

## CHEMICAL RESTRAINT OF RUMINANTS – KETAMINE STUN TECHNIQUE

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### *Key Points*

- Adding a small dose of ketamine to injectable chemical restraint cocktails (Ketamine Stun) can dramatically improve patient cooperation and systemic analgesia.
- Dosing must be more conservative if patient must remain standing. This limits the level of systemic analgesia that can be achieved, but improvements in patient cooperation are evident.

The Ketamine Stun is simply the addition of a small dose of ketamine to any injectable chemical restraint technique. I initially developed the Ketamine Stun technique in the early 1990's to cover my limited cat handling abilities. My first exposure to camelid patients came when I left equine practice to teach at Ohio State. The recalcitrant behavior they frequently exhibited quickly led to experimentation with low dose ketamine protocols to improve the level of patient cooperation during diagnostic and therapeutic procedures. Success was immediately evident and the technique became wildly popular with the food animal clinicians, residents, and students charged with the care of these patients (1).

I named this technique the Ketamine Stun (aka Ket Stun) because of the stunned effect it produced in patients when administered at doses that produce recumbency. These patients appear to be awake, but seem oblivious to surroundings and procedure being performed. The intravenous effect is quite brief (approximately 15 minutes) and patients typically stand and appear fairly normal at that time. I initially referred to this state as semianesthetized, but perhaps chemical hypnosis is more appropriate. Because of the success in camelid patients the Ketamine Stun technique was adjusted for use in ruminants (less xylazine) and proved to be just as useful (2, 3). Equine applications have proven more challenging. Dramatic improvement in cooperation evident a minute or two after the IV bolus of ketamine is administered in patients that were totally uncooperative under the prior detomidine-morphine sedation suggests the potential of this technique. Unfortunately, the effective sedation-ketamine levels are not far removed from those that produce instability.

Alpha<sub>2</sub>-adrenergic agonists possess potent sedative and analgesic effects. Opioids are typically thought of as analgesic drugs, but they possess central nervous system effects that when combined with a tranquilizer or sedative produces a greater level of mental depression. Ketamine is a N-methyl-D-aspartate (NMDA) receptor antagonist that possesses potent analgesic effects at subanesthetic doses. Ketamine was initially included in the stun technique for its analgesic properties, but likely contributes to the mental aspects of the enhanced cooperation exhibited by patients under the influence of the Ketamine Stun technique. By combining drugs one is able to use smaller doses of the individual components while still achieving the desired level of patient control. Dosing must be more conservative when using the ketamine stun technique in standing patients. This limits the degree of systemic analgesia relative to what can be achieved in recumbent patients, but still provides improved patient cooperation when compared with more traditional methods of standing chemical restraint.

In ruminants and camelid patients I typically use a combination of xylazine, butorphanol, and ketamine. In equine patients I generally use detomidine, morphine, and ketamine. Morphine is used to provide analgesic relief in food animal patients and is much cheaper than butorphanol.

I have used morphine (0.05–0.06 mg/kg) in ruminant stuns. In standing adult cattle stuns, a similar level of cooperation is achieved with either opioid, but patients appear less obtunded when morphine is used. Some practitioners may find the obtunded appearance useful because it allows them to follow the decay over time in the level of chemical restraint. Deterioration in the level of patient cooperation also can be used to determine when supplemental drug administration may be required.

Ketamine Stun techniques can be divided into two broad categories: standing and recumbent. The standing Ketamine Stun is used primarily in large ruminants and horses. The recumbent Ketamine Stun is used primarily in small ruminants, camelids, and foals. The level of effect achieved is determined by three variables (dose, route of administration, initial demeanor of the patient). The stun cocktail can be administered IV, IM, or SQ depending on the systemic analgesia, patient cooperation, and duration desired (**Table 1**).

**(Table 1)** Route of administration determines the relative impact of the ketamine stun technique.

<b>Parameter</b>	<b>Relative ranking</b>
Intensity (analgesia/cooperation)	IV >> IM > SQ
Onset	IV >> IM > SQ
Duration of effect	SQ > IM >> IV

Aggressive dosing increases the level of systemic analgesia and patient cooperation, but also increases the risk of instability, unintended recumbency, or the duration of intended recumbency. In patients that must remain standing balance between the alpha<sub>2</sub>-adrenergic agonist and ketamine is crucial. Greater levels of sedation require lower peak blood levels of ketamine to avoid producing a transient period of instability in equine patients and recumbency in ruminant and camelid patients. Obtaining maximum benefit from the Ketamine Stun technique requires pushing up against the limits of this balancing act. The rapid rise in blood levels produced by IV administration of ketamine presents the greatest challenge. Titrated administration of IV ketamine can be used to minimize risk of untoward responses.

An endless number of permutations are possible when using the Ketamine Stun. Many years of experimentation in many different species have provided a great deal of insight into the potential of this technique, but have not produced a definitive combination for all situations in each species. The following examples are provided as a guide and practitioners are encouraged to experiment with adjustments in doses.

#### *IV Recumbent Ketamine Stun*

The IV recumbent Ketamine Stun was my first adaption for ruminants. It is intended for short procedures requiring a high level of systemic analgesia and/or patient cooperation. Numerous minor procedures (castrations, biopsies, septic joints, casting fractures, etc.) have been successfully completed in small ruminants using the IV recumbent Ketamine Stun.

A combination of xylazine (0.025-0.05 mg/kg), butorphanol (0.05-0.1 mg/kg), and ketamine (0.3-0.5 mg/kg) is administered IV. I generally use the upper end of the dose ranges unless contraindicated. Onset is approximately 1 minute. Patients gracefully become recumbent. Patients appear awake, but seem oblivious to surroundings and procedure being performed. Mild random head or limb motion is not unusual, but purposeful movement or vocalization are signs of an inadequate stun level and additional drug should be administered. One half of the initial ketamine dose should be administered IV and is often effective. If, after allowing 60 to 90

seconds for onset, this additional half dose of ketamine fails to produce the desired level of analgesia a second half dose of ketamine along with one half of the initial dose of xylazine should be administered IV. The level of systemic analgesia produced varies depending on the doses administered, but tends to be fairly intense. Peak analgesia occurs at time of onset and decays over time. Surgical levels of analgesia have been achieved with this technique, but local anesthetic blockade should be used whenever feasible to reduce the risk of patient awareness and stress. Local anesthetic blockade also provides analgesia in the immediate post-procedure period. Having syringes preloaded with local anesthetic speeds the blockade process, which reduces its impact on the diminishing level of systemic analgesia. Duration of the stun effect is approximately 15 minutes and patients typically are able to stand and walk immediately or shortly after this point.

The intravenous recumbent Ketamine Stun is designed for short procedures. One should plan ahead and work fast. Supplemental doses of ketamine or xylazine can be administered to extend duration, but this technique is not intended for procedures that are expected to last significantly beyond the 15-25 minute range. The degree of extension is relative to the amount of supplemental drug administered.

An example of a somewhat more potent recumbent IV recumbent Ketamine Stun application in ruminants is a recent adaption developed by Dr. David Anderson, DVM, MS, DACVS, Professor of Large Animal Surgery at Kansas State University College of Veterinary Medicine. He needed to do laparotomies on 100 ewes (60-75 kg), so efficiency was important. Safety was imperative, as they needed to breed back three weeks after surgery. The ewes were held off water and feed overnight prior to surgery. Xylazine (0.05 mg/kg IV), ketamine (1 mg/kg IV) and butorphanol (0.025 mg/kg IV) were administered as a combination (basically 4 mg xylazine, 2 mg butorphanol, 75 mg ketamine). Ewes were placed in dorsal recumbency (not intubated) and midline local anesthetic blockade performed. Surgery time was 15-20 minutes. When lifted off the table and rolled into sternal, 90% of the ewes stood and walked back to the pen. Zero morbidity and mortality! David's summary defines the benefits of the Ketamine Stun technique "Pretty awesome - totally conscious, aware and would watch you if you walked in front of them - but they did not have a care in the world, did not move a muscle". Movement occurred when a reduced dose of ketamine (50 mg IV) was tried.

#### *IM or SQ Recumbent Ketamine Stun*

Administering the upper end of the IV recumbent Ketamine Stun doses IM or SQ produces a longer, less intense form of chemical restraint. Local anesthetic blockade is required for painful procedures. A combination of butorphanol (0.025 mg/kg), xylazine (0.05 mg/kg), and ketamine (0.1 mg/kg) is administered IM or SQ. Subcutaneous administration provides a slightly longer duration of effect. This technique can also be used to improve cooperation in patients that have gone down before or during a surgical procedure.

The IM or SQ recumbent Ketamine Stun has been used at Kansas State to provide chemical restraint for umbilical hernia repair. Onset time was approximately 3 to 10 minutes. Patients were obtunded enough to require (and tolerate) intubation when placed in dorsal recumbency. Duration of effect with subcutaneous administration was approximately 45 minutes. Patients were typically ambulatory within 30 minutes following arousal.

#### *IV Standing Ketamine Stun*

Small doses of IV ketamine can markedly improve the level of cooperation in standing

patients. Dosing is more critical when the Ketamine Stun is administered IV in patients that must remain standing. I generally sedate the patient first with xylazine (0.02-0.0275 mg/kg IV) prior to slowly administering the ketamine (0.05-0.1 mg/kg IV). This allows me to reduce the dose of ketamine administered if I have any concerns regarding the level of sedation. An opioid (butorphanol 0.05–0.1 mg/kg IV or IM in smaller ruminants, 0.02–0.05 mg/kg IV or IM in larger ruminants or morphine 0.05–0.1 mg/kg IV or IM) can be added to augment the level of systemic analgesia and patient control.

The following example demonstrates the value of this technique. A 725-775-kg Charolais bull was run into the chute for examination of a possible penile injury. He was extremely agitated and just kept banging around inside the chute despite being left alone. Examination was impossible and patient injury was a valid concern. To calm him down I administered 20 mg of intravenous xylazine (0.0275 mg/kg). This made him stand still when left alone, but he would not tolerate attempts at examination. I then administered 40 mg of intravenous ketamine (0.055 mg/kg). The ketamine made him extremely cooperative, but the chute hampered full examination. A decision was made to place him on the tilt table. He was very compliant during the tabling process and subsequent examination.

### *IM or SQ Standing Stun*

*5-10-20 Technique* (beef cattle – dosages may need to be adjusted when using the IM/SQ standing Ketamine Stun technique in milder mannered cattle)

A combination of butorphanol (0.01 mg/kg), xylazine (0.02 mg/kg), and ketamine (0.04 mg/kg) is administered IM or SQ. In a 500-kg cow this equates to butorphanol (5mg), xylazine (10mg), and ketamine (20mg). For a 680-kg patient the doses are 7 mg butorphanol, 15 mg xylazine, and 25 mg ketamine. Morphine (25 mg for 500 kg cow, 30 mg for 680 kg cow) can be substituted for butorphanol. Patients will appear less obtunded, but the level of cooperation is similar to stuns using butorphanol. The level of systemic analgesia is limited and local anesthetic blockade should be used to reduce the risk of patient awareness and stress.

The *5:10:20* standing Ketamine Stun technique was developed in the Kansas State University junior surgery laboratories, where it was used to provide chemical restraint for standing C-sections in beef cattle. Patients received 5 mg of butorphanol, 10 mg of xylazine, and 20 mg of ketamine. Patient weights varied from 340 to 660 kg, but no adjustments were made in the combination administered. Subcutaneous administration is preferred to minimize the risk of recumbency, but in very unruly cows intramuscular administration provided better patient control. Onset is 5 to 10 minutes with subcutaneous administration. The initial dose of *5-10-20* has not resulted in recumbency. Cows stood quietly during the C-sections (many were ill mannered before the ketamine stun). Duration of effect is approximately 60–90 minutes. Additional xylazine and ketamine can be administered SQ to extend the duration of chemical restraint. Recumbency has occasionally occurred with readministration of 50% of all three components. Current recommendation for supplemental drug administration is 25%–50% of the initial xylazine and ketamine doses (*0-2.5-5*) and (*0-5-10*), respectively, depending on the degree of cooperation and time required to complete the procedure.

A similar approach (*10-20-40* technique) has been used successfully in adult bulls. Preputial surgery (with a local anesthetic block) is an example of the procedures performed using this technique.

*References*

- (1) Abrahamsen, EJ; Chemical Restraint, Anesthesia, and Analgesia for Camelids. *Vet Clin Food Animal* 2009; 25(2):455-494
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- (3) Coetzee, JF, Gehring, R, Tarus-Sang, J, et al; Effect of sub-anesthetic xylazine and ketamine ("ketamine stun") administered to calves immediately prior to castration. *Vet Anaesth Anlg* 2010; 37(6):566-78