

REPRODUCTIVE ULTRASONOGRAPHY: SMALL RUMINANT



BASICS

OVERVIEW

- Ultrasonography of the reproductive tract is an invaluable technique for the examination of the reproductive state of the female and diagnosis of pathological conditions in both the male and the female small ruminants.
- Transcutaneous abdominal ultrasonography is a simple technique mainly used for the diagnosis of pregnancy after 45 days.
- Transrectal ultrasonography is a more difficult technique to master but is very rewarding in the examination of ovarian and uterine function as well as early pregnancy diagnosis and fetal numbering.
- Ovarian ultrasonographic techniques are of paramount importance in superovulation studies.
- Ultrasonography in the male small ruminant concerns mainly the testis and epididymis and to some extent the evaluation of preputial lesions.
- Machines with Color Doppler have become affordable and portable and add a new dimension to diagnosis by evaluating blood flow to the reproductive organs and fetus.

INCIDENCE/PREVALENCE

- Pregnancy diagnosis by ultrasonography is commonly used in sheep operation
- Transrectal ultrasonography is not used routinely. The technique is occasionally used in the management of embryo transfer donors or for the examination of valuable females with urogenital disorders.

GEOGRAPHIC DISTRIBUTION

- Worldwide

SYSTEMS AFFECTED

- Reproductive

PATHOPHYSIOLOGY

- Many pathological processes in the reproductive tract result in visible ultrasonographic changes.
- Abnormal accumulation of fluid in the uterus (pyometra, hydrometra, Mucometra) or in the testis and epididymis (rete testis and epididymal cysts) can be easily visualized by their characteristic ultrasonographic features
- Degenerative changes accompanied by fibrosis and sometimes calcification are identified by the increased echogenicity or tissue and comet tail appearance (calcification)
- Pregnancy disorders can be identified by changes in the echogenicity of fetal fluids, fetal cardiac activity, fetal abnormal development, and appearance of the placenta.

HISTORICAL FINDINGS

- Breeding management history: estrus synchronization, artificial insemination of mating
- Abnormal vaginal discharge after positive pregnancy diagnosis
- Abnormal cyclicity or vaginal discharge
- Abdominal distension
- Overdue females
- Males with abnormal ejaculates or abnormal scrotal or epididymal enlargement in the male

SIGNALMENT

- Reproductively advanced females and males

PHYSICAL EXAMINATION FINDINGS

- Depends on the complaint.
 - No abnormalities in animals presenting for pregnancy diagnosis
 - Abnormal bloody or mucopurulent discharge in females suspected to have aborted or in the process of aborting as well as in females with uterine infections or cervical or uterine tumors
 - Abnormal abdominal distension in females with hydrometra, fetal hydrops
 - Depression, anorexia and inability to rise in females with pregnancy toxemia
 - Asymmetrical, enlarged or painful scrotum in males with orchitis, epididymitis or inguinal hernia

GENETICS

- N/A

CAUSES AND RISK FACTORS

- Ultrasonography is considered the gold standard for pregnancy diagnosis and evaluation of reproductive organs



DIAGNOSIS

DIFFERENTIAL DIAGNOSIS

- See imaging below

CBC/BIOCHEMISTRY/URINALYSIS

- Indicated in cases of pregnancy toxemia.

OTHER LABORATORY TESTS

- Depends on complaint and specific ultrasonography findings.

IMAGING

Reproductive ultrasonography in the open female

Technique

- Because of their size, transrectal reproductive ultrasonography in the ewe and doe requires the use of linear transducers mounted on a rigid extension handle
- Use of a small diameter 7.5 MHz transducer is recommended (Figure1)



(a)



(b)

Figure 1: Use of a linear transducer mounted on a rigid extension handle (a) for transrectal ultrasonography on a doe (b)

- Sheep tolerate the procedure quite well but some does may need to be sedated particularly if the examination is lengthy.
- Some practitioner prefer to perform tranrectal examination on the animal placed in dorsal recumbency in an insemination crate
- The general procedure follows that described for alpacas (see ultrasonography in camelids)
- Withholding food for 12 hours may improve the ability to scan the genital organs

- Transrectal ultrasonography of the ovaries is best learned initially by scanning females with known stage of the cycle particularly estrus animals (large follicles are generally present)
- Transabdominal ultrasonography is performed using a 3.5 or 5 Mhz convex or sector transducer. Clipping of the wool or fiber is required in advanced pregnancy.
- The main purpose of ultrasonography in the non-pregnant female is to determine the normalcy of genital tract and stage of the cycle. All examinations are performed transrectally. If transrectal examination is difficult the animal may be examined transvaginally

Cervix

- The cervix is relatively easy to recognize as a echogenic cartilaginous linear structure with its characteristic cervical rings (Figure 2)

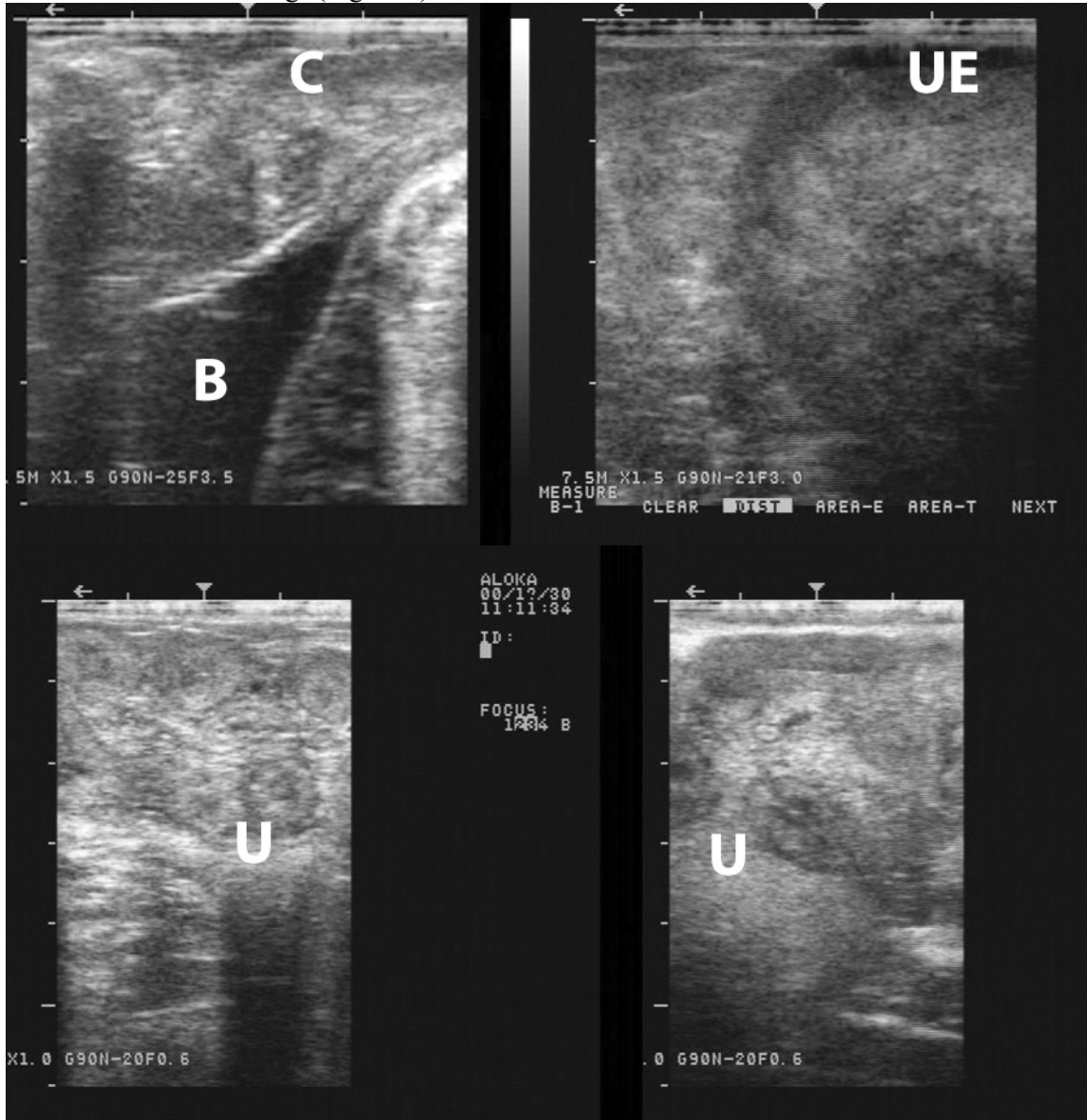


Figure 2: Transrectal ultrasonography of the normal reproductive tract: Figure 1: C: cervix; B: Bladder; UE: uterine edema; U: uterus in diestrus

- Difficulties in advancing the transducer over or beyond the cervix may be due to cervical neoplasm or adhesions.
- Cervical tumors (adenocarcinoma) are usually multi-pocketed structures. Large tumors can be visualized by transabdominal examination (Figure 3)

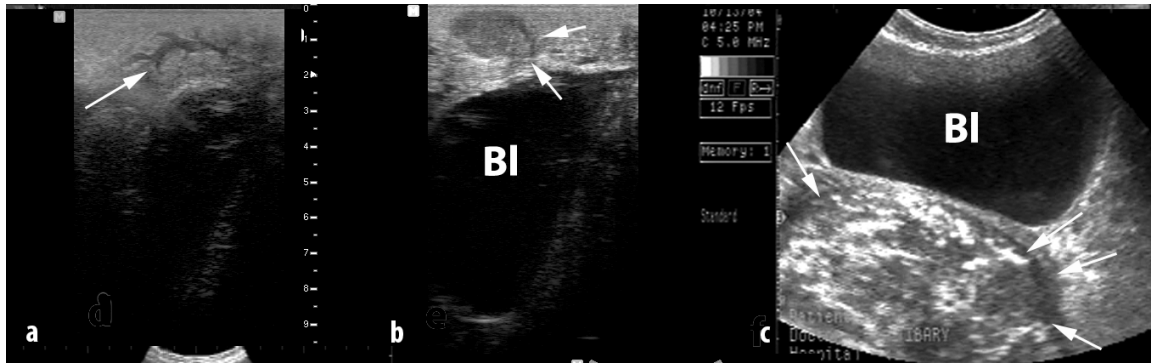


Figure 3: Transrectal ultrasonography of cervical abnormalities: incompetent cervix, b) small cervical mass. c) Transabdominal ultrasonography of a cervical mass (arrows) compressing the bladder (Bl)

Uterus

- The uterine horns are curled downward and are visualized in several cross-sections
- The uterus is edematous, and heteroechogenic during estrus and early metestrus (Figure 2)
- The uterus has a uniform medium echogenecity during the luteal phase (Figure 2)
- The lesser curvature presents various degrees of hypoechoic areas corresponding to vasculature
- Detailed examination of the uterine wall and contents requires the use of contrast ultrasound techniques
- Abnormalities of the uterus include:
 - Presence of hypoechoic free fluid: hydrometra (mainly in goats), segmental aplasia (Figure 4)
 - Presence of echogenic (snowy) fluid: pyometra or Mucometra (Figure 4)
 - Presence of echogenic content: retained fetal parts (maceration or membranes) (Figure 5)
 - Presence of uterine masses: delayed involution of caruncles (medium echogenecity and characteristic mushroom shape), uterine tumors (variable echogenecity and sometimes are multilobulated), and fetal mummification. Differential diagnosis may require the use of contrast ultrasound techniques (Figure 5)

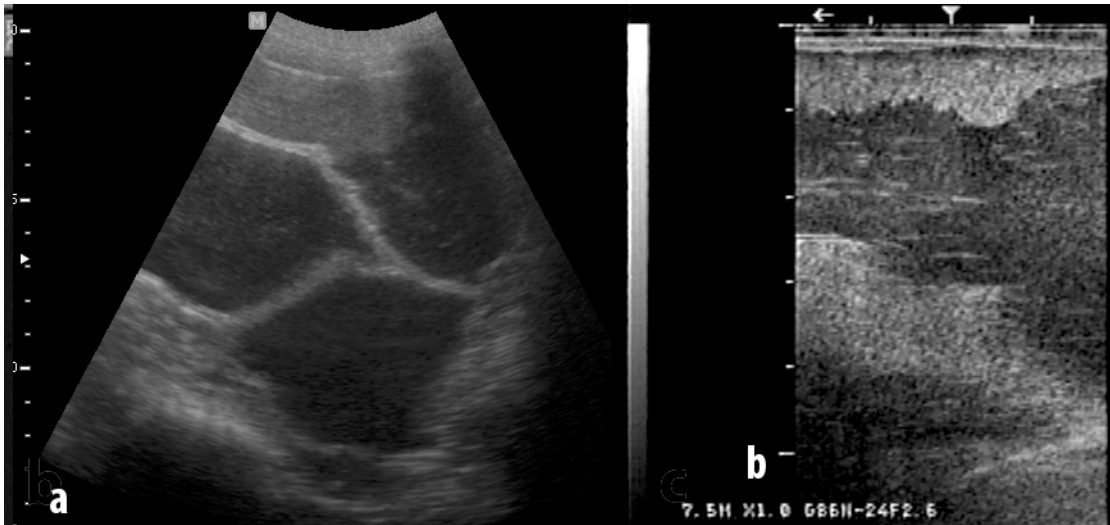


Figure 4 Abnormal ultrasonogram of the uterus: a) hydrometra, b) mucometra/pyometra



Figure 5 Abnormal ultrasonograms of the uterus: a) transabdominal ultrasonography of uterine mass (arrow); b) and c) postpartum metritis.

Ovaries

- The ovaries are visualized in the same manner described for alpacas (see ultrasonography in camelid).
- The ovary is recognized by its echogenic ovarian stroma surrounded by a hypoechoic zone (Figure 6)
- In the cyclic female, follicles or corpora lutea can be visualized and present the same ultrasonographic characteristics as in the bovine
- Follicles are anechoic structures on the periphery of the ovary with sizes varying between 5 and 10 mm (Figure 6)
- The corpus luteum has a liver like echotexture (medium gray) and ranges in size from 9 mm to 15 mm (Figure 6)
- Abnormalities of the ovaries include:
 - Anestrus: lack of follicular activity after serial examination
 - Cystic ovaries: large anechoic, simple or multiple ovarian structures (particularly in dairy goats) (Figure 7)
 - Ovarian tumors: large heteroechoic structures with absence of or abnormal follicular waves (Figure 8)

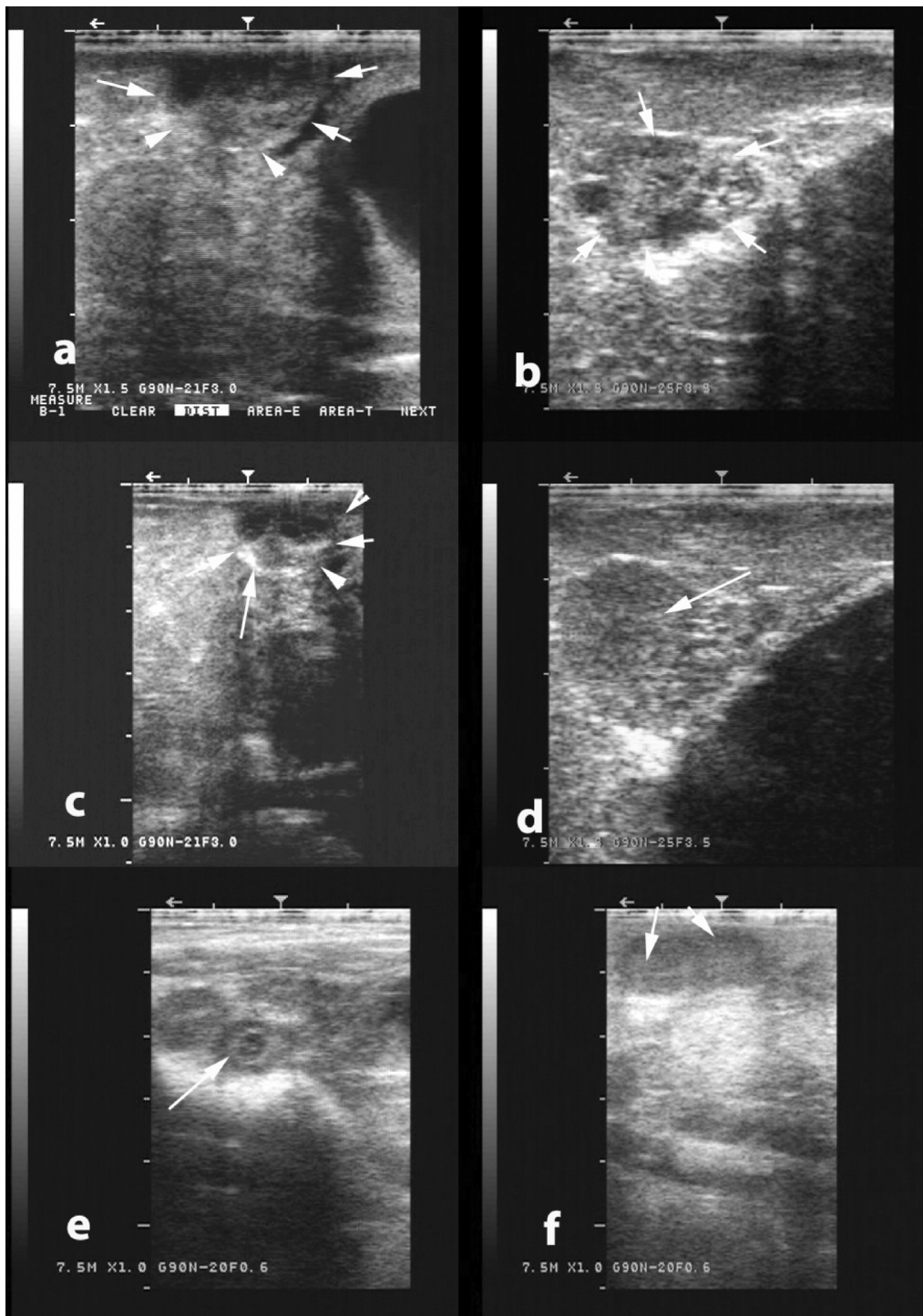


Figure 6 Transrectal ultrasonograms of the ovary. Ovarian ultrasonography (arrows): a) and b) quiescent ovary; c) follicles; d) corpus luteum; e) cavitory corpus luteum; f) double ovulation (2 corpora lutea)

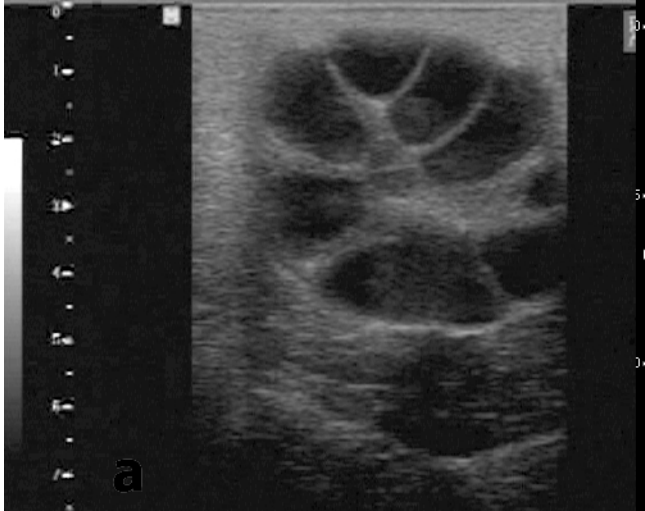


Figure 7 Transrectal ultrasonogram of a goat ovary: cystic ovarian disease

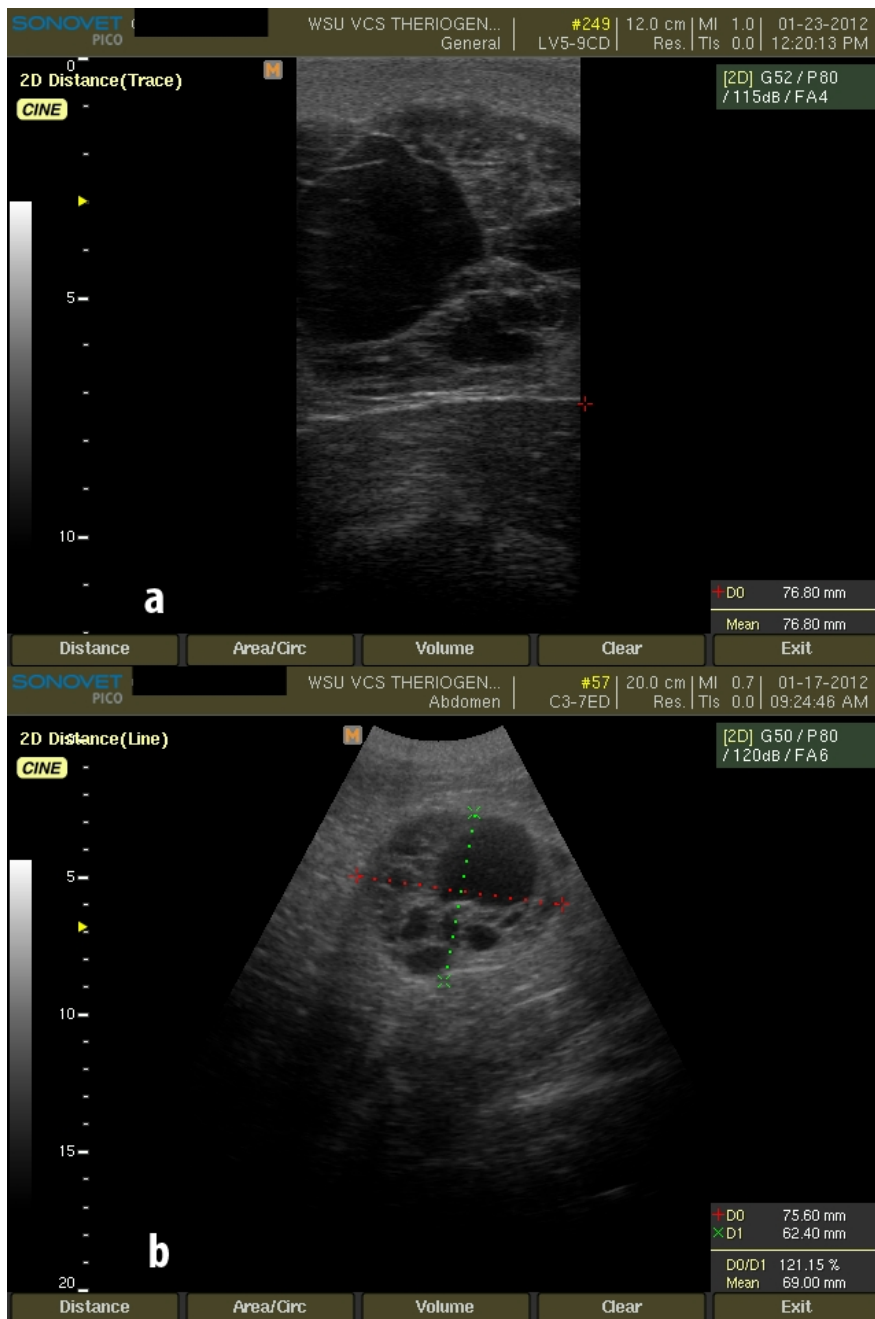


Figure 8 Transrectal (a) and transabdominal (b) ultrasonogram of a granulosa-theca cell tumor of 7.6 x 6.9 cm in a doe

Pregnancy diagnosis and evaluation of fetal health

- Pregnancy diagnosis is the most common reason for ultrasonographic imaging of the reproductive tract in small ruminants
- Although the embryonic vesicle is visible by transrectal ultrasonography as early as 13 days, it is better to wait until 25 days for greater accuracy.
- Accuracy of pregnancy diagnosis between 19 and 24 days may be increased by use of a higher frequency transducer (7.5 or 8 MHz) and by placing the ewes on their back during the examination.

- The early stages are identified by visualization of fetal fluid within the uterine horn and CLs on the ovaries. (Figure 9)
- Visualization of the conceptus and fetal heart beat is possible starting on day 25 of pregnancy. (Figure 9)

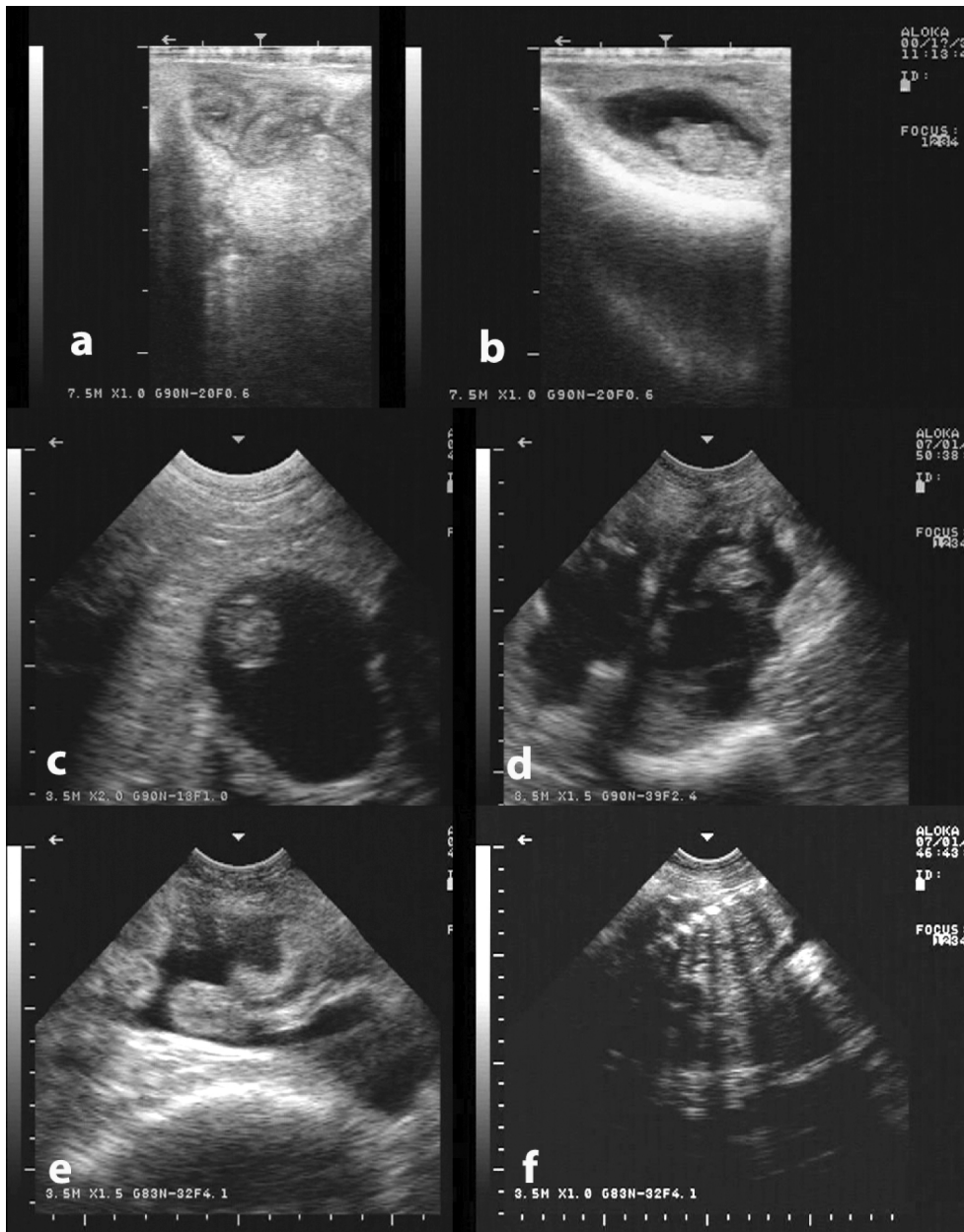


Figure 9 Ultrasonographic pregnancy diagnosis: a) transrectal 21 days, b) transrectal 29 days), c) transabdominal 32 days, d) transabdominal 40-day twins, e) 70 days placentomes; f) 72 days fetal chest

- Diameter of the vesicle increases steadily from 10 mm on day 20 to 20 mm on day 30 of pregnancy. With increasing age of pregnancy, fluid is visualized along the entire horns producing a multilocular image.
- The placentomes start to develop around day 25 and should not be confused with the conceptus.

- The amniotic membrane can be visualized between days 25 and 30 as a hyperechoic line surrounding the embryo.
- Transrectal ultrasonography is helpful not only for pregnancy diagnosis before day 35 but it is also an accurate technique for fetal number determination up to 40 days.
- Accuracy of early pregnancy diagnosis is affected by operator experience, animal age, breed and animal handling. Fasting (12 hours) and lifting of the abdomen during examination improves accuracy of diagnosis.
- Transabdominal pregnancy diagnosis is possible from day 30 of pregnancy provided that a 3.5 MHz transducer is used and animals are prepared by fasting. Accuracy of pregnancy diagnosis using this technique is close to 100% after 40 days. (Figure 9)
- Conceptus growth curves have been established but they are not always accurate and do not easily extrapolate from one breed to another. The main fetal measurements used to estimate fetal age are:
 - Crown-Rump Length (CRL) from day 24 to day 65 and Biparietal Diameter (BPD) from day 40 to term. These measurements are easier to obtain and highly correlated with fetal age between 40 and 100 days of pregnancy.
 - Other fetal measurements used to determine fetal age include head length, orbital diameter or volume and thoracic width. (Figure 10)



Figure 10 Ultrasonogram of 75 day pregnancy: p= placentome, n= fetal neck, e= fetal eye orbit, s= fetal skull

- Determination of the number of fetuses is a service that is requested by producers in order to separate females in different feeding groups based on prolificacy.

- In early pregnancy the entire fetus can be visualized which facilitates fetal numbering. In later stages, the number of fetuses is determined by counting the skulls, fetal hearts or thoracic cages. (Figures 12 and 13)

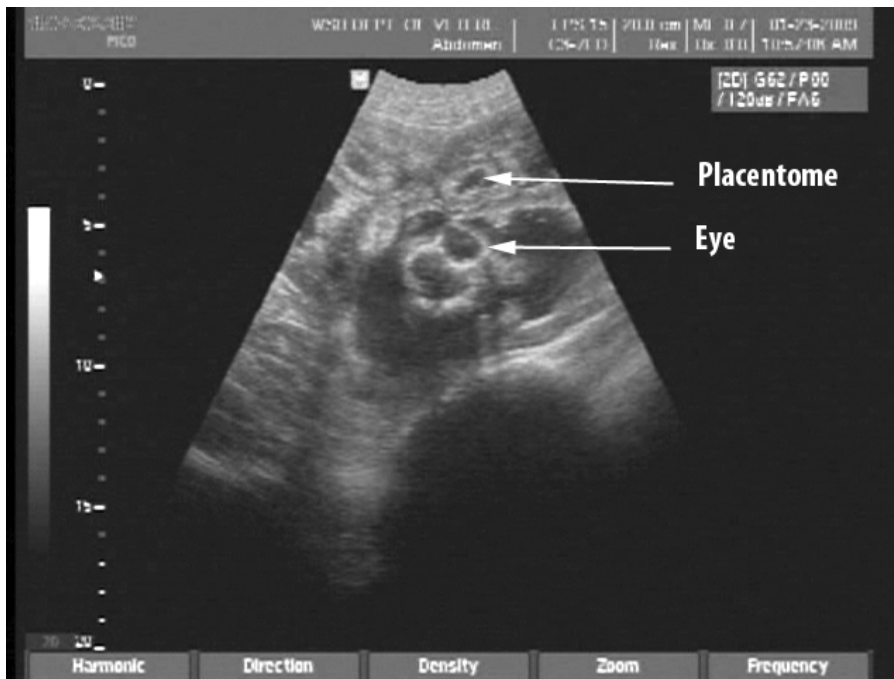


Figure 11 Ultrasonogram of 60 days pregnancy



Figure 12 Ultrasonogram of a twin pregnancy showing two skulls (s)

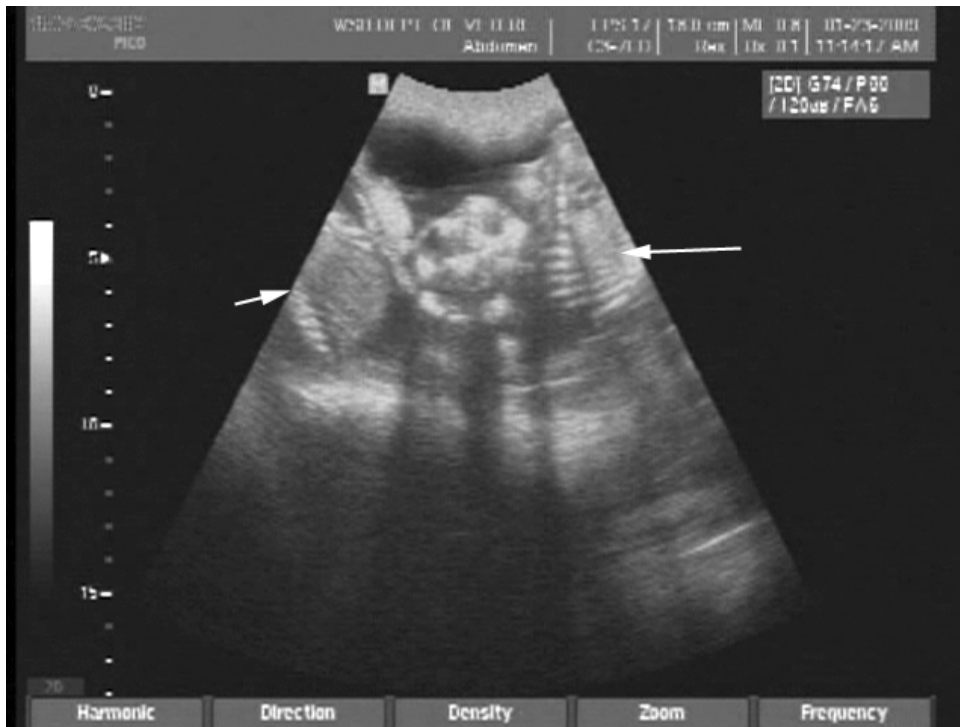


Figure 13 Ultrasonogram of a twin pregnancy showing two thoracic cages

- Determination of fetal number by transrectal ultrasonography is possible from 25 days of pregnancy when using a 7.5 or 8 MHz transducer. The accuracy of this technique is usually in the range of 80 to 90%.
- Fetal numbering is most accurate when evaluated by transabdominal ultrasonography between 45 and 100 days. During this window, the accuracy of diagnosis of singletons, twins and triplets is 98%, 97% and 82% respectively.
- Accuracy of early pregnancy diagnosis is affected by the rate early pregnancy loss which may reach 10 to 20% in some situations
- Fetal health evaluation: Evaluation of fetal viability is often required in females with systemic disease and pregnancy toxemia. This is accomplished by the evaluation of fetal cardiac activity and the amount and echotexture of fluid (Figure 14).

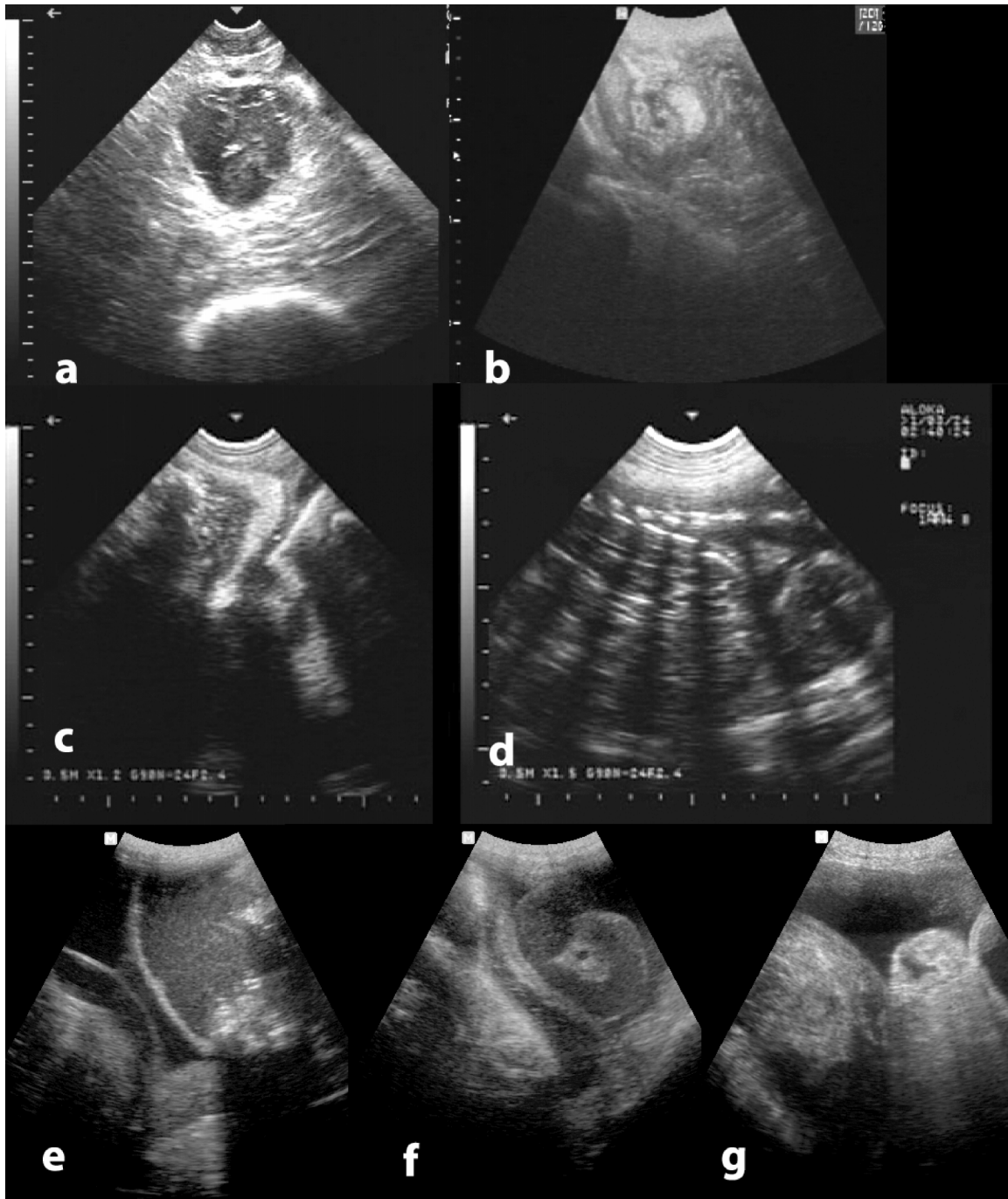


Figure 14 Ultrasonograms of abnormal pregnancies. a) fetal maceration, b) mummification; c) and d) uterine rupture; e-g) uterine torsion; note the free abdominal fluid (g) and obvious uterine horn tip distension (f)

Reproductive ultrasonography in the male

Ultrasonography of the scrotum and its content in rams and bucks

- Ultrasonographic examination is performed using a linear array transducer with 7.5 MHz or 5 MHz frequency depending on the penetration depth desired (size of the scrotal sac and its content).

- High frequency transducers (7.5 MHz) offer the advantages of high resolution and more detailed images, which is suitable for examination of specific areas where lesions are suspected from clinical examination.
- The epididymis (tail and head) is best visualized with a 7 MHz transducer.
- Scanning of the scrotum and its content should be done methodically and completely.
- One approach is to place the male in sitting position and examine each testicle separately starting from the testicular cord (pampiniform plexus), the head of the epididymis, the testicular parenchyma and finishing with the tail of the epididymis. During the examination, longitudinal and transverse scans are made of each section.

Normal ultrasonography

- Testicular parenchyma is homogenous and moderately echoic with a centrally located hyperechoic mediastinum testis (Figure 15)
- The head of the epididymis is homogenous and less echoic compared to the testis.
- The tail of epididymis is relatively heterogeneous and less echoic than the testicular parenchyma, and presents some anechogenic areas. (Figure 15)
- The vascular cone of the spermatic cord present a characteristic appearance which include the tortuous testicular artery and a network of veins (pampiniform plexus) (Figure 15). Blood flow within the vascular cone can be evaluated by color Doppler ultrasonography.
- Any deviation from these observations should be taken into consideration and the ultrasonographic diagnosis should be combined with other examination data (palpation and semen evaluation) for accurate diagnosis.

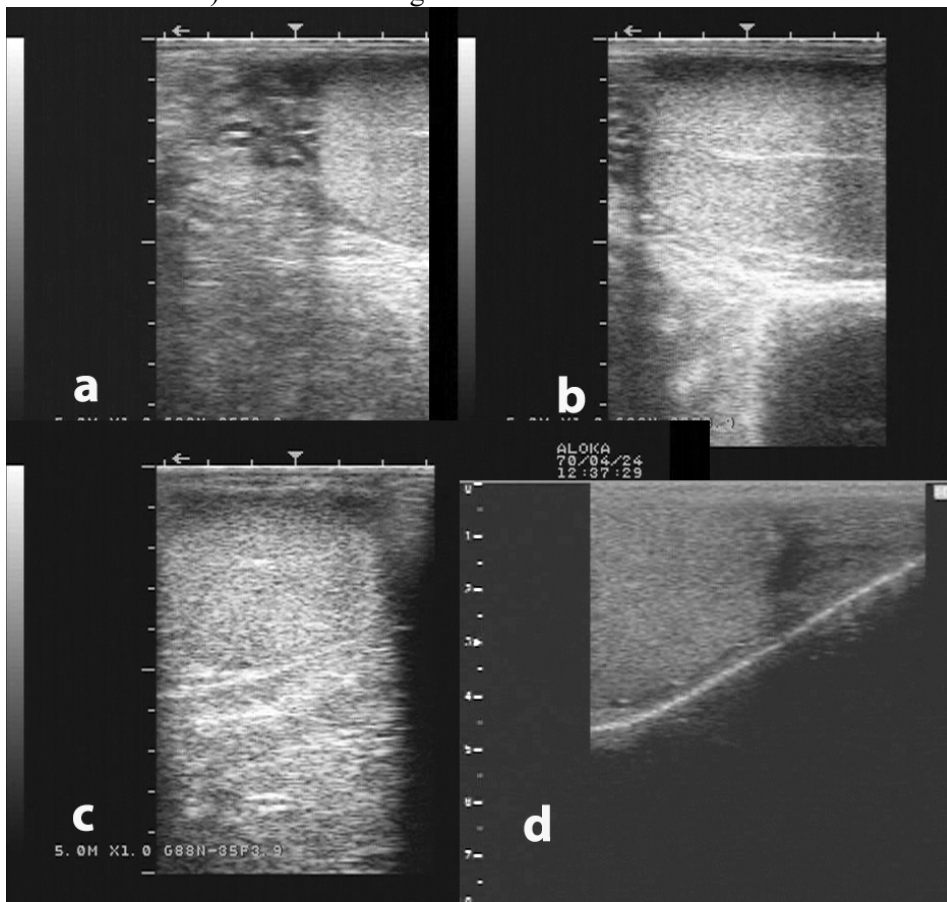


Figure 15 Ultrasonography of the scrotum and its content; a) Pampiniform plexus and testis; b) longitudinal view of testis, c) cross section of testis; d) tail of epididymis

Abnormal ultrasonography

- Ultrasonographically visible lesions increased echogenicity (testicular fibrosis, with or without mineralization), fluid-filled lesions or increased thickness and heterogenous architecture within the testicular parenchyma or between the tunica vaginalis layers. Various lesions are illustrated in figures 16 to 23
- Testicular fibrosis consists of hyperechogenic and patchy scar tissue regions with single or multifocal mineralized lesions.
- Fluid-filled ultrasonographic lesions are of 4 types: cysts, hydroceles (without a circumscribing wall), abscesses, and sperm granulomas (with a circumscribing wall).
 - Epididymal cysts: Cystic dilation of the epididymis may be due to segmental aplasia (goats)
 - Sperm granulomas
 - Can be detected in the testicle, head or tail of the epididymis.
 - Early stages appear as anechoic well-circumscribed masses with distal enhancement.
 - Later stages become hyperechoic due to fibrosis of the lining tissue. A few echogenic spots may be visible within the lesion and corresponds to calcification of inspissated sperm.
 - Granulomas are commonly seen as a result of spermastasis or following vasectomy.
 - Granulomas of the head of the epididymis appear as anechoic or hyperechoic areas with a distinct margin with or without a hyperechoic capsule.
 - An enlargement of the mediastinum testis accompanies sperm granulomas of the head of the epididymis.
 - Granulomas in the tail of the epididymis are usually anechoic or have mixed echogenicity with or without a hyperechoic capsule surrounding the lesions.
 - Granulomas of the tail of the epididymis are not associated with an enlargement of mediastinum testis.
 - In the acute phase, spermatoc granulomas smaller than 1 cm can be detected by ultrasonography before they become palpable.
 - Granulomas, localized in the head or tail of the epididymis or within the testis are associated with varying degrees of testicular degeneration.
 - Intra-testicular granulomas are microscopic and are not easily detected by ultrasonography. The only observation in these cases may be an increased heterogeneity of the parenchyma with numerous hyperechoic foci. Speckling (hyperechoic area with acoustic shadowing) of the testicular parenchyma can also be due to chronic testicular degeneration with calcification.
 - Distention of the mediastinum testis
 - Enlargement and decrease in the echogenicity of the mediastinum testis can be used as a suggestive sign of granulomas within the head of the epididymis.
 - This is clinically important because the pampiniform plexus frequently masks the head of the epididymis during ultrasonographic examination.
 - Distension of the mediastinum testis can also be the result of segmental aplasia of the epididymis.

- The absence of dilation and change in echogenicity of the mediastinum testis in the case of granulomas of the tail of the epididymis has been attributed to absorption of the accumulated semen by the epididymis.
- Differential diagnosis of scrotal enlargement
 - Hydrocele: accumulation of fluid between the parietal and visceral tunic, testicular tissue appears normal, mediastinum testis normal, the pampiniform plexus may show dilation
 - Hematoma: accumulation of fluid with various echogenicity depending on organization
 - Abscesses: generally well circumscribed thick-walled lesions
 - Hernia: intestinal loops may or may not be present. A hyperechoic area, presumably omental fat within the hernial sac, covers the testis. Anechoic fluid trapped within a fold of omentum may be visible around the head of the epididymal head
 - Pre-orchitis, and orchitis. Thickening of the scrotal wall and various amounts of fibrin and adhesions between the scrotal wall and the testis.



Figure 16 Testicular degeneration. Arrows indicate the mediastinum testis

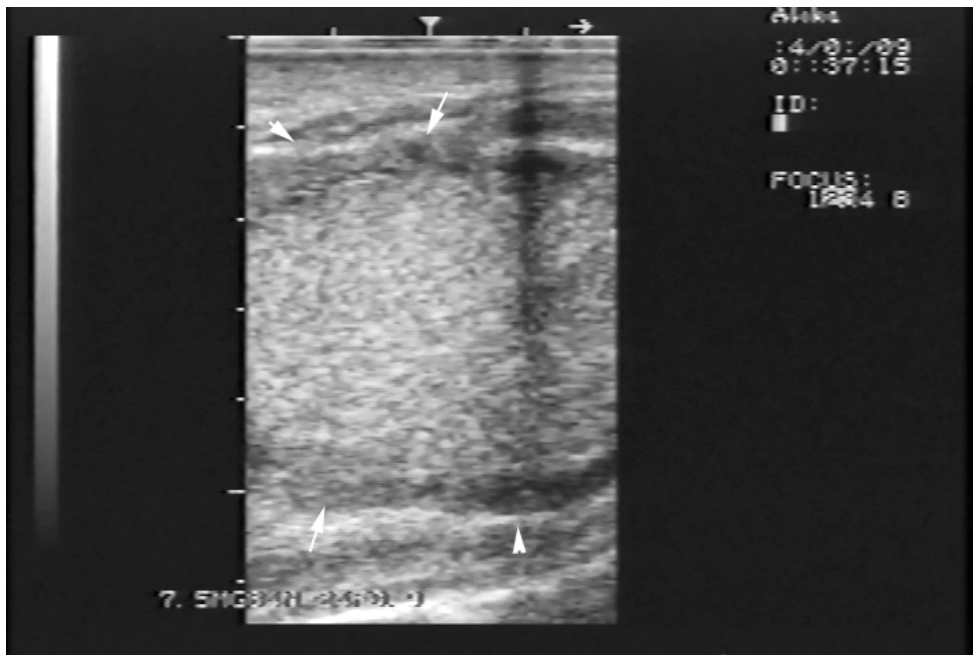


Figure 17 Orchitis and periorchitis, note the irregular contour of the testicle (arrows)



Figure 18 Testicular degeneration with fibrosis and mineralization of the testicular parenchyma

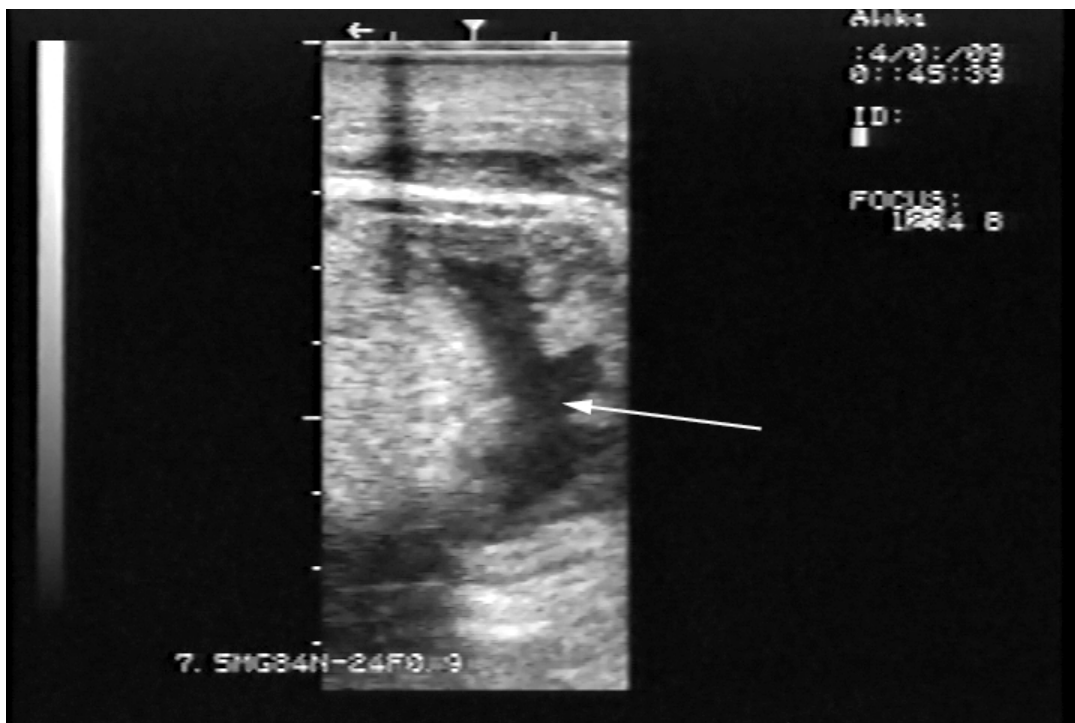


Figure 19 Accumulation of blood in the vaginal cavity (hematocele) indicated by arrow



Figure 20 Epididymitis (arrows indicate the head of the epididymis)



Figure 21 Epididymitis (TE= tail of the epididymis, T= Testicular parenchyma)



Figure 22 Sperm granuloma (arrows) at the tail of epididymis

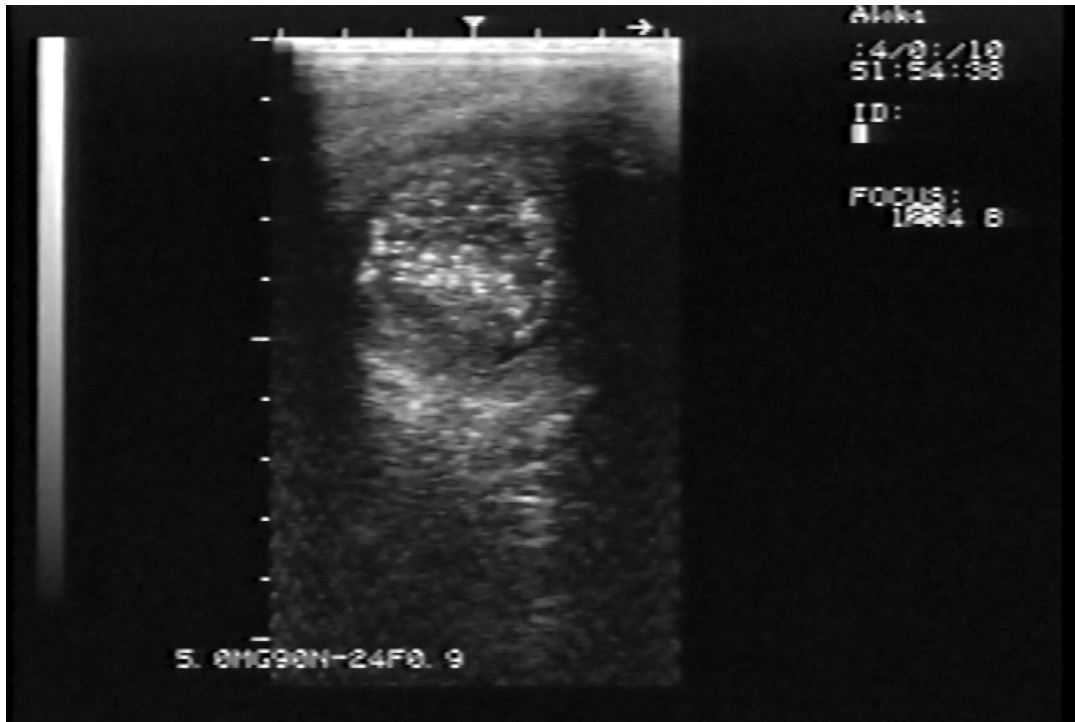


Figure 23 Testicular abscess.

Other uses of ultrasonography in small ruminant reproduction

- Monitoring of the response to superovulation
- Monitoring of the response to synchronization



TREATMENT

THERAPEUTIC APPROACH

- Depends of complaints and ultrasonographic findings

SURGICAL CONSIDERATIONS AND TECHNIQUES

- Depends of complaints and ultrasonographic findings



MEDICATIONS

DRUGS OF CHOICE

- Depend on diagnosis

CONTRAINDICATIONS

- Appropriate milk and meat withdrawal times must be followed.

PRECAUTIONS

- N/A

POSSIBLE INTERACTIONS

- N/A



FOLLOW-UP

EXPECTED COURSE AND PROGNOSIS

- Depend on diagnosis

POSSIBLE COMPLICATIONS

- Rectal or colonic perforation if transrectal ultrasonography is not done correctly

CLIENT EDUCATION

- Pregnancy confirmation should be done at a later date if early pregnancy diagnosis is done

PATIENT CARE

- Depend on diagnosis

PREVENTION

- Depend on diagnosis



MISCELLANEOUS

ASSOCIATED CONDITIONS

- Infertility
- Early embryonic loss or abortion

AGE-RELATED FACTORS

- N/A

ZOONOTIC POTENTIAL

- Flocks or herds experiencing brucellosis, toxoplasmosis, leptospirosis, chlamydiosis, Q-fever

PREGNANCY

- See discussion above

BIOSECURITY

- Transmission of diseases from a flock/herd to another is possible if the transducer and extension handle are not cleaned.
- Bioscurity issues are difficult to address in flocks/herds in a scrapie control program

PRODUCTION MANAGEMENT

- Ewes/does should be managed appropriately based on the number of fetuses they are carrying

SYNONYM

- N/A

ABBREVIATIONS

- CLs: Corpus luteum
- MHz= megahertz

SEE ALSO

- Anestrus
- Breeding Soundness Examination
- Infertility and Subfertility Issues
- Orchitis and Epididymitis
- Ovarian Cystic Degeneration
- Pregnancy Diagnosis: Small Ruminant
- Pyometra
- Reproductive Tumors
- Testicular Disorders: Bovine

Suggested Reading

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