Review Session for Residents:

**Generating a Meaningful Radiology Report**

**Moderator:** Dr. Peter Scrivani
Cornell University

8:00 – 8:10 am Welcome and Introductions
Dr. Peter Scrivani
Cornell University

8:10 – 9:10 What is a Meaningful Report?
Dr. Howard Dobson
University of Guelph, Canada

9:10 – 10:00 Organizing Information in a Meaningful Way
Dr. Nathan Dykes
Cornell University

10:00 – 10:10 BREAK

10:10 – 11:00 Ranking the Differential Diagnosis
Dr. Peter Scrivani
Cornell University

11:00 – 12:00 pm Plain-Film Radiography
Dr. Norman Ackerman

12:00 – 1:00 LUNCH

1:00 – 2:00 Musculoskeletal Radiography
Dr. Richard Park
Colorado State University

2:00 – 2:50 Special Procedures
Dr. Federica Morandi
University of Tennessee

2:50 – 3:00 BREAK

3:00 – 4:50 Discussion/Review Session
All Presenters

4:50 – 5:00 Closing Comments – Dr. Scrivani, Coordinator
Announcements – Dr. Perry, 2003 ACVR Program Chairperson
7:00 am  Nuclear Medicine Society Meeting

**Scientific Session: Nuclear Medicine**

**Moderator:** Dr. Kari L. Anderson  
University of Minnesota

8:30 – 8:35 am  Opening Session  & Welcoming Comments

8:35 – 8:50 ACVR Presidential Address  
Dr. H. Mark Saunders  
Shelburne, Vermont

8:50 – 9:00  Resident Scientific Paper & Grant Awards

9:00 – 10:30 ACVR Keynote Speaker  
“**Clinical Fusion: PET/CT**”  
Kevin Berger, MD  
Michigan State University College of Human Medicine

10:30 – 11:00  **BREAK**

11:00 – 11:12  **Thyroid to salivary ratios determined by technetium-99m pertechnetate imaging in 32 euthyroid cats**  
Dr. Todd Henrikson, Kansas State University

11:12 – 11:24  **Evaluation of 99mTc-DTPA renal scintigram curves in normal dogs after induction of diuresis**  
Dr. Christopher Kunze, Texas A & M University

11:24 – 11:36  **99mTc-ciprofloxacin imaging in camelids/small ruminants**  
Dr. Kate Alexander, The Ohio State University

11:36 – 11:48  **Evaluation of the fractionated HMPAO kits for radiolabeling leukocytes**  
Dr. Gregory Daniel, University of Tennessee

11:48 – 12:00  **Diagnosis of feline pancreatitis using radiolabeled leukocytes and computed tomography**  
Dr. Laurie Head, University of Tennessee

12:00 – 1:00 pm  **LUNCH**
Scientific Session: General Diagnostic Radiology

Moderator: Dr. Erik Wisner
University of California-Davis

1:00 – 1:12 pm Radiographic evidence of pneumatosis and pneumoperitoneum as predictors of gastric necrosis in gastric dilatation-volvulus syndrome
Dr. Anthony Fischetti, The Ohio State University

1:12 – 1:24 A study of cats with a radiolucent band in the stomach wall
Dr. Hock Gan Heng, Colorado State University

1:24 – 1:36 Bone healing after distraction osteogenesis in dogs
Dr. Sloan Dupree, North Carolina State University

1:36 – 1:48 Sensitivity and specificity of radiology in the detection of canine elbow incongruence in an in vitro model
Dr. Laurent Blond, University of Montreal, Canada

1:48 – 2:00 Radiographic evaluation of the stifle joint in experimentally induced osteoarthritis in dogs
Dr. Gustavo Sepúlveda, Michigan State University

2:00 – 2:12 Effects of restricted feeding on radiographic and histopathologic hip phenotype: a life long study in Labrador retrievers
Dr. Gail Smith, University of Pennsylvania

2:15 – 2:45 BREAK

2:48 – 3:00 Aneurysmal right auricle in two dogs
Dr. Tobias Schwarz, University of Pennsylvania

3:00 – 3:12 Thoracic radiography in the newborn foal
Dr. Guy Lester, Murdoch University, Australia

3:12 – 3:24 Atlas of bovine medical imagery and anatomy
Dr. Isabelle Masseau, University of Montreal, Canada

3:24 – 3:36 Digital radiography: a review of current technologies
Dr. Halise Diamond, University of Georgia

3:36 – 3:48 “Uberschwinger” or “rebound effect” artifact in computed radiographic imaging of metallic implants in veterinary medicine
Dr. Robert McLear, PetRad, Swarthmore, Pennsylvania

3:48 – 4:00 Experiences with electronic teaching and evaluation of radiology to student veterinarians
Dr. Howard Dobson, University of Guelph, Canada

6:00 – 8:00 pm Exhibitors' Reception
7:00 am     VRTOG Meeting

**Scientific Session: Radiation Oncology**

**Moderator:** Dr. Ronald Burk  
Veterinary Radiology Services of South Florida

- **8:30 – 8:35 am** Opening Session and Welcoming Comments  
  Dr. Michael Walker, Texas A & M University  
  President – Radiation Oncology

- **8:35 – 10:00 am** Radiation Oncology Keynote Speaker  
  "From Bergonie to B.E.D.: The History of Time, Dose and Fractionation Practices in Radiation Therapy"  
  Elaine M. Zeman, Ph.D.  
  University of North Carolina School of Medicine

- **10:00 – 10:30 am** BREAK

- **10:30 – 10:42 am** Computed tomography versus magnetic resonance imaging in the imaging of dogs with nasal tumors: a pilot study  
  Dr. Melissa Paoloni, University of Wisconsin-Madison

- **10:42 – 10:54 am** PET/CT images of a primary lung tumor with two radionuclides following IMRT  
  Dr. Elizabeth Ballegeer, University of Wisconsin-Madison

- **10:54 – 11:06 am** Imaging for radiation therapy planning: CT vs. MR  
  Dr. Patrick Gavin, Washington State University

- **11:06 – 11:18 am** Three-dimensional treatment planning for brain tumors: walking with scissors before running with them  
  Dr. David Ruslander, North Carolina State University

- **11:18 – 11:30 am** Pituitary tumor irradiation in eight cats  
  Dr. Monique Mayer, Colorado State University

- **11:30 – 11:42 am** Radiation effects following treatment of brain lesions  
  Dr. Susan LaRue, Colorado State University

- **11:42 – 1:00 pm** LUNCH
Scientific Session: Radiation Oncology

Moderator: Dr. Deborah Prescott
MedVet, Worthington, Ohio

1:00 – 1:12 pm  Intensity modulated radiation therapy in veterinary medicine: defining the learning curve
Dr. Lisa DiBernardi, Louisiana State University

1:12 – 1:24  Helical tomotherapy: 3-D set-up verification and ocular toxicity in an initial cohort of dogs with spontaneous nasopharyngeal tumors
Dr. Michelle Turek, University of Wisconsin-Madison

1:24 – 1:36  From dose response assays to clinical trials
Dr. Edward Gillette, Colorado State University

1:36 – 1:48  Epidermal growth factor receptor expression in feline oral squamous cell carcinomas
Dr. Jayme Looper, North Carolina State University

1:48 – 2:00  Effects of low-dose total body irradiation in the treatment of spontaneous canine lymphoma
Dr. Elizabeth Brown, Tufts University

2:00 – 3:00  Round Table Presentation/Discussion
Moderator: Dr. Lisa Forrest, University of Wisconsin-Madison
“Palliative Radiation Therapy: Coarse Fractionation vs. Traditional Fractionation”

3:00 – 4:00  BREAK

4:00 – 6:00  Film Reading & Interpretation Session
Moderator: Dr. Valerie Samii, The Ohio State University

6:30  ACVR Reception
Hosted by Radiation Oncology
Sponsored by Computerized Medical Systems
Mr. Carl Arnold, Representative
FRIDAY, DECEMBER 5, 2003

7:00 am  CT/MRI Society Meeting

8:30 – 10:30  ACVR Business Meeting (Diplomates only)

10:30 – 11:00  BREAK

**Scientific Session: CT/MRI**

**Moderator:** Dr. Gregory Daniel
University of Tennessee

11:00 – 11:12  Multiple phase helical computed tomography of the canine liver: protocol for contrast injection and scan timing
Dr. Andrew Jones, University of California-Davis

11:12 – 11:24  Three dimensional helical computed tomographic angiography of the liver
Dr. Matthew Winter, Tufts University

11:24 – 11:36  Helical CT angiography of the normal canine pancreas
Dr. Ana Caceres, University of Pennsylvania

11:36 – 11:48  Computed tomography, but not ultrasound, identifies small adrenal glands in cats with feline interstitial cystitis
Dr. Tod Drost, The Ohio State University

11:48 – 12:00  Dynamic computed tomography (CT) of the normal feline pituitary gland
Dr. Reid Tyson, Central Florida Veterinary Radiology

12:00 – 12:12  Measurement of femoral anteversion angle: correlation of radiographic, CT and volume rendering measurement
Dr. Mike Thomas, University of Illinois

12:12 – 12:24  The effects of patient positioning and slice selection on canine acetabular angle assessment with computed tomography
Dr. Sandy Wang, North Carolina State University

12:24 - 1:30 pm  LUNCH
Scientific Session: CT/MRI

Moderator: Dr. Renee Leveille
Veterinary Specialty Center, Illinois

1:30 – 1:42  Computed tomography arthrography of the normal canine stifle
Dr. Valerie Samii, The Ohio State University

1:42 – 1:54  Thoracolumbar spinal cord atrophy and vertebral canal stenosis in dogs with degenerative myelopathy
Dr. Jeryl Jones, Virginia Tech

1:54 – 2:06  Thick-section reformatting of thinly collimated computed tomography for reduction of skull-base related artifacts in dogs and horses
Dr. Yael Porat-Mosenco, University of Pennsylvania

2:06 – 2:18  A technique for contrast enhanced CT examination of the equine digit
Dr. Sarah Puchalski, University of California-Davis

2:18 – 2:30  Computed tomography of extradural abscesses of the thoracic spine in two quarterhorse foals
Dr. Diana Rosenstein, Michigan State University

2:30 – 3:00  BREAK

3:00 – 3:12  Low-field magnetic resonance imaging of bone marrow in the lumbar spine, pelvis, and femur in the adult dog
Dr. Laura Armbrust, Kansas State University

3:12 – 3:24  Magnetic resonance appearance of the normal pituitary gland in 19 horses
Dr. Travis Saveraid, Washington State University

3:24 – 3:36  Evaluation of various sequences with and without gadolinium enhancement for MR imaging of equine articular cartilage
Dr. Natasha Werpy, Colorado State University

3:36 – 3:48  The clinical use of standing equine MRI to investigate foot lameness
Dr. Jennifer Kinns, Bell Equine Veterinary Clinic, England

4:00 – 5:00  Radiation Oncology Business Meeting
7:00 am  Ultrasound Society Meeting

**Scientific Session: Ultrasound**

**Moderator:** Dr. Jay Stefanacci

8:30 – 8:36 am  Opening Session and Welcoming Comments

8:36 – 8:48  Radiographic, ultrasonographic (US) and computed tomographic (CT) appearance of alveolar echinococcosis in dogs – 11 cases

Dr. Gernot Scharf, University of Zurich, Switzerland

8:48 – 9:00  Characterization of lymphomatous lymph nodes in dogs using contrast harmonic and power doppler ultrasound

Dr. Rochelle Salwei, University of Wisconsin-Madison

9:00 – 9:12  Contrast harmonic ultrasound for the characterization of liver nodules in dogs

Dr. Robert O'Brien, University of Wisconsin-Madison

9:12 – 9:24  Prognostic indicators of splenic masses

Dr. Janelle Wierenga, University of Illinois

9:24 – 9:36  Evaluation of sonography to detect vascular invasion resulting from adrenal neoplasia

Dr. Rachel Schochet, Colorado State University

9:36 – 9:48  Age related changes in the ultrasound appearance of the normal feline pancreas

Dr. Martha Moon, Virginia Tech

9:48 – 10:00  Ultrasonographic appearance of ovarian changes during the peri-ovulatory period in female dogs

Dr. Giliola Spattini, University of Parma, Italy

10:00 – 10:12  Accuracy of increased large-intestinal wall thickness during ultrasonography for diagnosing large-colon torsion in 42 horses

Dr. Tony Pease, Cornell University

10:15 – 10:45  **BREAK**

10:45 – 12:30 pm  Panel Discussion (topics and presenters to be determined)

12:30  2003 ACVR-RO Scientific Program Adjourns
THYROID TO SALIVARY RATIOS DETERMINED BY TECHNETIUM-99m PERTECHNETATE IMAGING IN 32 EUTHYROID CATS

TD Henrikson DVM*, LJ Armbrust DVM*, JJ Hoskinson DVM*, KJ Wedekind MS, PhD**, CA Kirk DVM, PhD**, GA Milliken PhD***, RF Nachreiner ****
Kansas State University, Departments of Clinical Sciences* and Statistics***, Manhattan, KS 66506. **Hill’s Pet Nutrition, Inc., Topeka, KS. **** Michigan State University, College of Veterinary Medicine, Department of Physiology, East Lansing, MI 48824.

Introduction: Thyroid to Salivary (TS) ratio is a commonly used scintigraphic index for differentiating euthyroid and hyperthyroid cats. Previous studies to determine normal TS ratios have used small animal numbers, and relatively young cats. In these studies, euthyroid status was based on results of thyroid hormone assays at a single point in time. The purpose of this study was to determine TS ratios in 32 healthy euthyroid cats, of an age commonly affected with hyperthyroidism.

Methods: Thirty-two colony cats (13 castrated males, 18 spayed females) determined to be healthy based on physical exam, CBC, and serum chemistry results were included in the study. The cats were between 8-13 years of age. Cats were determined to be euthyroid based on normal serum thyroid hormone concentrations [total thyroxine (TT4), free thyroxine (FT4), total triiodothyronine (TT3), free triiodothyronine (FT3)] measured before and 6 weeks after scintigraphy, and a normal T3 suppression test performed prior to scintigraphy. All cats were injected intravenously with approximately 111MBq (3.0 mCi) of sodium pertechnetate (99mTcO4\(^-\)). Cats were sedated with intravenous ketamine (15mg) and diazepam (0.75mg) just prior to scanning 20-40 minutes after the injection of 99mTcO4\(^-\). Ventral, left and right lateral images were obtained with a large field of view camera fitted with a low energy all purpose parallel hole collimator. Regions of interest (ROI) were manually drawn around both thyroid lobes and salivary glands. Thyroid to salivary ratios were determined by dividing the mean count density within the thyroid gland by the mean count density within the ipsilateral salivary gland. The highest TS ratio (right or left) was recorded for data analysis.

Results: TS ratios ranged from 0.51 to 1.65. The mean was 0.94 with a standard deviation of 0.29. The resulting 95% prediction interval was 0.33 to 1.54. No sex or age influence was identified.

Conclusions: The range in our normal population was higher than that reported in previous studies. The prediction interval suggests that TS ratio of up to 1.5 may be normal in older cats. The larger range of TS ratios may more accurately reflect what exists among euthyroid cats in the age range commonly associated with hyperthyroidism.
EVALUATION OF 99mTc-DTPA RENAL SCINTIGRAM CURVES IN NORMAL DOGS AFTER INDUCTION OF DIURESIS

C. Kunze, DVM; A. Bahr, DVM, MS; G. Lees, DVM, MS
College of Veterinary Medicine, Texas A&M University, College Station, TX 77843

Introduction: The normal 99mTc-DTPA renal scintigram curve has 3 distinct phases; an arterial blush followed by progressive uptake and subsequently excretion from the kidney. In a previous study of male dogs with X-linked hereditary nephritis, a distinct flattening of the renal scintigram curve was observed preceding any decline in GFR. The exact cause of this shape change was not determined, however the finding was concurrent with decreased urine specific gravity and thus might have been related to polyuria.

Objective: This study was intended to determine whether diuresis without concurrent renal disease could flatten the 99mTc-DTPA renal scintigram curve.

Materials and Methods: Six healthy, adult dogs (3 male, 3 female) were used. Dynamic renal scintigraphy using 99mTc-DTPA was performed 5 times in each dog with a minimum of 7 days between studies. Dogs were imaged without diuresis as a baseline and imaged after induction of diuresis by each of four methods: 1) intravenous administration of 80 ml/kg of 0.9% NaCl, 2) gavage with a volume of water equal to 3% of body weight, 3) intravenous injection of 4 mg/kg of furosemide, and 4) intravenous administration of 80 ml/kg of 0.9% NaCl, with scintigraphy delayed three hours after completion of fluid administration. Scintigram curves were evaluated subjectively as well as quantitatively by calculation of GFR estimates, mean transit times, times to peak and half-times of the excretion phase. Statistical analysis was performed using an ANOVA with repeated measures and p<0.05 was considered significant.

Results: Subjective evaluation of the renal scintigram curves did not detect complete flattening of the curve, but diuresis method 1 did cause noticeable blunting of the curve in 4 of 6 dogs. There was no significant difference in the GFR estimations; however, the mean GFR value for diuresis method 1 was less than normal (2.28 ml/min/kg). When compared with baseline (1.96 ± 0.44 min), the mean renal transit times were decreased by all four methods of diuresis (Method 1-4 respectively: 0.83 ± 0.3; 1.44 ±0.31; 1.18 ±0.27; 0.97 ± 0.13 min). The reduction in MTT was statistically significant (p ≤ 0.02) for methods 1,3 and 4. Time to peak activity was significantly reduced (p < 0.02) by all four methods of diuresis (Baseline = 4.4 ± 0.92; Methods 1-4 respectively: 1.89 ± 0.36; 3.18 ± 0.78; 2.65 ± 0.59; 2.46 ± 0.17 min). \( T_{1/2} \) was not statistically different for any method of diuresis.

Conclusions: Diuresis alone does not cause complete flattening of the 99mTc-DTPA renal scintigram curve. However, alterations in time to peak and MTT may create inaccuracies in GFR estimation based on the conventional regression formula causing a false lowering of the resultant value.

Financial support for this study was provided by the American College of Veterinary Radiology and the Department of Large Animal Medicine and Surgery, Texas A&M University.
**Introduction:** Early detection of osteomyelitis is difficult due to the delay between the development of clinical signs and radiographic changes and the lack of specific radiographic signs. Detection of soft tissue infection can be equally as challenging in large animals. $^{99m}$Tc-ciprofloxacinc ($^{99m}$Tc-cipro) was developed to detect sites of infection through binding to bacterial DNA gyrase. Results of $^{99m}$Tc-cipro scintigraphy in 6 animals with suspected bacterial infections are presented.

**Methods:** 5 camelids (3 adults, 2 crias) and a goat kid were imaged. The 3 adult camelids had radiographic and/or clinical signs of skull osteomyelitis. One scan was performed postoperatively in an alpaca with a tooth root infection. One cria had intermittent leukocytosis and diarrhea and the other had hyperfibrinogenemia. Soft tissue infection was suspected in both. Vertebral osteomyelitis was diagnosed radiographically in the goat. $^{99m}$Tc-cipro (range 4.5-37 MBq/kg) was injected intravenously. A series of 2-minute static images were acquired at 1 and 4 hr post-injection. At 24 hr post-injection, 5-minute static images were acquired. The whole body was imaged in the crias and goat; only the skull was imaged in the adults. The quality of the 1, 4 and 24 hr studies was subjectively evaluated. Areas of $^{99m}$Tc-cipro uptake were recorded and subjectively graded as mild, moderate or severe. The adult camelids and goat were necropsied. The crias were discharged upon resolution of clinical abnormalities.

**Results:** Image quality was best 4 hr post-injection. 24 hr images were severely degraded due to poor count statistics. The crias and goat had intense $^{99m}$Tc-cipro activity in the lungs and urinary bladder, moderate activity in the kidneys and mild activity in the physes, joints, liver and intermittently in the GI tract at all time points. No abnormal $^{99m}$Tc-cipro uptake was noted in the crias and goat. An alpaca with a tooth root abscess had focal intense (4 hr) and moderate (24 hr) $^{99m}$Tc-cipro uptake. A llama cross with severe otitis media/interna had focal mild (1 hr) and moderate (4 hr) $^{99m}$Tc-cipro uptake. No $^{99m}$Tc-cipro uptake was present (1, 4 or 24 hr) in a llama with a sterile mandibular cyst. Mild thyroid and salivary gland activity were present in this animal, likely indicating some dissociation of the radiopharmaceutical. Infections in the adult camelids and goat were confirmed at necropsy.

**Conclusion:** The 4 hr post-injection scan seems most useful. The distribution of $^{99m}$Tc-cipro in camelids/small ruminants appears to differ from that described in humans and dogs. In those species, pulmonary activity is minimal and hepatic uptake exceeds pulmonary uptake. $^{99m}$Tc-cipro lead to confirmation or rule out of a septic process in 3 of 4 animals for which necropsy results were available. The main limitation of this technique in animals is the low lesion-to-background difference necessitating a long image acquisition time, which results in motion artifact.

*The authors thank Draximage Inc. for providing the radiolabeling kits.*
EVALUATION OF THE FRACTIONATED HMPAO KITS FOR RADIOLABELING LEUKOCYTES.  Gregory B. Daniel, Dana Smith, College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37996

INTRODUCTION: Hexamethylpropyleneamine oxime (HMPAO) has been used for many years as a white blood cell labeling agent. $^{99m}$Tc-HMPAO is a lipophilic compound that diffuses across the cell membrane and binds within the leukocyte. $^{99m}$Tc-HMPAO-WBCs are used to image areas of inflammation. The use of radiolabeled leukocytes is well established in people and there have been many reports of the effectiveness of this imaging agent in veterinary medicine. One of the biggest limitations in the use of this agent is its cost. (Current cost of HMPAO is $320/kit) A solution to this problem is fractionation of the HMPAO kit. The purpose of this project was to evaluate radiochemical purity and WBC labeling efficiency following fractionation of HMPAO (Ceretec®) kits.

MATERIAL AND METHODS: Seven HMPAO kits were reconstituted using 6 ml of nitrogen-flushed sterile saline. Twelve equal aliquots from each reconstituted kit were divided into nitrogen filled vials. These vials were frozen and stored at -70°C. On days 3, 7, 14, 28 and 56, selected vials were allowed to thaw to room temperature. Day 0 vials were also tested (without freezing) immediately after fractionation of the HMPAO kits. Freshly eluted pertechnetate was added to the fractionated vials to form $^{99m}$Tc-HMPAO. Radiochemical purity was assessed 15 minutes following addition of pertechnetate by instant thin layer chromatography per manufacturers recommendations. It has been suggested that larger number of fractions can be made from each kit if a reducing agent is added. To test this theory; fractioned vials were tested alone or after the administration of either 1 or 2 µg of stannous fluoride (SnF). Labeling efficiency and cell viability were tested using 15 ml of equine blood. Blood was collected in acid citrate dextrose (ACD) and leukocytes isolated by centrifugation. The leukocytes were re-suspended in a phosphate buffered saline/plasma solution and incubated with $^{99m}$Tc-HMPAO for 30 minutes. Labeling efficiency was determined by measuring the percentage of the radionuclide associated with the cells versus the supernatant. Trypan blue exclusion test were performed on the radiolabeled WBC to access viability.

RESULTS: The graph below shows changes in radiochemical purity over time with varying amounts of SnF added. Radiochemical purity decreased over time. The addition of stannous fluoride significantly decreased the radiochemical purity; this was dose related. The mean labeling efficiency for all groups was 37.9% with a range of 27 to 54%. Higher labeling efficiency was significantly correlated with radiochemical purity (Pearson product moment correlation) (r =0.62). Over a 56-day period, there was no significant difference in labeling efficiency of vials containing no additional SnF (ANOVA). Cell viability was high for all groups with a mean of 99% and a range of 92% to 100%.

Graph 1 - Radiochemical purity of reconstituted vials frozen for varying time intervals. The graph shows the percent of Technetium bound to HMPAO.

DISCUSSION: In conclusion, we found that HMPAO kits can be fractionated and stored at -70°C. This technique is quick and easy. We do not recommend stannous ion augmentation for kits used within 8 weeks of freezing. Although labeling efficiency was correlated with radiochemical purity there was no significant difference in labeling efficiency for at least 56 days.
Diagnosis of Feline Pancreatitis Using Radiolabeled Leukocytes and Computed Tomography. Head LL, Daniel GB, Becker TJ, Lidbetter DA. Department of Small Animal Clinical Sciences, University of Tennessee, Knoxville, TN.

**Introduction:** The normal feline pancreas has been evaluated using radiolabeled leukocytes ($^{99m}$Tc-HMPAO) and computed tomography. The purpose of this report is to describe a clinical case where both modalities were utilized to assess the inflamed feline pancreas.

**Materials and methods:** A nine-year old female spayed cat presented with anorexia, depression and some vomiting. Blood values and radiographs were unremarkable. Abdominal ultrasound was suggestive of pancreatitis. White blood cells were separated and labeled with $^{99m}$Tc-HMPAO according to an established protocol. The radiolabeled leukocytes were injected into the cat and images were acquired immediately, at 5 minutes, 30 minutes, 1, 2, 4 and 17 hours post injection. Approximately 48 hours later, the animal was anesthetized and computed tomography was performed on the abdomen. Two mm slices were acquired both pre and post contrast through the region of the pancreas. A representative slice was chosen and images were also acquired 5, 10, 15 and 20 minutes post contrast injection. A celiotomy was performed for the purpose of placing a jejunostomy tube, and biopsies were taken from the pancreas, stomach, jejunum, liver and lymph node.

**Results:** The white cell labeling efficiency was 21.1%. The distribution of the cells was similar to what has previously been reported, localizing predominantly in the lung, liver and spleen. On the two hour image, there is a faint area of uptake in the region of the body and right limb of the pancreas. This persisted and became more intense at 4 hours (arrow) and was still present at 17 hours. This area was best appreciated on the dorsal images without superimposition of the spleen. On computed tomographic images, the pancreas was large and heterogeneous. There were multiple areas of hypoattenuation present. The margin of the pancreas and surrounding mesentery were indistinct. Splenic Hounsfield units peaked immediately following contrast enhancement and then gradually decreased over the study period. Pancreatic Hounsfield units peaked 10 minutes following contrast enhancement, and then gradually declined but never dropping below the immediate post-contrast value. This pattern differs from that identified in normal cats. Histopathology confirmed pancreatitis with lymphocytic, plasmacytic, neutrophilic and eosinophilic inflammation and fibrosis.

**Conclusion:** Radiolabeled leukocytes will localize in the inflamed pancreas. This is best seen at 4 hours post injection. Computed tomography allows superior visualization of the pancreas and changes consistent with pancreatitis. The contrast enhancement pattern and wash out differ markedly from the normal pancreas. Both of these modalities should be further investigated for use in diagnosing feline pancreatitis.
RADIOGRAPHIC EVIDENCE OF PNEUMATOSIS AND PNEUMOPERITONEUM AS PREDICTORS OF GASTRIC NECROSIS IN GASTRIC DILATATION-VOLVULUS SYNDROME. Anthony J. Fischetti, DVM, H. Mark Saunders, VMD, MS, Kenneth J. Drobatz, DVM Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, 3900 Delancey St., Philadelphia, PA 19104.

Introduction: Gastric wall necrosis is a complication associated with fatality in dogs with gastric dilation-volvulus (GDV). Accurate pre-operative risk factors that are predictive of gastric wall necrosis are valuable for determining prognosis. Pneumatosis is defined as gas present within a wall of the gastrointestinal tract. Cases of pneumatosis have been associated with both life-threatening and spontaneously resolving etiologies. The purpose of this study was to determine the accuracy of abdominal radiographic signs of pneumatosis and pneumoperitoneum for predicting gastric necrosis in dogs with GDV.

Methods: 243 dogs with radiographic evidence of GDV were studied retrospectively for radiographic signs of pneumatosis and pneumoperitoneum for predicting gastric necrosis in dogs with GDV. The sensitivity, specificity, and predictive value of these imaging signs as predictors of gastric wall necrosis, as determined by visual inspection at surgery or necropsy, were determined.

Results: Twenty-two dogs (9.1%) had radiographic evidence of gastric pneumatosis on at least one view. The gas within the wall was consistently linear to curvilinear and parallel to the wall of the body or fundus of the stomach. The sensitivity and specificity of gastric pneumatosis as a predictor of gastric wall necrosis were 14.1% and 92.7%, respectively. The prevalence of gastric wall necrosis was 26.6%, similar to that of other studies. The positive and negative predictive values of gastric pneumatosis for predicting gastric necrosis were 40.9% and 74.9%, respectively. Gastric pneumatosis and pneumoperitoneum were identified together in four dogs. Pneumoperitoneum, either alone or in conjunction with pneumatosis, yielded similar results as a test for gastric necrosis. Orogastric tube placement or percutaneous gastric trocharization prior to making abdominal radiographs was documented within the medical record in 56 (23.3%) and 63 (26.3%) dogs, respectively. Thirteen dogs (59.1%) with pneumatosis had received percutaneous gastric trocharization (n=6) or gastric intubation (n=7). Seven dogs (25%) with pneumoperitoneum had a record of percutaneous gastric trocharization prior to radiographs.

Conclusions: Although pneumatosis and pneumoperitoneum are relatively specific signs of gastric wall necrosis, the utility of these signs as a test for gastric necrosis is limited in clinical practice. The significance of these radiographic signs should be taken into consideration with previous treatments for gastric decompression, as percutaneous gastric trocharization or orogastric intubation may increase the number of false positive results.
A STUDY OF CATS WITH A RADIOLUCENT BAND IN THE STOMACH WALL

Hock Gan Heng, DVM, MVS, Robert H. Wrigley, BVSc, MS, Susan L. Kraft, DVM, PhD, Barbara E. Powers, DVM, PhD.
James L Voss Veterinary Teaching Hospital, Colorado State University, Fort Collins, CO 80523-1601, USA.

Introduction
Radiographic and computed tomographic (CT) examination of the normal stomach wall typically reveals only one homogeneous soft tissue layer, whereas sonography of the stomach consists of 5 distinct hyper- and hypoechoic layers which are the serosa, muscularis, submucosa, mucosa and the mucosal surface. Gas dissection between the stomach layers (emphysematous gastritis) is the only time when radiography has been reported to reveal apparent layering of the stomach wall due to corrosive gastritis and gastric ulcers. A similar distinct radiolucent band has been observed within the stomach wall of some normal cats. This observation prompted this study to identify the cause of this radiolucent gastric band, which could be confused with emphysematous gastritis.

Materials and methods
Abdominal radiographs were obtained from recently euthanized cats to identify an animal exhibiting the described radiolucent gastric wall line. Abdominal CT and sonography and histopathology examination of the stomach were then performed. Retrospective evaluation was done of cats’ cranial abdominal CT examinations at CSU for the last 5 years. The CT images of the stomach were then scrutinized for the presence of a linear radiolucent band in the stomach wall. This was then correlated with any available radiographs from the same cats. Also, a retrospective study of cats’ normal abdominal radiographs of year 2001 was performed.

Result
One of 7 dead cats had linear radiolucent band in the stomach. The CT examination of this cat revealed a hypodense layer (CT number of -80) between the serosa and mucosal surface of the stomach. Sonography of the stomach did not reveal the classical 5 layers stomach wall. There were only 3 layers to this cat’s stomach, consisting of a hypoechoic layer sandwiched by 2 hyperechoic layers. Histologically, there is a thick layer of fat deposited in the submucosal layer. Four of 15 (26%) cats had a hypodense layer between the serosa and mucosal surface of the stomach on CT examination. The linear radiolucent line in the stomach wall was visualized radiographically in all of these cats. Radiolucent lines were presence in the stomach walls of 28% (18/64) of cats of normal abdominal radiographs.

Discussion/Conclusion
The linear radiolucent band seen on radiographs of these feline stomach walls is explained by fat in the stomach wall. This presumably normal or incidental finding should not be confused with the presence emphysematous gastritis.
Bone distraction osteogenesis (BDO) is the slow, progressive distraction of bone under controlled mechanical conditions. In dogs, BDO is generally achieved using circular external fixation (CEF) frames. Bone healing after CEF is highly variable and may be influenced by epidemiological, biological, surgical, and mechanical factors. The purpose of this study was to assess the specific influence of these factors on bone healing after treatment with CEF in dogs. We hypothesized that young age, large size, good limb function during treatment, a metaphyseal osteotomy site, large bone size / ring size ratio, a moderately stiff frame, or having no mechanical complications would enhance bone healing after osteotomy, BDO, and stabilization using CEF in dogs.

All patients undergoing corrective osteotomies stabilized with hinged CEF in the Teaching Hospital at the College of Veterinary Medicine, North Carolina State University between 1992 and 2001 were included in this study. Exclusion criteria consisted of death, loss of follow-up before frame removal, and/or incomplete medical or radiographic records. Putative variables were obtained from the records: age, weight, gender, breed, cause of surgery, osteotomy method, limb function during treatment, and treatment complications. Also recorded were dates of surgery, delay before distraction, duration of distraction, and date of frame removal. Information pertaining to the operated bone was obtained, including bone length, craniocaudal and mediolateral bone and limb widths at the osteotomy site, distraction rate, osteotomy site (diaphyseal, proximal or distal metaphyseal location), and size of the distraction gap at the cis-cortex and trans-cortex measured on radiographs. The number of rings, ring size, number of connecting rods, and number of wires were recorded and used to compile a mechanical score. Kaplan-Meier product limit and the Cox-proportional hazard model were used to determine median time to bone healing after BDO and relationships with possible prognostic factors.

Seventy osteotomies were included in the study. Bone was 53% less likely to heal as fast in patients with large bones compared to patients with small bones (median healing time [MHT], 68 versus 53 days). Tibiae were 20% less likely to heal as fast as radii (MHT, 84 versus 51 days). Bone was 24% less likely to heal as fast in patients with stiff frames compared to patients with less stiff frames (MHT, 84 versus 45 days). Bone was 51% less likely to heal as fast in patients with a distraction duration longer than 12 days compared to patients with a distraction duration shorter than 12 days (MHT, 68 versus 52 days). Dogs older than 10 months were 33% less likely to heal as fast as dogs younger than 10 months (MHT, 69 versus 54 days).

Bone healing was slower in skeletally mature dogs compared to skeletally immature dogs. This is in agreement with previous reports comparing bone healing in people younger and older than 20 years of age. Bone healing in the studied dogs was slower in tibiae than in radii. This finding was not expected and may result from loading differences between these two bones or differences between patient groups treated for tibial and radial deformities. Bone healing was slower in patients who wore stiffer frames; this is in agreement with previous reports evaluating bone healing under experimental conditions.
SENSITIVITY AND SPECIFICITY OF RADIOLOGY IN THE DETECTION OF CANINE ELBOW INCONGRUENCE IN AN IN VITRO MODEL.


Introduction/Purpose: Canine elbow incongruence (CEI) is frequently characterized by a step defect between the proximal articular surfaces of the radius and ulna. This is believed to be the consequence of an underdevelopment of the radius leading to osteoarthritis. Recognition of CEI is important for therapeutic planning. For economical and practical reasons, radiology is the primary diagnostic tool. The purpose of this study is to determine the sensitivity and specificity of radiology to detect CEI in an in vitro model and to assess the optimal elbow and radiographic beam position.

Methods: Five normal cadaveric canine left forelimbs were used. A four-pin, type 1 external fixator with a linear motor side bar was fixed to the cranial part of the radius of each limb and a 1 cm segment of bone was removed from the mid-diaphysis to allow radial shortening. Each elbow was submitted to the same protocol. They were radiographed at 2 different angles (90° and 135°) of flexion, with 10 different radiographic beam positions (centred on the medial humeral epicondyle, 3 cm cranial, 3 cm caudal, 3 cm distal, 3 cm proximal, 3 cm cranio-proximal, 3 cm cranio-distal, 3 cm caudo-proximal, 3 cm caudo-distal and on the shoulder) and at 4 different lengths of radius (normal, 1, 2 and 3 mm of radial shortening). In addition a view centred on the elbows flexed in a 135° angle was taken after simulating weight bearing. The acquired digital images were independently evaluated by 3 radiologists who were unaware of the elbows' status. The elbows were judged positive, negative or doubtful for CEI based on specific criteria and personal impression.

Results: The sensitivity for detection of CEI at and beyond 2 mm of incongruence was excellent at 90° (median = 100% for all views) and good at 135° (med = 80%) of flexion with no difference between examiners. The sensitivity at 1 mm of incongruence was unchanged at 135° but was reduced at 90° of flexion (med = 60%) with a significant difference between the radiologists. The specificity was significantly different between the radiologists and ranged from 70% to 90% at 90° of flexion and from 50% to 80% at 135°. The lowest specificities at 90° were obtained with the proximal displacements of the X-ray beam. The highest specificity was obtained by the most experienced radiologist (90% at 90° and 80% at 135°). Simulating weight bearing significantly decreased the sensitivity at 1 mm (from 80% to 50%) and 3 mm (from 100% to 80%) of incongruence and increased the specificity (from 55% to 65%).

Discussion/Conclusion: Radiology was a sensitive and specific test to detect moderate to severe radio-ulnar incongruence (2 mm and over) with the elbow flexed at a 90° angle and was not influenced by the position of the X-ray beam. For discrete CEI, radiology is less sensitive but some views increased the accuracy of the detection and should be further investigated. Finally, CEI on radiography was reduced with an in vitro weight bearing simulation which should be investigated in vivo.
Radiographic evaluation of the stifle joint in experimentally induced osteoarthritis.
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INTRODUCTION
Degenerative joint disease of the stifle joint secondary to cranial cruciate disease is a common cause of lameness in the small animal patients. Degenerative joint disease resulting from destabilization of the stifle joint by resection of the cranial cruciate ligament has been useful for studying the pathogenesis of osteoarthritis. There are a number of published studies on the radiographic changes associated with cranial cruciate disease, however the majority of the studies have been retrospective, involving a small number of animals and with small number of radiographic studies. The purpose of the present study was to determine the early radiographic changes associated with osteoarthritis in the stifle joint and their progression after surgical destabilization of the joint.

MATERIAL AND METHODS
Sixty two clinically normal 1-5 years old, 27-34 kg, mixed breed dogs were obtained from a research breeding facility. Physical examination, a complete orthopedic exam, complete blood count, serum chemistry profile and urinalysis were performed. Survey ventrodorsal radiographs of the pelvis and mediolateral and craniocaudal radiographs of both stifle joints were performed to determine that there were no evidence of DJD on this joints. Thirty two dogs were consider normal and included in the prospective study. The right stifle joints in all 32 dogs were destabilized by transecting the cranial cruciate ligament. Transection of the cranial cruciate ligament was performed arthroscopically in a standardized manner. After destabilizing the right stifle joint orthogonal radiographs of the joint were taken at 2,4,8,12,16,20,24,28 and 32 weeks post transection of the cranial cruciate ligament. A numeric scoring method was used to quantify radiographic changes of osteoarthritis that were observed on each of the radiographic studies.

RESULTS
The earliest evidence of osteophytosis was noted on the lateral fabella, distal patella and the medial femoral condyle. Throughout the study period the soft tissue swelling/ thickening was more pronounced in the medial aspect of the stifle joints as compared to the lateral. Enthesophytes were more evident on the lateral fabella as compared to the medial one throughout the study.

DISCUSSION/CONCLUSION
As previously described ostearthitis of the stifle joint following transection of the cranial cruciate ligament is progressive. Radiographic evidence of bone remodeling within the joint can be noted as early as 4 weeks post joint destabilization. The differences in DJD score between the medial and lateral compartment could be associated with weight bearing. On the other hand, the sclerosis noted on the proximomedial aspect of the lateral femoral condyle and the lateral fabella could represent a more specific finding associated with cranial cruciate disease since this area represents the origin of the ligament. To our knowledge this specific finding has not been described in the literature.
EFFECTS OF RESTRICTED FEEDING ON RADIOGRAPHIC AND HISTOPATHOLOGIC HIP PHENOTYPE: A LIFE LONG STUDY IN LABRADOR RETRIEVERS
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Introduction: The diagnosis of canine hip dysplasia (CHD) by convention is based on subjective radiographic findings of subluxation of the coxofemoral joint, or secondary osteoarthritis (OA) on the hip-extended, ventrodorsal radiographic projection of the pelvis. It has been generally accepted that this hip phenotype at 1 or 2 years of age accurately reflects the true phenotype and genotype of the dog. The purpose of this investigation was to test the influence of food restriction on hip phenotype, and to compare 2 years of age and end-of-life hip phenotypes of OFA type scores, OA scores and PennHIP scores to histopathology.

Methods: 48, 8-week old Labrador retriever puppies from 7 litters were allotted by pairing to 2 groups of 24 dogs each. The control-fed (CF) group was fed for 15 minutes, and each member of the other group (restricted-fed, RF) was always offered 25% less of the same food given to the control-fed pair mate. Hip radiographs were made when the dogs were 30, 42, and 54 weeks of age, then yearly until end of life. The hips were evaluated for CHD and OA using criteria of the OFA scoring system. At 2 years of age, PennHIP distraction indexes were done. Histopathology of the hips was done on 45/48 dogs.

Results: Restricted-feeding had a profound positive effect on the hip phenotype of Labrador retrievers. RF dogs had significantly lower incidence and severity of CHD and OA compared to CF pairmates. This benefit continued for the life of the dogs. In the pooled sample of 48 dogs, the prevalence of hip OA increased linearly throughout the study, from 15% at 2 years of age to 67% at end-of-life. For the CF dogs, end-of-life OA prevalence was 83% and for the RF dogs, 50%. At two years of age, OFA-type scoring judged 19 of the 48 dogs to be ‘dysplastic’ while 29 dogs were scored as ‘normal’. The 19 dysplastic dogs remained dysplastic for life, with OA increasing in severity for many of the dogs. However, of the 29 dogs scored ‘normal’, 16 (55%) were scored radiographically dysplastic by end-of-life, equating to a 46% false-negative rate of diagnosis at 2 years of age. Twenty-four of 26 dogs scored normal at 2 years of age went on to develop histopath OA, equating to 8% negative predictive value using the OFA type scoring method. In contrast, PennHIP results showed that all the dogs in this study were susceptible to OA (DI’s >0.36, range 0.36 – 0.92). Kaplan-Meier curves of disease-free interval showed that dogs with DI ≤0.4 had a median disease free interval of 12 years of age, compared to dogs with DI >0.6 whose median disease free interval was only 3 years of age.

Discussion: This lifelong study showed that by keeping dogs lean the onset of OA was delayed and its severity and prevalence was reduced significantly. Fifty percent of RF dogs (mean body condition score of 4.6) had OA compared to 83% of the CF dogs (6.7 mean body score). The linear increase in OA incidence over the life of these Labrador retrievers refutes the accepted belief that the radiographic onset of hip dysplasia is negligible after 3 years of age. This life-long study provides conclusive evidence, at least for Labs, that the designation of "normal" hips at 2 years of age was incorrect more than it was correct. The negative predictive value of the OFA type score at 2 years of age compared to histopathology was 8%, meaning that of the dogs scored ‘normal’, 92% went on to develop OA. The PennHIP DI indicated that all dogs in this study were susceptible to OA and therefore genotypically abnormal. Diet did not influence the distraction index.
ANEURYSMAL RIGHT AURICLE IN TWO DOGS

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Introduction: A radiographically visible mass lesion in the region of the right atrium in the dog is commonly contributed to heart base tumors, tricuspid-stenosis related right atrial dilatation or a cranial mediastinal or lung mass silhouetting with the cardiac silhouette. This report describes two dogs, in which an aneurysmal right auricle caused such a mass lesion.

Material & Methods: An 8-year-old male intact Golden retriever was presented with a history of collapse during exercise. Clinical investigation revealed a tachydysrhythmia consistent with atrial fibrillation. A 14-year-old female spayed Lhasa Apso was referred for cough and evaluation of a heart murmur. In both cases echocardiography, thoracic radiographs, a non-selective angiography and contrast-enhanced computed tomography (CT) of the cranial mediastinum were performed.

Results: Plain radiography showed an enlarged cardiac silhouette with a bulging right atrium in the retriever and a cranial mediastinal mass adjacent to the cranial cardiac silhouette in the Lhasa Apso. Echocardiographic examination revealed a marked right atrial and auricular enlargement with a thin-walled chamber that protruded from the right side of the heart in the retriever, and mild mitral and tricuspid regurgitation in the Lhasa Apso without evidence of right atrial enlargement. Visibility of the right auricle was compromised in both dogs due to lung interference. In both dogs, non-selective angiography and contrast-enhanced CT showed a contrast-enhancing lumen of a markedly enlarged, thin-walled right auricle, which was continuous with the right atrial lumen. Exploratory thoracotomy in the retriever revealed a defect in the pericardium through which the right auricle and part of the atrium had herniated and a partial pericardectomy was performed. Because of the mild cardiac signs, no further diagnostic or therapeutic measures were taken in the Lhasa Apso.

Conclusions: Incidental pericardial defects and a single case of a right auricle herniating through such a defect have been described in dogs.1,2 Although such cases are certainly a very rare cause of a radiographically visible mass in the cranial thorax, they should be considered in the differential diagnosis. The inability to see these large lesions echocardiographically does not rule out their cardiac origin. An angiographic work-up of suspected cranial mediastinal lesions might be warranted before fine-needle aspirates or biopsies are attempted.

THORACIC RADIOGRAPHY IN THE NEWBORN FOAL.
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Introduction: There are a number of factors that predispose the newborn foal to respiratory disease. These include an immature immune system, a highly compliant thoracic wall, and problems in transition from a fluid-filled lung to one that can efficiently exchange gases. Identification of respiratory disease during the post-natal period can be challenging. In contrast to older foals and adult horses neonates with respiratory disease rarely demonstrate cough or nasal discharge, and have inconsistent changes in rectal temperature. Auscultation lacks sensitivity and specificity in predicting parenchymal changes in the neonatal lung. Thoracic radiography is one of the most important components of the diagnostic evaluation of foals with suspected respiratory disease. The primary objective of this study was to categorize the radiographic appearance of the lungs in the newborn foal with respect to pattern, distribution, change over time, impact on short-term survival and long-term performance.

Methods: Thoracic radiographs obtained from 312 foals admitted to the Veterinary Medical Teaching Hospital at the University of Florida over a 7-year-period were evaluated retrospectively. Views were limited to left and right lateral projections. The lungs were evaluated in 4 regions: caudodorsal (CaD), caudoventral (CaV), hilar (Hil), and cranioventral (CrV). Each region was categorized based on pattern (normal, interstitial, alveolar, nodular) and severity of change (normal, mild, moderate, severe, very severe). Foals that were ventilated were excluded from the study. Complete clinical and arterial blood gas data were available for 158 of these foals. A generalized linear model was used (GLIMMIX, SAS) to examine the impact of film characteristics on survival. The change in radiographic appearance was evaluated in 83 foals in which repeat films were obtained within 7 days of the initial study. The racing performance of surviving Thoroughbred foals was examined statistically using the GLM procedure (SAS).

Results: The mean age at admission was 3.7 days; 51.2% were male and 48.8% were female. Gender and gestational age had no significant impact on short-term survival. Approximately 22% of the foals were premature (GA <324d). Only 2% of the premature group had radiographs classified as normal. Across all foals the most common pattern was interstitial, and the most frequent region(s) affected was 1) CaD and CaV (25%), all regions (24%), CaD alone (14%), and CaV alone (9%). The presence or absence of radiographic abnormalities was a good predictor of short-term survival for all regions except for the CaD area. However, the severity of radiographic changes significantly influenced survival. Foals with a severe or very severe interstitial pattern in the CaD region had a 50% survival rates whereas those with a mild pattern had an 80% rate of survival. Analysis of sequential radiographs revealed that the CaV region was the slowest to clear. The arterial blood gas data were closely correlated with radiographic appearance. In surviving foals there was no significant effect of disease location or severity on long-term performance.

Conclusions: Lung infiltrates, as reflected radiographically, settled caudoventrally over time. This may be due to improvement in ambulation associated with resolution of disease. Almost all premature foals have an interstitial radiographic pattern, illustrating the difficulty differentiating atelectasis from cellular infiltrates or pneumonia. Alveolar patterns were uncommon, but when present were often associated with hypoxemia and hypercapnia and poor short-term survival. Some of these data were presented at the 2nd Havemeyer workshop on neonatal septicemia.
ATLAS OF BOVINE MEDICAL IMAGERY AND ANATOMY
Isabelle Masseau, Guy Beauregard, André Desrochers, André Bisaillon, Denis Harvey

Introduction/Purpose
Excellent knowledge of anatomy is essential for the interpretation of radiographic images as well as any advanced medical imaging. Searching multiple textbooks is necessary to access the information needed, which is time consuming. Multimedia technology provides simultaneous consulting of different kind of information (text, pictures, videos, sound) on the same screen without flipping through different books, journals or videos. This situation is quite true in bovine imaging where only sparse literature is available which directly affect veterinary and graduate students teaching as well as practitioners.

The purposes of this atlas were (1) to create a complete teaching tool in bovine medical imagery to the veterinary student using macroscopic anatomy and commonly used medical imagery facilities in cattle such as radiology and ultrasonography, (2) to provide an accessible computer-based document for veterinarians wishing to use more medical imaging in their practice.

Methods
Initially, cadaver specimens were obtained from the necropsy room for dissection. Conventional and computed radiography (Agfa, RADview) of normal and pathological cases were chosen from medical record. Conventional radiographic images were digitized using a Lumiscan 20 scanner and Lumisys Windows Scan Demo software. Ultrasound images and videos from normal and abnormal cows were obtained using an Aloka SSD-5500 ultrasound unit. 3-D models were created to facilitate the comprehension of complex phenomena with the Softimage software (Softimage/XSI v. 2.03). Several digitized photographs, video and comments of pathologies and surgical procedures related to the studied anatomical structures were included. The relevant information identified on each image was divided in three levels for various needs: (1) general knowledge of the cattle, (2) current information used by bovine practitioners, and (3) thorough information for specialists. The structure identification and the interface of navigation were created with ToolBook Software (ToolBook II v. 1.2). A glossary of all identified structure constantly available during atlas consultation was included in order to facilitate quick search.

Results/Discussion/Conclusions
This Atlas is a powerful multilingual tool for veterinary students as well as a valuable source of information for practitioners with the desire to improve their knowledge of radiology and ultrasonography. The inclusion of images or practical tips (fractures, radiographic images, surgeries) will improve the retentiveness of all this information by students. The use of 3-D models to explain complex concepts or phenomena facilitate their understanding. The Atlas gives access to an important bank of images based on the most common pathologies diagnosed in cattle. It is designed to be interactive with the possibility of self-evaluation during consultation. We believe that this concept could easily be applied to other species or specialties.
Introduction: All digital radiographic images begin in an analog format as transmitted x-rays of varying energies. Conversion of these x-rays into a format representing the latent image as a digital signal can be involved, and various manufacturers use different processes to make this conversion. Digital radiography can be classified into two broad categories, direct digital signal conversion and indirect digital signal conversion. The use of light as an intermediate signal medium is the distinguishing characteristic.

Indirect Digital Radiography

Technologies that fall into the indirect digital radiography category include computed radiography, charged-coupled devices, and indirect detection flat panel systems. Each of these modalities utilizes light as an intermediate signal in the analog to digital signal transformation.

Computed radiography uses a cassette enclosed photostimulable phosphor plate in place of radiographic film. When the plate is placed into the reader, a laser scans the plate and electrons are remobilized resulting in blue-green light emission. The light signal then undergoes amplification and digitization. Benefits of computed radiography include greater exposure latitude and contrast resolution.

Charged coupled-device detectors are made with an intensifying screen, a minification lens, and a light sensitive silicon coated microchip. X-rays are converted into light by the intensifying screen, minified through a lens and focused onto the microchip. The photosensitive silicon chip surface liberates electrons in proportion to the amount of light falling on the surface of each pixel of the chip. Charge in each pixel is read out as the digital image. Due to the image minification and loss of photons not directed at the lens, spatial resolution of these devices is poor.

The indirect detection flat panel systems utilize an array of silicon coated thin-film diodes coupled to thin-film transistors to capture the energy of transmitted x-rays. An intensifying screen converts x-rays into light. The light is converted into charge by the silicon-coated photodiode coupled to a transistor. Charge is stored in the capacitor and is sequentially read out and digitized. Contrast of these systems is good; however, high spatial resolution is limited by low signal to noise ratio.

Direct Digital Radiography

Direct detection flat panel systems use amorphous selenium to convert the energy of x-rays directly into liberated electrons. These electrons are stored in a thin-film transistor array pixel matrix for read-out and formation of the digital image. Application of electric fields contains liberated electrons within a pixel resulting in improved spatial resolution. Local alteration of electric field lines within a pixel can redirect electrons from insensitive to sensitive regions of the detector, thereby increasing the signal to noise ratio and increasing contrast resolution.

Summary: All digital radiography technologies enhance contrast resolution. Indirect digital x-ray technologies produce images with varying degrees of decreased spatial resolution when compared to direct digital x-ray technology.
Background: Digital radiographs performed using storage phosphor based systems are subject to artifacts just as traditional radiographs have been. In a computed radiography (CR) system, artifacts can arise from defects in the image plate, within the plate reader, or in the processing of the image data. To accurately interpret images obtained using CR, it is important to be able to recognize and correct for these artifacts. A series of veterinary cases will be presented to highlight one such artifact, previously described as “Uberschwinger” or the “rebound effect”.

Materials and Methods: Radiographs were obtained using a CR system consisting of AGFA brand image plates and a Kodak ACR 2000i CR plate reader.

Results: The artifact was perceived as a thin area of decreased density surrounding metallic implants on post-operative radiographs, simulating the typical radiographic appearance of implant loosening. Loosening could not be confirmed on surgical exploration, which prompted further investigation of the abnormality. A literature search revealed publications confirming the existence of the rebound effect, or “Uberschwinger”, which can occur in computed radiography when the density of adjacent objects is significantly different. The artifact appears as a stripe of decreased density parallel to the interface between two dissimilar densities, in this case metal and bone. Its cause is the frequency processing algorithm used in CR systems, in which an unsharp mask is applied to determine the degree of edge enhancement in the final image. Once the artifact was recognized, the Kodak plate reader was reconfigured to remove all preprocessing algorithms from the scanning process. On the unprocessed images the areas of decreased density were no longer visible.

Conclusion: Computed radiography is a technology long used in medical imaging but only recently becoming common in veterinary medicine. It is important to recognize new artifacts that are unique to this modality. The processing algorithms applied to the raw image data in a CR system are designed to create an aesthetically pleasing radiographic image. The algorithms may be referred to as “image sharpness”, “unsharp mask”, or “edge-enhancement”. In the Kodak system, the plate reader itself applied the preprocessing algorithm, and disabling it was difficult; other CR systems may use different algorithms and apply them at different stages in the imaging process. If this artifact is suspected, it is important to be able to view raw images with no additional processing algorithms applied. In the series of cases presented, correction of the artifact was crucial to making a correct radiographic diagnosis and determining the course of therapy.

References:
The objective of this project was to develop teaching tools that allowed individual evaluation of images, provided immediate feedback based on the student’s assessment of the images and encouraged the development of a systematic method of image review. A secondary objective was the development of an individual image evaluation test that could be used with a large class of students. Radiographs of the cases selected were scanned using a Kodak laser film scanner. The images were cropped and brightness and contrast adjusted using Adobe Photoshop. For each body cavity a list of organs was developed. Using a web-based format the evaluator indicated, by clicking in the appropriate box, if each structure was normal or abnormal. Some difficulties occurred with organs that are not normally visible, for example the adrenal gland. In earlier versions of the programme and additional category, not identified was used. With this category there was some confusion among students as to when it should be used. In the later versions this answer choice was removed and the users were instructed to assume that any organ that was not visible was normal. Once the abnormalities have been identified the users then choose the correct diagnosis form a list provided.

The programme has been developed into two formats. The first is used in teaching a series of elective courses. For each elective a series of 26 cases are available for review by the students. As they complete each case the number of correct answers is indicated and they are directed to a web page that give a short paragraph of text describing the abnormalities. Annotated versions of the relevant images are also provided. A formal class at the end of the elective is held in a computer lab that accommodates 50 students. Each case is reviewed and any questions regarding the case are answered. The elective courses have been well received by the students and have represented an efficient use of faculty time for teaching, although a very large time investment was required to develop the case studies.

The examination format was developed to replace a one on one film reading examination at the end of the final year Radiology Rotation. It is also used for examinations for the entire class in the earlier years of the programme. A full class examination presents some logistical problems, however with 100 students in the year and a classroom with 50 computers allows to back to back examinations. For the final year examination each student is given a random choice from, for example, a series of chest cases. The same pool of cases is used for the entire year. The marking scheme gives marks for correct answers and deducts marks for incorrect answers. Abnormal features are given a mark ranging from 1 to 10, depending on how important the abnormality is considered to be. One mark is deducted for each incorrect answer. In the exam format the list of differential diagnoses is relatively long and the student is expected to make the single most appropriate choice. The format has proven to be very effective at discriminating between students. The range of marks is very wide, ranging from 15 to 95%.
COMPUTED TOMOGRAPHY VERSUS MAGNETIC RESONANCE IMAGING IN THE IMAGING OF DOGS WITH NASAL TUMORS: A PILOT STUDY

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Introduction:
Nasal tumors are a relatively common canine neoplasm. The advent of more sophisticated 3-D imaging modalities has made the diagnosis of this tumor type more reliable and accurate than traditional skull radiography. Computed Tomography (CT) has been the standard of care for imaging nasal tumors in the dog. Common CT findings in dogs with intranasal neoplasms include a soft tissue attenuating mass with contrast enhancement, evidence of bony lysis, and turbinate destruction. However, both fluid and tumor appear as soft tissue attenuating material on CT, hindering our ability to define tumor margins. Previous literature has documented that Magnetic Resonance Imaging (MRI) is superior to CT in defining soft tissue structures, making it the gold standard for neurological imaging. The purpose of this pilot study is to compare the features of CT versus MRI in the imaging of dogs with nasal tumors and define the advantages and disadvantages of each modality for this tumor type.

Methods:
CT and MRI imaging were each performed on nine patients enrolled in the University of Wisconsin-Madison Nasal Tumor Tomotherapy Study prior to initiation of radiation therapy. These two imaging modalities were compared for delineation of tumor extension, fluid versus soft tissue demarcation, bony lysis, ethmoid destruction and CNS involvement, lymphadenopathy and duration of imaging procedure.

Results:
MRI imaging was superior to CT imaging in identifying frontal sinus tumor extension versus fluid accumulation in 3/9 patients (33 %). Both modalities were similar in identifying areas of bony lysis. Ethmoid destruction was identified on CT imaging in one patient with aggressive tumor histology; this destruction was not identified on MRI. Although, a significant lag period occurred between the timing of these two studies. CT imaging more frequently identified lymphadenopathy; however no patients in this study group had cytologic evidence of metastatic disease.

Conclusions:
Both CT and MRI are efficacious for imaging the nasal cavity in the dog. MRI imaging of the nasal cavity and sinuses is marginally superior to CT in defining tumor extent and areas of fluid accumulation in dogs with nasal tumors.
PET/CT IMAGES OF A PRIMARY LUNG TUMOR WITH TWO RADIONUCLIDES FOLLOWING IMRT

University of Wisconsin-Madison

Introduction/Purpose – PET/CT images of a primary lung tumor were obtained to monitor response post radiation therapy in a dog with two radionuclides, F\textsuperscript{18}-fluorodeoxyglucose (FDG) and F\textsuperscript{18}-fluorothymidine (FLT). FDG signal represents a rough estimate of glycolysis, elevated in most tumor tissues compared to normal tissues, while FLT represents cellular proliferation, as an indicator of DNA synthesis.

Methods – A 13 year-old female spayed Labrador retriever mix with a primary lung tumor of the right caudal lung lobe and no other gross metastasis was treated with intensity-modulated radiation therapy, 3.75 Gy x 8 fractions, to a total dose of 30 Gy. 2 months after completion of treatment, whole-body PET/CT scans were performed under general anesthesia. A dose of 5.3 mCi of FDG was administered intravenously and PET scan performed 40 minutes later on day 1, the same procedure performed after a dose of 5.14 mCi of FLT administered intravenously on day 2.

Results - On FDG images, edge enhancement, as well as a diffuse intensity surrounding the mass is seen. On FLT images, edge enhancement of the mass is still seen, but diffuse signal surrounding the mass is not. Also of note on FLT images is the lack of PET signal in 5 thoracic vertebral segments, whose estimated RT dose in 8 fractions was 18 Gy (spinal cord).

Discussion/Conclusions – Edge enhancement on both FDG and FLT images denotes presence of tumor tissue at the periphery of the treated tumor tissue. Diffuse signal surrounding tumor on FDG scan indicates the presence of inflammation producing signal, not seen on FLT scan. The lack of signal in thoracic vertebral segments, presumed due to lack of normal bone marrow signal, secondary to RT, was unexpected with a low local dose to those vertebrae, and suggests that marrow may be more radiosensitive than previously thought. FLT used with PET imaging may prove to be an excellent indicator of viable proliferating tumor tissue, invaluable in monitoring response to therapy, especially in those therapies with a marked inflammatory response.
IMAGING FOR RADIATION THERAPY PLANNING: CT VS. MR.

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Introduction: Advanced medical imaging has helped define the gross tumor volume to allow for proper delineation of clinical treatment volumes and patient treatment volumes. Improved patient restraint and positioning devices have allowed for reduction in the margins between the gross tumor volume and the patient treatment volume. While computed tomography (CT) has been the traditional mainstay of radiation therapy planning, magnetic resonance (MR) imaging provides superior image characteristics.

Methods: Review of patient treatment devices utilized for both CT and MR imaging as they relate to eventual patient treatment parameters will be discussed. Examples of CT and MR on the same patient for therapy planning purposes will also be discussed. Modification of patient treatment programs to accept DICOM images will be given.

Results: The accurate patient registration system, coupled with advanced imaging, will be summarized and conformal radiation therapy will be reviewed. In addition, the combination of MR imaging and small treatment fields for the use of radiosurgery utilizing a 360 degree arc therapy will be illustrated.

Discussion and Conclusions: Many currently utilized treatment planning systems use proprietary medical image formats. Newer planning systems utilize DICOM images. MR is spatially accurate unless there is significant metallic implant within the treatment field. Superiority of MR imaging for tumor visualizations is preferable to utilization of radiopaque markers at the time of surgery. We are working with a programmer to utilize publicly available noncommercial treatment planning systems coupled to DICOM imaging. We hope to demonstrate this at the meeting.
In the past decade there has been a true technological revolution in the area of radiation oncology involving computerized treatment planning, leading to widespread adoption of three-dimensional planning as “state of the art” treatment at the many institutions. I contend this is dangerous and premature on several fronts, especially in veterinary medicine. First and foremost, while there is no question 3D planning allows for more precise delivery of radiation, it is still an unproven therapy in terms of outcome and normal tissue toxicity for the majority of human malignancies. Unfortunately, the opportunity to prove or disprove its utility may be lost as human facilities drop conventional treatment planning systems for conformal therapy, multileaf collimators and other similar technologies designed to provide the holy grail of radiation oncology: maximal tumor dose with minimal normal tissue toxicity. These new technologies will only be of benefit to the patient if there is high (almost total) confidence that the tumor is confined to the planning target volume (PTV). Even if the dose is escalated, it is useless if tumor cells are outside the field.

As is too often the case, veterinary medicine has extrapolated these advancements for use in companion animals, but has lagged behind tremendously in several basic areas. Computerized treatment planning is employed in most institutions but certainly not universally. Problems abound for veterinary radiation oncologists as they struggle to define treatment volumes for patients presenting in postoperative settings without the benefit of detailed surgery reports, much less preoperative imaging. Reporting of dose prescriptions and treatment volumes in animals is not standardized, vague and often missing completely, leading to a dearth of meaningful information on the dose-response relationship. This is compounded by a lack of information regarding normal tissue toxicity, only recently standardized by the VRTOG. 3D planning does not help in these everyday clinical situations, but rather intensifies the problem by increasing the probability of geographic misses, currently a relatively infrequent outcome given the liberal margins for most conventional treatment fields. They may be a need for highly sophisticated treatment planning and certainly the CNS would be the poster child for careful delivery of radiation therapy. However, huge sums of money are being dedicated to technologies that may in fact be needed in only a minority of patients. It is a programmatic decision. The alternative use of resources is the critical issue. In my opinion, it is preferable to use conventional computerized treatment planning for brain tumors and allocate the remainder of what to basic oncology research into tumor biology, molecular imaging and augmentation of the radiation response with novel approaches such as COX-2 inhibitors, gene therapy and others. Veterinary radiation oncology can lead the profession by doing just that, leading rather than simply following our human counterparts.
PITUITARY TUMOR IRRADIATION IN EIGHT CATS


Introduction/Purpose: Results of pituitary irradiation in the small number of cats described in veterinary literature show that radiotherapy may be effective alone or in combination therapy, however more information on tumor control and effects on normal dose-limiting tissues is needed. The purpose of this case series was to describe the outcome and incidence of adverse normal tissue effects in eight cats with pituitary tumors irradiated at Colorado State University (CSU) between 1991 and 2002.

Materials/Methods: The medical and radiation records of six cats with pituitary adenomas and two cats with pituitary carcinomas treated with a 6MV linear accelerator were reviewed. Presumptive diagnosis was made based on computed tomography (CT) or magnetic resonance imaging (MRI) findings and clinical signs, and confirmed histopathologically in two cats. Clinical signs, clinicopathologic abnormalities and endocrinologic abnormalities at time of referral for radiotherapy were determined. Post-irradiation information collected included CT and/or MRI brain imaging reports, clinical pathology results and endocrine function testing. Improvement of clinical signs was assessed using physical examination findings by CSU clinicians and/or referring veterinarians, and owner observations. Acute and late normal tissue effects were assessed by physical examination by clinicians at CSU during therapy, and by CSU clinicians, referring veterinarians and/or owner observations after completion of therapy. Survival time was calculated from the first day of radiotherapy to the day of death.

Results: The median age of the cats was 10.5 years (range 7.1 to 14 years). There were seven neutered males and one neutered female. Four cats presented with hyperadrenocorticism and neurological abnormalities. Three cats presented with acromegaly. Three of the cats with hyperadrenocorticism and all of the cats with acromegaly had concurrent diabetes mellitus that was poorly responsive to insulin. One cat had neurological signs only. Cats were treated using photons from a 6MV linear accelerator. Total radiation dose ranged from 45 to 54 Gy administered Monday through Friday. Dose per fraction was 2.7 or 3 Gy. The target volume used in the computerized treatment plans was visible tumor plus a 1 cm margin in all directions. Median survival of the eight cats was 19.6 months (range 8.4 to 63.1 months). Acute effects from radiotherapy were limited to epilation in one cat and mild otitis externa in one cat. Focal brain necrosis associated with recurrence of a pituitary carcinoma and a squamous cell carcinoma in the radiation field were reported. Tumor recurrence was seen in one cat with a pituitary carcinoma. Neurological signs improved within two months in all 5 cats with abnormal neurological status at presentation. Clinical signs caused by a concurrent endocrine disorder began to improve within 1-5 months in the 7 cats with hyperadrenocorticism or acromegaly.

Discussion/Conclusions: Tumor control was felt to be good for the six cats with presumed adenomas (one confirmed with histopathology). Incidence of acute effects was low. Despite a lack of normalization in endocrine function testing, clinical signs improved after radiotherapy in all cats. Radiation therapy is an effective primary treatment modality for cats showing neurological signs associated with a pituitary mass, and may improve clinical signs associated with concurrent hyperadrenocorticism or acromegaly in cats with no neurological abnormalities.
RADIATION EFFECTS FOLLOWING TREATMENT OF BRAIN LESIONS. S.M. LaRue, D.V.M., Ph.D., Department of Environmental and Radiological Health Sciences, Colorado State University, Fort Collins, CO 80523

Introduction/Purpose: Radiation therapy an important treatment modality for canine brain lesions, including meningiomas, pituitary macroadenomas and granulomatous meningoencephalitis. Radiation may be administered alone or following surgical excision of the tumor. Acute reactions, which develop during the course of irradiation, and early delayed reactions, which develop within a few weeks to a few months after the delivery of cranial irradiation, are usually mild and transient. Late effects develop several months to years following irradiation and include vessel damage, loss of function and necrosis. Radiation necrosis constitutes the major hazard of radiotherapy to the region, and limits the dose of irradiation that can be administered. Radiation necrosis is progressive, irreversible and often leads to death or euthanasia. The purpose of this presentation is to review effects associated with radiation therapy for brain lesions in pet dogs with naturally occurring tumors.

Methods: Histological and clinical findings following brain irradiation from 3 clinical studies were evaluated. In one study, dogs with brain lesions were treated with whole brain irradiation with fraction sizes varying from 3 to 4 Gray. The second study was a previously published dose escalation study where whole brains were treated with 2 Gy fractions with total doses ranging from 48 to 60 Gy. The third study was a dose fractionation study for the treatment of nasal tumors. However, all of these patients had the rostral to 1/3 of the brain irradiated. These dogs were treated with 1.5, 3 and 4.5 Gy fractions with total doses ranging from 36 Gy to 67.5 Gy. In all 3 studies the brains were evaluated grossly and histologically following death. Alterations in vasculature, edema and necrosis were graded histologically and correlated with clinical signs.

Results/Discussion: Preliminary evaluation of data indicates a relationship between dose per fraction and increasing total dose and late effects to brain. Tolerance to radiation is decreased in the face of previous surgery and/or chemotherapy. There appears to be a volume effect. This work was supported by grant numbers RO1 CA 36992, PO1 CA 29582 and by the National Cancer Institute.
INTENSITY MODULATED RADIATION THERAPY IN VETERINARY MEDICINE: DEFINING THE LEARNING CURVE
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The ability to deliver radiation therapy to a target volume while sparing critical normal tissues and structures has been greatly enhanced with the development of three dimensional image based conformal therapy (3-D CRT). 3-D CRT is the process by which ionizing radiation is delivered to the target volume using the patient’s 3-D image data set(s). Following 3D reconstruction of the image data, treatment portals are assigned using beam’s eye views (BEV). Following the identification of critical tissues and the patient’s tumor volume, a series of objectives is defined to maximize dose delivery to the desired target volume. Evaluation of the treatment plan includes the analysis of structure specific dose volumes by means of histograms (DVH) and assessment of biological indices such as tumor control probability (TCP) and non-tumor control probabilities (NTCP).

Intensity Modulated Radiation Therapy (IMRT) is a method of 3-D CRT employing a computer controlled multi-leaf collimator. This improves the conformality of the dose distribution over fixed leaf collimation by allowing each beam to be broken down into segments or control points. The practice of radiation oncology in humans has shifted dramatically with the emergence of IMRT. This technique is advantageous for treatment sites that have a characteristically poor response to radiation therapy due to limiting critical structures within the radiation field. For these sites, there is a potential that tumor specific dose escalation may result in improved regional control (e.g. head and neck tumors). Implementation of IMRT entails changing the approach of treatment planning design and optimization from forward treatment planning to an inverse treatment plan.

Forward planning utilizes operator defined manual beam configurations and modifications to achieve optimal dose distribution, while inverse planning provides computer optimized beam and multileaf collimator configurations based on a series of clinician defined parameters. This considerably reduces planning time while improving target volume dose characteristics through the computer assisted development of complex treatment plans that would not be possible manually.

The purpose of this discussion is to describe the process of IMRT delivery as well as to contrast and compare conventional forward and IMRT treatment planning through case examples.
HELICAL TOMOTHERAPY: 3-D SET-UP VERIFICATION AND OCULAR TOXICITY IN AN INITIAL COHORT OF DOGS WITH SPONTANEOUS NASOPHARYNGEAL TUMORS

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Introduction: Helical tomotherapy (HT) is a novel intensity-modulated, fan-beam, rotational radiation therapy (RT) treatment modality that allows conformal avoidance of peritumoral tissue yet compromises tumor dose minimally. It merges a helical computed tomography (CT) unit with a megavoltage (MV) linear accelerator to enable MV CT images for accurate patient set-up verification prior to each treatment. Due to the conformation of the dose to the canine nasal passage and the proximity of critical normal structures (eyes and brain), nasopharyngeal tumors in dogs represent an ideal model to test the adaptive tomotherapy processes. Treatment of these tumors with conventional ⁶⁰Co external beam RT to a total dose of 42 Gy in 10 fractions results in ocular toxicity in 95% of dogs. The purpose of this initial work in a cohort of client-owned dogs with nasopharyngeal tumors was to test the adaptive capabilities of the HT unit with respect to set-up verification, and to evaluate the ability of HT to conformally avoid the eyes.

Methods: Kilovoltage (kV) CT images of the primary tumor were obtained in nine dogs with nasopharyngeal tumors for treatment planning. Optimization of the treatment plan using HT was performed to achieve delivery of the prescribed dose (42 Gy) to 95% of the planning treatment volume, and no more than 15 Gy to 50% of ocular volume and no more than 20 Gy to 50% of brain volume. With the dogs in treatment position, MV CT images were obtained with the HT unit just prior to treatment and were fused with the planning kV CT to verify accuracy of set-up. Based on image fusion, dogs were repositioned, as necessary, prior to treatment. Translational and rotational values were recorded. Dose delivered was 4.2 Gy per fraction for 10 fractions. Ophthalmic exams were done prior to irradiation, at the end of therapy, 2 and 4 weeks post-RT, then every 3 months.

Results: For each dog, a treatment plan was devised using HT that spares critical normal tissues (eyes and brain) and effectively covers the tumor volume. In 5 dogs, all 10 fractions were delivered by HT. In the remaining 4 dogs, occasional fractions were delivered by intensity-modulated RT (1, 3, 4 and 6 fractions, respectively). Image fusion of the MV and kV CT images was rapid and allowed for precise repositioning of the patient in 6 degrees of freedom prior to treatment. To date, median follow-up is 4.5 months (range 0-6.5 months) and ocular toxicity has been minimal. No dog, except one, has experienced keratoconjunctivitis sicca (KCS). In the dog with KCS, severe peri-orbital tumor extension precluded avoidance of the affected eye, and at 6 months post-RT, ocular changes were limited to mild, focal corneal neovascularisation and hyperpigmentation. Transient mucoid ocular discharge, likely due to poor tear quality, developed in most dogs. Mild retinal hemorrhage was noted in one dog at 6 months post-RT. All eyes have remained visual.

Conclusions: Set-up verification by fusion of MV and kV CT images is superior to conventional portal imaging. It allows precise patient positioning, and more conservative planning treatment volumes. To date, ocular complications associated with treatment of nasopharyngeal tumors by HT are less severe than those associated with conventional ⁶⁰Co therapy. This ongoing project represents the initial in vivo testing of the adaptive tomotherapy processes, and represents the groundwork for implementation of HT in human trials. (Supported by NCI grant 1PO1 CA88960).
Introduction/Purpose: The major objective of veterinary radiation oncology is to provide a reasonable probability for durable local tumor control with minimal probability of late normal tissue injury for animals with loco-regional cancers. The purpose of this presentation is to remind that the objective is being met today and to propose methods to improve. In earlier times it was possible to do total dose and dose fractionation studies. Various societal and financial constraints have curtailed that work.

Materials/Methods: Dogs with a variety of cancers were assigned to receive variable total doses of radiation. TCD_{50}s and ED_{50}s for bone or soft tissue necrosis were determined. The 50% response level was chosen to provide for statistical strength. Several dose response studies were done of canine normal tissues to determine tolerance for a variety of endpoints.

Results: The TCD_{50} for measurable canine cancers ranged from 38 Gy for oral squamous cell carcinomas to 52 Gy for soft tissue sarcomas. The complete dose response curves indicated that 54 Gy should control 90% of oral squamous cell carcinomas and 60% of soft tissue sarcomas for 1 year. Those estimates are not statistically significant. Normal tissue studies showed that late responding tissues would have an ED_{5} equal to or greater than 52 Gy given in 3Gy fractions. The ED_{1} for spinal cord was estimated at 51 Gy given in 3 Gy fractions.

Discussion/Conclusions: Many cancers of animal patients are being controlled with radiation alone or in combination with other modalities. Today the risk of serious normal tissue complications is low. Clinical experience at Colorado State University is that the risk of late normal tissue complications is about 5%. The perception is that the complication rate may be increasing due to increased survival times. It’s important to remember that clinical normal tissue tolerance is determined by owners and referring veterinarians. There is room for improvement and more work remains to determine optimal fractionation schemes. Lower doses per fraction and combinations with other modalities could lead to more effective therapy. Multi-institutional clinical trials are very challenging, requiring large numbers of patients and a high level of coordination. Veterinary radiation oncologists must be very active in publishing data from their own practices. The clinical data must be carefully recorded, the methods consistent and follow up information aggressively pursued. Sharing information in a timely manner can be facilitated by the ACVR-O meetings, newsletters and by way of the internet. Collectively ACVR-O diplomates and their residents can contribute to meaningful therapeutic gains in radiation oncology.
Introduction: Feline oral squamous cell carcinomas carry a poor prognosis despite treatment with aggressive surgery, radiation therapy, and chemotherapy. Overexpression of the epidermal growth factor receptor (EGFR) has been demonstrated in most human epithelial neoplasms, including oral squamous cell carcinomas. EGFR is a membrane-bound tyrosine kinase receptor that modulates signaling pathways which control cellular proliferation and death in normal and neoplastic cells. Overexpression of EGFR leads to cellular proliferation, inhibition of apoptosis, angiogenesis, and metastatic spread of neoplastic cells. EGFR overexpression is associated with resistance to hormonal therapy, cytotoxic agents, and radiotherapy in human neoplasms. Various studies have correlated EGFR overexpression with advanced disease and a poor prognosis. It is unknown if feline oral squamous cell carcinomas express EGFR. This purpose of this study is to demonstrate whether feline oral SCC express EGFR.

Methods: Twelve formalin fixed paraffin embedded biopsy samples from feline oral SCC were analyzed for EGFR expression using immunohistochemistry. The specimens were collected from clinical patients from 1996-2003. Sections were deparaffinized, rehydrated, and prepared with peroxide, PBS, and blocking serum. Primary antibody was polyclonal rabbit antihuman EGFR antiserum. Streptavidin peroxidase method was used to detect immunoreactive complexes. DAB chromogen was used to visualize the immunocomplexes, and the slides were counterstained with hematoxylin. The intensity and distribution of EGFR staining was evaluated using light microscopy. Normal feline oral mucosa and control tissue were also stained for EGFR expression.

Results/Discussion: Results are presently being analyzed. EGFR overexpression, if documented in feline oral SCC, may provide a basis for evaluation of therapies such as tyrosine kinase inhibitors in the treatment of this aggressive neoplasm.
**EFFECTS OF LOW-DOSE TOTAL BODY IRRADIATION IN THE TREATMENT OF SPONTANEOUS CANINE LYMPHOMA.**

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**Introduction:** Currently, the most successful treatment modality for canine lymphoma is chemotherapy with a median survival of 6-12 months and a cure rate of less than 15%. Both high dose total body irradiation with bone marrow transplantation and half-body irradiation have been used to treat canine lymphoma. However, a risk of significant toxicity exists for these regimens. LDTBI is an established technique, which has the potential to improve therapeutic effects for canine lymphomas. Thrombocytopenia has been reported as a dose limiting factor. Objectives of this prospective study were 1) to characterize the thrombocytopenia response to LDTBI, 2) to investigate the immune modulatory effects of LDTBI, and 3) to evaluate the clinical response with LDTBI.

**Methods:** A total body midline dose of 1.0 Gray at 10 cGy/min was given to 9 dogs with histologically confirmed lymphoma that were in complete remission following a 14-week chemotherapy protocol. The dogs were treated with a Siemens Mevatron 77 linear accelerator (6 MV photons) at an extended distance in order to irradiate the entire body and to reduce the dose rate. A complete blood count was performed on the day of treatment and then weekly until the platelet count returned to normal. Blood samples were collected on the day of treatment and 2 weeks after LDTBI to evaluate the effects of LDTBI on peripheral blood lymphocytes (PBL) and platelets. Changes in PBL population and expression of 16 cell markers, such as CD3, CD4, CD8b, MHCII, and platelet surface associated antigen were assessed using commercially available monoclonal antibodies to canine antigens.

**Results:** Study protocol is ongoing. Nine dogs (5 B cell, 2 T cell, 2 others) were enrolled in this protocol between January and June 2003. The primary adverse effect of LDTBI was uncomplicated, severe and prolonged thrombocytopenia in all dogs. The median nadir platelet count was 39,000/ul (range 7,000-111,000/µl) at a median time of 14 days from irradiation (range 14-28 days). The platelet median recovery time was 42 days (range 35-63 days). Mild neutropenia occurred (n=4), and the median neutrophil nadir was 2,932/ul (range 1,060-4,200/µl) at a median time of 21 days (range 14-35 days). Flow cytometry results are being analyzed. Preliminary data from flow cytometric analysis indicate that MCHII expression (constitutively expressed by B cells and expressed by activated macrophages and T cells) decreased after LDTBI. Also, flow cytometry was able to detect markers such as CD79a (immature B/plasma cells, not present in normal PBL), even when the CBC did not detect any abnormal cells in the peripheral blood (n= 3/3). The median follow-up time after LDTBI was 80 days (range 34–163 days). Seven of 9 dogs are still in complete remission. Two dogs relapsed on day 53 and 63 post LDTBI, respectively.

**Discussion:** LDTBI was well tolerated with asymptomatic thrombocytopenia being a major acute adverse effect. Decreased expression in cell markers could reflect the loss in B cells with down regulation of activation molecules on the other PBL populations. Flow cytometric analysis is a powerful tool to detect cell markers on PBL and has the potential to enhance the predictability of the outcome and response to therapy. Ultimately, successful application of LDTBI could improve treatment response for dogs with lymphoma and other cancers, and could assist in the development of a novel cancer strategy based on immune enhancement of LDTBI as an effective adjuvant therapy.
MULTIPLE PHASE HELICAL COMPUTED TOMOGRAPHY OF THE CANINE LIVER: PROTOCOL FOR CONTRAST INJECTION AND SCAN TIMING


Introduction: Contrast-enhanced Computed Tomography (CT) of the liver is commonly performed for the evaluation of many types of liver disease, including primary and metastatic neoplasia. Using a helical CT scanner with the proper relationship between injection rate, scan delays, and scan time, the hepatic-arterial, portal-venous, and equilibrium phases of contrast enhancement can be imaged separately. The purpose of this study was to establish a safe and practical protocol for Multiple-phase imaging of dogs in clinical situations, and to compare multiphase helical CT to ultrasound for identification of hepatic lesions.

Methods: 10 canine patients with hepatic nodules seen on ultrasound were scanned with owner consent using a protocol adapted from the human and veterinary literature. Dogs were anesthetized and a pre-contrast scan (GE HiSpeed) was acquired during manual breath hold at 20 cm H2O positive pressure to define cranial and caudal liver margins for the post-contrast scans. Using 1 slice per second, slice thickness was adjusted to incorporate the entire liver in approximately 20 slices. Sodium Iothalamate (Conray 400) at a dose of 880 mg I/kg was injected through an 18 gauge cephalic catheter with a pressure injector at a rate of 4 ml/sec. Beginning 7 seconds from the start of injection, sequential scans were performed, starting in a caudal to cranial direction, then alternating scan direction after each pass through the liver for a total of 6 scans. Dogs were manually ventilated during a 10 second pause between each scan, and breath-held during image acquisition. Immediately following the CT scan, follow-up ultrasound was performed to evaluate lesions seen on CT. Fine needle aspirates or biopsies of accessible lesions were obtained with ultrasound guidance or during surgery.

Results: Patient weights ranged between 10 kg to 50 kg and breeds were variable. Nodules generally ranged from .5-3.0 cm diameter and were of variable ultrasonographic appearance. All scans were of excellent diagnostic quality, with good visibility of hepatic vasculature and an obvious progression through the vascular phases. Hepatic parenchymal enhancement was maximal during the portal-venous phase. Most nodules were iso/hypoattenuating compared to normal parenchyma on pre-contrast scans, and enhanced less than surrounding liver, resulting in maximal conspicuity during the portal phase. In 5/10 patients, a solitary hyperattenuating nodule appeared during the arterial phase. In one patient, this was the only lesion seen. All nodules seen on ultrasound were visible on CT. In contrast, of 30 lesions seen on CT which measured at least one centimeter in diameter, 6 were not identifiable on follow-up ultrasound, even when their location was known. Clinical considerations and technical difficulties prevented histologic diagnosis of some nodules. Two hepatocellular tumors; an adenoma and a low grade carcinoma, were also imaged. Both appeared to be served by arterial and portal vessels, and had peak attenuation early in the portal phase which was less than the surrounding normal liver. As of yet, data has not been quantitatively analyzed, but subjectively the timing of the liver enhancement phases parallels that documented in the referenced literature.

Conclusion: The protocol utilized in this study is a good model for performing Multiple-phase helical CT in dogs quickly and safely, with minimal technical accommodation. The procedure is useful for identification of hepatic nodules of various types and liver locations, as well as evaluating hepatic masses for operability and surgical planning.
THREE DIMENSIONAL HELICAL COMPUTED TOMOGRAPHIC ANGIOGRAPHY OF THE LIVER

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Purpose: We set out to develop an efficient, safe, minimally-invasive, effective imaging protocol that would provide a reliable three-dimensional map of the hepatic circulation in the dog for clinical use.

Methods: Five purpose-bred Beagle dogs were anesthetized and monitored using standard TUSVM protocols. In each case, a survey (non-contrast) scan of the entire abdomen was done first. Our protocol called for the use of two separate imaging sequences; the first highlighted the arterial, the second the portal phase of hepatic circulation. A test bolus was used to determine scan delay parameters for each phase. The dog was hyperventilated prior to the scans to prevent motion artifacts. Diatrizoate meglumine (128 mg I/kg) was injected through an 18 gauge cephalic vein catheter at a rate of 5ml/sec. Scanning was initiated after the appropriate scan delay to optimize the specific phase of vascular filling. Maximum intensity projections with thresholding allowed clear delineation of the structures of interest, while eliminating overlying structures that might interfere with image analysis. Time/density curves were generated.

Results: Hepatic arteries and portal veins were clearly visualized in all cases. Time to peak arterial enhancement ranged from 2.0 to 7.0, with an average of 3.6 +/- 2.3, and a median of 2.0 seconds. Time to peak portal venous enhancement ranged from 23.0 to 46.0, with an average of 32.8 +/- 10.2, and a median of 32.0 seconds. Scan delay for arterial opacification ranged from 0 to 5.0, with an average of 2.0 +/- 2.7, and a median of 0 seconds. Scan delay for the portal phase of opacification ranged from 6.0 to 21.0 with an average of 14.6 +/- 6.0, and a median of 17.0 seconds. Hepatic parenchymal opacification was also observed.

Conclusion: Three-dimensional CT of the hepatic arteries and portal venous system provided excellent visualization of the proximal branches of the hepatic artery and the portal venous system. The procedure was simple, safe and minimally invasive. A test bolus accurately predicted optimal scan delay. Volume rendering clearly depicted anatomical details of the hepatic circulation. Three-dimensional display of the hepatic circulation has clinical application in any case where anatomic details are relevant to the diagnosis or treatment of liver disease. The pattern, timing and degree of parenchymal hepatic opacification may be proved useful in assessment of the location and the classification of liver disease in the future.
HELICAL CT ANGIOGRAPHY OF THE NORMAL CANINE PANCREAS

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Background:
Helical abdominal computed tomography (CT) can demonstrate detailed morphology of the normal and abnormal canine pancreas. To accurately diagnose & stage pancreatic diseases a combination of arterial, venous and parenchymal uptake evaluation on CT angiography is used in humans. The aim of this study was to describe canine pancreatic and associated vascular CT anatomy and normal CT-angiographic enhancement patterns.

Material & Methods:
Helical abdominal CT with was performed in 9 normal beagle-mix dogs, 4 males and 5 females. Following cephalic vein injection of ionic iodinated contrast medium via power injector (rate 5 ml/ s) venous-phase CT was performed in 3 dogs and dual-phase CT in 6 dogs. A delayed scan was performed in 7 dogs between 5 to 20 minutes after the contrast medium injection. A dynamic CT scan (level pancreatic body) was performed in 6 dogs prior to the above scan to generate time-density curves of the pancreatic or peripancreatic vessels.

Results:
Helical CT showed good anatomic detail of pancreatic and peripancreatic tissue and vasculature such as the hepatic, gastroduodenal, cranial pancreaticoduodenal, splenic, left and right gastric, left and right gastroepiploic arteries as well as splenic vein with pancreatic branches, gastroduodenal, right gastroepiploic, cranial pancreaticoduodenal, hepatic, right and left gastric veins. In 7 of 9 dogs the common bile duct could be identified ventral and to the right of the portal vein joining the dorsomedial aspect of proximal descending duodenum. The peak enhancement of the gastroduodenal or hepatic artery occurred at 6 - 9 s post start injection and in the gastroduodenal or portal vein at 13 - 20 s, resulting in a purely arterial time window of 7 to 11 seconds. Pancreatic veins and parenchyma remained enhanced until the end of the dynamic scan (40 s) and appeared hypodense to the liver on delayed scans, providing better delineation of the pancreatic body.

Conclusions:
Helical CT provides excellent anatomic detail of the canine pancreas and associated structures. The common bile duct can be identified. Dual-phase CT angiography enables assessment of the arterial supply, parenchymal perfusion and venous drainage of the pancreas. Due to the very short time window and variable onset of pure arterial enhancement careful planning of dual-phase studies with prior dynamic CT is recommended. It may not be possible to include the entire pancreas in an arterial-phase CT with a pitch and collimation sufficient for arterial detail. Biliary excretion of ionic contrast medium resulting in late hepatic enhancement provides optimal delineation of the pancreatic body. Arterial-phase imaging is potentially useful to evaluate vascular abnormalities and highly vascularized neoplasia, venous- and delayed-phase CT for pancreatic inflammation, necrosis, cysts, pseudocysts and non-vascular tumors.

References:
COMPUTED TOMOGRAPHY, BUT NOT ULTRASOUND, IDENTIFIES SMALL ADRENAL GLANDS IN CATS WITH FELINE INTERSTITIAL CYSTITIS

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Introduction: Owners surrender millions of cats to animal shelters each year for euthanasia. Inappropriate elimination, most commonly associated with urologic signs, is the most common reason given for abandoning the cat. In a recent post mortem study, cats with a common form of urinary problem, feline interstitial cystitis (FIC), had abnormally small adrenal glands. An antemortem method for determining adrenal gland volume might be a useful screening test for FIC.

Methods: 11 cats with FIC and 11 healthy cats were evaluated using CT. 8 FIC cats and 9 healthy cats also had ultrasound evaluations. Cats were anesthetized with isoflurane after which CT scans, pre and post-contrast medium-enhancement, were performed. Adrenal gland volumes were calculated and normalized to body weight for each cat. Ultrasound measurements were obtained and adrenal gland volumes calculated using the following formula: \((L \times W \times H) \times \pi/6\). Both of these measurements were compared to a group of 15 FIC and 11 healthy cats where necropsies were available and actual adrenal volume measurements could be obtained.

Results: Cats with FIC had significantly smaller adrenal gland volumes compared to healthy cats when evaluated by CT or necropsy (Table). Adrenal gland volumes calculated by ultrasound were not significantly different from normal cats.

Conclusions and Clinical Relevance: Results of this study suggest that CT scans can be used to accurately evaluate adrenal gland volumes in cats. Caution should be used when utilizing ultrasound volume calculation based on a prolate ellipse. The reason for the small adrenal glands remains unknown at this time, but future studies to evaluate the hypothalamic-pituitary-adrenal axis should be done in cats with FIC. CT scans of their adrenal glands could be used as a screening test for FIC if sensitivity and specificity are determined.

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<tr>
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<tr>
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<td>6 MN, 1 FI, 8 FS</td>
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<td>46.6 ± 4.3</td>
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Supported by NIH-NIDDK DK 47538, 64539 and 09958
DYNAMIC COMPUTED TOMOGRAPHY (CT) OF THE NORMAL FELINE PITUITARY GLAND. R Tyson, JP Graham and CR Berry. Veterinary Specialists Center, Central Florida Veterinary Radiology, P.A. Maitland, FL 32751.

Introduction/Purpose: CT and magnetic resonance imaging (MRI) represent excellent ways to evaluate the pituitary gland. The MRI enhancement characteristics of the feline pituitary gland have been described retrospectively.1 The feline pituitary measured 5 x 3 mm at its widest point on gadolinium enhanced T1-weighted images. The enhancement pattern was noted to be homogeneous, although, the time post injection was not recorded and cats were imaged because of intracranial disease, though cats with clinical signs referable to pituitary disease were excluded. The purpose of this study was to determine the normal appearance and contrast medium uptake pattern of the feline pituitary, feline pituitary mensuration and provide a basis for future clinical evaluation of the feline pituitary using dynamic contrast enhanced CT.

Methods: Dynamic CT imaging of the pituitary gland from 9 cats were evaluated after being determined to be normal based on physical examination, complete blood count, chemistry panel, and urinalysis. There were five female neutered and four male neutered cats. The average cat weight was 5.7 kg (range from 3.7 to 8.4 kg). The ages ranged from one to 12 years with two cats being of unknown age. A cephalic catheter was placed and each cat anesthetized and maintained using isofluorane anesthesia. Cats were placed in sternal recumbency and contiguous 1 mm transverse images were obtained using a third generation CT scanner.2 The pituitary gland was localized at the midpoint between the rostral and caudal clinoid processes in the sagittal plane and at the broadest part of the sella turcica in the transverse plane. An intravenous bolus (0.5 ml/kg) of an ionic iodinated contrast medium3 was given via a pressure injector4 (5 ml/sec), with the onset of the bolus injection being at the time of acquisition of the third dynamic transverse image. Dynamic images were obtained every five seconds for five cats and every seven seconds for four cats. Pituitary measurements obtained included: maximum pituitary height and width, time to peak contrast enhancement, and pattern of contrast enhancement. Time-attenuation curves were created from regions of interest (ROI) hand drawn around the maximum pituitary enhanced image, with the ROI subsequently being applied to the entire dynamic data set. These curves were fit using a mono-exponential, least squares analysis. Decay constants and 50% clearance half times were calculated and averaged.

Results: One cat moved after contrast medium injection and was not included. The mean width and height of the pituitary gland was 0.52 ± 0.04 cm and 0.31 ± 0.03 cm, respectively. The average time to peak contrast enhancement was 28.6 ± 14.8 sec, (range: 14 to 50 sec). Four cats had initial dorsal and peripheral contrast enhancement followed by homogenous appearance. The other four cats had an initial homogeneous contrast enhancement pattern that persisted throughout the dynamic acquisition. The average decay constant and 50% clearance half time was similar to that reported for dogs and will be presented5.

Discussion/Conclusion: The normal CT appearance, mensuration and enhancement pattern of the pituitary gland will provide a foundation for evaluating cats with potential pituitary disorders.

2 Sytec Sri, GE Medical Systems, Waukesha, WI
3 RenoCal-76®, Bracco Diagnostics, Princeton, NJ 08543
4 MedRad Mark V®, Indianola, PA
Anteversion angle of the femur has been measured to quantify femoral malformation in the dog. Accurate positioning of the femur and subsequent filming can be difficult with conventional radiography. Three dimensional reconstruction from CT data and subsequent image manipulation simplifies this measurement.

Anteversion angles measured on conventional radiographs, CT cross sectional images and volume rendered images are compared in dogs presented with patellar luxation. These measurements are also compared to gross examination in five cadaver specimens.

The advanced capabilities of the 3-D workstation can be a double edged sword, while some measurements are simplified, potential for error can also increase.
THE EFFECTS OF PATIENT POSITIONING AND SLICE SELECTION ON CANINE ACETABULAR ANGLE ASSESSMENT WITH COMPUTED TOMOGRAPHY


**Introduction:** Many imaging techniques for the canine hip exist. Recent publications have used computed tomographic imaging to acquire acetabular angles (AA) and dorsal acetabular rim (DAR) angles to assess patient response post juvenile pubic symphysiodesis surgery. The criteria for slice selection is somewhat subjective. Because the pelvis is a complex structure, minor variations in patient positioning and slice selection may affect the ability to accurately assess post-surgical changes. The purposes of this study were to evaluate the effects of patient positioning and slice selection on AA and DAR angles as measured with CT, and to investigate a new method which may eliminate the effects of pelvic tilt and improve repeatability in slice selection.

**Methods:** Twelve medium-to-large mixed breed canine cadavers with no radiographic evidence of lumbar or pelvic abnormalities were used in this study. 1mm contiguous transverse slices were acquired through the acetabula with the cadavers in sternal recumbency. Transverse CT scans were repeated with the gantry tilted forward and backward 5 degrees to mimic potential changes in pelvic tilt between studies for a given patient. The slice which corresponded with the center of the acetabulum was determined for each scan using previously described methods. Five 1mm slices were evaluated, including 2 cranial and 2 caudal to the central slice, for each scan. AA and DAR angles were measured in triplicate. On six of the cadavers, a template was used as a guide to adjust the tilt angle of the gantry in reference to the floor of the sacral canal. This was repeated by three operators. The AA and DAR angles for each additional scan were measured one slice immediately cranial to the obturator foramina. Finally, eight anesthetized dogs were positioned by three different investigators and a lateral scout image was generated. Pelvic tilt was measured. Variations in pelvic tilt were calculated between repositioning events.

**Results:** Gantry (pelvic) tilt of 5° had significant effects on angle measurements. Slice selection had significant effects on acetabular angle measurements but not on DAR angle measurements. When bearing off of the floor of the sacral canal, there was no significant difference between operators in AA or right DAR angle. The mean variation in pelvic tilt was 4.6° between repositioning events, with the largest variation being 22.4°.

**Discussion:** We found significant variations in angle measurements with small differences in patient positioning or slice selection. Unless pelvic tilt is recorded and an attempt is made to reproduce that tilt on a follow-up study, calculating changes in acetabular angles from one study to the next is prone to some error. Slice selection also had a significant effect on acetabular angles. This effect was minimized when the gantry was tilted forward 5°. In an attempt to decrease positioning effects the use of an anatomic bearing point, such as the floor of the sacral canal, may be advantageous.
Introduction: Computed tomography arthrography (CTA) is recognized in people to be a highly sensitive and specific means of evaluating stifle joint ligamentous pathology. The purpose of this study was to investigate the utility of CTA for identifying ligamentous structures in the normal canine stifle and establish a repeatable imaging protocol.

Methods: Eight hind limbs harvested from 5 cadaver beagle dogs (<20kg) were evaluated. Standard mediolateral and 15° caudodistal-cranio proximal radiographs of the stifle were made to screen for joint pathology. For CT imaging, each limb was positioned feet-first toward the gantry with the cranial surface of the limb apposed to the CT couch (sternal recumbency with the hind leg extended caudally). A lateral pilot image was made for planning. The CT gantry was tilted such that the plane of scanning was parallel to the tibial plateau. One-millimeter transverse contiguous pre-arthrography CT images were acquired in a bone algorithm using 130 kVp, 125 mAs, and FOV of 90-mm. Intra-articular injections of Iohexol contrast medium at iodine concentrations of 300 mg I, 150 mg I and 75 mg I were investigated. Contrast medium was injected into the stifle joint with a 22-gauge needle via a medial approach just distal to the patella at a volume of 0.3ml/cm lateromedial thickness of the stifle joint. Stifle joints were repeatedly flexed and extended to ensure distribution of contrast medium throughout the joint. CT imaging was repeated. CT images were reconstructed in dorsal, parasagittal and oblique planes. All stifle joints were necropsied after imaging to verify absence of gross joint pathology.

Results: Iohexol 150mg I was the preferred concentration for evaluation of the stifle joint with CT. A window width of 3000 and level of 400 were standard for viewing CT and CTA images. The following ligamentous structures were identified on transverse images in all stifles following CTA: cranial cruciate ligament, caudal cruciate ligament, medial meniscus, lateral meniscus, meniscofemoral ligament, cranial meniscotibial ligaments, caudal meniscotibial ligaments, intermeniscal (transverse ligament) and the medial and lateral collateral ligaments of the stifle. The patellar tendon was identified on transverse and reconstructed dorsal and parasagittal CT and CTA images in all stifles. Multiplanar reconstructions were helpful for further evaluation of cruciate (dorsal and oblique) and meniscal (dorsal and parasagittal) ligament continuity. The medial and lateral collateral ligaments were inconsistently identified on multiplanar reconstructed images.

Conclusion: The ligamentous structures of the normal canine stifle were easily identified using CT arthrography. Multiplanar reconstructions were helpful for complete evaluation of cruciate and meniscal ligaments and the patellar tendon. The sensitivity and specificity of CTA for the diagnosis of stifle ligament pathology in the dog is currently being investigated.
THORACOLUMBAR SPINAL CORD ATROPHY AND VERTEBRAL CANAL STENOSIS IN DOGS WITH DEGENERATIVE MYELOPATHY. J.C. Jones DVM, PhD; K.D. Inzana DVM, PhD; J. H. Rossmeisl, DVM, MS; K.M. Butler, T. J. Wells. Department of Small Animal Clinical Sciences. Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA 24061-0442

Introduction:
Degenerative myelopathy (DM) is a neuro-degenerative disorder that most commonly affects large breed dogs, especially German Shepherds. The disease may mimic other thoraco-lumbar myelopathies in that affected dogs also suffer progressive hindlimb dysfunction and urinary/fecal incontinence. Clinical diagnosis of DM is usually based on exclusion of other possible causes of neurologic signs. Definitive diagnosis requires histopathologic demonstration of diffuse axon and myelin degeneration of the spinal cord white matter. The cause of DM in German Shepherds is believed to be immune-related, but the triggering mechanism remains unknown. Myelographic and MRI examinations of DM dogs at our teaching hospital have demonstrated a subjectively small spinal cord with mild, multi-focal type II disc protrusions in the thoracolumbar region. We developed a theory that spinal cord atrophy and mild, multi-focal vertebral canal stenosis may be associated with DM in dogs. Since initiation of our study, other investigators have also reported this theory. The purpose of this prospective study was to describe CT morphometric characteristics of the thoracolumbar spine in DM versus normal dogs.

Methods:
Eight client-owned dogs diagnosed with DM and three clinically-normal research dogs were used in the study. A board-certified veterinary neurologist examined all dogs. Diagnostic criteria for inclusion of DM dogs were: consistent signalment, history and neurologic exam findings; no evidence of significant spinal cord compression on myelography; and no evidence of inflammatory cells in the cerebrospinal fluid. Computed tomography of the T11-L2 vertebrae was performed in all dogs immediately following myelography. Spinal cord (SC), dural sac (DS), vertebral canal (VC), and vertebral body (VB) area measurements were made at four slice locations for each vertebra. Mean area ratios (SC:DS, DS:VC, VC:VB) for DM and normal dogs were calculated and graphically compared, by slice location and vertebra.

Results:
Multi-focal type II disc protrusions and areas of decreased spinal cord size were identified in CT images of all DM dogs. Minimal to mild extradural compression was seen at disc protrusion sites. The diagnosis of DM was confirmed by histopathologic examination in one dog. Mean SC:DS ratios for DM dogs were numerically smaller than those for normal dogs at the T12-13 disc and from mid L1 to mid L2. Mean DS:VC ratios were numerically smaller from mid T11 to cranial L2. Mean VC:VB ratios were numerically smaller at the T11-12 disc, mid T12, T12-13 disc, T13-L1 disc to mid L1, cranial L2, and mid L2.

Discussion:
Findings support the theory that spinal cord atrophy and mild, multi-focal vertebral canal stenosis may be associated with DM in dogs. Future studies in a larger number of dogs are needed to determine if associations between these characteristics and DM are statistically significant.
THICK-SECTION REFORMATTING OF THINLY COLLIMATED COMPUTED TOMOGRAPHY FOR REDUCTION OF SKULL-BASE RELATED ARTIFACTS IN DOGS AND HORSES
Yael Porat-Mosenco, Tobias Schwarz & Philip Kass*
University of Pennsylvania School of Veterinary Medicine, Philadelphia, PA, School of Veterinary Medicine, University of California, Davis, CA*

Introduction: Skull-base related artifact are common important artifacts limiting the diagnostic value of brain computed tomography (CT) in humans and animals most prominently seen in the caudal fossa, between the thick petrous temporal bones. The addition of thinly collimated slices for reformatting of thick-section images has been shown to reduce skull-base related artifacts in humans. The purpose of this study was to test the efficacy of this method in canine and equine CT brain scans.

Materials and methods: CT of the caudal fossa of 10 canine and 9 equine cadaver heads was performed with 1 mm (thin collimation) and 5 mm slice width (conventional images) in dogs and 2 and 10 mm in horses. Reformatted images of 5 and 10 mm section thickness respectively were created by addition of thinly collimated images on standard CT software. A total of 152 images (76 pairs of conventional and reformatted images of identical anatomic locations) were evaluated with a subjective scoring system by 4 radiologists for magnitude of artifacts and image noise and with an objective artifact assessment based on magnitude of standard deviation (SD) of attenuation values in the interpetrosal region. Median subjective scores and objective values were calculated per head, species and reviewer for conventional and reformatted images. Median score and objective value differences between image types were calculated per species. Exact Wilcoxin signed-ranks for paired data were performed to evaluate differences in medians.

Results: There was a statistically significant reduction of artifact magnitude in canine and equine brains on reformatted images compared to conventional ones based on subjective scoring (30% & 50% respectively) and objective assessment (23% & 39 % respectively). There was no significant difference in image noise between the two image types.

Discussion: Thick-section reformatting of thinly collimated CT images significantly reduces skull-base related image artifacts and enhances diagnostic quality in canine and equine heads compared to conventional CT images, without significantly increasing image noise. To limit CT tube load, a scanning protocol with conventional imaging of the cranial and middle fossae and thin collimation imaging only of the caudal fossa can be performed. Post acquisition reformatting can be accomplished within less than a minute.
A TECHNIQUE FOR CONTRAST ENHANCED CT EXAMINATION OF THE EQUINE DIGIT
SM Puchalski, DVM, LD Galuppo, DVM, ER Wisner, DVM, WJ Hornof, DVM, MS University of California, Davis, Davis, California

Introduction: Lameness arising from the foot is one of the most commonly diagnosed lameness conditions in both performance and pleasure horses. Widespread clinical observations have shown that heel pain likely arises from many different structures within the hoof capsule including both the bone and soft tissues. Superimposition and the inability to resolve specific soft tissue structures limit radiology and scintigraphy in diagnosing soft tissue injuries. The hoof capsule and anisotropy limit the use of ultrasound. Magnetic resonance imaging is useful but it has limited availability. Computed tomography is useful in the identification of soft tissues and bone and we hypothesized that contrast enhanced CT of the digit will identify areas of increased vascular permeability (inflammation). Non-selective contrast administration in the horse is impractical and can be cost prohibitive. The objective of this study was to develop a reliable technique to inject contrast medium into the median artery during a CT scan of the equine digit.

Methods: Five normal horses without evidence of lameness were anesthetized and positioned in lateral recumbency in the CT gantry. The medial aspect of the antebrachium was clipped and prepared for aseptic catheter placement. A 10MHz linear ultrasound probe was used to guide a 20g catheter into the median artery. The catheter was connected via a pressure extension set to a pressure injector. Three helical CT runs were performed. The first non-contrast run was performed using 5mm slice thickness that extended from the mid portion of the first phalanx to the end of the third phalanx. The second CT scan was performed at a fixed location that included the navicular bone and bursa, the deep digital flexor tendon and the collateral ligaments of the distal interphalangeal joint. A 1 cm slice thickness was used and images were obtained every other second for 90 seconds before, during and after infusion of dilute iodinated contrast material. The infusion rate was 3mL/s. A third helical run was performed identical to the first run during a 2mL/s infusion of contrast material. The images were evaluated subjectively for patterns of contrast enhancement.

In addition, six clinical cases have been studied in the described manner. All of the horses had varying degrees (2-4/5) of lameness that was alleviated with palmar digital nerve anesthesia. These horses showed alteration from the patterns of contrast enhancement that were seen in the normal horses.

Results: Preliminary results show that this technique is reliable and safe and that horses have predictable patterns of contrast enhancement. The localization of the median artery and catheterization can be performed with ultrasonographic guidance and this procedure proved to be repeatable. Of the five clinical cases that had this procedure, the diagnosis of deep digital flexor tendinitis (2), distal interphalangeal collateral ligament rupture (1), deep digital flexor tenosynovitis (1) and no abnormal findings (1) have been made.

Discussion: This study demonstrates that this technique of contrast enhanced computed tomographic examination of the equine distal limb is feasible, safe and clinically useful. It allows interrogation of specific bone and soft tissue structures within the hoof capsule that are inaccessible to many of the commonly available diagnostics.
COMPUTED TOMOGRAPHY OF EXTRADURAL ABSCESSSES OF THE THORACIC SPINE IN TWO QUARTERHORSE FOALS. D.S. Rosenstein, D.V.M., C.M. Brown, B.V.Sc. Michigan State University College of Veterinary Medicine, East Lansing, MI 48824

Introduction: Spinal abscesses have been reported in horses in association with discospondylitis and vertebral osteomyelitis. Radiographic osseous abnormalities may be detectable in advanced cases of vertebral osteomyelitis and traumatic fracture while myelography is helpful for localization of a spinal compressive lesion. This report describes two Quarter Horse foals that presented for bilateral pelvic limb paresis, in which computed tomography was most useful for visualization of the lesions.

Case Summaries: Foal A was a two-week-old Quarter Horse filly that presented for acute, bilateral pelvic limb paresis. Radiographs of the spine and pelvis did not demonstrate a lesion. Myelography was performed and a focal compressive lesion was localized to T2 and T3. Computed tomographic (CT) examination was performed immediately following the myelogram and a focal, extradural mass effect was present at T2-T3, causing displacement of the spinal cord. A poorly marginated lesion, of low CT density, extended from the extradural lesion into the subscapular muscles. Exudative material aspirated from the intramuscular lesion was identified as *Streptococcus zooepidemicus*. The foal was euthanized and the post mortem examination confirmed the presence of an intramuscular abscess that extended into the vertebral canal, involving the meninges at T3.

Foal B was a 4-week-old Paint filly that presented for acute onset, bilateral pelvic limb paresis. Clinical signs began two weeks prior to presentation. Radiographs of the spine did not demonstrate a lesion. Myelography was performed and a lesion was localized to the ventral extradural space at T6. A CT scan demonstrated an extradural mass effect at the level of T6 with osteolysis of T6 and the head of the sixth right rib. The mass extended into the adjacent dorsal pleural space. The foal was euthanized and the post mortem examination confirmed the presence of vertebral osteomyelitis and an extradural abscess.

Conclusion: Myelography is useful for localization of a thoracic spinal compressive lesion, however it is insensitive for visualization of adjacent soft tissue or subtle osseous lesions. Computed tomographic images provide further information about the extent of a paraspinal lesion and involvement of surrounding tissues. Both modalities are indicated in the diagnostic plan for cases of acute pelvic limb paresis.
INTRODUCTION: The characterization of normal and pathologic changes of bone marrow using magnetic resonance imaging (MRI) has been described in people but there is limited information available in animals. The purpose of this study was to describe normal MRI of bone marrow in the lumbar spine, pelvis, and femur of adult dogs.

MATERIALS AND METHODS: Seven adult greyhounds (2-7 years) were imaged in a 0.3 Tesla magnet with a small body coil. The dogs were positioned in dorsal recumbency with the femurs extended and parallel to both the table and each other. Sagittal scans of the femur, coronal scans of the pelvis, and sagittal scans of the lumbar spine were obtained. For all areas T1-weighted (TR=600; TE=25), T2-weighted (TR=3,100; TE=119), and STIR (TR=2,000; TE=25) sequences were performed. Magnetic resonance images were evaluated for signal intensity, distribution, and pattern of bone marrow. Histopathology was performed on the 6th lumbar vertebral body, the wing of the ilium, and the femur (head and neck, mid-diaphysis, condyle) for evaluation of cellular and fat content.

RESULTS: MRI findings for the lumbar spine and ilium were similar in all dogs. The bone marrow of the lumbar vertebral body and wing of the ilium was uniform, of medium signal intensity and isointense to muscle on T1-weighted and STIR images. On T2-weighted images the vertebral bodies remained of intermediate signal intensity that was isointense or slightly less than muscle. There was a linear to patchy area of variable signal intensity in the mid-body of the ilium. This area was increased in signal intensity on T1-weighted and T2-weighted images, and hypointense on STIR images.

On T1-weighted images, the femoral heads were iso- to hyperintense to the femoral neck. T2-weighted images showed uniform intermediate signal intensity in the femoral head and neck. The femoral head was very low signal with intermediate signal of the femoral neck on STIR images. In the proximal and mid-diaphysis of the femur there was patchy high signal intensity on T1-weighted and T2-weighted images, and hypointense foci on the STIR images. The distal femoral metaphysis had a variable pattern ranging from intermediate to high signal on T1-weighted and T2-weighted images and intermediate to low signal on STIR images. The femoral condyles were uniformly high signal on T1-weighted and T2-weighted images and hypointense on STIR images.

Histopathology showed normocellular marrow (25-75% cellularity) for all sites examined except the femoral condyles, which were hypocellular (< 25% cellularity).

DISCUSSION AND CONCLUSION: The establishment of normal MRI signal pattern of the bone marrow in veterinary patients is important because of the increased use of MRI of the musculoskeletal system. The MRI signal pattern and distribution of bone marrow in the lumbar spine and pelvis is similar for adult greyhounds. There is both intra- and inter-dog variability of the MRI pattern of bone marrow in the femur.

Introduction/Purpose:
Magnetic resonance imaging of equine extremities and the head is routinely performed at our institution. This retrospective study describes the appearance of the normal equine pituitary gland using magnetic resonance. Description of the normal size, shape, and paramagnetic properties of the equine pituitary is important as a reference for future studies of horses with potentially abnormal pituitary characteristics.

Methods:
Nineteen live horses greater than one year of age were imaged in a 1.0 Tesla magnetic resonance system for evaluation of a variety of medical conditions such as headshaking, central neurologic signs, narcolepsy, head trauma, and suspected nasal sinus disease. The horses were imaged during the period from January 1998 to June 2003 and included two stallions, nine geldings, and eight mares of a variety of breeds. The range of ages was 2 to 27 years with a mean of 10 years. The weight range of the horses was from 885 to 1380 pounds with a mean of 1114 pounds. Medical records were reviewed for evidence of pituitary dysfunction, final clinical diagnosis, or final necropsy result when available. All horses in the present study were considered to have normal pituitary function. A variety of sequences were evaluated for appearance of the pituitary gland. Non-contrast T1-weighted transverse sequences were available on all studies and were used to maintain a consistent comparison. Measurements were made using electronic calipers on digital images. Measurements were taken at the greatest height and width in the transverse plane. Shape and appearance characteristics were recorded.

Results:
In the 19 horses, the average size of the pituitary gland was 8.7 mm +/- 0.2 mm in height (range 6 to 12 mm) and 20 mm +/- 0.3 mm in width (range 15 to 25 mm). All pituitary glands exhibited a central circular hyperintense region on pre-contrast T1-weighted images. This hyperintense region measured on average 4.6 mm in diameter with a range 3 to 8 mm. The majority of the pituitary glands had a bilobed shape in the transverse plane.

Discussion:
The equine pituitary gland is easy to recognize and measure. The equine pituitary glands contain a similar characteristic hyperintense spot that is seen in humans, cats, and dogs. In this study the hyperintense spot was more frequently noted (19/19) than in studies on other species. The relative large size of the central hyperintense area of the equine pituitary gland may serve as an excellent model for further histopathologic and chemical analysis of this region. This study should serve as a standard for comparison of potentially abnormal equine pituitary glands as seen on magnetic resonance.
EVALUATION OF VARIOUS SEQUENCES WITH AND WITHOUT GADOLINIUM ENHANCEMENT FOR MR IMAGING OF EQUINE ARTICULAR CARTILAGE. N.M. Werpy, D.V.M., M.S. Shearin, B.S., C. E. Kawcak, D.V.M., PhD, R. D. Park, D.V.M., PhD. Department of Environmental and Radiological Health Sciences and The Orthopaedic Research Center, Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO. 80523.

INTRODUCTION
Osteochondral injury is of great importance in equine athletes and can result in career-ending or catastrophic injury. Osteochondral damage, including osteochondral fracture, fragmentation and osteoarthritis, occurs commonly in the metacarpophalangeal (MCP) joint in horses. Current diagnostic techniques, such as radiology and ultrasound, can be used to demonstrate severe articular cartilage degradation. Magnetic resonance (MR) imaging has been shown in humans to be superior to current imaging techniques because it provides a 3-D image and is sensitive for assessment of articular cartilage. Gadolinium uptake in articular cartilage has been correlated with GAG content in human literature. Gadolinium enhancement of articular cartilage would allow detection of early degradative changes prior to the development of macroscopic lesions. Implementation of this technique in veterinary medicine requires the development of sequences that maximize MR imaging of articular cartilage and subchondral bone. The purpose of this study was to evaluate various MR sequences in order to determine the most appropriate technique to maximize imaging of articular cartilage and subchondral bone with and without intraarticular gadolinium administration.

METHODS
Twelve normal equine MCP joints were obtained and scanned in a GE Signa 1.5 Tesla MR machine. The following sequences were obtained: PD Fat Saturation, T2 Weighted, STIR, T2* Gradient Echo, T1 Weighted Spin Echo, 3D Gradient Echo, and 3D Gradient Echo Fat Saturation.

Gadolinium dimeglumine (MagnevistR, 0.1 ml of 469.01 mg/ml) was diluted in 20 mls of saline along with .3 ml epinephrine (1:1000) and injected into the palmar aspect of the MCP joint. The joints were scanned 1 hour later using the above sequences.

Images are currently being subjectively evaluated by 3 independent observers and ranked for visualization of articular cartilage. Furthermore, image will be exported to a proprietary software program for objective comparison of T1 signal before and after gadolinium enhancement. Results are pending.

REFERENCES
THE CLINICAL USE OF STANDING EQUINE MRI TO INVESTIGATE FOOT LAMENESS

J Kinns BSc, VetMB, MRCVS and T.S. Mair BVSc, PhD, DEIM, MRCVS.

Introduction: Foot pain is the most common cause of equine lameness. Open human MRI systems have been in use for several years to assess the soft and mineralised tissues of horses with foot lameness, but general anaesthesia has been necessary for MR assessment. A low field MRI system has now been developed for use in the standing horse. The purpose of this study was to assess the clinical use of the system in 30 horses presenting with foot lameness.

Methods: The records of 30 horses presenting for MR evaluation of foot lameness over a 6-month period were reviewed. The lameness was isolated by response to abaxial sesamoid perineural analgesia. Standard radiographic views of the foot and pastern were taken in all cases. Ultrasound of the pastern region was performed in 10 cases and scintigraphic evaluation in 8.

MRI was performed using a 0.21T low field open U-shaped magnet with a transmitting and receiving radio frequency coil fitted around the foot. The patient was positioned in stocks and sedated prior to movement of the magnet in to place. A standard protocol was applied for scanning of the foot. 3-D T1 (TR 40, TE 7, flip angle 60°), multislice T1 (TR 120, TE 7, flip angle 90°), FSE T2 (TR 2000, TE 80) and STIR (TR 1700, TE 20, TI 67ms) weighted sequences were taken in sagittal, transverse and frontal planes.

Results: Pathological changes were identified in soft tissue, synovial structures and bone. These were isolated to the navicular bone (6 cases), the deep digital flexor tendon (6 cases), the navicular bursa (4 cases), the navicular collateral ligaments (3 cases), the distal interphalangeal joint collateral ligaments (3 cases), the digital sheath (2 cases) and the distal sesamoidean impar ligament (2 cases). In 4 cases there were no significant findings.

Conclusion: These findings support the clinical use of low field MRI in the standing horse. The changes identified are consistent with those found using conventional MRI. In all cases radiographic, ultrasonographic and scintigraphic evaluation had been inadequate to identify the cause of lameness. This study indicates that standing MRI is a practical and effective way of evaluating foot lameness that avoids the necessity for a general anaesthetic.

References:
RADIOGRAPHIC, ULTRASONOGRAPHIC (US) AND COMPUTED TOMOGRAPHIC (CT) APPEARANCE OF ALVEOLAR ECHINOCOCCOSIS IN DOGS – 11 CASES

G. Scharr1, Dr. med. vet., P. Deplazes2, Dr. med. vet., B. Kaser-Hotz1, Dr. med. vet., L. Borger3, Dr. med. vet., A. Hasler4, Dr. med. vet., M. Haller4, Dr. med. vet., M. Fluckiger1, Dr. med. vet..

1Diagnostic Imaging and Radio-Oncology, 2Institute of Parasitology and 3clinic of small animal surgery, University of Zurich, Winterthurerstrasse 260, 8057 Zurich, Switzerland, 4Specialists in internal medicine, private practice in Switzerland.

Introduction: Alveolar echinococcosis (AE) caused by the metacestodal stage of Echinococcus multilocularis is a rare infection of humans and domestic animals (e.g. dog, monkey). In these aberrant hosts, the disease is often fatal if left untreated. In humans, clinical diagnosis is based on serology, ultrasonography (US), computed tomography (CT) and magnetic resonance imaging (MRI). These techniques have not yet been validated for diagnosis of AE in dogs. Therefore, the purpose of this retrospective study was to a) analyse the clinical findings and b) describe the radiographic, ultrasonographic and CT appearance of canine AE.

Methods: Eleven dogs were included in the study. They were diagnosed between 1995 and 2003 with AE using PCR or histology. Abdominal US was performed in 10 dogs. In nine animals abdominal radiographs were available for analysis. In one dog, CT studies performed 14 and 22 months after surgery could be evaluated. After surgical and subsequent medical therapy with albendazole (10 mg/kg) seven animals went into clinical remission and presented at least once for follow-up, including a physical exam and ultrasonography.

Results: The age of the dogs at initial presentation ranged from 7 months to 10.5 years (median 4.1 years, mean 5.25 years). Four dogs were male, seven female. Predominantly medium to large breed dogs were included. The history and clinical examination revealed a progressively distended non-painful abdomen (9/11) and non-specific symptoms, such as vomiting, decreased appetite or soft faeces. The most frequent biochemical abnormality was hypoalbuminemia (7/11) and elevated globulin (3/11). Radiographically, liver masses were identified in all animals. Abdominal detail was reduced in five dogs. The liver masses frequently contained small mineralizations (5/11). On US, cystic masses were visualized in nine animals, whereas in one dog the masses were round, hyperechoic and granular. In seven dogs multiple large caverns of up to 17 cm diameter with an irregular, thick capsule were seen. Small mineralizations within the capsule were found in five dogs. In one dog, completely and irregularly calcified cysts of 0.5-5 cm diameter were noted. In another dog, small thin-walled cysts of 0.5-3 cm diameter were seen at the periphery of round, hyperechoic granular masses of 6-7 cm diameter. Peritoneal effusion was present in four animals, a patchy omentum and enlarged mesentery lymph nodes were noted in two. On CT, multiple cystic masses between 2 and 5 cm in diameter were visualized. In all cysts there was a distinct hyperdense wall (35-100 Hounsfield Units (HU)) and a hypodense center (20-35 HU).

Discussion: The history, clinical presentation, and laboratory work-up for all dogs were unspecific. Radiographically, all dogs had large liver masses with peritoneal effusion in a minority of the cases. The most frequent US-finding was multiple large cavernous masses, with or without wall mineralizations. Such an ultrasonographic appearance must be differentiated from primary or metastatic neoplasia, liver abscesses, granuloma, haematoma or congenital cysts. In people, the ultrasonographic characteristics of AE includes cavernous lesions at the porta hepatis, micro-calculifications and avascularity of the cystic wall. Imaging studies of additional cases may improve specificity of findings. In conclusion, in dogs with large, cavernous liver masses and unspecific history and clinic, AE should be included in the list of differential diagnoses.
CHARACTERIZATION OF LYMPHOMATOUS LYMPH NODES IN DOGS USING CONTRAST HARMONIC AND POWER DOPPLER ULTRASOUND. R.M. Salwei, D.V.M., R.T. O’Brien, M.S., D.V.M., J.S. Matheson, D.V.M. University of Wisconsin-Madison, School of Veterinary Medicine, Madison, WI 53706.

Introduction: In human medicine Doppler ultrasound has been used to determine angioarchitecture of lymph nodes as the criterion for the determination of malignancy. We hypothesized that the vascular and perfusion patterns of a canine malignant lymph node could be characterized with intravenous microbubble ultrasound contrast media, thus improving diagnostic and prognostic information.

Methods: In this study, 11 peripheral lymph nodes in dogs with histologically verified malignant lymphoma were imaged with fundamental ultrasound, Power Doppler ultrasound and three contrast harmonic pulse sequences to characterize the vascular pattern and perfusion.

Results: Vascular imaging was greatly enhanced in these nodes with 2.13 times more vessels seen with contrast harmonic ultrasound compared to Power Doppler ultrasound (p<0.01). The angioarchitecture of lymphomatous lymph nodes of dogs in this study were similar to those previously described in malignant superficial lymph nodes in human patients; 45.5% of the nodes had displacement of the central hilar vessel, 45.5% had aberrant vessels, 63.6% had pericapsular vessels, 36.4% had subcapsular vessels, and 81.8% had loss of the central hyperechoic band in fundamental sonography. Poor perfusion, indicated by a lower mean pixel intensity increase between pre- and post-contrast administration images, was seen in 36.4% of the lymph nodes while 63.6% had fair to good perfusion. The perfusion patterns in 9 of the 11 lymph nodes were homogenous and 2 showed focal hypoperfused regions.

Conclusion: We conclude that Power Doppler and contrast harmonic ultrasound are beneficial in accurately depicting angioarchitecture and determining the presence of malignant vascular characteristics within lymphomatous nodes in dogs.
CONTRAST HARMONIC ULTRASOUND FOR THE CHARACTERIZATION OF LIVER NODULES IN DOGS

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Introduction/Purpose: The goals of this project were to determine if contrast harmonic ultrasound, compared to fundamental grey-scale ultrasound, was clinically useful for 1) improved detection of nodules, 2) differentiating between malignant and benign nodule types, or 3) improved determination of particular histological types based on the contrast enhancement pattern.

Methods: twenty-eight dogs with histologically proven liver nodules were imaged with grey-scale and contrast harmonic ultrasound. Either Definity® (0.1 – 0.2 ml) or Sonovue® (0.5 – 1.0 ml) were injected into a cephalic vein catheter and imaged with an ultrasound machine system (Esaote Megas or General Electric LOGIQ 700 or LOGIQ 9) capable of low mechanical index perfusion mode imaging. Images were collected on a digital video camera and analyzed offline using image analysis software (ECHOTECH 3D Imaging Systems QuantiCon). A subjective review was performed as a group consensus to verify diagnostic quality of the scans, subjective determination of conspicuity compared to fundamental ultrasound and enhancement pattern characteristics. Quantitative analysis of each injection was performed. Objective and subjective criteria of enhancement pattern compared to normal adjacent liver included overall echogenicity and homogeneity at peak, wash-in time, washout time and number and location of large afferent vessels.

Results: Improved conspicuity and increased numbers of lesions were noted in most dogs with malignant nodules. Five distinct patterns were noted. Benign nodules (n=12), regardless of grey-scale echogenicity, had wash-in times, washout times and peak perfusion echogenicity similar to normal liver. Hemangiosarcoma (HSA) masses (n=4) had consistently peripheral small afferent vessels but very low overall nodule perfusion. This was the only tumor type that did not reach peak contrast enhanced intensity similar to normal liver. In one case the nodules were occult on fundamental ultrasound but too numerous to count with contrast. A similar peripheral vessel and overall perfusion pattern was noted with primary and metastatic HSA masses in lung and spleen and metastases to the omentum. Endocrine neoplastic nodules (n=2) had faster wash-in and washout times compared to normal liver with rim enhancement. Carcinoma, non-HSA sarcoma and round cells tumors (n=4) had fast wash-in and washout times compared to normal liver and no rim enhancement. The hepatocellular carcinomas (n=6) had many afferent vessels throughout the mass with heterogeneous enhancement at peak.

Discussion/Conclusions: These data indicate that contrast harmonic ultrasound improves the conspicuity and accuracy of determining number of malignant nodules. CHU also had improved characterization between benign and malignant nodules and for particular histological types. Hemangiosarcoma masses had a very distinctive perfusion pattern regardless of the organ in which the mass was located.

Introduction and hypothesis: Masses of the spleen may be benign or malignant. It would be useful to predict biological behavior of the splenic tumor from routine diagnostics, including imaging studies, prior to surgery. The null hypothesis of this study was that the following variables (sex, weight, age, abdominal effusion, packed red cell percentage (PCV), total solids (TS), white blood cell count (WBC), ultrasound size of mass, ultrasound size of mass divided by weight) would have no effect on whether the splenic mass was benign or malignant.

Materials and methods: A retrospective study was completed on records of dogs (n=70) splenectomized at Michigan State University Veterinary Teaching Hospital between 1997-2002. The following data were retrieved: Histopathology (benign/malignant), age, weight, sex, presence of abdominal effusion, PCV, TS, WBC, size of splenic mass on ultrasound. Exclusion criteria included diffuse or infiltrative disease processes of the spleen (such as lymphosarcoma), splenic torsion, or immune-mediated hemolytic anemia. Data were analyzed by multiple logistic regression.

Results: The following factors had no effect in the determination of benign vs. malignant: age, weight, sex, TS, WBC, ultrasound size, and ultrasound size divided by weight. Abdominal effusion increased the odds of malignancy by 6X (P=0.005). For every 10% decrease in the PCV, the odds of malignancy increased by 3X (P=0.002).

Conclusion: PCV and abdominal effusion may predict the biological behavior of a splenic tumor. Size, based on imaging studies, did not predict biological behavior in this study.

![Probability of Malignancy](image)

Figure 1: The probability that a splenic mass is malignant based on the pre-operative PCV
Introduction: Previous studies have shown that an intravascular thrombus associated with an adrenal tumor was correlated with increased incidence of regional and distant metastasis, and increased morbidity with surgery. The purpose of this study was to determine the sensitivity of ultrasound to detect vascular invasion associated with adrenal tumors.

Methods: This is a retrospective analysis of dogs that presented to the VTH at CSU between 1990 and 2001. Selection criteria included histological diagnosis of adrenal neoplasia, sonography, and surgery, that confirmed or denied vascular invasion. The ultrasonographic exams were analyzed by two independent reviewers. These findings were then correlated with surgery reports, necropsy findings or both. Results were statistically evaluated by Chi-squared crosstabs analysis.

Results: Thirty-six dogs with thirty-eight adrenal tumors fit the selected criteria for this study. Twenty-two adrenal masses without surgical or histological evidence of vascular invasion were all correctly characterized by sonography. Nine of fifteen cases with vascular invasion were correctly characterized by sonography. All nine cases had caudal vena caval thrombi. Sonography failed to in four cases to identify the vascular invasion found at surgery or histopathology which had occurred without development of a caudal venal caval thrombus. A false positive occurred with a caudal vena caval thrombus identified on ultrasonographic exam, but at surgery no mass was found in the caudal vena cava. Pearson Chi-square analysis using crosstabs showed statistical correlation with a P value of less than .001 of ultrasound to detect vascular invasion with adrenal tumors. Further statistical analysis revealed that of the malignant neoplasias, pheocromocytomas, followed by adenocarcinomas were most likely to have vascular invasion. Adenomas were least likely to have vascular invasion.

Conclusions: Sonography was found to be a sensitive tool in detecting vascular invasion of adrenal tumors. The limitations of sonography are related to the type of vascular invasion. Vascular invasion into the intimal tissue of a vessel wall (without thrombus formation) was not readily detected by ultrasound, whereas vascular invasion with a caudal vena caval thrombus formation was accurately detected (90% of the time).
AGE RELATED CHANGES IN THE ULTRASOUND APPEARANCE OF THE NORMAL FELINE PANCREAS  
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**Introduction:**  
Geriatric changes have been reported on ultrasound examination of the human pancreas. With increasing age, the pancreas may increase in echogenicity. In addition, the pancreatic duct may dilate with increasing age. Age related changes have not been reported in the feline pancreas. Normal aging changes could be misinterpreted as pancreatitis. This study was performed to determine if aging changes occur in the ultrasound appearance of the normal feline pancreas.

**Methods:**  
Ultrasound examinations were performed on 80 normal (based on physical exam, biochemical profile, and feline trypsin-like immunoreactivity and feline pancreatic lipase immunoreactivity assays) cats. There were 43 cats 5 years or younger, 22 cats between 6 and 10 years of age, and 15 cats older than 10 years. Thirty-nine cats were female/spay, 39 were male/neuter, and 2 cats were intact males. Cats were fasted overnight prior to scanning. The pancreas was scanned with a 8.5 MHz sector transducer, in longitudinal and cross-sectional planes. Measurements of the width of the body and left limb of the pancreas were made, along with pancreatic duct diameters at the same locations. The right limb was not consistently visualized and was not included in the study measurements. The echogenicity of the pancreas was compared to the liver and surrounding mesenteric fat.

**Results:**  
There was no significant difference in the width of the pancreatic body versus left limb in each cat. Pancreatic duct diameters in the left limb versus body also showed no difference. Pancreatic width ranged from 2.6-9.7mm, with a mean of 5.4mm. Pancreatic duct diameter ranged from 0.6-2.5mm, with a mean of 1.1mm. There was no correlation of age or body weight with pancreatic width, pancreatic duct diameter, and pancreatic echogenicity. The pancreas was similar in echogenicity to the liver in all cats except for 2, in which it was hyperechoic to liver.

**Conclusion:**  
Pancreatic thickness was similar to previous reports. Pancreatic duct diameter was slightly greater than reported. There does not appear to be age related change in the ultrasound appearance of the normal feline pancreas.
ULTRASONOGRAPHIC APPEARANCE OF OVARIAN CHANGES DURING THE PERI-OVULATORY PERIOD IN FEMALE DOGS

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Introduction: Early reports of ultrasonography described the canine ovary as only rarely visible; however, with technological advances the canine ovary and its follicular population have been described sonographically. Despite these advances, ovulation per se remains undetectable because follicular structures do not disappear at the time of predicted ovulation. The aim of this study was to describe ultrasonographic changes in the ovary during the peri-ovulatory period.

Material and methods: Twelve female greyhounds were examined twice a day from day –6 to day 9 relative to the day of estrus (day 0) to assess changes in ovarian morphology. The first day of estrus was defined as the first day on which the female accepted a male. Ultrasonographic examination was carried out using an Esaote Challenge ultrasound machine with a 7.5MHz sector probe. The scans were bilateral using an area approximately 5cm² on the dorsolateral body wall immediately caudal to the last rib. All visible follicles and luteal structures were measured in two dimensions. Ovarian follicles were divided into 3 classes based on the average diameter of the three largest follicles of each ovary: class 1 were <4 mm; class 2, 4-6 mm; and class 3 >6 mm. An ovulatory follicle was defined as a class 3 follicle with an increased wall thickness and a variable, rounded or oblong shape. A corpus luteum was defined as a rounded structure having hyper- to isoechoic walls compared to the surrounding ovarian parenchyma, with or without an anechoic center.

Results: The ovary and its structures were readily visualized by ultrasonography. Six days before estrus only class 1 follicles were detected. The size of follicles increased during proestrus and by the day of estrus class 2 and 3 follicles were detected. By day three, in addition to class 2 and 3 follicles, ovulatory follicles were detected in 3 of 24 ovaries. This pattern continued to day 6 when corpora lutea were detected for the first time. The early corpora lutea were characterized by anechoic central area with thin hyper- or isoechoic wall that made them difficult to distinguish from follicular structures. By day 9 corpora lutea were detected in 20 of 24 ovaries. The detection of ovulatory follicles was not reliable and they were seen in only 3 ovaries from 2 animals.

Conclusions: The results of this study show (i) it is possible to monitor follicular development over the peri-ovulatory period in the female dog; (ii) the ovulatory follicle cannot be detected with high reliability; (iii) the best indicator of ovulation may be the presence of a newly formed corpus luteum; (iv) newly formed corpora lutea can be confused with follicular structures because of the presence of a hypoechoic central area.
ACCURACY OF INCREASED LARGE-INTESTINE WALL THICKNESS DURING ULTRASONOGRAPHY FOR DIAGNOSING LARGE-COLON TORSION IN 42 HORSES.

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Abstract

Large-colon torsion is a common cause of colic in horses and has a worse prognosis and higher cost than other causes of surgical colic of the large colon. During large-colon torsion, the colon wall becomes thick due to vascular occlusion. Therefore, we hypothesized that detecting increased colon-wall thickness during ultrasonography would be an accurate pre-operative test for large-colon torsion. The sample population consisted of 42 horses that were admitted for surgical treatment of colic localized to the large colon. The diagnosis was confirmed at surgery or necropsy examination. Twelve (29%) of these horses were diagnosed with large-colon torsion. Duplicate ultrasonographic measurements of colon-wall thickness were made at 6 abdominal locations and an average measurement was calculated. For 4 of these 6 sites, a significant difference (p<0.005) was detected between horses with and without large-colon torsion. All 4 tests were highly specific and moderately sensitive for diagnosing large-colon torsion using 5 decision criteria. Using a ventral abdominal window, a colon-wall thickness ≥ 9 mm accurately predicted large-colon torsion in 8/12 horses (sensitivity, 67%; confidence interval [CI], 36 to 98%) and correctly predicted that large-colon torsion was absent in 28/28 horses (specificity, 100%; CI 98 to 100%). Intraobserver repeatability was assessed by evaluating the difference between the first and second measurement obtained, which was ≤ 2 mm. Therefore, detecting increased large-colon-wall thickness during ultrasonography is a reproducible and accurate pre-operative test for large-colon torsion in horses with surgical colic localized to the large colon.