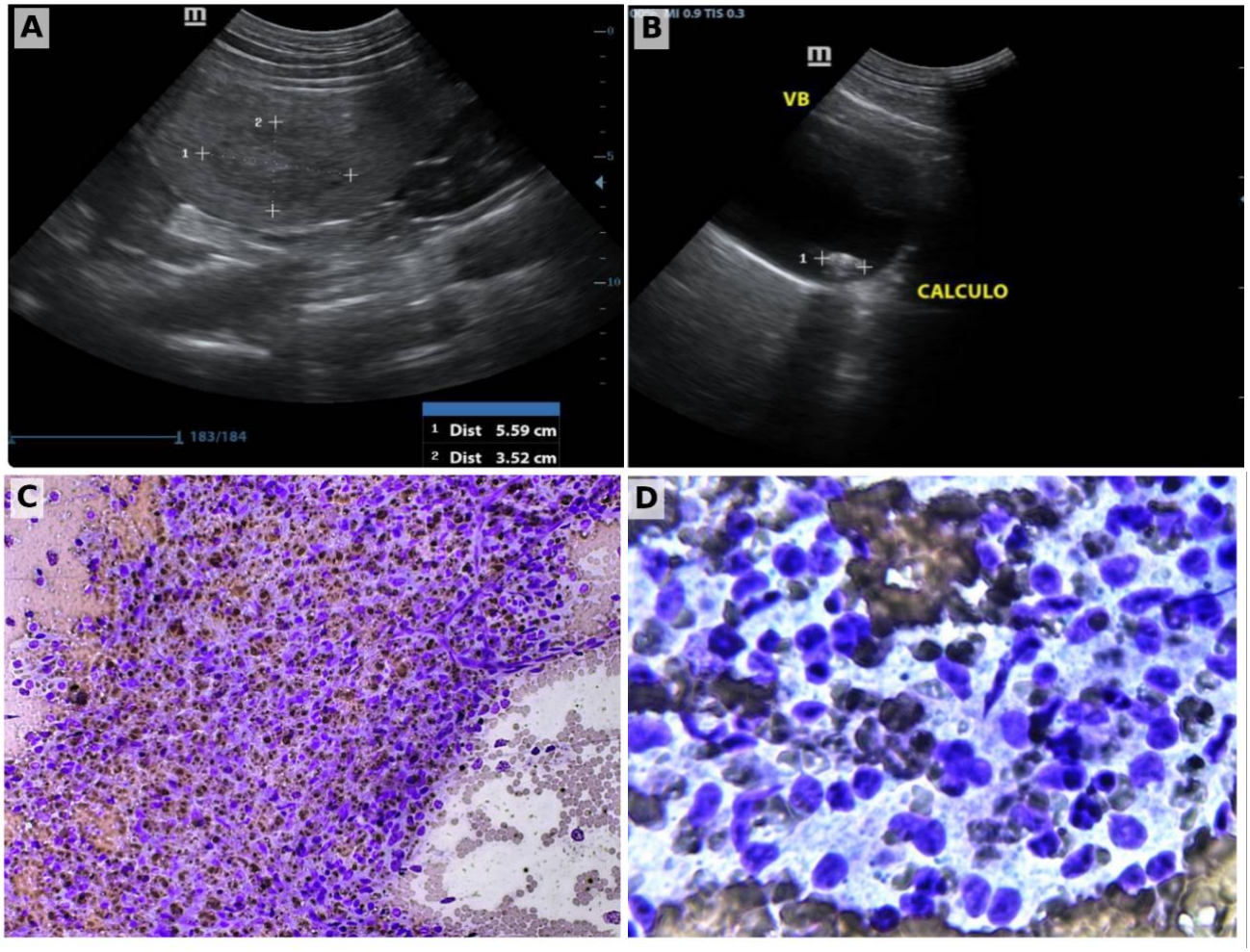


Figure 3 Image-based diagnosis of a putative malignant neoplasm and vesicle calculus associated with cytopathological investigation. (A) Detection of splenic nodule; (B) Detection of biliary calculus; (C) FNAB at 10x magnification, colored with rapid panoptic method evidencing disorganized mesenchymal cells; and (D) FNAB at 1000x magnification, colored with rapid panoptic method evidencing malignancy features such karyorrhexis and karyolysis. Haemorrhagic environment compromised cellular definition in cytology evaluation.

Although specific mitotic figures were sparse in the evaluated sections, the malignancy was evidenced by extensive areas of geographic necrosis and total loss of typical splenic architecture. In contrast to the preserved capsule and lymphoid follicles seen in the murine reference model (**Figures 4A–B**), the bear's splenic tissue showed clear evidence of aggressive behavior, including infiltration and subsequent rupture of the splenic capsule (**Figure 4C**, black arrow) and distortion of the trabecular septa (**Figures 4C** and **4E**, thick black arrows). Significant secondary changes were observed, including multifocal hemorrhagic areas (**Figure 4D**, asterisk) and the complete disorganization and displacement of lymphoid follicles (**Figure 4F**, curved arrow). Furthermore, widespread deposition of hemosiderin within macrophages was noted (**Figure 4F**, short black arrow), indicating chronic hemorrhage. Collectively, these cytomorphological and architectural features are morphologically consistent with a high-grade undifferentiated sarcoma.

Dental diagnosis and procedures

The dental condition was evaluated during the exploratory analysis, in which a deep canal was observed on tooth 23th (**Figure 5A**). Tartarectomy is shown in **Figure 5B**. Due to the severity of the dental condition, radiographic examination was necessary to assess the injury depth. Skull radiography revealed preserved dental elements, nasal cavities, and frontal sinuses. A discrete, amorphous structure with slightly increased radiopacity was identified in the topography of the nasal cavity, cranial to the nasal bone, consistent with a mineralized formation or foreign body (**Figure 5C**). After careful evaluation, dental surgery was performed during the surgical phase to remove the 23th and 24th teeth's which were cast (**Figure 5D**). Regarding the radiography of the pelvic limbs (laterolateral, mediolateral, and ventrodorsal projections), the appendicular skeleton and coxofemoral joints were anatomically preserved. Evaluation of the stifles revealed a slight cranial displacement of the right tibial intercondylar eminence relative to the femoral condyles, suggesting cranial cruciate ligament (CCL) insufficiency. Conversely, the left tibial intercondylar eminence remained anatomically preserved. No further significant radiographic alterations were noted in the structures under study, demonstrating that claudication was not related to joint issues.

Welfare assessment and weight loss plan

During the first two months of dietary changes, no significant differences were observed for weight loss (**Figure 6**). However, after the implementation of a reduction of up to 58% of the minimal Kcal/day in dietary components, it was observed that weight loss started to decrease. Associated with weight measurements, 15 other welfare indicators were applied. Interestingly, it was found that after surgery, which occurred on 17th October 2025 several indicators suggestive of stress-related conditions, behavioral and physical constraints presented increased scores, (e.g. footpads, foraging, aggression, claws, climbing, hair, playing, skin, and abnormal behaviors/stereotypy). Nevertheless, the teeth score increased after the procedure of tooth removal performed during surgery. Other welfare indicators such as noise/snout and eye health did not change over time. Overall, surgery was associated with improvements in certain welfare indicators, despite the temporary decreasing of abnormal behaviors/stereotypy scoring (**Figure 6**).

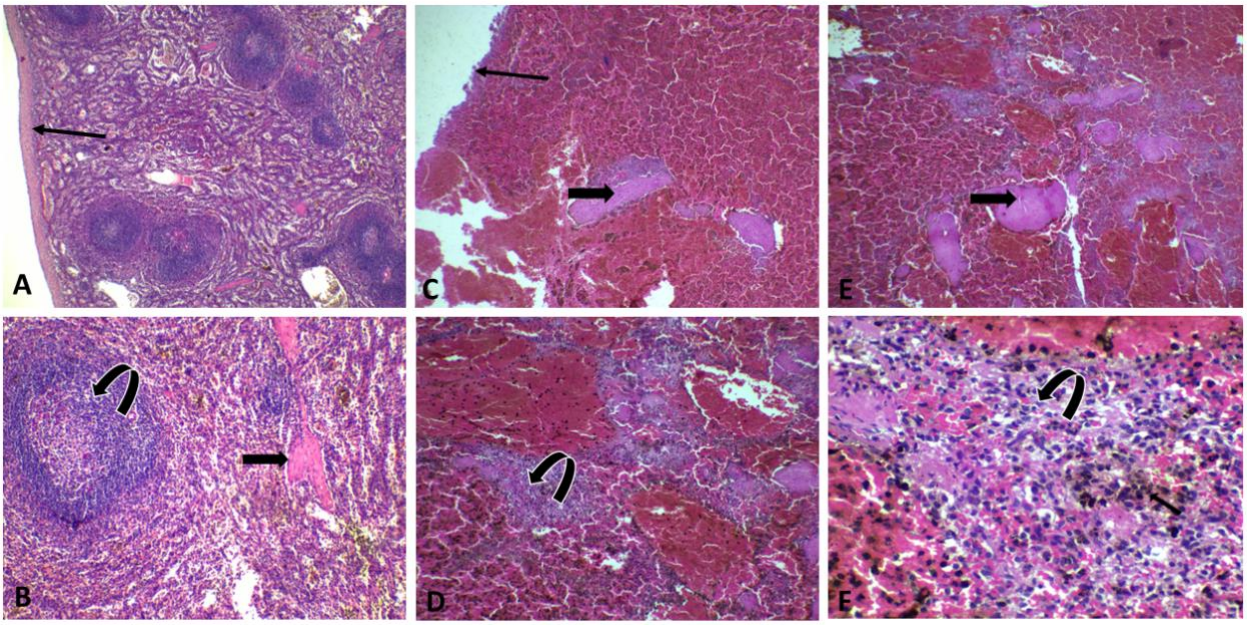


Figure 4 Histopathological investigation of the splenic nodule. (A) and (B): Normal spleen morphology (rat). Note the connective tissue capsule (thin black arrow), trabeculae/septa (short black arrow), and lymphoid follicles comprising the white pulp (curved arrow). H&E stain. Mag. 100x and 400x; (C) and (E): Spleen with tumour. Observation of a ruptured capsule (black arrow) and prominent septa (thick black arrow). H&E stain. Mag. 100x; (D) and (F): Spleen with tumor. Presence of haemorrhagic areas (asterisk), disorganized lymphoid follicles (curved arrow), and hemosiderin deposits (thin black arrow). H&E stain. Mag. 400x.



Figure 5 Dental evaluation. (A) Visual inspection of a dental canal on 23th teeth; (B) Tartarectomy (C) Radiography for evaluation of damage extension of tooth root; and (D) Result of the extraction of 23th and 24th teeth during the surgical procedure.

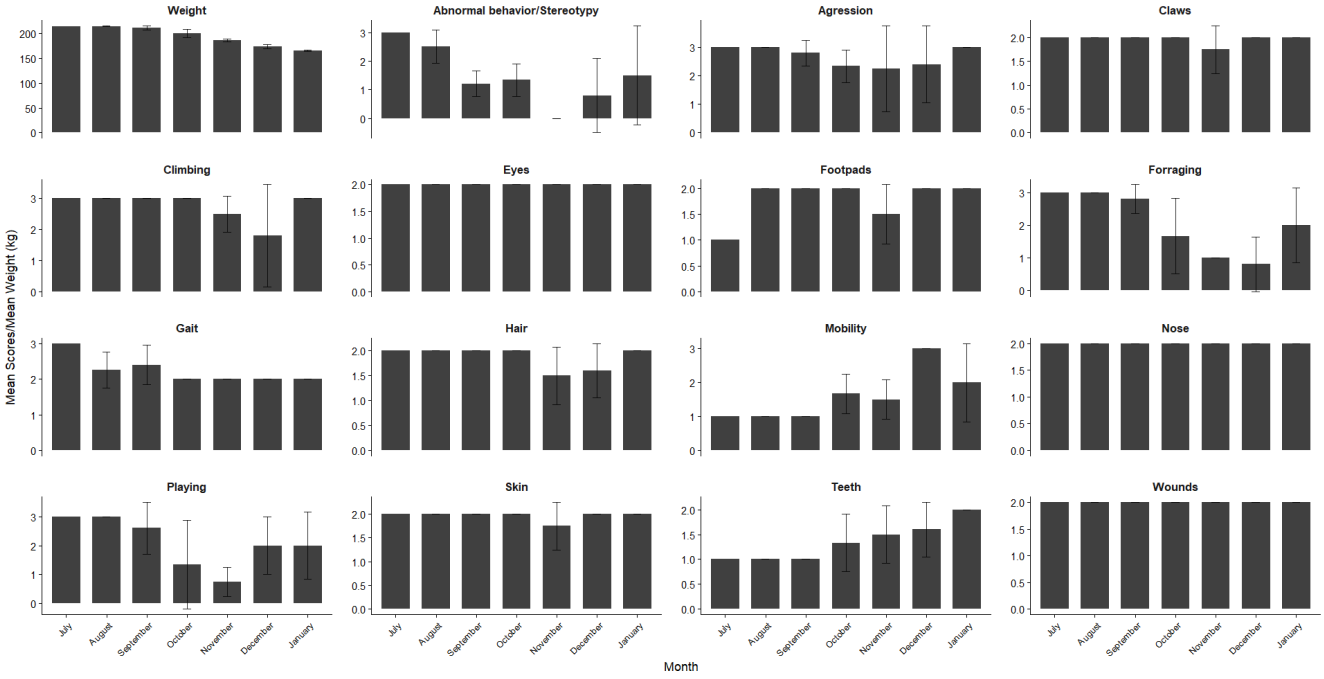


Figure 6 Welfare qualitative and quantitative analysis of bear's behavior during all the interventions performed for weight management and surgical-related stress. Note that the larger the size of the bars better is the score punctuation for the parameter.

Discussion

Combination of dissociative and hypnotic medications resulted in a safe and prolonged time for checkup and surgery

Post-surgical recovery was directly correlated with diminished welfare indicators, including increased aggression and stereotypy, alongside a reduction in exploratory and foraging behaviors. These manifestations are frequently linked to suboptimal husbandry conditions and restricted environments (Correa *et al.*, 2022). In this case, the confinement necessary for medical support likely inhibited species-specific motivated behaviors, preventing the satiety mechanism of the "seeking system" from inhibiting the behavioral drive (Coria-Avila *et al.*, 2022).

The persistence of these behaviors even after re-exposure to environmental enrichment suggests a complex neurological response to chronic stress. Stereotypies may function as a "feel-good" feedback loop, where repetitive acts trigger dopamine and endorphin release to provide euphoric relief from distress (Shih *et al.*, 2016). Research in other species indicates that such behaviors may counterbalance the depletion of opioid receptors in the hippocampus caused by chronic distress (Loijens *et al.*, 1999). While similar behaviors in spectacled bears have been attributed to self-narcotization against physical pain (Malask *et al.*, 2013), the strict adherence to analgesic protocols with tramadol and morphine in this case suggests that the stereotypy was primarily triggered by spatial restriction.

Furthermore, the synergy between exogenous opioid administration and a potential disruption in endogenous signaling during confinement may have reinforced these repetitive patterns (Hemmings *et al.*, 2004). Clinically, this persistent stereotypic repertoire likely contributed to the observed decrease in claw and footpad scores, as repetitive contact with enclosure barriers resulted in mild epidermal dryness and cracking.

Endocrine physiology

Given the patient's obesity and the lack of reference data for Tremarctos ornatus, an endocrine profile was conducted to investigate potential metabolic triggers. Serum testosterone was recorded at < 20 ng/dL, which is notably lower than the breeding season peaks reported for *U. arctos* (up to 1600 ng/dl; Anel-López *et al.*, 2017) and *U. maritimus* (up to 600 ng/dL; Howell-Skalla *et al.*, 2002). This low concentration likely reflects a non-breeding state or obesity-linked suppression, as nutritional status is a known driver of testosterone levels in ursids (Tomiyasu *et al.*, 2021).

Additionally, thyroid function was evaluated to differentiate between primary obesity and endocrine dysfunction. The patient's T3 and T4 levels aligned with the active-phase ranges reported for other bears (0.02–0.04 ng/dL and 0.26–0.69 ng/dL, respectively; Frøbert *et al.*, 2023), contrasting with the suppressed levels typical of hibernation or thyroid resistance. These findings excluded hypothyroidism as a contributing factor to the patient's condition, reinforcing that his clinical state was primarily related to diet and inactivity rather than endocrine pathology.

Other indicators of welfare and overall health

Optimizing welfare in captive environments is a primary concern for zookeepers and veterinary staff. Bears are susceptible to a variety of species-specific infectious and non-infectious diseases. Infectious pathologies include parasitic infestations (such as skin mites and ascarid worms), as well as bacterial and viral infections, notably infectious canine hepatitis. Non-infectious conditions frequently include dental disease, degenerative joint disorders, and neoplasia (Bourne *et al.*, 2010).

Currently, there is a limited body of literature describing neoplasia in spectacled bears. In other captive ursids, neoplasms of the digestive and hepatobiliary systems are the most frequently recorded (Stagni *et al.*, 2023). While the exact etiology of these neoplasms often remains unidentified, certain cases have been tentatively linked to genetic predisposition (extrahepatic biliary carcinoma) or nutritional factors, such as high carbohydrate consumption (multiple pancreatic beta-cell neoplasms). Other proposed triggers include exposure to industrial pollutants, Clonorchis flukes, and viral agents such as canine adenovirus. Furthermore, it has been hypothesized that continuous feeding schedules in captivity, which lack natural intermittent fasting and hibernation cycles, might lead to an overproduction of cholelytic agents in the bile (Newman & Smith, 2006).

The simultaneous occurrence of unrelated neoplasms has been documented in the literature, such as in a case report of a 25-year-old polar bear presenting with insulinoma, hepatoma, follicular thyroid adenomas, and intestinal leiomyoma. This case also identified a localized splenic mass associated with pyogranulomatous lesions, which were interpreted as independent tumors potentially related to age-related degenerative disorders rather than metastatic disease (Fortin & Benoit-Biancamano, 2014).

In the present case, Renan's history of an ad libitum diet primarily composed of honey and fruits for conditioning purposes raises questions regarding nutritional balance. While it is speculative to draw a direct causal link, such a diet could be considered a potential contributing factor to the animal's overall neoplastic condition. However, given the limitations of a single case report and the complexity of tumor pathogenesis, further investigation is required to explore the specific relationship between dietary carbohydrates and the development of splenic or other neoplasms in this species.

Another indicator of welfare in bears refers to dental conditions. Teeth may present root canals, fractures, and advanced states of decay, causing pain and discomfort, while also serving as gateways for secondary bacterial infections that can compromise the kidneys, bones, and myocardium (Bourne *et al.*, 2010). Tooth breakage can also be caused by stereotypy, as it has been reported that bears with oral stereotypies bite the bars of enclosure structures. Surgery for the extraction of canines requiring root canal treatment,

along with dental scaling (tartarectomy), mitigated the chronic issues faced by Renan.

Diet is a crucial factor related not only to oral health, specifically the occurrence of caries and root canal issues, but also to joint health. It can promote the occurrence of degenerative diseases due to weight gain in bears (Aminkov *et al.*, 2018). Although the incidence of joint diseases increases with age, trauma can lead to rheumatic conditions when affecting synovium, articular cartilage, and the underlying bone (Selvaraj *et al.*, 2017; Aminkov *et al.*, 2018; Sha *et al.*, 2021). Consequently, weight management is an important measure for the control and treatment of joint conditions (Sha *et al.*, 2021).

Interestingly, despite his elevated weight, approximately 26% (214.5/170) above the maximum tolerable weight for spectacled bears (170 kg) (Gerstner *et al.,* 2016; Velez-Liendo & García-Rangel, 2017), radiographic examinations did not corroborate a condition compatible with joint disease, which was the initial complaint that prompted the investigation presented in this study. Following a dietary prescription, Renan reached an appropriate weight range for a healthy male of his species, achieving a body fat percentage loss within the 1-2% safety margin established in the literature (Lisi *et al.*, 2013). As observed by Gerstner *et al.* (2016), the weight-loss dietary protocol was not related to the stereotypies presented in the post-surgical phase, which was caused by temporary confinement. As expected, Renan showed improvement in mobility and an absence of lameness episodes (Gerstner *et al.*, 2016).

Since bears are susceptible to several eye disorders, cataracts and lens luxation being among the most common, especially in captive populations, infections, injuries, and congenital abnormalities were also reported (Hartley & Oliveira, 2022). Thus, ocular scores are relevant indicators of bears' welfare. Regarding this concern, evaluation showed no clinical alterations, except signals of dry keratoconjunctivitis, with the right eye severely affected by the absence of a lipid layer. Since the observed nuclear sclerosis and asteroid hyalosis are expected senile degenerations, the overall eye health was considered satisfactory. It is important in captive conditions as well in rehabilitation of free-living species to tackle eyes alterations since it is expected that bears present a dichromatic vision that enables animals to forrage and hunt (Dogan *et al.*, 2020; Paszta *et al.*, 2022), which may also confer a selective advantage to find food and preys due to the detection of camuflated preys as shown in some non-human primates behaviour (Newman & D'Angelo, 2024).

The anatomy of Ursidae eyes, with few exceptions, tends to resemble canine structure (Dogan *et al.*, 2020; Paszta *et al.*, 2022). While visual capabilities in bears are not yet fully understood, especially in spectacled bears, comparative anatomical studies of brown bears and polar bears have identified both L/M and S cones, noting a higher cone density than is typical for mammals. Behavioural experiments with American black bears support these findings; because they can differentiate between blue, green, and grey shades, they are likely dichromatic. While researchers expect to find both cone types in black bears, the exact arrangement and distribution of these cells remain unknown (Heyward *et al.*, 2020).

Conclusion

Zoos play a crucial role in maintaining genetic banks through the comprehensive care of endangered species, such as the spectacled bear (*Tremarctos ornatus*). This care must integrate a series of metrics that translate qualitative ethological monitoring into quantitative, measurable assessments of behavioral displays during interventions or routine changes. Such rigorous monitoring is fundamental for the early detection of clinical abnormalities, allowing for medical intervention before pathologies reach advanced stages. By identifying behaviors associated with distress, teams can proactively mitigate injuries caused by stereotypies and other deleterious behaviors.

The multidisciplinary approach presented in this work demonstrates the application of an integrated behavior and welfare assessment protocol to monitor dietary and surgical interventions. This study underscores the importance of routine health monitoring in captive wildlife. Our findings indicate that while changes in feeding routines may not immediately trigger distress-related stereotypies, the confinement required for complex surgical recovery can. This highlights the need for a balanced management strategy that includes pharmacological support to manage behavioral health during recovery.

Furthermore, the data gathered corroborates the literature regarding the occurrence of tumors in bears with long-term nutritional imbalances, particularly those high in carbohydrates. The identification of an undifferentiated splenic sarcoma in this case emphasizes the clinical value of integrated veterinary management, where nutritional history, clinical diagnostics, and behavioral data converge to inform prognosis. Despite the animal's advanced age and previous ad libitum diet, factors typically associated with joint disorders, no such pathologies were identified. The implemented nutritional and behavioral strategies successfully mitigated secondary health issues, with behavioral patterns returning to baseline levels by January 2026, two months post-surgery.

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Conflict of interest

All authors declare no conflict of interest in this research.

Author contribution

PFMW: Conceptualization, methodology, investigation, data curation, and analysis; ACG: Conceptualization, analysis, and methodology, review & editing; : Conceptualization and writing – review & editing; MVS: methodology and investigation; ARC: methodology, investigation, writing – original draft, and writing – review and editing; FM: methodology and investigation; YR: methodology and investigation; PSC: investigation and data curation; VMS: investigation and data curation; LAM: investigation and formal analysis; HSC: methodology, data curation and investigation; ACS: formal analysis, writing – original draft, writing – review & editing; OGGA: Conceptualization, methodology, data curation, formal analysis, investigation, supervision, writing – original draft, and writing – review & editing.

Declaration of generative AI in writing process

During the preparation of this work, the author(s) used GEMINI to review English errors. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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