Practical Camelid Reproduction

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Female Reproductive Tract Anatomy

- **Ovaries** produce gametes and hormones that act on other parts of the reproductive tract
- **Oviducts** provide optimum environment for fertilization and pre-attachment development of the embryo
- **Cervix** is a barrier that secretes mucus during receptivity and produces a mucus plug seal during pregnancy
- **Vagina** is the copulatory organ and produces lubricating mucus during receptivity
Vulva

- Normal vertical orientation
- May be slightly tipped forward at top
- Observe for discharge
  - also check tail for evidence of discharge
- Orifice 3-5 cm long (alpaca > llama)
Cervix

– The external os protrudes slightly into the vagina.

– 2 - 3 cartilage rings within

– The cervix of a pregnant animal
  
  • rigid and relatively dry compared to the relaxed moist cervix and vagina of the non pregnant female under estrogen stimulation
  
  • a mucus plug is seen protruding from the cervix on vaginal examination in advanced pregnancy
External cervical os

• Relaxed/closed depending on the stage of follicular cycle or pregnancy status
• Natural or exogenous estrogen influence causes relaxation
• Decide if cervix is damaged
  – Scarring- usually permanent
  – Incompetence = excessive dilation
    • predisposed to infection
    • recheck in 10 to 14 days to see if still dilated
    • may resolve over time
Major effects of estrogen on the camelid reproductive tract

- ↑ blood flow
- Relaxation of the cervix
- ↑ white blood cells within the reproductive tract to counteract the contamination which occurs at breeding time
- ↑ mucosal secretion of mucus
- Initiation of uterine gland growth
- ↑ uterine muscular tone
- Behavioral receptivity
• All types (maturation levels) of follicles are present in the ovary at all times.
• Corpora lutea (CLs) may or may not be present depending on whether ovulation has occurred.
Ovarian physiology

• **Follicular Phase**
  • Follicles are fluid filled structures within the ovaries that contain the eggs (ova)
  • Camelids do not have estrous cycles as in other mammals
  • Camelids are termed “**induced ovulators**”
    • breeding causes ovulation= rupture of the follicle and release of the egg
    • **does not mean always receptive!!**
• **Continuous in camelids**
  • Several small (< 3mm) follicles are present at all times on the ovaries
  • **Some** follicles grow and regress producing estrogen
  • Interrupted by ovulation after copulation or exogenous hormone stimulation
Follicles

• Located on the surface of the ovaries
• Protrude during the follicular phase
• “Waves of follicles” are said by some to occur on the ovaries with follicles appearing, growing and shrinking in size
  • has not been consistently seen by us at UMass!
• The follicles present on both ovaries contribute estrogen
  • results in female receptive behavior when it overwhelms the effect of progesterone
Follicles

Picture from A. Tibary
Follicular Growth

– Multiple follicles
  • present on both ovaries at all times
  • common to have several of 3mm or less on both ovaries
  • often grow on one or both ovaries at the same time

– Follicles are capable of ovulation after a breeding at a minimum 6 mm diameter.
- 6-15 mm follicles burst releasing the ovum or egg approximately 24 hours after breeding

- If no ovulation occurs the follicle regresses, shrinking back down in size, or disappears within 2 days (unpublished, 2011)

- Follicular sizes do not necessarily correlate with sexual receptivity
Ovulatory Follicles
Luteal phase of the ovarian cycle

– Occurs after ovulation
– Lasts for months if the female is pregnant
– Ovulatory Corpus Luteum (CL) is responsible for progesterone production throughout pregnancy
Atretic/cystic/anovulatory/hemorrhagic Follicles

- Follicles > 15 mm diameter are abnormal
  - most often are termed atretic and have no effect on sexual receptivity
  - will resolve without treatment
    - rupture during US exam or on their own
    - gradual decrease in size and disappear
Cystic/ hemorrhagic follicle
Luteal phase of the ovarian cycle

• Occurs after ovulation
• Lasts for months if the female is pregnant
• A transitory corpus hemorrhagicum is present for 36 – 48 hrs. after ovulation
Corpus Luteum

- CH is replaced by the **corpus luteum (CL)**
- grows for 3 to 4 days and begins to secrete **progesterone**.
- May be cystic normally
Ovary with Corpus Luteum (CL)
Return to Receptivity

– If no pregnancy is established expect in approximately 12 to 14 days
– A longer period of time is involved after loss of the CL if the female was pregnant and the animal experienced early embryonic death
– varies with each ovulation
– not necessarily consistent for a specific female
Retained CL

– Occasionally the CL remains functioning without a pregnancy resulting in **non receptive behavior**
  • called a retained CL
  • treatment with PGF$_2$α resolves
    – suggest 150 μg of cloprostenol sodium (0.6 ml of Estrumate®) SQ one time
Sexual receptivity in the female

- Extremely variable among female alpacas!
- In the presence of the male:
  - Immediate acceptance = receptive (R)
  - Female stands when mounted by the male, but does not drop = recheck later = not receptive (NR)
  - Refusal = not receptive (NR)
- Acceptance = dropping for breeding upon approach of, or mounting by, the male
- Refusal = standing, running away, spitting, and/or vocalizing
– Some females run with others and do not show receptivity unless cornered
– Females demonstrate preferences for different males on the same day
– Males and females get used to each other if housed in close proximity
  • will stop showing aggressive breeding and receptivity behavior
• A new male may have to be brought in to stimulate female sexual receptivity and male aggressive behavior.

• Females will show receptivity as early as 24 hours after birthing.

• The best fertility rates have been achieved by breeding between days 21 to 30 after birthing.
Male Camelid
Reproductive Anatomy

• Two testicles of equal size located in the scrotum
  – much smaller than those of other species of comparable body size
    • length 3.5 to 5.0 cm
    • thickness 2.0 to 3.0 cm
    • measure with ultrasound or calipers
  – larger testicle = greater sperm production (in one study)
  – size does not vary with photoperiod length
Male Camelid Genitalia

- Testicle (enlarged)
- Scrotal Ligament
- Fowler Testes
- Spine
- Pelvis
- Rectum
- Bladder
- Prostate
- Sigmoid Flexure
- Peniss

E = Epididymus
B = Bulbourethral Gland
Alpaca Testicles

Normal Scrotal Location with 2 Symmetrical Testicles

Anus
Penis is fibroelastic with a sigmoid flexure.

- Males urinate backwards between the legs since the tip of the sheath points caudally and the penis is not extended during urination.
- Mature male camelids can partially extend the penis out of its sheath in the standing position when mounting receptive females.
- The penis has a cartilaginous, corkscrew appendage at its tip that is used to dilate the cervix and enter the uterus during breeding.
- Urethral opening is under cartilaginous appendage.
Close-up of Camelid Penis

CP = Cartilaginous Process
U = Urethral Orifice
GP = Glans Penis
P = Prepuce
Sigmoid Flexure of Camelid Penis

Sigmoid Flexure
Teat
Tip of Sheath

Purdy
Male Breeding Behavior

• Most male camelids will start breeding at 1+ years old if allowed but it is best to start at 2 to 3 years of age to achieve the best fertility.
  – If breeding is done earlier there can be vaginal or uterine problems with the female
  – The male may suffer penile injuries inflicted by mature females rejecting him
• Breeding usually lasts 10 to 45 minutes and is very noisy (orgling) in the down position.
• The male camelid will creep forward to achieve the correct penile penetration into the uterine horns.
• Produce a dribble ejaculate of small volume (0.5 to 7.5 ml collected in an artificial vagina) over the course of the breeding.
• Hot humid weather reduces libido for males and females and is reported to reduce sperm output from the testes.
Male Infertility Problems

• Won’t breed
  • Inexperienced
    • Train by observation of active males
  • Provide competition
  • Quiet environment- fewer people watching
  • Musculoskeletal problem in back or legs prevents assuming the correct copulatory position

• Penis not working
  • Check anatomy
  • Check libido
• **Semen problems**
  • Will not ejaculate- check postbreeding sample from vagina for sperm
  • Poor semen quality- perform semen evaluation from postbreeding or breeding dummy/artificial vagina collection

• **Abnormal testes**
  • Palpate
  • Ultrasound or calipers to measure
  • US to look for normal anatomy
Caliper Method
Ultrasound
Semen Evaluation

– Evaluate the male’s starting fertility, along with the initial conception results of breeding females
  • During the breeding season
    – How he is doing?
    – Does he need a rest?
– Information is available immediately without waiting for the results of breedings and thus will save time and money.
Semen Collection

- Two methods of collection
  - Post breeding vaginal collection with a speculum just like a vaginal exam - Nunoa
  - Breeding dummy with sheep artificial vagina
Parameters evaluated during semen analysis:

- **Semen Volume**
- **Sperm Activity** (not motility)
  - Camelid semen is very viscous
  - Sperm move in place rather than exhibiting progressive motility
- **Semen Viscosity**
  - Measured by drawing up some semen into a micropipette, dispensing half of it onto a slide, and then pulling upwards and measuring the height at which the semen thread breaks
• Sperm Concentration
  – observe one drop of semen on a slide and cover slip at 400X magnification
  – Estimate as high, medium, or low
  – Use hemacytometer to calculate sperm \( \times 10^6/\text{ml} \) after semen has liquefied- 12+ hours at room temperature
• **Percentage of live sperm**
  – Use Live-Dead stain (eosin-nigrosin)
  – Warm stain in tuberculin syringe and add to one drop of fresh semen
  – Mix by drawing a second slide over the two drops on the first slide
  – Live sperm = light in color
  – Dead sperm = dark in color
• **Sperm Morphology**
  • Use same live dead slide
  • Common findings in alpacas (southern Peru and northeastern US)
    • Decapitated heads *(1%)*
    • Cytoplasmic droplets
      • Proximal *(5-11%)*
      • Distal *(1-9%)*
    • Headless tail *(1-2%)*
    • Normal sperm *(25-70%)*
    • Midpiece abnormalities (low %)
      • Irregular midpiece
      • Thickened midpiece
      • Bent midpiece
• Terminally coiled tail
  • cold shock artifact of staining
  • not common
• Severely coiled tail- abnormal
• Head abnormalities
  • Double heads (< 1%)
  • Microcephaly (<1%)
  • Tailless heads (<5%)
  • Misshapen head (<1%)
Under investigation

• Variation among sequential ejaculates from the same male- proven
• Much variation among males- proven
• Seasonal variation in semen characteristics- in progress
• Relationship between semen parameters and fertility- in progress