

Assessment of Meloxicam Therapy in a Lamé Bactrian Camel (*Camelus bactrianus*) Using Force-Plate Gait Analysis

*Jennifer E. Flower, DVM, Stuart C. Clark-Price, DVM, MS, DACVIM , DACVAA,
Rachel E. Griffith CVT, Santiago D. Gutierrez Nibeyro, DVM, MS, DACVS-LA

From the Department of Veterinary Clinical Medicine, College of Veterinary Medicine, University of Illinois, Urbana IL 61802 USA. (Flower, Clark-Price, Griffith, Gutierrez-Nibeyro).

Abstract

An 18-year-old castrated male bactrian camel (*Camelus bactrianus*) presented with a history of chronic intermittent lameness associated with presumed osteoarthritis. Physical examination and lameness evaluation were consistent with osteoarthritis that subjectively appeared more severe in the pelvic limbs. Clinical signs appeared more pronounced in the late fall and winter season when temperatures were consistently colder. The camel appeared stiff, had difficulty rising from sternal recumbency, and struggled when navigating slippery surfaces. It was observed to be reluctant to walk, and when encouraged moved at a slower pace than usual. Meloxicam (0.5 mg/kg, p.o. q 72 h) was prescribed to treat presumptive osteoarthritis. Force plate gait analysis was performed before and 12 weeks after starting meloxicam therapy and was used to assess lameness using peak vertical force and peak propulsive force values. Subjectively, lameness improved during meloxicam therapy and force plate gait analysis demonstrated peak vertical force increases in both thoracic limbs and an increase in peak propulsive force in all limbs. Findings suggest that meloxicam administration (0.5 mg/kg, p.o. q 72 h) was effective in subjectively improving lameness and objectively improving force plate gait analysis in this bactrian camel. Lameness evaluation using force plate gait analysis may be a useful quantitative assessment tool of non-steroidal anti-inflammatory efficacy in bactrian camels.

Keywords: arthritis, camel, *Camelus bactrianus*, force plate gait analysis, lameness, non-steroidal anti-inflammatory drug (NSAID)

* Corresponding author: Dr. J.E. Flower (FlowerJe@gmail.com).

Acknowledgement: The authors thank: The animal care staff at the Scovill Zoo (Decatur, IL).

Introduction

NSAIDs are commonly utilized in large animal veterinary practice for relief of painful inflammatory conditions (Kreuder et al., 2012). Dromedary (*Camelus dromedarius*) and bactrian camels (*Camelus*

bactrianus) are popular and common zoological display species in North America. As veterinary care continues to improve for zoological species, an increase in the need for advanced and compassionate veterinary care has followed.

Joint disease, specifically osteoarthritis, is a chronic debilitating disease that affects many species and can result in significant economic loss in large animals used for performance and production purposes, including horses, cows, and camelids (Kreuder et al., 2012; Wasfi et al., 2001; Mohamed et al., 1999; Schulz et al., 2011; McIlwraith et al., 2012; Keegan et al., 2012). Additionally, osteoarthritis is considered an important animal welfare issue for animals in a performance and production setting, or those in zoological institutions.

Various studies have examined the pharmacokinetics of meloxicam in camelid and bovine species, but the objective assessment of its efficacy on osteoarthritis is limited and can be technically difficult (Kreuder et al., 2012; Wasfi et al., 2001; Coetzee et al., 2012). The availability of quantitative measures of chronic pain that are valid and reliable in clinical patients is a valuable resource for the assessment of interventional strategies including pain control (Keegan et al., 2012; Brown et al., 2013; Foss et al., 2013; Olsen et al., 2012; Symonds et al., 2006). Multiple studies designed to test the efficacy of interventions intended to decrease chronic pain in animals such as dogs and horses have relied on the assessment of lameness through the use of force plate gait analysis (Brown et al., 2013; Foss et al., 2013; Symonds et al., 2006; Ortvad et al., 2009). This methodology is viewed as an accurate means for evaluation of lameness in many species, and the case presented here provides the first attempt at FPGA in a bactrian camel.

Case history and treatment

An 18-year-old, 900 kg, castrated male bactrian camel (*Camelus bactrianus*) was evaluated for a history of chronic intermittent lameness presumed to be associated with

elbow and stifle osteoarthritis. The camel was housed at a zoological institution in a 0.6 acre outdoor pen with grass and dirt substrate with access to an indoor barn with concrete flooring and straw substrate for inclement weather. The only previous medical history of this animal included a tooth root abscess that was surgically removed without complication 1 year prior to presentation.

Primary care-givers for this camel reported a chronic intermittent lameness of approximately 1 year duration which seemed worse in the pelvic limbs and more pronounced in the late fall and winter season when temperatures were consistently colder. The camel commonly appeared stiff, had trouble rising from sternal recumbency, and struggled when navigating slippery surfaces. It had begun to show a tendency to stand still or walk at a slow pace as opposed to a historically faster gait at a walk with occasional running.

On initial physical examination, all parameters including body condition, heart rate, respiratory rate, temperature, and gastric motility were within normal limits. The camel demonstrated sensitivity on palpation of the stifle joints and manipulation of both pelvic limbs although no joints were appreciably warm. Observation of the camel revealed partial shifting of weight from the pelvic limbs to the thoracic limbs and a subjective appearance of stiffness and discomfort. Lameness evaluation at a walk revealed a bilateral pelvic limb lameness that appeared worse in the right pelvic limb. The camel tired quickly during walking evaluation and the pelvic limb lameness worsened over time during the session. Radiographic examination was not performed due to the animal's size and equipment limitations. However, a presumptive diagnosis of osteoarthritis was made based on physical examination and

lameness findings and the history of progressive clinical signs during colder weather.

Treatment options considered included conservative therapy with non-steroidal anti-inflammatory drugs (NSAID), chondroprotective nutritional supplements, intra-articular anti-inflammatory medications and acupuncture. Due to the risk associated with anesthesia and surgery and monetary constraints, surgical intervention was not considered. The zoological institution opted for NSAID therapy with the understanding of possible side-effects and that use in bactrian camels is limited. In order to better assess the effects of meloxicam use in this species, force-plate gait analysis was utilized to monitor the animal's progress.

Prior to force plate gait analysis (FPGA), the camel was acclimated to its diet and surroundings at the University of Illinois Veterinary Teaching Hospital for 7 days. The diet provided was consistent with what the camel consumed at the zoological institution and included free choice grass hay, commercial camel pellets, and free access to fresh water. Daily physical examinations were performed, including recording of vital parameters and subjective changes in lameness.

Prior to NSAID treatment, a complete blood cell count, biochemistry analysis, and urinalysis were performed. All complete blood cell count and chemistry values were within normal references ranges for a camel, aside from an elevated creatinine (4.0 mg/dl; reference range 0.7-1.4 mg/dl) (Bogin, 2000). Urinalysis results were indicative of normal urine concentrating ability and no additional abnormalities were detected.

Force-Plate Gait Analysis

A force plate session consisted of 5 valid trials with a handler leading the camel at a

walk across a centrally positioned floor-mounted force plate (AMTI EQ6001200-4000, Watertown, MA). Trials were considered valid if a walking speed between 1.2-1.8 m/second was achieved, and if distinct ipsilateral thoracic and pelvic limb strikes were seen. Trials were rejected if strikes were partial or questionable or if strikes were abnormal due to obvious changes in gait. Valid trials were analyzed with specialized software (Acquire 7.33V, Sharon software INC., Owosso MI.). Body weight was assessed just prior to each force plate evaluation.

Peak vertical force (PVF) and peak propulsive force (PPF) values were obtained prior to starting meloxicam therapy (baseline). All valid trials were averaged to obtain average PVF and PPF values (Table 1, 2). Once baseline PVF and PPF values were obtained, meloxicam therapy was initiated.

Due to the elevation in creatinine observed on routine blood work, a conservative dose of meloxicam (Aurobindo Pharmacy USA Inc., Dayton, New Jersey) was chosen based on previously published pharmacokinetics studies in camelid species (Kreuder et al., 2012; Wasfi et al., 2001) (0.5mg/kg orally q 72 hours) and biochemistry analysis was repeated monthly to monitor creatinine concentration. The camel remained in the Veterinary Teaching Hospital for five days after initiating NSAID therapy for monitoring purposes. Three days after beginning NSAID therapy, the camel's attitude appeared improved and although the pelvic limb lameness was still appreciable at a walk, the camel's walking stamina had increased and stiffness had improved.

The camel was returned to the zoological institution for continued meloxicam therapy and monitoring. Serum biochemistry analysis a fortnight later revealed a decrease in creatinine concentration (2.4 mg/dl) despite

continued NSAID therapy. This decrease may have been attributable to an increase in water consumption noted when the camel returned to its normal environment as compared to when housed at the Veterinary Teaching Hospital. Recheck lameness evaluation was performed 12 weeks after starting meloxicam therapy. Subjectively, the camel showed a decreased sensitivity on palpation of the stifle joints and a decrease in overall limb stiffness. Lameness evaluation at a walk revealed subjective improvement in pelvic limb lameness and the camel's walking endurance had increased substantially during long sessions.

The camel returned to the Veterinary Teaching Hospital 12 weeks after initiating meloxicam therapy for repeat PVF and PPF values. The results of pre-treatment and recheck PVF values are reported in Table 1, 2 and displayed in Fig. 1, 2. Recheck FPGA demonstrated increased PVF in both thoracic limbs and an increased PPF in all limbs when compared with the values obtained on baseline. A summary figure (Figure 3) with pre-treatment and recheck weight distribution between thoracic and pelvic limbs demonstrates an improvement in weight redistribution after treatment. The camel distributed more weight toward the thoracic limbs after initiation of meloxicam therapy which may be supportive of an analgesic effect and resulting improvement of presumed elbow osteoarthritis.

Over the 12-week treatment period, primary care-givers reported improvement in the animal's gait, activity level, and attitude. A recheck of creatinine levels 16 weeks after initiating meloxicam therapy revealed a consistent creatinine value (2.6 ng/dl), despite long-term NSAID therapy. The camel was seen to be occasionally trotting and running in its enclosure and had a subjective reduction in the time that it spent standing

still or lying down. Transition from sternal recumbency to standing appeared to require less effort by the camel and care-givers reported improved training compliance and a normal appetite.

Discussion

In this report, meloxicam administered at 0.5mg/kg every 72 hours was selected after review of pharmacokinetic research in camelid species (Kreuder et al., 2012). Dose reduction occurred in this camel due to elevated serum creatinine on initial biochemistry profile. Meloxicam was chosen due to the relative cost reduction over other NSAID drugs and its previous success and minimal reported side-effects in similar species (Kreuder et al., 2012; Wasfi et al., 2001; Coetzee et al., 2012). We used FPGA as an objective measure of the effects of meloxicam in this bactrian camel. Of all ground reaction forces measured, we examined PVF and PPF as they represent the largest loads applied to the limb during ambulation (Case et al., 2013). The clinical improvement noted in this case in combination with the increases in PPF and PVF from baseline to recheck on FPGA are supportive of an analgesic effect provided by the oral meloxicam administered at 0.5mg/kg every 72 hours. These data provide quantitative evidence of successful treatment of the camel's presumed osteoarthritis with meloxicam; however, force plate gait analysis has not been validated in camelids and to our knowledge this is the first report of its use in a bactrian camel. A controlled study with an increased sample size and power analysis would be required to ensure clinical improvement was directly correlated with meloxicam administration.

Subjectively, the camel showed a decrease in overall stiffness and lameness as well as an increase in walking endurance. The camel

appeared to shift more weight to its thoracic limbs after treatment and the peak propulsive forces increased in all four limbs. It is currently unknown why the camel's PVF in the pelvic limbs decreased at post-treatment recheck trials, but it may be associated with the redistribution of an increased percentage of body weight to the thoracic limbs after treatment.

FPGA may be a valuable diagnostic tool for clinicians attempting to evaluate lameness in bactrian camels. Future research in the use of force plate analysis and meloxicam therapy for the treatment of osteoarthritis in camels is warranted.

	RF Baseline (Newtons)	RF Recheck (Newtons)	LF Baseline (Newtons)	LF Recheck (Newtons)	RH Baseline (Newtons)	RH Recheck (Newtons)	LH Baseline (Newtons)	LH Recheck (Newtons)
	5951.53	6854.38	5921.51	6262.5	3256.53	3284.59	3481.19	3260.14
	6307.98	6391.39	5738.76	7570.97	3433.91	3255.74	3517.69	3370.7
	6000.11	6734.61	6134.50	6396.88	3444.41	3195.81	3467.63	3130.05
	6097.83	6347.78	6305.23	5992.83	3327.27	3053.51	3473.72	3203.69
	6297.74	6685.78			3366.74	3144.02		
					3461.62	3391.98		
Mean	6131.04	6602.79	6025.00	6555.80	3365.77	3186.73	3485.06	3241.15
SD	165.50	222.08	247.09	697.32	77.85	92.19	22.45	101.47

Table 1. Baseline and post-treatment recheck PVF values in a bactrian camel (*Camelus bactrianus*) using FPGA. RF – right front limb, LF – left front limb, RH – right hind limb, LH – left hind limb.

	RF Baseline (Newtons)	RF Recheck (Newtons)	LF Baseline (Newtons)	LF Recheck (Newtons)	RH Baseline (Newtons)	RH Recheck (Newtons)	LH Baseline (Newtons)	LH Recheck (Newtons)
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	661.90	779.82	589.87	917.60	133.87	404.8	114.49	335.26
	745.89	717.62	674.49	766.37	292.83	452.95	207.77	297.03
	699.56	757.85	607.71	776.33	404.09	338.97	113.45	440.37
	607.76	703.91	768.50	887.61	366.58	478.40	227.80	462.41
	697.10	824.84			349.43	331.66		
					322.66	484.29		
Mean	678.78	739.80	660.14	836.98	299.34	418.78	165.88	383.77
SD	58.50	35.15	80.90	76.87	119.61	61.34	60.49	80.14

Table 2. Baseline and post-treatment recheck PPF values in a bactrian camel (*Camelus bactrianus*) using FPGA. RF – right front limb, LF – left front limb, RH – right hind limb, LH – left hind limb.

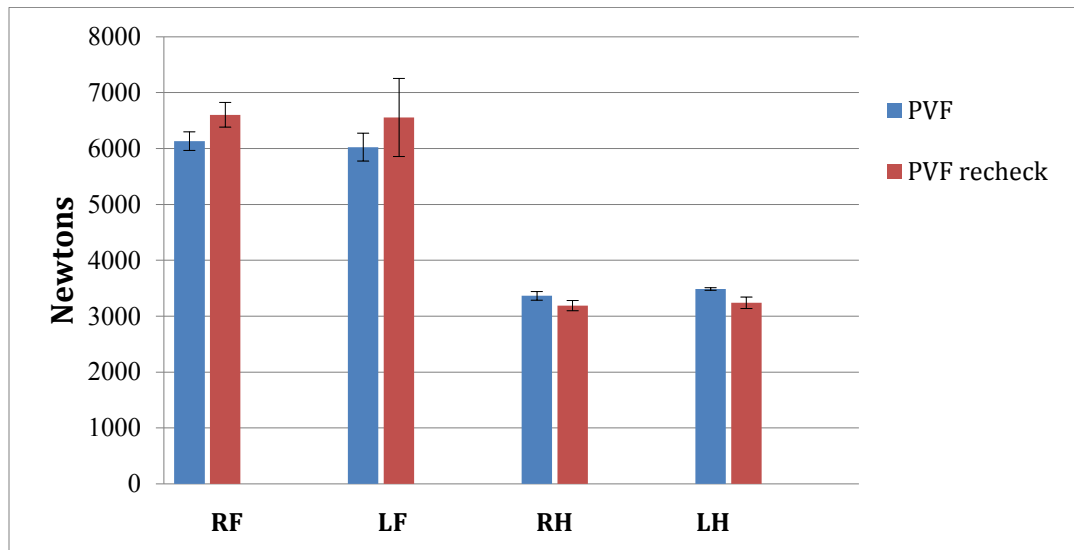


Figure 1. Graph of baseline and post-treatment recheck PVF values in a bactrian camel (*Camelus bactrianus*) using FPGA. RF – right front limb, LF – left front limb, RH – right hind limb, LH – left hind limb.

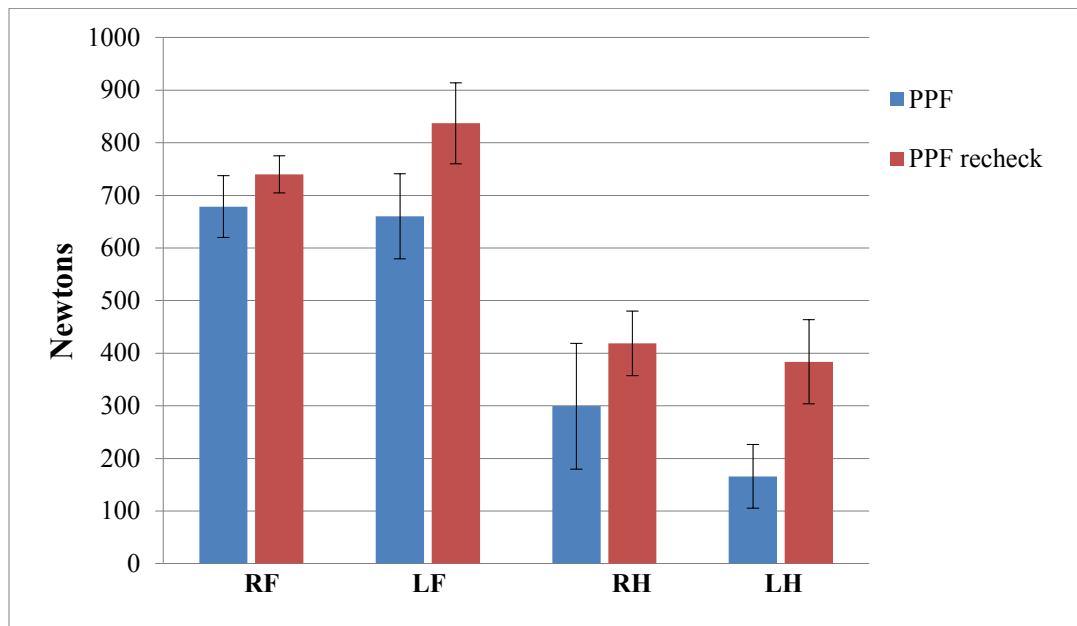


Figure 2. Graph of baseline and post-treatment recheck PPF values in a bactrian camel (*Camelus bactrianus*). RF – right front limb, LF – left front limb, RH – right hind limb, LH – left hind limb.

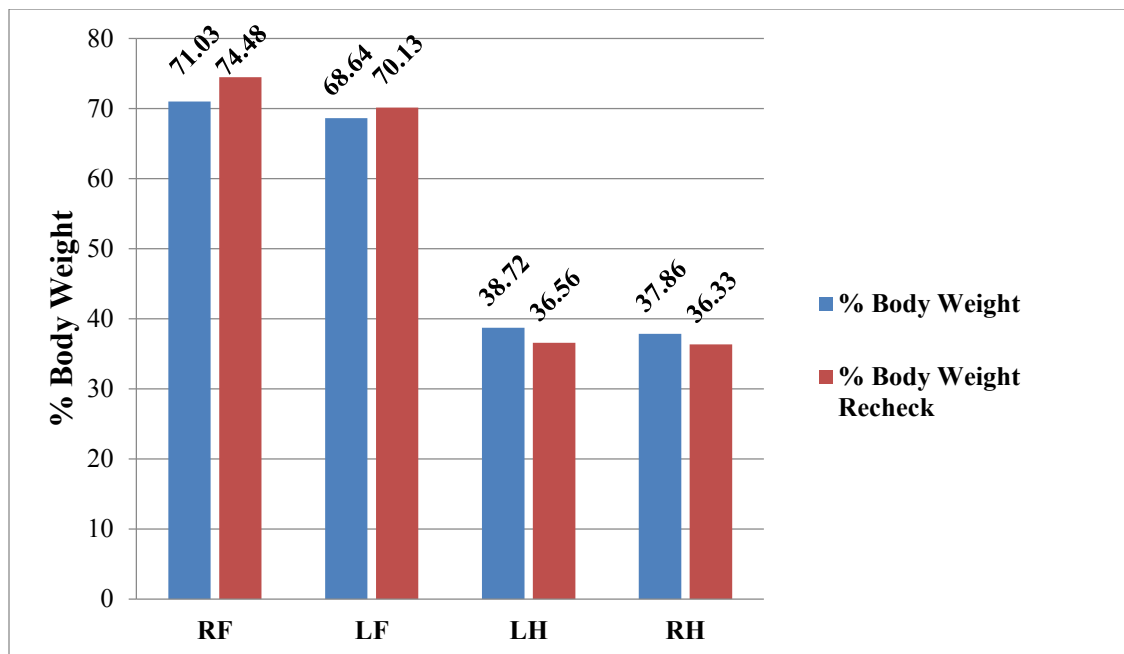


Figure 3. Graph of baseline and post-treatment recheck weight distribution between thoracic and pelvic limbs in a bactrian camel (*Camelus bactrianus*). Based on these percentages it appears that weight redistribution occurred after treatment with a weight shift toward the thoracic limbs.

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