Infertility of female and male camelids
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Introduction
Reproductive capacity is an important component of production and profitability within the camelid industry. Poor reproductive efficiency is a major problem and infertility represents the most common complaint in practice. Camelids have the lowest reproductive efficiency of all domestic farm animal species, where even the smallest decreases in fertility can have significant effects. Camelids present several anatomical and physiological reproductive differences (induced nature of ovulation, overlapping follicular waves, importance of corpus luteum [CL] for pregnancy maintenance, traumatic intrauterine copulatory mechanism, duration of mating, semen viscosity, etc.) compared to other large animal domestic species which may offer some challenges in the diagnosis and treatment of infertility.

The objectives of the present paper are to discuss the most commonly encountered female and male reproductive tract disorders resulting in infertility as seen in practice, along with the approach to diagnosis and treatment. Throughout the paper unless a specific species is mentioned, the term South American Camels (SAC) will be used to refer to alpacas (Vicugna pacos) and llamas (Lama glama). The term camels will refer to all old-world camelids (Camelus dromedarius and Camelus bactrianus). The term camelids will be used to include all of these species.

Keywords: Camelid, infertility, ultrasonography, repeat breeding, endometritis, testicular degeneration, poor libido

Common presenting complaints
In female camelids the most common presenting complaints to veterinarians related to infertility can be categorized into repeat breeding, early pregnancy loss, abnormal behavior (continuous receptivity or rejection of the male), and visible abnormalities of the external genitalia.1 Reproductive efficiency may be approached from a herd perspective or an individual perspective.2 In a large number of breeding systems, mating is based on receptive behavior and not on specific ovarian follicular status. Most breeders use behavioral signs for pregnancy diagnosis (spitting and attempts to escape the male in SAC and tail curling in camels) at 14 days after mating.1, 2 Arriving at a definitive diagnosis of the cause of infertility requires a thorough evaluation that should include a comprehensive history (thorough review of all breeding records and management practices), physical examination, and complete evaluation of the reproductive organs. An important consideration in the evaluation of the infertile female is that monitoring over at least one reproductive cycle (from follicular growth to mating to pregnancy diagnosis) may be necessary to determine a definitive diagnosis.1-3 In some cases, a diagnosis may be made on a single examination.

Male camelids are often selected as herd sires based on pedigree, fiber quality, conformation, or performance, and not on standardized reproductive parameters.4,5 Infertility in males is most often noticed when there is an inability to complete mating or when bred females do not become pregnant. As with evaluation of infertility in the female, determination of a definitive diagnosis in the male also requires a thorough evaluation including a comprehensive history, physical examination, and complete evaluation of the reproductive organs.4, 5 In some cases, males may present for examination under emergency situations (sudden increase in testicular size, acute preputial swelling, paraphimosis etc.).

Breeding soundness examination of the female
Infertility workup in the female requires a systematic approach and timing of the initial examination is very important to gain maximum information. If a female does not become pregnant after a maximum of three matings (mating only once per week based on strong receptive behavior) she should be presented for a breeding soundness examination.2 It is recommended that females are presented for an
Evaluation 14 days following mating. This examination should start with a complete health/reproductive history and physical examination. Physical examination should include overall body condition, examination of the major organ systems, and evaluation for clinical signs of infectious disease.

Examination of the external genitalia should be emphasized. The vulva should be inspected for size, conformation, and presence of any abnormalities. Special attention should be given to evaluation for congenital defects in maiden females (discussed in more detail below). A reproductive examination will consist of examination of the external genitalia (described above), transrectal ultrasonography, vaginal examination (digital examination and vaginoscopy), and in some cases hysteroscopy. Additional diagnostics include endometrial cytology and culture, endometrial biopsy, endocrinology evaluation, laparoscopy/exploratory laparotomy, and cytogenetic evaluation.

Transrectal ultrasonography is an essential part of the examination of the female camelid. Transrectal palpation alone is not accurate in assessing ovarian structures or evaluating the cervix and often times the size of the female may limit the ability for transrectal palpation to be performed. Follicular waves are overlapping and ultrasonography allows for precise evaluation of follicular and luteal activity within the ovary. The dominant follicle grows (0.6 mm per day in SAC and 1.5 to 2 mm per day in camels) until it reaches a maximal size (nine to 14 mm in llamas, eight to 12 mm in alpacas, and 12 to 25 mm in camels). The CL is easily visualized by day 4 after mating or induction of ovulation. Uterine tone and edema increase during the follicular phase (maximal in the presence of mature follicle). The uterus becomes relaxed during the luteal phase and pregnancy. Transrectal ultrasonography is performed using a 5 to 7.5 MHz linear transducer. For alpacas, the transducer is mounted on a handle to allow manipulation without inserting the hand into the rectum.

Digital examination of the vestibule-vaginal area should be performed on all maiden females (potential persistent hymen or vaginal segmental aplasia) and cases where vestibular or vaginal adhesions are suspected. Vaginal and cervical examinations are performed using a sigmoidoscope in alpacas and a tube vaginoscope in llamas and camels. The cervix should be clearly visualized during normal examination. Hysteroscopy may be recommended for more thorough evaluation of the cervix and evaluation of the endometrium for presence of scarring or adhesions.

Endometrial cytology and culture should be a part of any infertility workup. An equine double-guarded brush (cytology) or swab (culture) is introduced through the cervix via a speculum (alpacas) or by recto-vaginal manipulation (llamas and camels). Cultures should be performed for aerobic and anaerobic bacteria, Ureaplasma, Mycoplasma, and fungi. Endometrial biopsy should be considered in cases presented for infertility, chronic endometritis, or a history of recurrent pregnancy loss/abortion. An equine endometrial biopsy punch can be used in llamas and camels. For alpacas, the use of a Turret rectal biopsy punch is recommended. Targeted biopsies can be performed in combination with hysteroscopy. Although a grading system for histological evaluation has been proposed in camelids (Table 1), it is not widely used in a clinical setting. These techniques should be performed when the female has the presence of a dominant follicle and the cervix is open.

Table 1: Classification of endometrial biopsy and potential effect on fertility

<table>
<thead>
<tr>
<th>Biopsy Category</th>
<th>Histopathologic Characteristics</th>
<th>Effect on Fertility</th>
</tr>
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<tbody>
<tr>
<td>Grade 1A</td>
<td>Normal endometrium</td>
<td>Normal conception rates</td>
</tr>
<tr>
<td>Grade 1B</td>
<td>Few lymphocytes within the endometrium. Siderophages present.</td>
<td>Low-grade infection or remnants of previous inflammation. Mild surface irritations may indicate reaction to breeding. May be postpartum or post-abortion (siderophages).</td>
</tr>
<tr>
<td>Grade 2A to 2B</td>
<td>Active and acute, chronic, or chronic active endometritis. Chronic inflammation tends to be more deeply located in the endometrium, compared with active and chronic active inflammation.</td>
<td>Interferes with conception and may cause early embryonic death.</td>
</tr>
<tr>
<td>Grade 3A</td>
<td>Chronic endometritis with glandular fibrosis.</td>
<td>Interferes with implantation and placentation. May cause early embryonic death.</td>
</tr>
<tr>
<td>Grade 3B</td>
<td>Uterine neoplasia</td>
<td>Pregnancy loss or abortion.</td>
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Breeding soundness examination of the male

Infertility workup in the male, as with in the female, requires a systematic approach. Breeding soundness examination should include complete health/reproductive history (detailed description of presenting complaint), general physical examination, and thorough examination of the reproductive organs/genital system. Historical information should include age, breeding records (number of females, breeding frequency, type of mating), previous health problems, and current reason for examination. Poor conformation may impair the ability of the male to mount for mating and prolonged febrile conditions can affect spermatogenesis. Physical examination should include overall body condition, examination of the major organ systems, and evaluation for clinical signs of infectious disease. Examination of the external genitalia should be emphasized. The scrotal skin is thin and smooth. It should be examined for evidence of bite wounds or other abnormalities. In old males the scrotum may appear more pendulous. Testes should be present in the scrotum at birth in SAC. Testes enter the scrotum at two to three years of age in camels. Examination of the prepuce may require restraint in lateral recumbency. Sedation or anesthesia may be required to exteriorize the penis. Preputial attachment is normal in young, prepubertal males. In SAC the penis should be completely free in all males by the age of three years. A reproductive examination will consist of examination of the external genitalia (described above), testicular measurements, testicular ultrasonography, evaluation of the accessory sex glands, evaluation of mating ability, and semen collection/evaluation. Additional diagnostics include testicular biopsy, endocrinology, trace mineral analysis, and cytogenetics.

Examination of the testes and epididymides includes palpation, measurement, and ultrasonography. The testes should be smooth, firm, resilient to palpation, and nearly of equal size. Normally only the tail of the epididymis is palpable. Testicular size is an important indicator of sperm production ability and measurements should be taken with calipers or ultrasonography. Ultrasonography of the testes is important to detect problems that cannot be identified on palpation. Examination of the accessory sex glands (bulbourethral glands and prostate) may be recommended in some cases and is limited to ultrasonography.

Requesting owners to present a receptive female with the male for evaluation is imperative for assessment of mating ability. During this evaluation, the progression of a normal behavioral pattern should be recorded (along with duration) including vocalization, chasing, mounting, intromission, and duration of copulation.

Semen collection in camelids can be difficult due to the nature of copulatory behavior and process of ejaculation over an extended period of time. Techniques for collection of semen include use of an artificial vagina (in the case of trained males), electro-ejaculation, or post-coital aspiration from the female. In camels, the use of an artificial vagina is the preferred method for semen collection. Semen collected by post-coital aspiration typically contains blood contamination from the female and may provide a very small sample. In the authors’ practice semen evaluation was performed on samples collected by post-mating aspiration in the majority of alpaca cases (100% for routine breeding soundness examination and 59.2% for males presented for infertility). Electroejaculation was only performed in males that presented with a complaint of infertility. Electroejaculation requires general anesthesia with the male placed in lateral recumbency. An electroejaculator probe with linear, non-circumferential electrodes should be used. The electrodes should be placed at the level of the prostate (depth determined by transrectal ultrasonography). Stimulation should be done with extreme care starting with low voltage until erection is achieved. Urine contamination is a potential complication and males should be encouraged to void the bladder prior to anesthesia and electroejaculation. Studies have demonstrated that electroejaculation consistently resulted in ejaculate volumes of 0.25 to 1.75 mL in alpacas and did not produce an increased stress response from anesthesia alone.

Examination of semen should include motility, volume, color, viscosity, concentration, and morphology. Camellid semen is very viscous (attributed to secretions of the bulbourethral glands) and initial evaluation of motility will demonstrate oscillation prior to liquefaction of the sample. Progressive motility, as described in other species, is difficult to appreciate. Individual motility can range from 20 to 95%. Concentration is generally estimated using a hemocytometer.
similar to other species by examination with stained smears (eosin/nigrosine and Diff-Quick). Preparation of morphology slides may be difficult due to the viscosity of the semen. Several studies have demonstrated highly variable normal morphology. Normal males should have at least 50% morphologically normal spermatozoa. Normal cytology should not reveal erythrocytes or leukocytes in ejaculates collected by artificial vagina or electroejaculation. Research is needed to determine suggested parameters of an ejaculate that would be required for maximal fertility.

Testicular biopsy is not a routine part of the breeding soundness examination in the male. In some cases however, a diagnosis and prognosis of the male’s fertility cannot be reached based on physical examination, ultrasonography, and semen evaluation. Testicular biopsy can help distinguish azoospermia of testicular or non-testicular origin. Several techniques have been described including fine needle aspirate, large bore needle (14 gauge) core biopsy, wedge biopsy, and split needle biopsy. The recommended technique for collecting testicular biopsy samples is to use a spring-loaded split-needle biopsy instrument.

Assessment of female infertility

Infertility in females can be broadly categorized into congenital and acquired abnormalities. Several congenital abnormalities of the reproductive tract have been described in SAC. The most common congenital disorders that might be seen in practice include ovarian dysgenesis/hypoplasia, segmental aplasia of the uterus, vaginal aplasia, persistent hymen, and vulvar atresia. Females with ovarian hypoplasia will present as maidens, females with a history of multiple matings/continuous receptivity, or persistent rejection of the male. They tend to be taller have more fine fiber than normal females. Transrectal ultrasonography over several days will demonstrate a small uterus and either small follicles that do not progress to a dominant size or inability to visualize the ovaries entirely. Cytogenetics may reveal chromosomal abnormalities such as 73XO, 75XXX, 74XX/74XY, minute chromosome). The condition is confirmed by laparoscopy. Segmental aplasia of the reproductive tract may occur at the level of the uterine tube (formation of hydrosalpinx) or at the level of the uterine horn (uterus unicornis). These females will often present with normal cycles and ovulation but fail to achieve or maintain pregnancy. Diagnosis of uterus unicornis may be achieved by ultrasonography and confirmed by hysteroscopy or laparoscopy. Females with vaginal aplasia, persistent hymen, or vulvar atresia may present with a history of rejecting the male, persistent straining or pain during mating, or have excessive vulvar swelling after mating. Transrectal ultrasonography generally demonstrates accumulation of fluid or mucus in the vagina/uterus (hydrometra, mucometra). Confirmation is achieved by examination of the external genitalia and vaginal examination. Digital palpation is often sufficient to determine an occlusion at the level of the vestibulum. There is no treatment for complete vaginal aplasia. Females should be separated from males because they will continue to be receptive and breeding may lead to complications. An imperforate hymen is corrected by making an incision through the tissue with a scalpel, however potential genetic correlation and future breeding should be discussed with the owner. Incomplete perforation of the hymen (vestibular narrowing) is fairly common and may be managed successfully with bougienage. Vulvar aplasia is also relatively common and surgical repair is controversial.

The most common behavioral complaint in females is rejection of the male in absence of pregnancy. Spontaneous ovulation does occur and is more common during the postpartum period. Aggressive behavior and infertility may be associated with ovarian tumors (granulosa theca cell tumors) and unilateral ovariectomy may re-establish ovarian function of the contralateral ovary in some cases. Failure of ovulation is a common problem in camels. Anovulatory follicles can become hemorrhagic and in some cases luteinize and produce progesterone resulting in rejection of the male. It is important to note however that anovulatory follicles do not necessarily inhibit the growth of other follicles. Treatment with human chorionic gonadotropin (hCG) or gonadotropin releasing hormone (GnRH) may be attempted. Ovulation failure may also be observed in females with vagina/cervix abnormalities that may inhibit the normal mechanism of induction of ovulation. Ovarian follicular activity may be reduced in females that are lactating, obese, are heavily parasitized, are advanced in age, or have experienced severe...
Acquired ovarian inactivity is commonly observed in lactating camels. In SAC and camels, the major owner complaints on presentation to a veterinarian were “repeat breeding” and “early pregnancy loss” (76 and 18% respectively) in one study. Repeat breeding in a female with a history of at least one normal pregnancy/birth may be due to inappropriate breeding management, endometritis, failure of ovulation, failure of fertilization, or early embryonic loss. Management of reproduction in camelids can be complicated because female receptivity does not correlate to mature follicular size but rather absence of luteal tissue (progesterone). Failure of fertilization may also be due to uterine tube or ovarian bursal abnormalities including inflammation, pyosalpinx, or hydrosalpinx. In a recent study involving dromedary females, clinical endometritis, ovarian hydrobursitis, and vaginal adhesions were the most common clinical findings in females examined for repeat breeding with regular heat intervals, refused matings, or repeat breeding with long heat intervals. Ovarian hydrobursitis is a long-standing reproductive syndrome in dromedary camels characterized by fluid accumulation and encapsulation of the ovary. In camels, ovario-bursal adhesions and ovario-bursitis have also been reported. In some cases these conditions may be associated with *Chlamydophila* infections. Bilateral and unilateral left and right ovarian hydrobursitis was observed at frequencies of 42%, 46%, and 12%, respectively.

The major contributing factors to endometritis are over-breeding, unaddressed postpartum complications, and improper obstetrical manipulations. Endometritis can be classified as acute, sub-acute, or chronic. Nutritional deficiencies such as selenium and copper may also be linked to an increased incidence of endometritis. In cases of endometritis females will likely present for regular return to cyclicity and mucopurulent discharge. Transrectal ultrasonography may demonstrate areas of increased echogenicity and thickening of the uterine wall.

Cytology and culture are necessary in cases of suspected endometritis. Endometrial biopsy should also be considered in the diagnosis of endometritis and can be a prognostic indicator of future fertility. Bacteriological culture should include sensitivity testing for the major antibiotics. The most common bacteria isolated from cases of cameld endometritis are *Escherichia coli*, *Streptococcus equi zooepidemicus*, β-hemolytic *Streptococci*, *Enterococcus* spp., coagulase negative *Staphylococcus* spp., *Proteus* spp., *Enterobacter aerogenes*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa* and *Trueperella pyogenes*. Venereal transmission should be considered in case of herd infertility or abortion outbreaks. *Pseudomonas aeruginosa*, *Campylobacter fetus fetus*, *Tritrichomonas foetus*, *Aspergillus* spp., and *Mucor* spp. have been isolated from infertile camels.

Therapeutic management of endometritis involves uterine flushing, intrauterine antibiotic infusion, systemic antibiotic administration, or a combination. Uterine flushing is accomplished with lactated Ringer’s solution (LRS) or a proprietary equine uterine lavage solution. Administration of oxytocin may improve uterine clearance. Infusion with 30% DMSO solution or N-acetylcysteine prior to uterine lavage may be considered in chronic cases with thick mucopurulent discharge. Biofilm formation is a characteristic of many organisms found in endometritis and the addition of buffered chelating agents (tris-EDTA and Tricide®) may help dissolve the biofilm and improve antimicrobial action. A 4% metacresol-sulfonic acid and formaldehyde solution (Lotagen) has provided good results for treatment of endometritis and metritis in camels. Most antibiotics which can be used in utero can also or alternatively be used systemically and achieve very good concentration in uterine tissue. Success of treatment of endometritis depends on the duration of infection and females should be re-examined after a period of sexual rest. Chronic endometritis will lead to development of degenerative changes or fibrosis. In these cases the best option in valuable females is embryo transfer.

Early pregnancy loss is a common complaint in camelids as mentioned previously. Pregnancy loss may be the result of cervical incompetency (sequela to dystocia/obstetrical manipulation), uterine abnormalities (scarring, fibrosis, adhesions, etc.), genetic abnormalities, systemic disease (trypanosomiasis in camels), twinning, or luteal insufficiency. Most early embryonic loss occurs before 45 to 60 days of gestation. Management of recurrent pregnancy loss is usually managed with advanced reproductive techniques such as embryo transfer. Uterine fibrosis should be considered in
older females or those with long-standing infertility or pregnancy loss. Endometrial biopsy is diagnostic and provides prognosis for future fertility. Other causes of infertility include vaginal or cervical adhesions (may lead to development of pyometra or mucometra), uterine lacerations, ovarian neoplasia, uterine neoplasia, and peri-uterine adhesions. Referral is sometimes warranted for diagnostics such as hysteroscopy, laparoscopy, or fluoroscopy. A high incidence of pyometra was observed in middle-aged female dromedaries presented for infertility.

**Assessment of male infertility**

Infertility in males is most often noticed when there is an inability to complete mating or when bred females do not become pregnant. Inability to complete mating could be due to poor libido, abnormal mounting, erection failure, or ejaculation failure. Mating includes several steps that need to be observed for any abnormalities. Poor libido could be behavioral or functional. Young males may not have been socialized appropriately in groups (show animals), are inexperienced/timid, or have been reprimanded by handlers. It becomes important with young males to introduce them slowly to breeding. In adult proven males, deterioration of libido can be due to systemic disease, musculoskeletal abnormalities, or heat stress. Endocrinology testing can determine if poor libido is due to low testosterone. Males with musculoskeletal disorders may complete mating if they are supported during mating. Small males may not be able to maintain a normal mating position and achieve intromission. In camels a seasonal effect (heat stress) is present and poor libido (with corresponding decrease in testosterone) is observed during the summer months. Poor libido can also be the result of overuse. Excessive work load may result in a lack of libido. Dromedary bulls that are overused within the breeding season, and especially out of the breeding season, may demonstrate a decrease in libido, be slower to breed, and in some cases may fail to ejaculate. In such cases it is recommended to remove the male from work and provide a period of rest. Testosterone therapy in dromedary bulls increased libido but resulted in a significant reduction in spermatogenesis and sperm concentrations, and is therefore not recommended.

Semen is deposited deep into the uterine horns during copulation in camelids. Erection failure in young males may be due to immaturity (lack of preputial detachment). On evaluation, inability to exteriorize the penis or erection failure could be due to congenital abnormalities or acquired conditions. Congenital abnormalities that have been identified include persistent frenulum, short penis, or abnormal function of the penile retractor muscle. Acquired conditions such as preputial stenosis or adhesion formation may be due to severe inflammation from trauma (breeding the ground, fighting injuries, preputial prolapse, paraphimosis, etc.). Phimosis in camels may result from ischemic necrosis of the penis following application of straps for movement in and out of trucks for transport. Prognosis for any of these types of injuries is guarded to poor. Failure of ejaculation may be due to painful conditions (musculoskeletal abnormalities, hair rings, penile warts, abnormal vaginal conformation of the female) that force the male to interrupt breeding. Lack of achieved pregnancies may be the result of abnormalities leading to derangements in ejaculation (absence of ejaculation [aspermia] or incomplete ejaculation [oligospermia]) or within the spermiogram (azoospermia, oligozoospermia, teratozoospermia). Measurement of seminal plasma alkaline phosphatase is not a marker of ejaculation in alpacas. Testicular abnormalities are often identified during routine breeding soundness examination, which is why any male that is considered as a herd sire should be evaluated early to provide a baseline and rule out potential congenital abnormalities. The most common congenital abnormalities found on routine evaluation are testicular hypoplasia, cryptorchidism/ectopic testes, and testicular/epididymal cysts (Table 2). Some chromosomal abnormalities may result in teratozoospermia and cytogenetics may be necessary for diagnosis.
Table 2: Documented diseases of the reproductive organs in the male SAC at the WSU-VTH Theriogenology service

<table>
<thead>
<tr>
<th>Preputial edema (heat stress)</th>
<th>Prepuce</th>
<th>Penis</th>
<th>Testis and epididymis</th>
<th>Accessory sex glands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstruction</td>
<td>Prolapse</td>
<td>Prolapse</td>
<td>Cryptorchidism</td>
<td>Prostate hypertrophy</td>
</tr>
<tr>
<td>Laceration</td>
<td>Paraphimosis</td>
<td>Infiammation</td>
<td>Ectopic testis</td>
<td>Prostate abscess</td>
</tr>
<tr>
<td>Testes and epididymis</td>
<td>Inflammation</td>
<td>Ulcerations/Abrasions</td>
<td>Hydrocele</td>
<td></td>
</tr>
<tr>
<td>Necrosis</td>
<td>Hair ring</td>
<td>Penile warts</td>
<td>Testicular degeneration</td>
<td></td>
</tr>
<tr>
<td>Inflammation (Posthitis)</td>
<td>Urethral rupture</td>
<td>Urethritis</td>
<td>Testicular hypoplasia</td>
<td></td>
</tr>
<tr>
<td>Warts</td>
<td>Urolithiasis</td>
<td></td>
<td>Testicular cyst</td>
<td></td>
</tr>
<tr>
<td>Phimosis</td>
<td></td>
<td></td>
<td>Orchitis</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Epididymitis</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Epididymal segmental aplasia</td>
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</tbody>
</table>

Testicular hypoplasia, ectopic testes, and bilateral cryptorchidism often result in severely impaired testicular function (azoospermia) and complete sterility in some cases. Congenital segmental aplasia along the epididymal ducts or ductus deferens may also result in azoospermia. In the case of unilateral cryptorchidism males may be fertile but should be removed from the breeding pool. Rete testis and epididymal cysts are not uncommon, however they are not palpable and must be diagnosed with ultrasonography. They should be documented and monitored. Their role in infertility is variable. Ultrasonographic examination performed on 173 male alpacas presented for castration identified rete testis cysts in 18.5% of males. Following castration disruption of spermatogenesis was evident in testes with large cysts and examination of the epididymis of affected testes demonstrated 20% were completely void of spermatozoa.

Testicular hypoplasia has to be differentiated from testicular atrophy following injury to the testis, testicular disease/degeneration, heat stress, or debilitating disease. Testicular degeneration is not uncommon in older breeding males or those that have experienced severe systemic disease or heat stress. Testicular degeneration is probably the most common cause of infertility due to testicular pathology. The testes are small and either soft or hard/fibrous on palpation. In these cases evidence of oligozoospermia and teratozoospermia or azoospermia may be observed. In camels anabolic steroids are sometimes used in attempt to improve weight gain, muscle growth, and performance in stud camels, resulting in reduced spermatogenesis and testicular size. These drugs will have immediate effect, but may also have long-term effect. Testicular degeneration is irreversible, however if azoospermia has not yet developed, it may be possible to mate the male on a restricted breeding schedule to achieve pregnancies. Testicular tumors are rare. Testicular biopsy becomes important in providing a histological diagnosis of testicular abnormalities and is considered the gold standard for diagnostic evaluation of any case with azoospermia. In cases of acquired abnormalities, 60 days of sexual rest may be recommended followed by re-evaluation.

Scrotal trauma due to fighting with other males is common in camelids. Prognosis for reproductive function depends on the extent of the injury. Deep lacerations are often complicated due to testicular hemorrhage or development of infection. In some cases unilateral castration is recommended, if a single testicle is affected, to preserve fertility. Hydrocele can be due to inflammatory or non-inflammatory processes. The scrotum will become enlarged and initial diagnosis is based on palpation (generally non-painful). Confirmation is achieved with ultrasonography and visualization of fluid within the scrotal sac. Moderate hydrocele can be observed in males that are not well managed during summer months and will progressively decrease as the ambient temperature drops. Enlarged, painful testes on palpation could be the result of orchitis. Orchitis can result from trauma to the scrotum due to bite wounds from fighting. The most common systemic diseases that may result in orchitis in camel raising areas include trypanosomiasis (Trypanosoma evansi) and brucellosis (B. abortus, B. melitensis). Systemic antibiotics may be considered for treatment of infectious orchitis but in most cases are not efficacious and castration is recommended.
Conclusion

A diagnosis of infertility in the female can often be achieved with a methodical examination approach, although in some cases a diagnosis may remain difficult to attain. Evaluation of breeding records and discussion of appropriate breeding management protocols is vital. A breeding soundness examination is paramount to achieving maximal reproductive efficiency. Females should be mated once per week based on strong receptive behavior and if a female continues to be receptive after a maximum of three matings to a proven male, a breeding soundness examination should be performed.2 In some instances of acquired subfertility or infertility a minimum contamination breeding technique could be implemented. This requires ultrasonographic monitoring of ovarian activity and breeding only when a mature follicle is present. In cases where females have experienced previous uterine infections broad spectrum antibiotics may be administered daily starting one day prior and continuing for three days following mating. Only males with high fertility should be used and copulation should be limited to a maximum of 15 minutes, following which ovulation should be induced with administration of hCG or GnRH.

Infertility in the male can have a significant negative impact within a production system. Reproductive disorders in the male generally carry a poor prognosis when associated with severe lesions or a decline in semen quality. Hemicastration may be recommended in some cases and should not affect the fertility of the male if the remaining testis is still normal.4,18 Clients should be educated to examine the external genitalia frequently on prospective and current herd sires, and annual male breeding soundness examinations should be a routine part of breeding management as a screening tool for potential problems.18

References


