SPECIAL

visions

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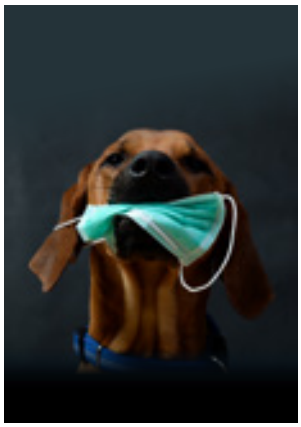
Portuguese Leading Vet Hospital Relies on the Aquilion Start

The Aplio i800 Takes Exotic Animals to the Next Level

Pushing the Bounderies in Veterinary Diagnostics

Advanced Diagnostic Capabilities Enable Veterinary Practice to Evolve

Canon



Cover Image:
This stockphoto reflects the current COVID-19 situation, the medical industry but most of all this VISIONS Special is about animals with the target audience the Veterinary industry.

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// EDITORIAL

Canon Medical Systems "Made for Life" philosophy is a long standing commitment towards our partners, patients, and you.
The "Made for Life" philosophy stands for improvement of the quality of life for all, humans and animals. Our mission is to provide medical professionals with solutions that support their efforts in contributing to the health and wellbeing of patients worldwide. Our goal is to deliver optimum health opportunities for patients through uncompromised performance, comfort and safety features.

An increasing Pet Ownership and Growing Technological Advancements in the Diagnostic Field, drive the Veterinary Diagnostics Market. Owners of all animals are increasingly looking for specialized care and hospital admission for their animals needing special treatment and expecting care as they would expect for themselves.
Adaptation to modern lifestyles and growing spending on animal healthcare, boosts the demand for high quality veterinary diagnosis and equipment.

Canon Medical offers a full range of diagnostic medical imaging solutions, for humans and animals, including CT, HIT, MR, Ultrasound and X-Ray.

- Computed Tomography: Canon provides a wide range of CT scanners, to mention a few, the Aquilion Start a compact CT system with impressive performance and the Aquilion Large Bore with its largest aperture ideally suited for Equine.
- Healthcare Information Technology: Vital's "Cloud Storage" assures optimized archiving and viewing solutions for those faced with a growing amount of image data.
- Magnetic Resonance: The compact Vantage Elan features advanced technologies and a variety of coils for high image quality in a wide range of anatomical regions and animal sizes.
- Ultrasound: Newly developed features like Micro-vascular Imaging (SMI), visualizes low-velocity microvascular flow in an unprecedented way.
- X-Ray: Our daughter company Oldelft Benelux specializes in customized diagnostic imaging such as integration and collaboration of different CE certified components, like Canon's Wireless Digital Imaging plates for digital Radiography and Fluoroscopy.

Canon Medical builds relationships based on transparency, trust and respect. Together as one, we strive to create industry-leading solutions that deliver an enriched quality of life. With more than 100 years in medical imaging expertise, we continue to follow and stay true to our "Made for Life" philosophy.

I would like to thank all our customers for their great work in animal healthcare, and their contribution to this VISIONS Special.

Kind regards,

HENK ZOMER
European Director - Veterinary
Canon Medical Systems Europe

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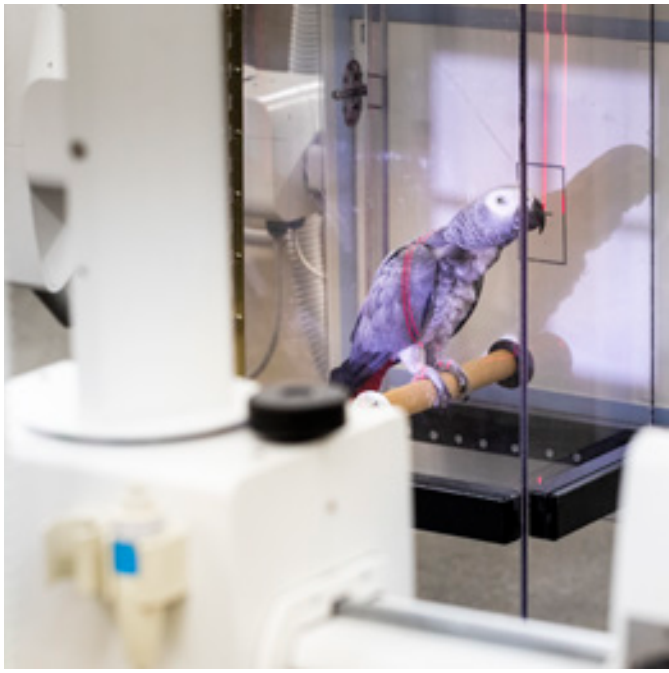

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X-RAY


Canon

VISIONS spoke with Dr. Lobo, Clinical Director of The Hospital Veterinário do Porto (HVP), Mr. Guilherme Assis, Managing Director of Onevet Group and Dr. Paulo Pimenta, who is Operations Director and Veterinary Surgeon.

Portuguese Leading Vet Hospital Relies on the Aquilion Start

The Hospital Veterinário do Porto (HVP) is a leading veterinary centre in Portugal that is part of the Onevet group, a company specialising in veterinary care, with 19 centres across the country. The HVP offers a wide range of services and covers many specialties, and uses the Aquilion Start for all its CT imaging procedures. Dr. Luís Lobo, Clinical Director of the Veterinary Centre, Guilherme Assis, Managing Director of Onevet Group and Dr. Paulo Pimenta, who is Operations Director and Veterinary Surgeon, explained why they chose Canon Medical to improve and expand their diagnostic imaging capacities.

Dr. Lobo's team of 27 includes 13 veterinarians and other profiles with various skills within veterinary medicine. "We are a mixture of experience and new perspectives regarding the approach to veterinary medicine.

All of us have a desire to learn and improve, and the drive to grow as veterinarian surgeons, making every effort to understand the precepts and procedures involved in this constantly evolving profession," he said.

The HVP was the first of its kind to perform minimally invasive surgery in veterinary cardiology in Portugal.

The centre also offers key services in anaesthesia and intensive care medicine, orthopaedics and traumatology, dermatology, animal behaviour, neurology, ophthalmology, feline medicine, gastroenterology and dentistry.

The number of patients - mainly cats and dogs - has grown steadily over the years, reaching about 3,300 patients in 2019 alone.

To keep on providing the best medical care, Lobo and his colleagues increasingly rely on diagnostic imaging. They use digital radiology and intraoral radiography, fluoroscopy, gastrointestinal and respiratory endoscopy and ultrasound.

CT pushes diagnostic capacities in many applications

Dr. Lobo and his colleagues have been using CT since 2000 and they bought the new Canon Medical's Aquilion Start a few months ago. The team and Onevet Group are so pleased with the negotiation process and support from Canon Medical that they've purchased another CT scanner for another site in Coimbra and are considering buying another by the end of the year.

Dr. Lobo is in charge of all CT acquisitions at the HVP and believes CT's diagnostic capabilities and ease of use can make it a first line diagnostic imaging tool in veterinary medicine.

He expects to use the Aquilion Start for complementary diagnostic imaging to x-ray and ultrasound, tumour staging, neurologic and orthopaedics diagnosis, as well as head pathology diagnosis and angiographic studies, among other tasks.

"Tumour staging and neurologic diagnosis are the most frequent indications for CT in our centre. Our knowledge of CT applications is growing and, in the future, I believe we´ll find it to be the best choice for a lot more examinations," he said.

Dr. Pimenta expects to carry out about 300 examinations with the Aquilion Start in its first year of use. "This kind of diagnosis will be used more and more and therefore we think the number of such scans will increase," he said.

The latest technology for faster exams

The HVP wanted a company that provides scanners featuring the latest technology available and adapted to veterinary medicine's peculiar needs: robustness, short acquisition times, ease of use, low radiation dose, small installation space, to name a few.

Another important decision driver was to have a relevant local after-sales support team, according to Guilherme Assis, Managing Director of Onevet Group. "We wanted a team based in the Portuguese market, but the impressions and testimonies collected with other international groups also influenced our decision," he said.

The Aquilion Start is a new product range with state-of-the-art technology and it is a good fit for veterinary medicine. The equipment is packed with premium technology originally developed for high-end CT systems and can be adapted to the changing requirements of healthcare organisations, including the need for faster workflows, universal accessibility, and sound economics. The scanner offers maximum patient comfort with its large gantry aperture of 78 cm. and superb imaging quality.

Particularly interesting in the Aquilion Start are rotation time, Flex e-Tilt technology and the range of acquisition allowing faster exams, the HVP doctors agree.

"Other important factors were the gantry aperture which is larger than the competition, and low radiation dosage, which is very important for our patients," Dr. Pimenta said.

The HVP chose the Aquilion Start with multi-slice CT, as it is particularly efficient in neurology, orthopedic and internal medicine specialties.

"The Aquilion Start is definitely well suited for veterinarian practice, and it is a fast and very user-friendly scanner that provides excellent image quality," Assis concluded.

"The Aquilion Start is definitely well suited for veterinarian practice, and it is a fast and very user-friendly scanner that provides excellent image quality."

Mr. Guilherme Assis, Managing Director of Onevet Group.

Onevet Group

Onevet Group was established January 2012 has a buy-and-build strategy in the Portuguese Veterinary Care industry, targeting the development of a nationwide corporate group. Currently holding 19 units, 7 hospitals and 12 clinics, with a reasonable geographical coverage. Nevertheless, the Group is more concentrated on the coastline, due to high concentration of urban population in those regions and low seasonality of those markets. Onevet Group encompasses both general practice vets and more specialized ones, including experienced in breakthrough fields as cardiology, oncology, ophthalmology and dermatology. Today Onevet Group counts with more than 200 staff and it's the largest veterinary care company operating in Portugal.

"Particularly interesting are rotation time, Flex e-Tilt technology for faster scan planning and the range of acquisition parameters allowing faster exams."

Dr. Paulo Pimenta, Operations Director and Veterinary Surgeon.

Biography

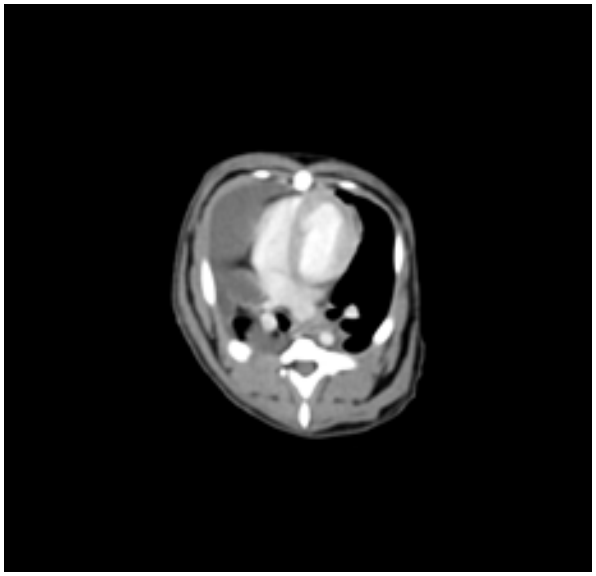
Dr. Luís Lobo obtained his Veterinary Medicine degree from Faculdade de Medicina Veterinária de Lisboa in 1992. He did his postgraduate in Internal Medicine at the European School for Advanced Veterinary Studies in Utrecht in 2003. He did his PhD in Veterinary Sciences at Abel Salazar Institute of Biomedical Sciences in 2011. Dr. Lobo is currently the Clinical Director of The Hospital Veterinário do Porto (HVP). He is the investigator at the Centre for the Study of Animal Sciences (CECA) in Porto University and Cardiology Professor at Lusofona University in Lisbon. Dr. Lobo is the founder and past president of the Portuguese Veterinary Cardiology Society. //

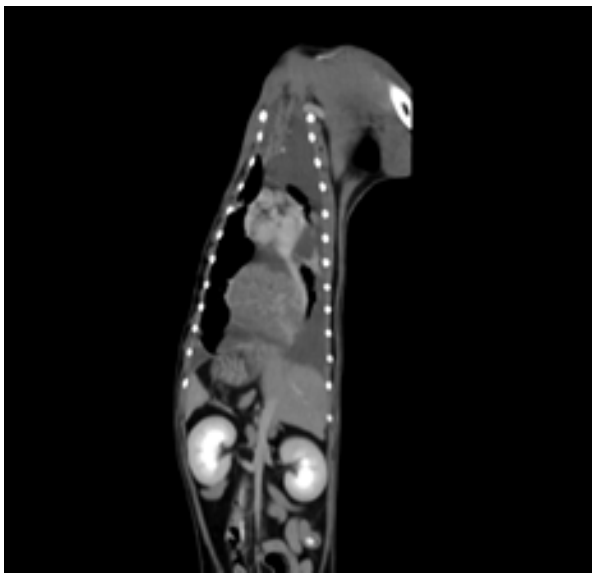
"Our hospital chose the Aquilion Start, as it is particularly efficient in neurology, orthopedic and internal medicine specialties."

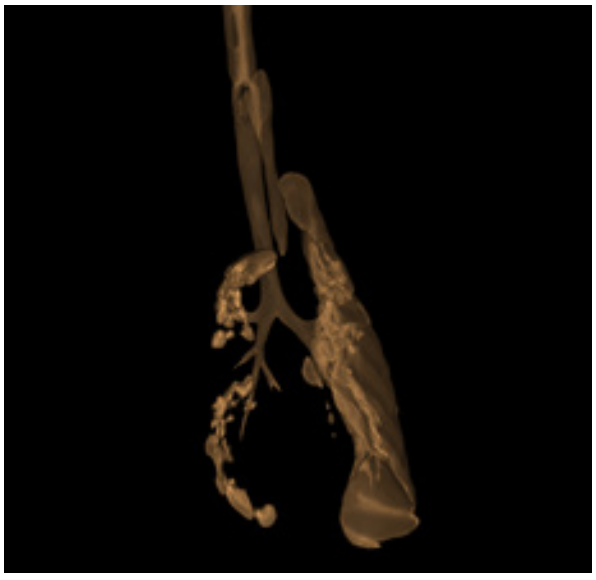
Dr. Luís Lobo, Clinical Director of the Hospital Veterinário do Porto (HVP).

Clinical case: European Cat

Diaphragmatic rupture with herniation of up to 3 hepatic lobes.







Clinical case: European Labrador dog

Metallic implants in the proximal tibia.

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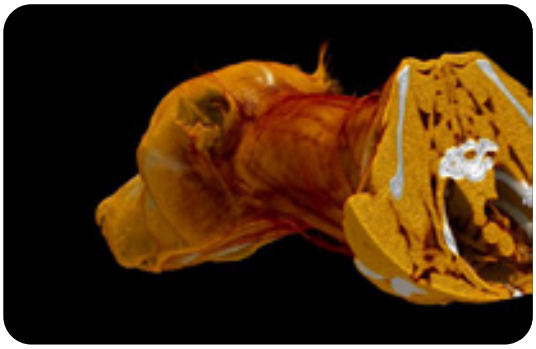

Aquilion Start

- Fits into small rooms
- Fast rotation speed
- Large gantry aperture
- Easy and fast patient positioning

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Made For life

The Aplio i800 Takes Exotic Animals Imaging to the Next Level

Ardiaca García, María; Bonvehí Nadeu, Cristina; Montesinos Barceló, Andrés.

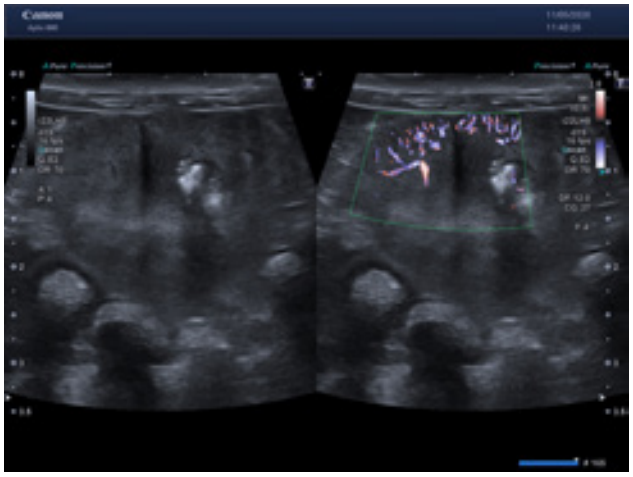
The Aplio i800 is a considerable advance in ultrasound technology, offering high-resolution images and high frequency transducers that are valuable in any clinical setting. The system's wide range of transducers and Superb Micro-vascular Imaging (SMI) modality have convinced a leading Spanish veterinarian to chose Canon Medical to carry out her ultrasound examinations. Dr. Maria Ardiaca, director of a veterinary centre specialising in exotic pets in Madrid, told VISIONS how she uses the Aplio i800 to diagnose and perform biopsies in her surprising patients.

Pythons, bearded dragons and cockatiels are not the traditional fauna in Spain, but they are typical patients at Los Sauces Veterinary Centre, a leading pet clinic located in the heart of Madrid. The facility has been caring for exotic pets since 1995, when it was launched by Dr. Andrés Montesinos, a pioneer in exotic animals medicine. The centre's nine veterinarians and seven nurses attend around 3,500 patients per year, from small mammals, birds, reptiles, amphibians, fish and even invertebrates.

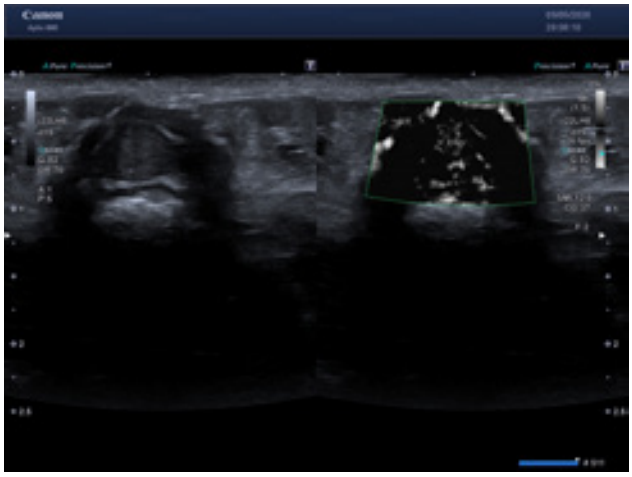
Exotic animals medicine: a growing and challenging field

Exotic veterinary medicine is experiencing a vertiginous development and this requires a considerable effort from the professionals to keep up to date with the latest medical advances, according to Dr. Maria Ardiaca, who has been working at the centre since November 2003. "All of us actively participate in national and international conferences to improve our training and present our scientific contributions. Our goal is to actively contribute to the development of the field and promote information, and thereby contribute to animal welfare and the reduction of illegal trade and capture of exotic and wild animals. Throughout the year, we receive dozens of Spanish and foreign veterinarians and students who want to improve their knowledge and skills in exotic animal medicine," she explained.

Specialising in exotic pets creates various challenges, starting with the vast diversity in the anatomic and physiologic particularities of patients. Dr. Ardiaca and her team attend a wide variety of species. Her avian patients include African grey parrots, budgerigars, cockatiels, lovebirds and other parrots, as well as canary finches and pigeons. Other regular patients comprise of rabbits, guinea pigs, chinchillas, degus, rats, hamsters, ferrets and minipigs, "the stars of mammalian visitors". In the reptile group, the team most commonly attends turtles and tortoises, bearded dragons, geckos, boas, pythons, milk and corn snakes.



Nephrocalcinosis in a domestic rabbit.



Inflammatory colitis with nodular mucosal hyperplasia in a rat.

Axolotls, goldfish, betta fish, frogs and toads are also frequent patients in the fish and amphibians hospital. The centre provides a comprehensive service of exotic animal medicine 24/7, offering consultation, diagnosis, hospitalisation, surgery and anaesthesia. The centre also has an internal laboratory where blood work, cytological or coprological analyses are performed.

As for diagnostic imaging, most examinations are performed in-house, but the team also works with specialists and advisors in different fields to offer the best option for patients.

Pushing ultrasound's capacities in diagnostic imaging and image-guided biopsies

Los Sauces veterinarians perform direct digital radiology, endoscopy and ultrasound examinations. For CT and MR studies, the team collaborates with a specialised veterinary imaging centre - Diez Bru Diagnostico por Imagen Veterinario - and with the Nuclear Magnetic Resonance Unit of the Multidisciplinary Institute (UCM) in Madrid.

To complete their diagnostic imaging capacities, Dr. Ardiaca and her team recently incorporated the new Aplio i800. The system will help perform abdominal and thoracic examinations, ultrasound-guided biopsies and nerve blocks, as well as echocardiography scans.

Biography

Dr. Maria Ardiaca is Director of the Los Sauces Veterinary Centre in Madrid. She received her veterinary degree at Madrid Universidad Complutense in 2002 and completed her university degree at wildlife recovery centres and at the Los Sauces Veterinary Centre in Madrid. She volunteered at the GREFA Wild Fauna Hospital and was an active member and president of the Veterinary Students' Association for Exotic and Wild Animals Medicine in Madrid. She worked as a veterinarian in wild fauna rehabilitation at the O Campiño Animal Rescue Centre during the Prestige oil spill in Galicia, Spain in 2002.

Dr. Ardiaca is an accredited veterinary specialist in exotic pets (New Companion Animals) at the Association of Small Animals Veterinarians of Spain (AVEPA). She is also president and scientific committee member of the Exotic Vets Association of Spain (GMCAE-AVEPA).

She regularly speaks in Continuing education courses and masters for veterinarians who are interested in exotic animal medicine. She has presented at several national and international conferences and published scientific papers on exotic animals medicine.

Besides high resolution images, one of Canon Medical's iconic trademarks, the wide range of transducers available with the Aplio i800 has been a determining factor in the decision to buy the equipment.

"The wide choice of transducers is suitable for all patients, from the largest to smallest companion animals, and this makes the Aplio i800 well suited for a veterinarian clinic or hospital," she said.

Dr. Ardiaca uses three configurations of probes: a 'Sector Probe' 3.5-12 MHz., a 'Linear Array Transducer' 4.0-18.3 MHz (intelligent Dynamic Micro-Slice - iDMS) and a 'Linear Probe for small superficial parts', ranging from 8.8-22 MHz, which offer high quality images. The 22 MHz hockey stick transducer is particularly useful with small pets, which constitute the vast majority of her patients. "Most of them weight less than one kilogram and many are thinner than 2-3 cm. I really appreciate resolution over penetration and need to work with high frequency linear transducers with good near field detail. This equipment offers outstanding resolution," she said.

Echocardiography is difficult to perform in small animals but the sector probe 12 MHz transducer of the Aplio i800 is up to the task and better suited than other equipment. "It is a significant improvement over my old 7 MHz transducer in obtaining images of my patients' small hearts at high frame rate," she said.

Aplio i800's ultra-wideband i-series transducers cover the same bandwidth as two conventional transducers, offering superior sensitivity and resolution for both near and far field. This groundbreaking transducer design helps provide better imaging regardless of the patient condition and helps to reduce costs.

"The Aplio i800's SMI expands the range of visible blood flow to visualise low-velocity microvascular flow in an unprecedented way."

Dr. Maria Ardiaca, Director of the Los Sauces Veterinary Centre in Madrid

The system's Superb Micro-vascular Imaging (SMI), an unique technology on the market, helps expand the range of visible blood flow to visualise low-velocity microvascular flow in an unprecedented way. The SMI software can be used in a wide range of settings, from liver and kidney tumours to ophthalmology, enabling detailed view of the pecten in both reptiles and birds' eyes. This technology is gaining momentum in many other areas of pet imaging.

"SMI enables to evaluate perfusion in smallest body parts such as intestines of small rodents, adrenal gland or lymph nodes of ferrets, among others, with really subtle low blood flow," Dr. Ardiaca said.

Last but not least, the Aplio i800 is robust and long lasting, two qualities that are essential in the context of pet imaging, as patients are not always cooperative.

Dr. Ardiaca expects to perform around 600 ultrasound examinations per year with the new equipment, and this activity is set to grow, as more and more people chose to adopt exotic pets. She is also planning on future collaboration with Canon Medical for projects in research and continuing education.

Pecten oculi of an orange winged amazon (Amazona amazonica).

Normally perfused mature ovarian follicle in a mississippi map turtle. A small immature follicle is visible as a blood flow pattern disruption.

Clinical Case: Metastatic Osteosarcoma in a Blue-Fronted Amazon Parrot *(Amazona aestiva)*

Dr. Maria Ardiaca, Los Sauces Veterinary Centre in Madrid, Spain

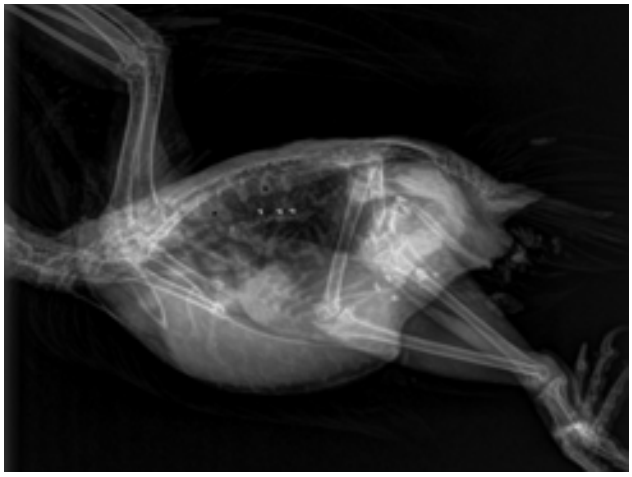
A blue-fronted Amazon parrot of unknown age (at least 36 years) was presented due to apathy, anorexia and lameness. The clinical history of this patient included bilateral chronic stifle arthritis and a diaphyseal fracture of the right femur 3 months ago that was treated surgically.

The clinical examination showed mild dehydration, poor body condition (body score 2/5), weakness, alert mental status and bilateral paraparesis. *(Figure 1)* The bird exhibited signs of pain during the palpation of the rear extremities and it was not possible to elicit a complete extension of the legs, especially the right leg.

Complete blood analysis revealed mild anemia (PCV 36%; reference range 42-53%), severely elevated alkaline phosphatase (2249 U/l, reference range 20-108 U/l) and mildly elevated bile acids (59 umol/l).[1]

Radiographs in laterolateral and ventrodorsal projections showed proliferative alterations in the right femur compatible with exuberant callus and misalignment in the diaphysis of the right femur and osteolysis in the distal epiphyseal region; cortical irregularities on the distal diaphysis and epiphysis of the left femur; irregular radiodense lesions on the vertebral column; calcification of the aorta and pulmonary arteries and moderate hepatomegaly. *(Figures 2 and 3)*

Figure 1: The patient, an Blue-fronted amazon parrot (Amazona aestiva) showing bilateral paraparesis.



Figures 2 and 3: Radiograph in ventrodorsal and laterolateral projections showing proliferative alterations in the right femur compatible with exuberant callus (arrow); osteolysis in the distal epiphyseal region (arrowhead) and irregular hyperdense lesions on the vertebral column (*) and calcification of the aorta and pulmonary arteries (notched arrowhead) among other findings. Positioning was suboptimal due to patient inability to extend the legs.

Ultrasonographic examination with the aid of a 22 MHz hockey stick transducer and Aplio i800 equipment (Canon Medical Systems) evidentiated several space occupying lesions of mixed echogenicity that varied from 2.6 to 3.7 mm in diameter within the hepatic parenchyma. These lesions presented an uncommon coffee-bean appearance as they were roundish predominantly hypoechoic with a slightly hyperechoic periphery and central area. The perfusion evaluation with the SMI (Superb Micro-vascular Imaging) consistently revealed mild signal in the central area of the lesion. *(Figures 4, 5 and 6)*

Based on clinical and diagnostic findings, particularly the coffee-bean-shaped lesions in the hepatic parenchyma, a presumed diagnosis of metastatic neoplasia was made. The differential diagnosis included multifocal osteomyelitis and abscesses in the liver. Bilateral paraparesis was attributed to medullar lesion, probably related to the vertebral lesions. Supportive and analgesic therapy was initiated in order to stabilize the patient and evaluate further diagnostic plan, but the bird died approximately 24 hours after presentation.

The necropsy revealed hard whitish masses in the cranial area of both lungs; ateromatosis, arteriosclerosis and calcification of aorta and pulmonary arteries; several whitish firm nodular lesions in the liver and kidneys, right adrenal gland; large proliferative cortical lesion in the right femur and several smaller proliferative lesions on the ribs and dorsal thoracic wall. *(Figure 7)*

The histopathological study of the tissue samples concluded that pulmonary atelectasis and acute shock associated with severe atheromatosis, a metastatic osteosarcoma involving several organs, particularly the liver, and hemorrhagic lesions in the spinal cord contributed to the clinical picture and death of this parrot.

It was not possible to determine the location of the primary neoplasm or to rule out a primary poliostic involvement. Osteosarcoma may have contributed to pulmonary atelectasis from local compression and the metastatic malignancy was complicated by a catabolic process and dehydration that contributed to the shock in this patient.

Fractures in elderly parrots must always include the differentials for pathological fractures, such as neoplastic disease and a thorough diagnostic approach is advisable.[2] In this case, the recent femoral fracture was most probably due to the osteosarcoma that was not detected.

Figure 4: Sonographic image of coffee-bean shaped SOL in the liver with mild signal in the central area on the SMI perfusion evaluation.

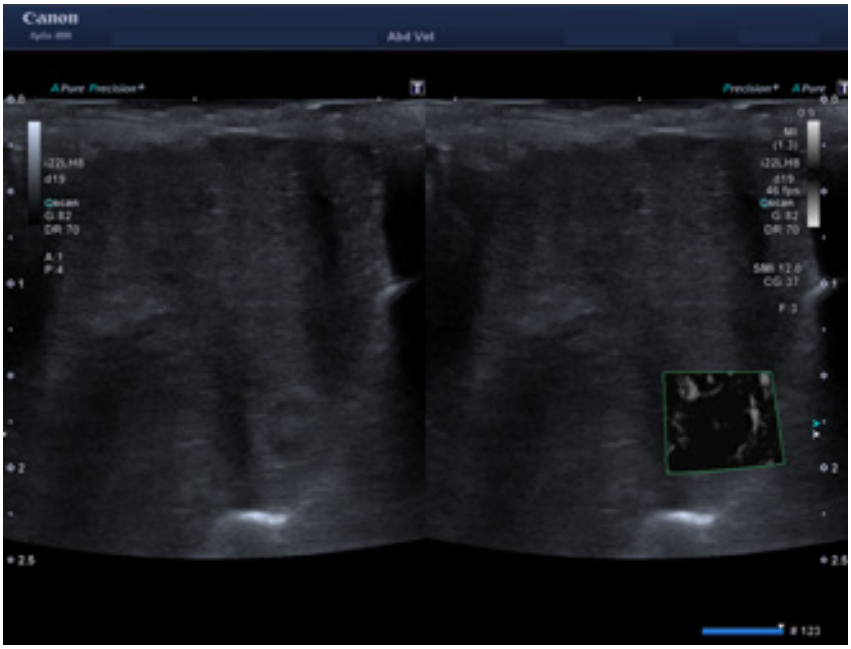


Figure 5: Sonographic image of coffee-bean shaped SOL in the liver with mild signal in the central area on the SMI perfusion evaluation.

Osteosarcomas are sporadically described in the scientific literature in different avian species, most often appendicular osteosarcomas.[1–5] Particularly in the blue-fronted Amazon parrot (Amazona aestiva) osteosarcoma, osteoma and chondrosarcoma are described.[2,6,7]

Osteosarcomas are locally aggressive tumors that cause osteolysis and local invasion and they metastasize frequently, while chondrosarcoma tends to be only locally invasive with low metastatic potential in birds.[1–4,7] Several attempts of chemotherapy for osteosarcoma in birds were made without success.[5]

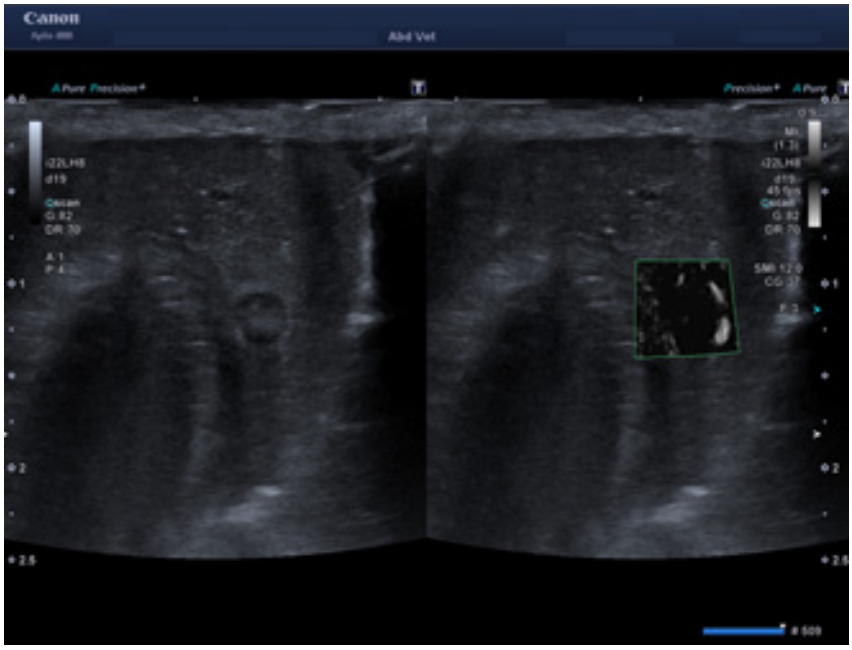


Figure 6: Sonographic image of coffee-bean shaped SOL in the liver with mild signal in the central area on the SMI perfusion evaluation.

Figure 7: Macroscopic appearance of the metastatic osteosarcoma lesions in the liver.

The differential diagnosis for the coffee-bean shaped lesions (sometimes also called bull`s eye or target-shaped) in the human liver ultrasonography includes abscess (particularly due to Candida sp. or Acinetobacter sp. Infection) and metastatic disease, considered the latest most probable.[8–11]

There are no scientific descriptions of this lesion in avian liver. In this case, the use of the novel SMI technique was particularly relevant as it allowed detection of very low flow perfusion that suggested neoplastic origin of the lesion, rather than an abscess. //

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Equine X-ray of the hind leg, using the portable static detector.

Interview with Joris de Brouwer, Leader Diagnostic Imaging, Faculty of Veterinary Medicine Utrecht (The Netherlands) about a new Multipurpose Veterinary X-Ray solution.

Pushing the Bounderies in Veterinary Diagnostics

Configuring medical equipment follows stringent regulations that may challenge the development of tailored solutions. Oldelft Benelux B.V. , a Canon company, has just built a unique solution using Canon and third-party X-ray equipment and technology to help Utrecht University in The Netherlands to perform both static and dynamic imaging. Visions spoke with Joris de Brouwer, Leader Diagnostic Imaging, Faculty of Veterinary Medicine Utrecht, to learn how the Multi purpose RF system, an exclusive solution that features a two column ceiling X-Ray system and Canon Digital Flat panel detector technology, came to life.

In an exceptional deal, Oldelft created a Multipurpose Veterinary X-Ray solution to combine fluoroscopy and X-ray imaging in one room, enabling the examination of all sorts of animals in a wide variety of clinical scenarios.

Oldelft is one of the few manufacturers to have received ISO13485 certification, which establishes a conformity assessment that is mandatory to build new solutions. This certification, which is featured in the Medical Devices Directive (MDD) 93/42/EEC, is the only way to configure individual medical devices into systems and ensure their safe use.

It was the basis for developing a multi-purpose system that matches the needs of Utrecht University Veterinary Centre, the largest academic veterinary hospital in Europe, with around 1,500 students.

Biography

Joris de Brouwer has been team leader of the diagnostic imaging department at the Faculty of Veterinary Medicine at Utrecht University since 2002, taking care of the day-to-day affairs of the supported personnel, maintenance and purchase of imaging equipment, and the department's finances. Previously, he worked as an imaging technician in a human hospital.

"The demand has changed. We need more and more functional imaging because it's easier to work with. If you can combine two systems into one, then you make a significant financial gain."

New equipment for new clinical needs

Utrecht's Faculty of Veterinary Medicine employs about 900 veterinarians, scientists and support staff, who provide healthcare to a wide diversity of patients.

Utrecht veterinary hospital treats over 10.000 small animal cases annually. The Equine section provides surgery, internal medicine and reproduction consultations to 3,500 inpatients and 2,500 outpatients.

The hospital cares about almost every other species and carries out about 10,000 imaging studies a year in all kinds of pets - horses, rodents, birds, reptiles etc.

Imaging such a wide diversity of patients places high demands on staff and equipment, Mr. de Brouwer explained.« Resolution, scan speed, flexibility in movement but also the weight capacity of the table and space of the room are important, and have to be adapted to veterinary use", he said.

Horses are particularly challenging to examine due to their weight, size and reactivity. The imaging equipment must be suspended high enough in the room, but the X-ray tube must also reach the floor. The system must therefore be flexible and easy to move.

"The X-ray tube has to be able to move around, below and above the animal. Horses startle easily when they hear a sound. They may get scared and jump. These patients easily weigh up to 600 kg, so the system must be silent, to guarantee both patient and staff safety," he said.

On top of these constraints, changes needed to be made to improve diagnostic imaging daily workflow at the hospital. De Brouwer and his team had been working in two rooms - one for horizontal fluoroscopy, to perform dynamic imaging or swallowing studies for pets, horses and birds, and another room for equine radiological examinations.

But combining these two services into one system increasingly became necessary to better match current needs and financial constraints. "The demand has changed. We need more and more functional imaging dedicated to veterinary use because it's easier to work with. If you can combine two systems into one, then you make a significant financial gain," he said.

To boost value, the new system had to allow imaging of a wide fauna of patients with the same level of quality. The system notably needed to include a tracking function with a dynamic detector to perform X-ray scans of the thorax, abdomen and spine of horses, and dynamic studies in companion animals. This tracking function also had to be disconnected easily whenever needed, in order to perform X-rays of horses' legs with a separate wireless detector.

"A third party had the ceiling construction including a tracking function that we wanted, but not the compatible dynamic detector. Oldelft would be able to complement the system with a Canon Image and X-Ray Chain including a hybrid detector and static detectors. So they suggested talking to Oldelft to see if they could help," de Brouwer explained.

A tailored solution that uses Canon technology

Oldelft is a system integrator and manufacturer, with over 75 years' experience in X-ray technology. The company has been working with the Canon Digital Flat Panel integrator since 2000. Because it has received ISO13485 certification, Oldelft was the properly designated expert company capable of adapting X-ray equipment to the customer's wishes.

After a year of brainstorming sessions and collecting the customers' requirements, Oldelft managed to redesign the existing analogue two-column ceiling X-ray system to a fully digital multipurpose two-column system, with Canon Image Chain including a Hybrid RF detector capable of both Radiography and Fluoroscopy and two static detectors.

Oldelft also upgraded the ceiling stands with a 150kV/100kW X-ray generator, with an integrated workstation with Canon RF Control software capable of acquiring and displaying both Radiographic and Fluoroscopic images in high resolution, two monitors behind the lead screen, two slave monitors in the X-ray room and double control to perform studies in or outside the room.

The new system integrated the Canon 35x43 Hybrid RF detector in the slave column, and extended the travel of the ceiling rails to create enough space to freely move around the horse.

Oldelft also upgraded the X/Y Cable management system, so the cable hoses would not scare the horse when moving the columns.

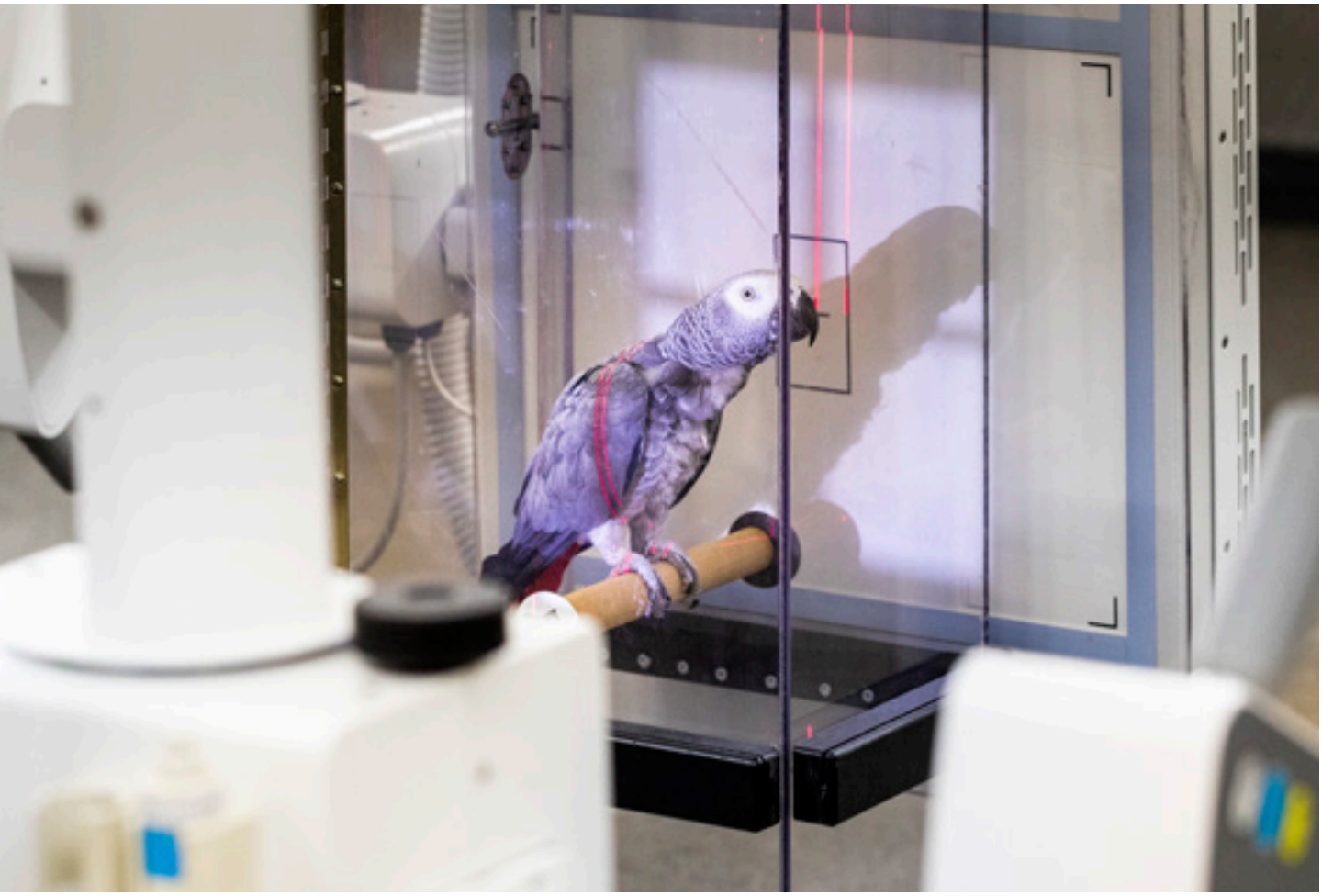
Oldelft took care of the complete project management, delivery and installation, installing even the steel construction that was needed for mounting the system.

The result is a High-end Multipurpose Veterinary X-Ray solution that perfectly matches the customer's needs. "I got exactly what I wanted.

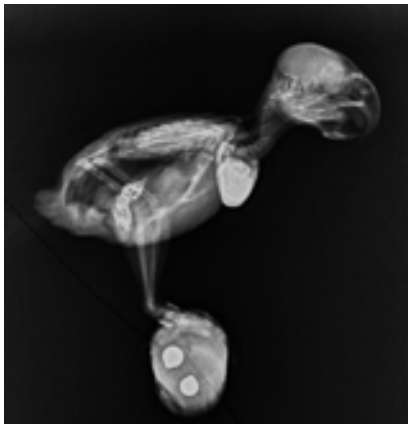
Now we can do everything in one room in the same amount of time on the same system," de Brouwer said.

Oldelft also made the necessary changes to guarantee silence during the examinations, to not to scare the horse. "They made a button that removes the brake and puts it back on silently. They're really good at all these little adaptations," he added.

Equine X-ray of the thoracic spine, using the Hybrid RF detector.



Barium contrast study of the digestive tract in a parrot, using the Hybrid RF detector.



Side view of a parrot 15 minutes after administering barium in the crop.

A system for hybrid and fast imaging

De Brouwer also praised Canon's Hybrid RF Detector, which greatly improves image acquisition in even the tiniest patients. "The frame rate is up to 30 frames per second, which is probably the fastest on the market. This speed is very useful in small animals, in which you need fast image acquisition.

The dynamic detector is also excellent for fluoroscopy of tiny patients. You obtain really high quality images. You can use the system in so many applications."

Canon's Flat Panel Detector is portable and offers a high level of flexibility in the digital radiography room. Introduced in the last decade as the first portable unit, it has proven its versatility in examinations where static imaging and functional dynamic imaging have to be combined.

It is the ideal detector for multi-purpose X-ray rooms, allowing all kinds of radiographic imaging, including special orthopaedic studies inside or outside the Bucky tray and functional imaging of joints when horses limp. It also helps position catheters and drains if needed with more accuracy.

For fluoroscopy and serial imaging, the detector is used in a docking station with an active air-cooling system. Static detectors are added in both 14x17" and 11x14" format to acquire free positioned examinations, such as orthopaedic projections of limbs and skull images while weight bearing.

Barium swallowing study in a dog with food visible in the esophagus.

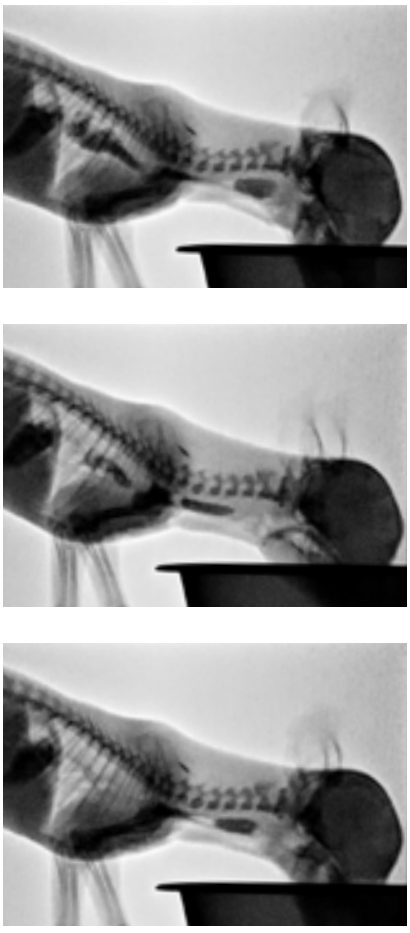
The detector also includes advanced image processing, like Edge Enhancement, Noise Reduction and Dynamic Range adjustment to ensure high image quality, even at low dose. All DICOM functions are integrated as a standard and multiple system configurations are possible in combinations with other Canon detectors.

The system is robust and flexible, and truly facilitates workflow. It has thus been widely adopted by staff. "People always need to get used to a new system. But this time, we've had almost no complaints!" he said.

The team is also happy about the regular maintenance provided by Oldelft engineers, who regularly pay visits to help optimise the system and guarantee smooth operation.

The experience with Oldelft Benelux B.V., a Canon company, on this unique equipment has been a positive one and de Brouwer has felt totally supported and understood.

"Hospitals have their own needs and if manufacturers remain fixed on what they do and what they don't do, customers go somewhere else. But Oldelft is used to developing special solutions on its own. They are close to our needs and available. They enabled us to work together to get us exactly what we wanted," he concluded. //



Barium contrast study of the digestive tract in a dog, using the Hybrid RF detector.

** The clinical data used in this article, may not always be of the same animal on the photo.*

Melanie Düringer and Caroline Hanke, Hofheim Veterinary Clinic in Germany.

Interview with Markus Tassani-Prell, co-founder and head of the diagnostic imaging department at Hofheim Veterinary Clinic in Germany.

Vantage Elan Offers Highlights in MRI Diagnostics

Magnetic Resonance Imaging proves a great help in veterinary Diagnostic Imaging, since this technique provides unequalled information on joint diseases and neurological conditions. Dr. Markus Tassani-Prell, co-founder and head of the diagnostic imaging department at Hofheim Veterinary Clinic in Germany, explains how Canon's Vantage Elan 1.5 Tesla MRI scanner helps him improve patient care in daily practise.

The Hofheim Veterinary Clinic employs 220 personnel including 80 veterinarians who tend to around 200 animals daily, the majority being cats and dogs.

The clinic has an important emergency department and a large inpatient department - a dual service that fewer and fewer animal clinics are able to offer nowadays. The institution cares for a large number of intensive care patients around the clock.

The founders are specialists in oncology, orthopaedics and medical imaging, and these specialties have been provided ever since the clinic was opened in 1997. The centre also provides physiotherapy, internal medicine, cardiology, skin, eye and ENT care, as well as veterinary Radiotherapy, a field it helped pioneer 17 years ago. Besides treatment of regional and national patients, also international patients found their way to Hofheim.

Tassani-Prell and his team are using a variety of Canon systems to perform diagnostic imaging, and currently have an Aquilion CT scanner, an Aplio MX, a Xario and three Aplio400s ultrasound systems.

In particular for neurological and imaging of the joints, the team relies on Canon's Vantage Elan system, performing around 1,200 examinations every year.

A gold standard for joint and neurological imaging

The Vantage Elan is particularly suitable for all types of neurological related problems and diagnosis in the brain. Magnetic resonance tomography is still a relatively new procedure in veterinary medicine, but it has become the gold standard in some areas, Tassani-Prell explained. "We use it when dogs are presented to us with epileptic seizures, to rule out a brain tumour. More rarely, we also use MRI to diagnose stroke. Neurologists often demand extensive MRI examinations of the spinal cord from the brain along the entire spine," Dr. Tassani-Prell said.

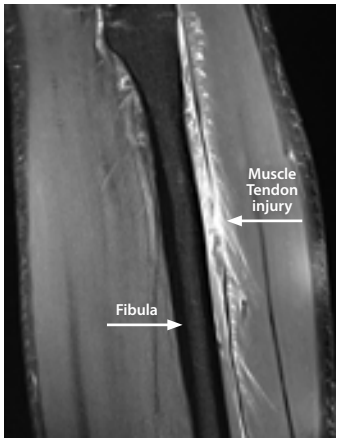
The Vantage Elan can also help to diagnose damage of joints and especially the knee, to exclude cruciate ligament damage. "Cruciate ligament damage has become a kind of widespread disease among large dog breeds such as Bernese mountain dogs or German shepherd dogs. MRI helps us to decide whether an operation is necessary or not," he said.

MRI offers benefits over other diagnostic methods in many instances, for example to start early treatment of patients presenting with lameness in their hind leg. "The earlier the animals are operated on for a torn cruciate ligament, the better their chances of recovery are after physiotherapy. If the findings are unclear, MRI quickly provides information and appropriate therapy can be initiated at an early stage. However, dogs and cats always have to be slightly sedated for MRI," he said.

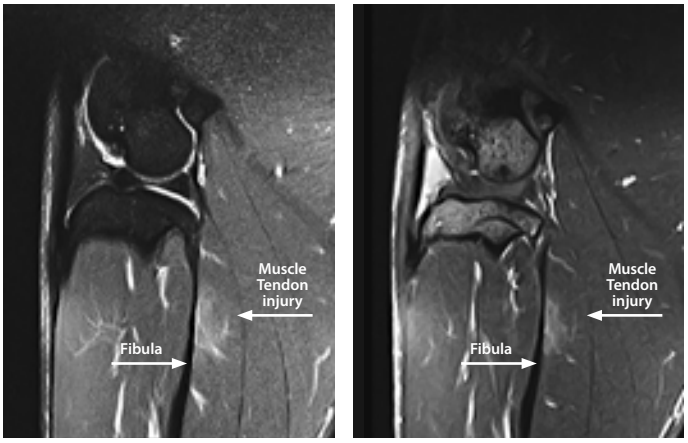
Flexibility and precision

The flexible 16 channel coils proved crucial in the decision to buy the Vantage Elan. "We can use them for animals of all sizes - for the head of a 3 kg dog and the shoulder of a 50 kg specimen. But our decision was certainly also due to our positive experience with the CT scanners from Canon, which we have been using since the clinic was founded," he said.

Tassani-Prell explained a recent MRI examination used to identify sports knee injury in a dog patient who slipped during agility exercise and limped as a result.



Muscle Tendon Injury of football player, 3T.
Courtesy of Dr. Maataoui, Radiologie am Turm, Frankfurt.



Muscle Tendon injury of dog, Elan 1.5T.
PD fatsat and T1 post CE of corresponding slice.

"The MRI image reminded me of the injury to a footballer's fibula that had been presented at the last Canon MR user meeting in human medicine. Normally, as a veterinarian, one looks primarily at an injury to the joint. The muscle tear could be seen very well on MR. I still had the lecture in mind and was able to transfer conclusions from human medicine to this case. As a result the dog was fit after resting for only two weeks. For me, that was a highlight in MRI diagnostics," he said.

MRI in veterinary medicine has a lot to offer, as sequences change very dynamically and the potential to transfer innovations in human medicine to veterinary. Tassani-Prell is currently testing new coils for skull examinations of particularly small and large dogs. "Using special software for an improved signal-to-noise ratio and a shortened examination time, bears still a lot of development potential," he said.

Further areas of development he identified include special 3-D sequences in the field of cardiac MRI, and breathing triggered abdominal MRI. "That would certainly be a broad field for the future, where, for example, pancreatic tumours could also be made visible," Dr. Tassani-Prell suggested. //

"The flexible 16 channel coils proved crucial in the decision to buy the Vantage Elan. We can use them for animals of all sizes - for the head of a 3 kg dog and the shoulder of a 50 kg specimen."

Dr. Markus Tassani-Prell.

Biography

Dr. Markus Tassani-Prell is co-founder of the Hofheim Veterinary Clinic (1997), where he serves as head of the diagnostic imaging department, clinic manager and specialist veterinarian for radiology and surgery.

He studied at the University of Veterinary Medicine in Hanover and received his doctorate degree at the surgical veterinary clinic of the LMU Munich, where he worked as an assistant and now as senior physician and head of the X-ray unit at the Surgical Veterinary Clinic.

He is a visiting physician at the Animal Medical Center in New York and the Clinic of Kentucky Veterinary Specialists in Louisville, USA.

He is Past President of the European Association of Veterinary Diagnostic Imaging (EAVDI).

CT in Equine Medicine: Another Revolution in Standing Resolution

Dr. Filip Vandenberghe is a partner and co-owner of the Bosdreef Equine Referral Hospital, based in Moerbeke-Waas in Belgium. Dr. Vandenberghe is an Equine Orthopedic Clinician and Associate of the European College of Veterinary Diagnostic Imaging. More than 15 years ago, he was a pioneer in the practical implementation of standing MRI in horses and is now considered a global expert in this field. In his daily work, Dr. Vandenberghe receives elite sports horses from all over the world. His focus is on detecting and managing mild pathology that can potentially limit the maximum performance of horses. In particular, the crossroads between orthopedics and neurology. With the installation of a new, Aquilion CT platform from Canon Medical last year, he is once again, leading a new revolution in equine diagnostic imaging.

Diagnostic imaging in veterinary medicine is, just as in human medicine, a discipline that is in permanent evolution. Technology that is introduced in humans quickly finds its way to the veterinary world. However, whereas humans all have a similar anatomy, the size and weight of animals differ widely. A veterinary radiologist working with horses faces two major challenges. Horses are tall and heavy, and they won't lay still on a table on command. It takes creativity and technology to adapt existing imaging modalities to be used in equine medicine, but once those tweaks are successfully made a whole new world of diagnostic capabilities opens up, and evolutions become revolutions.

The horse in diagnostic imaging

Horses have in a specific place in the veterinary world. Just like companion animals, such as dogs and cats, they have a high emotional value to their owners, and are part of the family. However, due to their use in all different equestrian disciplines, such as racing, show-jumping, dressage or reining, they also often have a very high financial and economic worth. The equestrian world has professionalized largely over the last decade, becoming a more solid industry with high financial interests. The value of the individual highly successful sports horse has increased enormously, to exceed multiple millions of euros. A high emotional or financial value of the individual animal implies a demand and need for state-of-the art veterinary medicine, including the most advanced diagnostic modalities. Whereas imaging was mainly limited to radiography and ultrasonography before the year 2000, MRI, CT and nuclear medicine are now part of the daily routine in a well-equipped equine hospital.

In contrast to companion animals, there's a certain hesitation in placing horses under general anesthesia for diagnostic purposes. Although very low, the risk of injury at recovery is present. Horses have to stand up when they come round from anesthetic. They cannot 'stay in bed' to recover. They are brought into a soft-padded recovery room and they are assisted with ropes when they rise. However, because of their 'flight behavior' they

can panic and injure themselves, and even break a limb in a worst-case scenario. As part of a good risk assessment, most of the diagnostic procedures involved in equine veterinary care are preferably performed on the standing horse under light sedation. If technology is adapted in such a way to be able to be performed on a standing horse, the case load increases enormously, and it revolutionizes our understanding of several pathologies.

Over 15 years ago, Bosdreef Hospital was one of the global pioneers working with an equine dedicated standing MRI system. Today, standing MRI has become the gold-standard in equine MRI. Today, we are working hard on the practicalities of performing standing high quality CT and setting the new standards in equine CT. Anatomical limitations or when an examination on the standing horse is not safe to the operators are two major reasons to put a horse under general anesthesia for a diagnostic procedure. Careful assessment of the potential risks to the horse or the operator, the diagnostic value of the obtained information, the ease of the procedure and the price, are essential in the case selection.

The platform and the gantry in a low position.

Horses are used in equestrian sports as true athletes. Modern equine sports medicine focuses strongly on prevention and early detection of injuries. As a consequence, diagnostic imaging has a strong focus on the musculoskeletal system. Detailed imaging of bone, cartilage, ligaments, muscle and tendon requires, next to radiography and ultrasonography, the implementation of MRI and CT in the diagnostic work up of the sports horse.

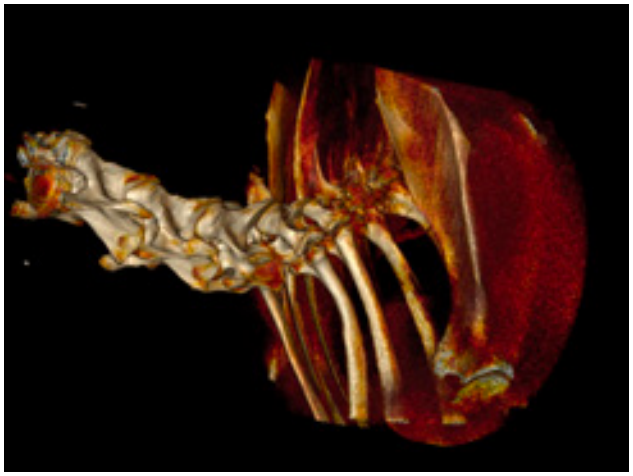
The platform and gantry in a high position to scan the head of the standing horse.

Positioning to scan the caudal neck and cranial thorax.

The horse and CT

For over 20 years, human CT devices have been used in equine medicine. To support the heavy weight of a horse, a dedicated large table is mounted over the original couch and the horse's limbs and head are scanned under general anesthesia. The possible volume to be imaged is limited to the size of the gantry. The development of large bore gantries in human imaging has allowed major progressions in equine imaging. It is now possible to scan more volume and, thus, different anatomical regions of the horse.

In a second phase of development of equine CT procedures, horses' heads were scanned standing. The horse is stood on a movable trolley, while under sedation. The trolley is located on the opposite side to the gantry, and connected to the original table coach. The horses head rests on the original table coach. As such, the horse is pulled or pushed through the gantry, while being scanned. To correct for the height of the standing horse, either the gantry is being placed on a higher fixed platform, or the trolley with the horse is sunk into the ground slightly with an elevator system. After some years, an update was made to this procedure by using sliding gantries. So the horse and trolley didn't have to move, but the gantry moved over the horse. A combination of both methods is still used in the majority of equine hospitals. Scanning under general anesthesia at one side of the gantry and scanning standing heads using the other side of the gantry.



3D reconstructed image of the caudal neck and cranial thorax.

In an attempt to image larger volumes in the standing horse, several cone beam systems have been introduced to the market with a gantry size of over one meter. Often a small field of view is obtained, and information is limited to bone with a relative low resolution. Similar systems mounted on robotic arms can image the distal limb of the standing horse, but resolution remains low. For a small selection of indications, and dependent on the case load, those systems might have their value, although technological advancements are still required.

Recently Qalibra and Canon Medical have brought a system to the equine market that serves many needs. A Canon Medical Aquilion Large Bore CT is mounted on a movable platform. The platform, with the gantry on it, can move up and down and back and forth. The platform is connected to the original moving system of the patient couch.

Scanning the equine stifle.

Sagittal reconstruction of a stifle showing contrast uptake in a medial meniscal tear.

While scanning the platform moves, and the gantry acts like a sliding gantry. The whole construction is mounted in a pit, so that the gantry can be positioned really low or very high. The platform allows high-quality imaging of the distal limb and the head and proximal neck in the standing horse. Under general anesthesia, any volume under 90 cm can be imaged. Essential to the set-up is that the horse is always in a safe position. The versatility of this system, in combination with the high-quality of the images obtained, will convince more hospitals, like Bosdreef, to install it and use CT on a daily basis. It will boost the use of CT in equine orthopedics and help us understand pathologies better, develop new treatments and improve our standards in high-quality care.

The distal limb

In over 70% of the cases of front limb lameness, the site of pathology is located in the distal limb. This means from the carpus down to the foot. The site of pain is localized to a specific region by diagnostic anesthesia. Standard imaging, like radiography and ultrasonography, often delivers the diagnosis, but more and more offen advanced imaging is required to diagnose or to better document the diagnosis. MRI and CT are of invaluable help in the foot especially, where the hoof-capsule limits the ultrasonographic examination options. Standing MRI has been in use for many years and continues to clarify a lot of pathologies encountered in sports horses.

"I believe this setup of gantry and platform will powerboost the use of CT in Equine Medicine."

Dr. Filip Vandenberghe , Bosdreef Equine Referral Hospital, Moerbeke-Waas, Belgium

Contrast CT of the DIP joint, acquired standing, showing a cartilage defect.

Scanning the distal limb standing.

Bone edema and soft tissue pathology are well-documented by MRI. With the implementation of standing high-quality CT in our hospital, we are now getting better at identifying subtle new bone formations, osteochondral fragmentation and hoof-capsule-related problems. The ease of use to perform contrast arthrography in the standing horse allows us to evaluate critically the integrity of the joint cartilage. No other previous system has delivered enough detail in the standing horse to pick up small cartilage erosions. With the speed and ease of the standing distal limb procedure, we believe CT imaging will over time partly or fully replace the radiographic studies of the distal limb.

The proximal limb

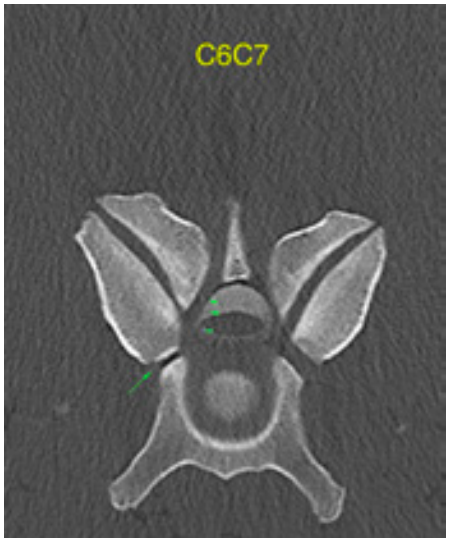
Imaging of proximal limbs always requires general anesthesia. Before the use of large bore gantries and moving platforms, imaging the more proximal regions was challenging and horses were literally squeezed into the gantry, in often very 'unphysiological' positions. Horses are heavy, and re-positioning a horse requires several people, and is often time consuming. In the new Qalibra system, the gantry can sink deep enough in the designated pit, and the horse can easily and safely be positioned on cushions on the ground. Easy positioning and short scan times reduce the time of general anesthesia and thus the risk on post-anesthetic complications.

The stifle is an especially interesting joint, for which 3D multi-slice imaging improves the diagnostic capabilities over radiography and ultrasonography. Open magnet low field MRI systems allow visualization of the equine stifle as well, but are often very time consuming. Stifle contrast CT is a fast procedure. The equine stifle is, like in another species, a complex joint that consists of several joint compartments, menisci and multiple ligaments. Just like knee trauma in human athletes, stifle injury in horses often implies damage to multiple structures, such as the medial menisci, the menisco-tibial ligament, or the cruciate ligament. Evaluation of the cartilage dictates the long-term prognosis. Contrast CT of the stifle on our hospital is mostly followed by an arthroscopy in the same general anesthesia.

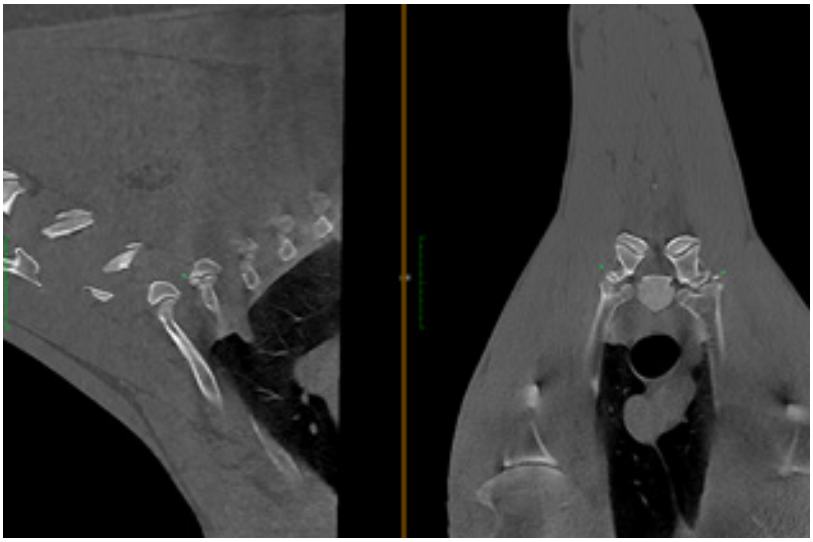
The neck

The neck of the horse is an anatomical region that has been neglected for many years in the diagnosis of performance issues. Nevertheless, it plays essential role in the biomechanics of the horse. Neck pathology can almost mimic any other pathology of the musculoskeletal system. A wide range of clinical signs can be directly or indirectly related to a reduced neck function. Horses can display stiff movement and become short gaited with a complete lack of hind limb propulsion, due to neck pain. In chronic cases, the behavior of the horse while being ridden can change, or they can even become very violent when certain exercises are asked of the horse. Arthropathies of the dorsal synovial facet joints often underpin neck pain. Soft tissue injury to the cranial neck (nuchal ligament origin, semispinalis tendinopathy, nuchal bursitis, etc.) can be diagnosed as well.

The presence of the spinal cord, spinal nerves and brachial plexus often explains neurological signs seen in combination with neck-related pathology. Congenital cervical vertebral malformation has been well-documented before as being a cause of spinal cord compression and ataxia, through diagnosis with (contrast-) radiography. The so-called 'wobblers'. Today, acquired ataxia caused by degenerative arthropathies in adult active athletes are diagnosed much more. Spinal cord compression is visible at the axial margin of the dorsal synovial facet joints, due to joint effusion, capsule thickening and osteophytosis.



Frontal reconstruction of a contrast myelogram of a caudal neck, showing massive enlargement of the articular processes of C7 with dorsolateral compression at the axial lining of the dorsal synovial joint and with stenosis of the intervertebral foramen left.



CT image of the cranial thorax showing large fragmentation of the costovertebral joints.

3D CT contrast-myelography has the potential to more exactly define the exact site of spinal cord compression, opening a broader window of treatment opportunities. Enlarged articular facets with ventral new bone formation might induce stenosis of the intervertebral foramen and potential dynamic impingement on the spinal nerves where they leave the vertebral canal. Neuropraxis of the nerve might induce paresis of the front line, with a reduced cranial phase of the stride, or even stumbling at work. Spinal nerves originating from the segments C5 up to T2 form the branchial plexus, being closely located ventral to the first thoracic vertebrae. From the plexus, the different nerves innervate the thoracic limb part. Today, we are able to image the whole neck and up to the fourth vertebral vertebra in any adult sports horse. All visualized pathology in the region, including the costovertebral joints, can affect the movement of the front limbs. CT is of invaluable help in unraveling the puzzle in between lameness originating from musculoskeletal pain and neurological dysfunction. In the forthcoming years, our knowledge and understanding of this common site of pathology will increase significantly, thanks to the new generation CT systems now available.

Scanning the equine head.

The head

For many years, CT of the equine head has been performed in the standing horse. The head is a complex and large structure, and interpretation of a radiographic examination of the head is difficult. Mild pathology might remain undiagnosed, going lost in the superposition of many structures in 2D imaging. Dental pathology, such as caries, pulpitis, fractures or diastema might directly affect the sinuses and cause infectious sinusitis. Bad tooth management can rapidly affect the welfare of the horse. CT examination assists in the early detection of dental disorders, sinus masses, ethmoid hematoma's or possible causes of head-shaking. Little by little, CT is replacing the use of a full radiographic study of the skull. //

A Secondlife for Medical Equipment

Canon Medical has been a pioneer in diagnostic imaging for over 100 years. Whether industry-leading X-ray products, powerful CT scanners, innovative ultrasound devices or patient-friendly MRI systems - our solutions have always contributed to revolutionizing everyday clinical practice with innovative technologies, reliable performance and exceptional added value.

Because excellent quality stays permanently, this also applies to used imaging systems staying valuable and forming the basis of our Secondlife program. After professional de-installation, cleaning and refurbishment certified by the manufacturer, we deliver used imaging systems with modern technology and quality at affordable prices and thus meeting the different budgets of our customers.

Our promise - Your guarantee

All of our Secondlife systems are refurbished to the highest industry standards, i.a. in line with the COCIR (European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry) Good Refurbishment Practice.

The Secondlife refurbishment program is a quality-controlled process and the only one certified in the industry according to ISO 13485: 2003. Our Secondlife systems come with the latest software upgrades and a full year warranty.

Canon's Secondlife program is the ideal source for reliably refurbished imaging systems. Secondlife sets the highest standards in order to meet the high quality standards and reliable working methods that you can expect from Canon Medical systems.
All imaging systems entering the Secondlife program go through the same process of careful selection, professional uninstallation, Refurbishment, installation and customer support after delivery.

Secondlife

Trade-in of systems from other providers

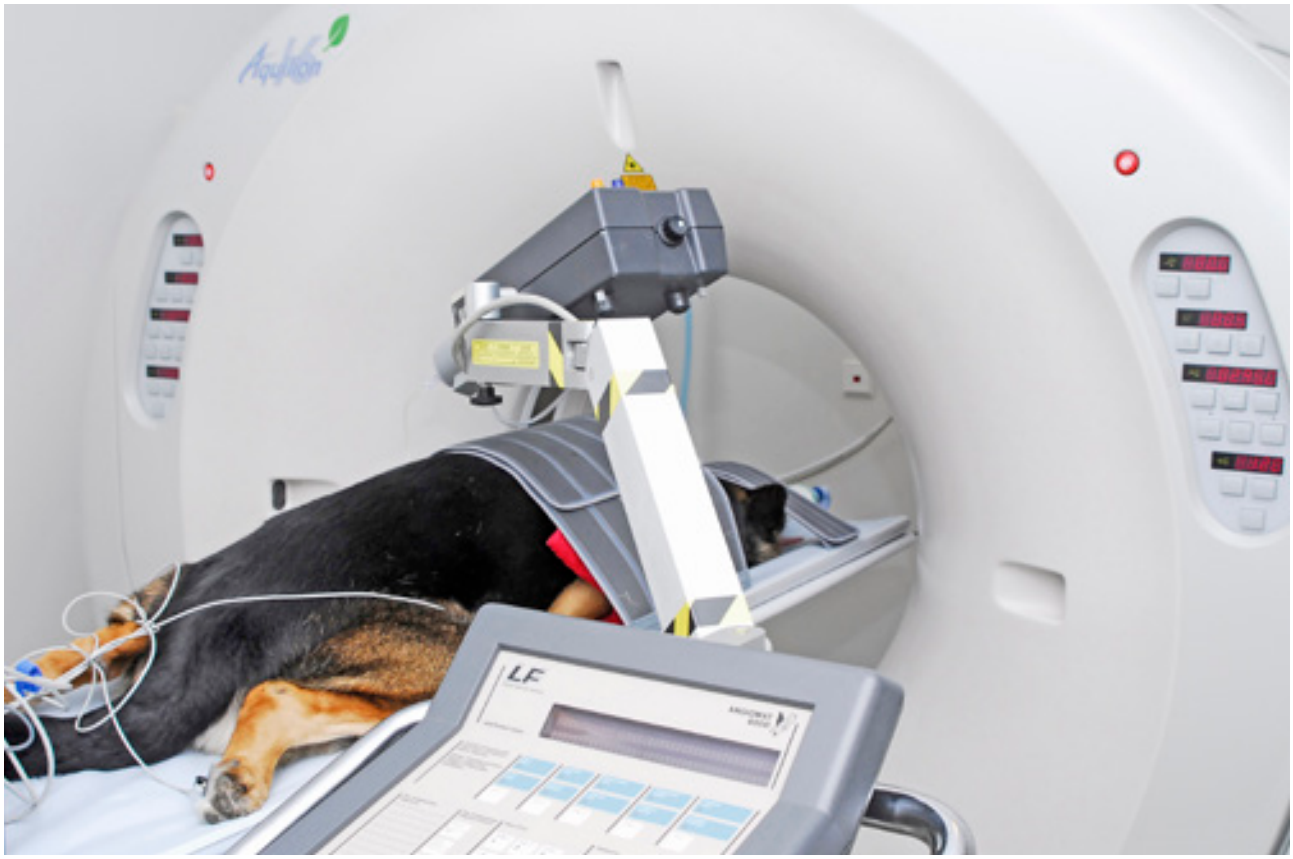
When you purchase a new Canon Medical imaging system, we offer a trade-in of your used system, regardless of brand. As part of a pre-purchase check, our experts test and assess your system and accept it for a fair market price.

Quality and service that only Canon Medical can offer you

From the procurement of used medical imaging systems to the provision of fully refurbished and factory-certified scanners, including installation and technical training -

"Canon Medical's refurbished systems guarantees equipment good as new, only more affordable."

Johan Vochteloo, Director Refurbished and Mobile Imaging Solutions, Canon Medical Systems Europe.



Canon Medical Secondlife offers a comprehensive service for high quality products and an excellent customer experience.

Our trained engineers have specialist knowledge of each individual system and our ISO certification Refurbishment program meets the highest industry standards.

The refurbishment process

After thorough disinfection of the system in our refurbishment center, all parts and components are subjected to certified functional and technical tests. The system is cleaned thoroughly and any damaged or worn parts are replaced with genuine Canon Medical replacement parts. Damaged parts are repainted or replaced.

Every Secondlife imaging system goes through our certified, from the original manufacturer approved quality control process. 162 steps are required for a CT scanner required.

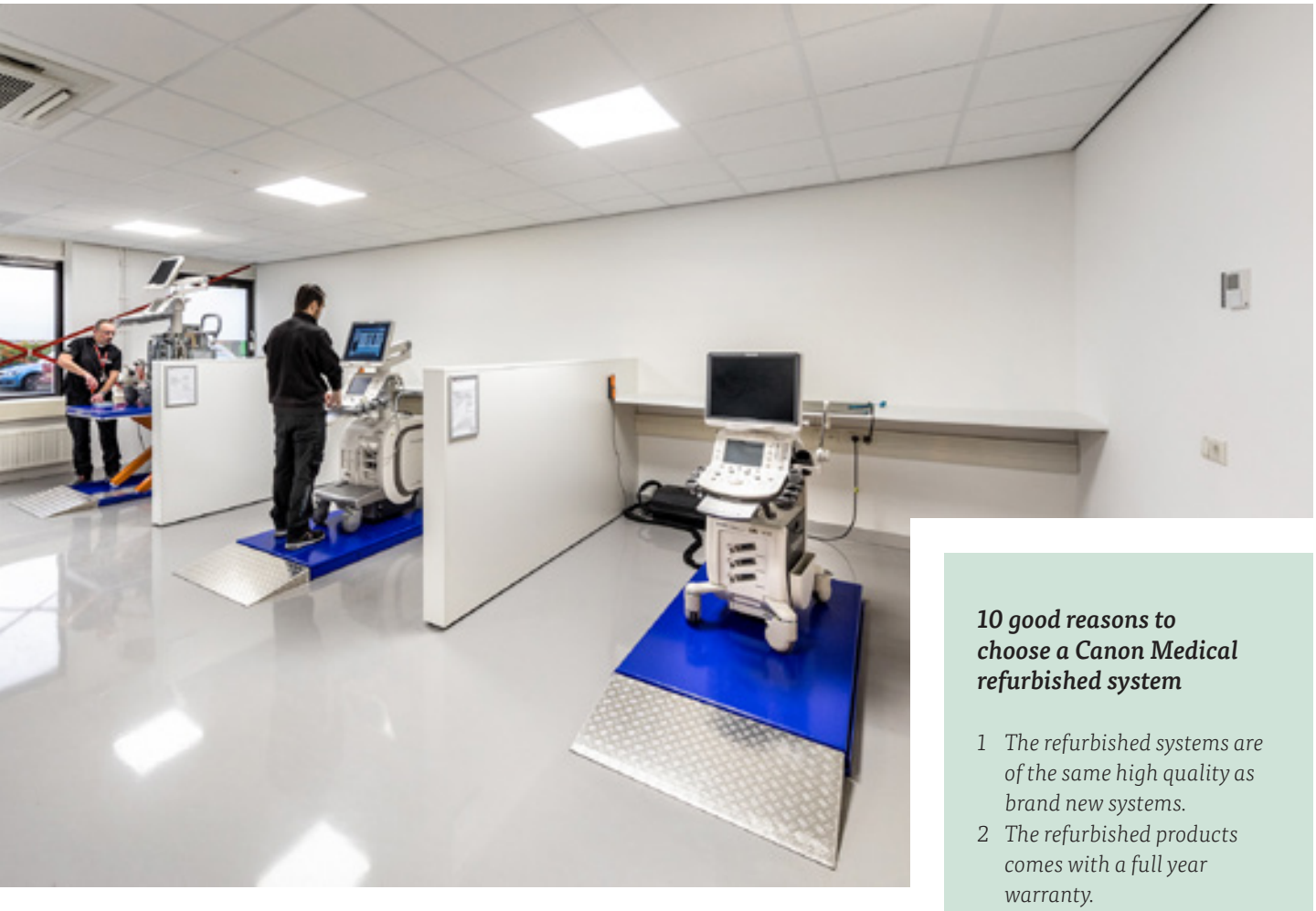
Software upgrade and customization

As a standard procedure in our Secondlife refurbishment program we upgrade each system to the current software version. As the manufacturer of the original system, we also have the option of adapting configurations and installing original options according to your specific requirements.

All Secondlife CT systems receive brand new original tubes to provide the best quality and reliability to ensure functionality.

Quality control and delivery

The re-manufacturing process is rounded off by an electrical safety review and an extensive quality control process to ensure that all manufacturer specifications of the original Canon Medical system are met. The system receives the Secondlife sticker as a seal of quality. Finally, your system comes with a 1-year warranty from the original manufacturer.



Refurbishment center at Canon Medical Systems Europe in Zoetermeer, the Netherlands.

Reliable probe from a reliable source

Canon Medical's ultrasound probes are designed to meet the most demanding requirements consistent with and clinical performance requirements across a wide range of clinical specialties. Our Secondlife program helps to maintain this high level of performance over an extended period of time. Factory-trained technicians perform test procedures to ensure that all specifications from the original manufacturer are met. No matter whether you need a replacement probe temporarily or permanently - Canon Medical provides you with an appropriate probe at low cost. //

10 good reasons to choose a Canon Medical refurbished system

1 *The refurbished systems are of the same high quality as brand new systems.*
2 *The refurbished products comes with a full year warranty.*
3 *Always updated to the current software version.*
4 *Only original spare parts as part of the Secondlife refurbishment process are used.*
5 *Can be configured individually to fully meet all requirements.*
6 *Canon Medical offers certified user trainings for each refurbished system.*
7 *The scope of delivery - CT scanners includes a standard guarantee of one year, which also applies to the X-ray tube.*
8 *We offer up to 5 years the availability of accessories and other options.*
9 *When you buy new Canon Medical equipment, your used system will be exchanged at a fair trade price.*
10 *We offer a wide range of Mobile solutions so that you can keep your business running.*

Canon
CANON MEDICAL

Working together to understand your needs and challenges drives valuable outcomes that positively impact you and your patient's future.

Canon Medical's visions and commitment to improving life for all, lies at the heart of everything we do. By partnering to focus on what matters, together we can deliver intelligent, high quality solutions.
With Canon Medical, true innovation is **made possible**.

Read more about our **Refurbishment solutions** on our website:

https://eu.medical.canon

CANON MEDICAL SYSTEMS EUROPE B.V.

Made For life

Reliable and Clear Reading of the Abdomen

Dr. Anaïs Combes, a veterinary imaging specialist working at the Alliance veterinary clinic in Bordeaux, France, uses Canon Medical's Xario 100G in general and emergency medicine and Aplio a-series for advanced diagnosis.

A multidisciplinary care center in southwestern France

The Alliance veterinary clinic employs 19 senior veterinarians, 9 junior veterinarians and 22 veterinary technicians who tend to more than 11,000 patients, for the most part cats and dogs, each year.

The clinic spreads over 850 m^2 divided over four floors and has progressed plans to build a state-of-the-art veterinary hospital. Alliance accommodates a high-performance technical platform right in the heart of Bordeaux, providing medical imaging, surgery, internal medicine, dermatology, oncology and stomatology care.

The clinic has four competency centers - a specialized veterinary medicine center, a 24/7 emergency veterinary center, a general veterinary medicine center and an Exotic and Wildlife Animal care center with dedicated medicine, surgery and hospitalisation areas - and is one of the few clinics in the region to provide an emergency service 24/7.

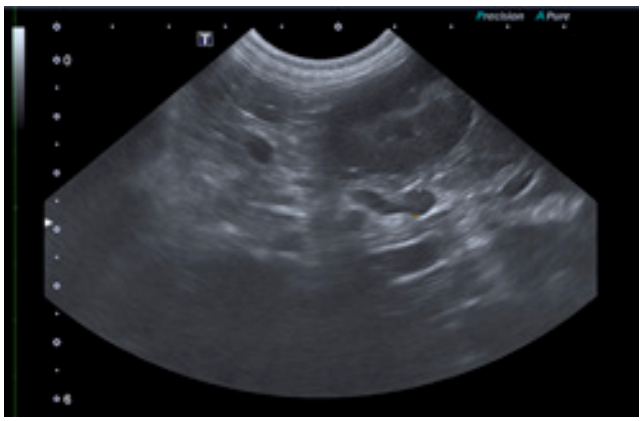
Dr. Combes, who is a diplomate from the European College of Veterinary Diagnostic Imaging (ECVDI), works in the medical imaging department together with an ECDVI resident, two junior veterinarians in training and a veterinary technician. The team is in the process of recruiting a third radiologist and works hand in hand with the rest of the clinic, she explained.

"The imaging department is inseparable from other clinicians, in order to provide the best possible care. The idea is to apply the most appropriate care in each area according to the latest scientific data," she said.

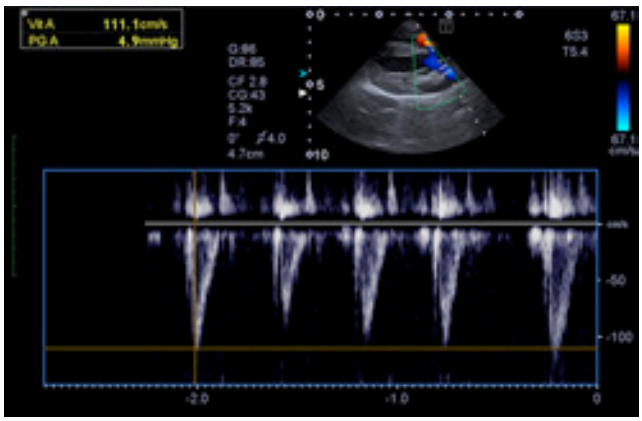
The imaging team carries out X-Ray, CT and ultrasound examinations, and deals with a wide variety of cases - from the most frequent pathologies in general medicine to the most complex cases in specialist or emergency medicine.

Dr. Combes and her colleagues must sometimes also tend to patients with an already long and cumbersome treatment history.

"The combination of specialized training, experience and state-of-the-art equipment is an essential asset to provide quality care in these cases," she said.



Abdominal examinations in Canine in 2D mode showing the adrenal gland. Source : Clinique Alliance.



Cardiac examinations in Canine in pulse wave mode showing the aorta flow. Source : Clinique Alliance.

Dr. Anaïs Combes.

Increasing use of ultrasound

Dr. Combes and her team perform annually around 2,000 abdominal, superficial lesions and cardiac ultrasound examinations - excluding emergency FAST ultrasound scans.

Alliance radiologists carry out more and more ultrasound scans each year and they expect this trend will continue, as the clinic is expanding and the number of in-house prescribing clinicians is increasing.

Dr. Combes regularly trains her colleagues in veterinary imaging, a specialty she felt attracted to ever since she was a student. To use ultrasound properly, veterinarians must have a good basic knowledge of anatomy to begin with. Then they will learn on the go.

"The technical aspect can be learned quite quickly, by combining training and daily practice. The key to progress is to see a lot of abnormal images, confirmed by surgery or histopathology, or at least cytology. I realize that it is not easy for a practicing veterinarian to do an internship or to train on films," she said.

Ultrasound is the modality of choice to image digestive diseases, for instance, or also to find and retrieve a grass awn or other foreign body in an abscess, often after CT, she explained.

"I most often see digestive foreign bodies, chronic inflammatory bowel disease, cholangitis and chronic kidney disease with a lot of ureteral stones in cats in the recent years," she said.

Ultrasound also contributes to better diagnosing of tumors, especially round cell tumors such as lymphoma and mast cell tumor.

"The Canon Xario 100G provides excellent abdominal contrast. The Doppler is very sensitive, even for vessels that are hard to access, such as in the abdomen."

Dr. Anaïs Combes, PhD, Diplomate ECVDI, veterinary imaging specialist, Alliance veterinary clinic, Bordeaux, France.

Biography

Dr. Anaïs Combes is a European veterinary diagnostic imaging specialist at the Alliance veterinary clinic in Bordeaux, France.

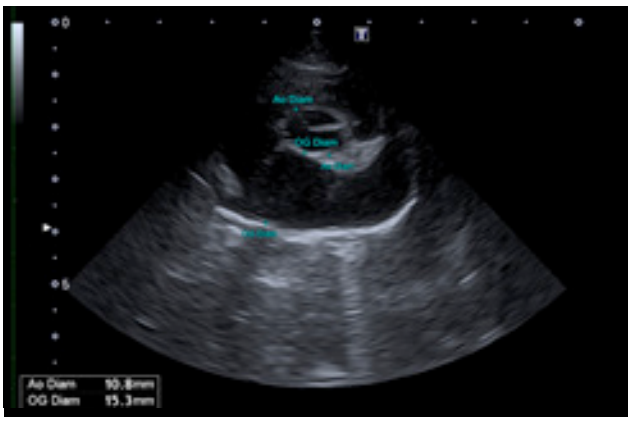
She is a diplomate from the European College of Veterinary Diagnostic Imaging (ECVDI) from 2013. She completed her residency and a PhD in Veterinary Sciences, with Prof. Jimmy Saunders at the University of Ghent (Belgium).

She graduated from the National Veterinary School of Toulouse and completed her internship at the National Veterinary School of Alfort, where she subsequently worked as an imaging and internal medicine assistant.

Dr. Combes specializes in veterinary diagnostic imaging and carries out international teleradiology and professional training activities in parallel to her clinical work.

In addition, ultrasound is well suited to veterinary cardiology, since cardiac CT and MRI are not sufficiently available yet. When general anesthesia is too risky, ultrasound is a very helpful diagnostic tool to guidefine needle aspiration of specific deep thoracic or abdominal organs.

Veterinary ultrasound differs from human ultrasound in many aspects. Patient size and weight, which ranges between 200g and 90kg, is the main challenge in daily practice, Dr. Combes believes. "Not to mention the furry skin of the animal and of course variability in patient cooperation,



Cardiac examination in M Mode.
Source: Clinique Alliance.

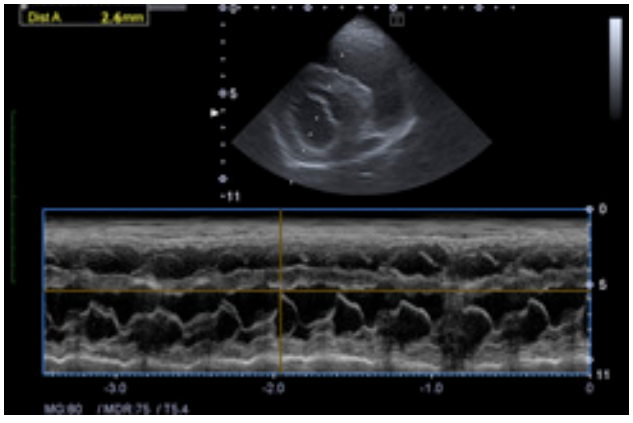
Alliance veterinary clinic, Bordeaux, France.

but we have solutions (shaving, sedation). Also, we perform more exhaustive ultrasound examinations than in human medicine, since the animal doesn't speak. We frequently need to perform ultrasound earlier in the diagnostic process," she said.

Dr. Combes is currently using Canon Medical's Xario 100G Ultrasound system, which she praises for its sensitivity in the abdomen. "The Canon Xario 100G provides excellent abdominal contrast. The Doppler is very sensitive, even for vessels that difficult to access, such as in the abdomen," she said.

The equipment allows a clear and efficient evaluation of the different organs. "The detection of organs and lesions is easier and faster. The exploration of organs in the deep upper abdomen on large dogs is much more reliable - for example the liver, portal system, bile ducts, digestive tract and adrenals," she said.

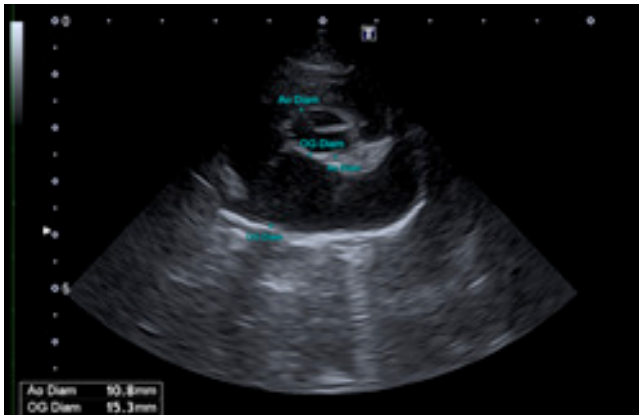
She would recommend using the Xario 100G in a general practice, where it offers excellent value for money. //

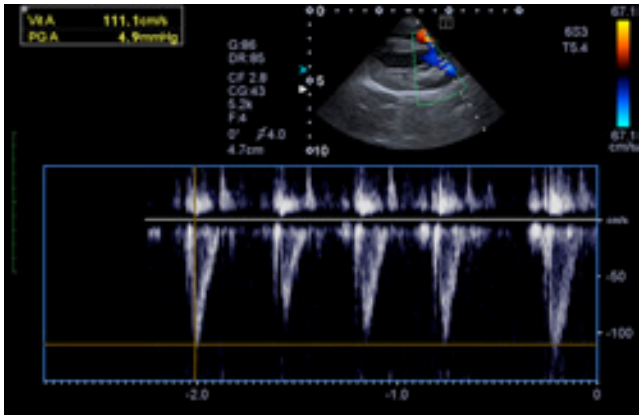


Cardiac examination in 2D mode with visualization of the left aorta and atrium. Source: Clinique Alliance

Xario g-series - Designed for Mobility and Productivity

- Developed on the successful Xario Platinum platform.
- Up to 8 hours of battery-powered, cable-free operation.
- 2 seconds boot-up time from smart standby mode.
- Wireless accessories.
- Energy efficient and energy saving functions.
- 21.5 inch wide-screen LCD monitor with LED backlight.





Example of cardiac examinations in canine.

In veterinary imaging, speed and efficiency are important factors - especially when the patient is restless and not cooperative. This is where the Xario g-series provides decisive advantages.

The new Xario g-series ultrasound systems stand for high image quality and offer the highest level of mobility and productivity.

The Xario g-series offers the user full freedom and clinical versatility with up to 4-8 hours of battery life in full operating mode. This makes a quick change of location possible, regardless of the power supply.

Because of the compact and lightweight design, the system maneuvers well in tight spaces.

The fully customizable operating panel and TCS layout and the 21.5-inch monitor helps to improve workflow and ergonomics.

The smart standby function with a boot time of only 2 seconds ensures that the Xario systems are always ready for use. This can also improve the users' workflow significantly.

Peripherals such as printers, ECG devices and foot switches can be connected wirelessly.

Transducers

The variety of veterinary patients requires a very versatile and diverse range of transducers. From high frequency hockey stick types which are ideal for small animal diagnostics to sector probes for difficult acoustic windows and low-frequency convex transducers for larger animals – all of Xario's transducers deliver superb image quality and respond with highest flexibility to the widest range of clinical applications. //

Battery Operation

- Powerful and energy-efficient batteries.
- 1 standard battery will keep your equipment running for approx. 2 hours.
- Upgradeable with 2 - 4 batteries for extended operations up to 4-8 hours.

Smart Standby

- Faster workflow and energy saving.
- Closing the monitor will, within 2 seconds, automatically put the system into the power-saving standby mode.
- By opening the monitor, the system is immediately ready for use in 2 seconds.

More flexibility thanks to the wireless connection

- Wireless connection to WLAN and peripheral devices, such as foot switches and ECG.
- Clinical safety, optimized productivity and high mobility.
- Outstanding image quality and innovative clinical applications such as Superb Micro-vascular Imaging (SMI).
- Improved examination times result in less stress from patient movement for the examiner.
- Better patient flow through faster system availability.
- Wireless peripherals.
- Extensive range of transducers.
- Storage and transportation accessories on the system.


Canon

VISIONS spoke with Dr. Niklas Bergknut, Veterinary Specialist Dipl. Neurology at the Evidensia 'Heart of Brabant' Veterinary Hospital in Waalwijk, The Netherlands.

Advanced Diagnostic Capabilities Enable Veterinary Practice to Evolve

The Evidensia 'Heart of Brabant' Veterinary Hospital in Waalwijk, The Netherlands, belongs to the IVC Evidensia Group - Europe's largest and fastest growing veterinary care provider. The Hospital offers specialist referrals in emergency/critical veterinary care, soft tissue and orthopedic surgery, neurology and neurosurgery, internal medicine, diagnostic imaging, dermatology and dentistry. It has one of the best veterinary diagnostic imaging departments in the Netherlands, which includes a 1.5 Tesla MR, 64 slice CT, digital X-ray, dental X-ray, two Ultrasound units and fluoroscopy. Installing Canon's Vantage Elan 1.5 Tesla MR at the end of 2018, has brought the Hospital high image quality, enabling to examine more varied and complex diagnostic cases.

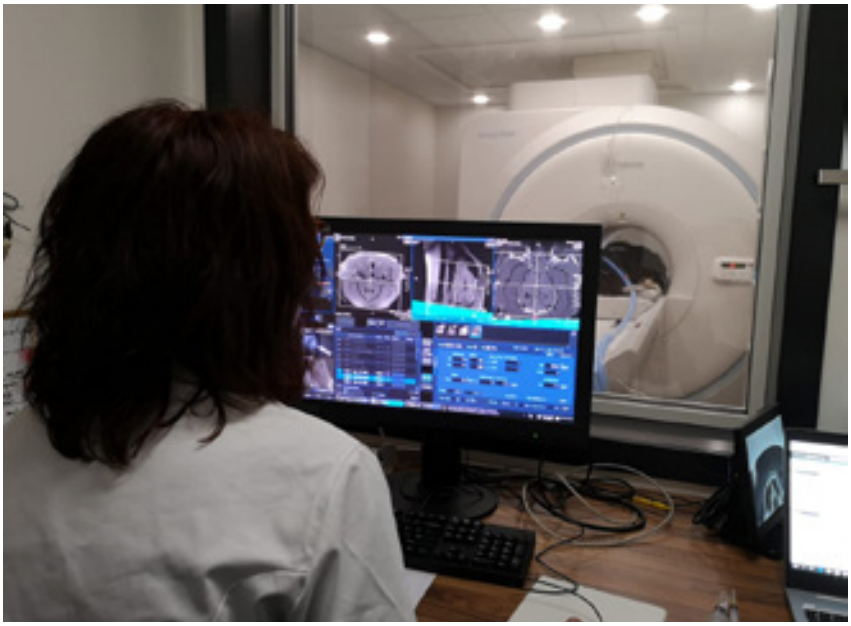
The Hospital treats around 10,920 to 14,000 animals each year. While many of its patients are dogs and cats, it also has a very active exotic animal department that treats species such as snakes, lizards, parrots and small rodents.

"We have chosen Canon's Vantage Elan because lower field scanners do not provide enough quality for what we want to see. Without question, the 1.5 T MR provides us the best neurological information," said Dr. Niklas Bergknut, Head of Neurology at the Hospital. "Our initial goal when we installed the system was five studies per week. Now we are almost on five MR studies per day, four days a week. A limiting factor is the additional preparation needed like anesthesia and how many days we are open for MR. I would like to be able to scan on Fridays and Saturdays.

By then, I hope, we will be performing somewhere between 20 to 30 studies per week. Besides regional patients, we receive also referrals from other hospitals, with lower field scanners, this because of the superior quality of the 1.5T MR. Sometimes we even receive patients from Germany and Belgium."

Extending MR usage

The majority of the MR studies the Hospital currently performs are brain and spinal scans, but the team has plans to extend the use of the Vantage Elan for scanning other animals and additional anatomical regions. For example scanning the joints. Dr. Bergknut expects that by stimulating the interest of orthopedic specialists, e.g. through online lectures, this will lead to even more referrals for MR studies for diagnosis of joints, providing better image quality for soft tissue related problems.



"We are also able to extend the variety of animals that we can scan. Lots of people keep nowadays exotic animals, especially parrots, but also reptiles such as iguanas, and bearded dragons. Recently we examined a bearded dragon that had its gallbladder removed. Using MR, little has been published on the normal anatomy of a bearded dragon, it would be very interesting to publish articles about this. Since anesthetics for exotic species are far more laborious, these animals are currently scanned with CT. In the future we intend to expand this service also to MRI. We have also recently diagnosed brain tumors in parrots, (that have walnut-sized brains), yet we were able to find the pathology. In addition we aim to extend MR angiography studies for our patients, requiring yet more knowledge and experience".

Clinical studies

"The Octave SPEEDER Spine coil works great, for spinal columns. For larger dogs, we combine this with the Atlas SPEEDER Body coil. I love working with smaller dogs in combination with the 16 ch Flex coils. We can easily place them on top of the animals. The Flex coils can be combined with spine coils to deliver an even higher image quality. I have also worked with rigid coils in the past which were not very practical and not really suitable for scanning animals. The Flex coils are actually ideal. Would you ever want to develop new coils, a somewhat wider Flex coil would be even nicer. We also have the Octave SPEEDER Head coil and this works very well with very large skulls, large dogs and with flat-nose bulldogs."

"Without question, the Vantage Elan provides us the best neurological information."

Dr. Niklas Bergknut, Veterinary Specialist Dipl. Neurology. Head of Neurology and Neurosurgery for Evidensia 'Heart of Brabant' Veterinary Hospital, Waalwijk, The Netherlands.

"We are also very happy with Canon's application support that enables us to get the most out of the system."

Dr. Niklas Bergknut, Veterinary Specialist Dipl. Neurology.

Biography

After graduating from the University of Uppsala in Sweden in 2000, Niklas worked with pets in Sweden and the UK for six years. He then started a joint PhD project between Sweden and the Netherlands between 2007 and 2010, in the field of intervertebral disc degeneration. After his PhD, he worked at Utrecht University, in the Netherlands, where he completed his European specialist training in Veterinary Neurology and Neurosurgery. Subsequently, he continued working as a Veterinary Neurologist at Utrecht University until 2016. In August 2016, Niklas moved to the United Kingdom and worked at North Downs Specialist Referrals for two years before returning to the Netherlands to take on the role of Head of Neurology and Neurosurgery for Evidensia.

Evidensia considers clinical research as an important factor for a company to be able to develop. "A great value is the image quality of the Vantage Elan - I really like it," remarked Dr. Bergknut. "An additional advantage of the Vantage Elan is that we can make DWI (Diffusion Weighted Imaging) scans and T2* weighted scans. MR Spectroscopy and Fiber tracking are also interesting for veterinary diagnostics. Potentially beneficial for birth defects studies or epilepsy."

The Vantage Elan also features advanced clinical functionalities like Fiber tracking, MR spectroscopy, contrast free and contrast enhanced MRI techniques. Some of these techniques are used for the clinical case studies found on the Evidensia website.

Demand for high quality

Providing a full range of high-quality general, surgical and specialist veterinary care to thousands of animals every year require top quality imaging equipment, post-processing and image management software. Cloud Archiving is applied for storing the multitude of generated image data.

To sustain this high quality, the support by Canon for the Vantage Elan has been found invaluable by the hospital.

"We are very happy with their application support that enables us to get the most out of the system," added Dr. Bergknut.

Advancing the veterinary market

"I hope the future will bring more dedicated products to the veterinary market, such as custom-made coils for dogs, cats and even smaller animals. But also further improvements for existing products like applications for 3D printing in combination with CT/MR, new series, and sequences," Dr. Bergknut concluded. //

For more information on the Evidensia 'Heart of Brabant' Hospital and their MR research, (in Dutch) visit:
https://www.edz-hartvanbrabant.nl/nl-nl/mri

**Susceptibility Weighted Imaging*

A Plant Foreign Material within the Lacrimal Sac as a Cause of Recurrent Epiphora and Dacryocystitis in a Dog

Rafal Wojciechowski

The precorneal tear film is crucial for the maintenance of ocular surface health and clear vision. The aqueous component of canine tears is secreted by the lacrimal gland of the orbit and the accessory gland of the third eyelid ('nictitans gland'). The aqueous tear film serves most of the avascular cornea's metabolic needs. Not only it aids in lubrication of the cornea, conjunctiva, and nictitating membrane, removal of certain metabolites but also flushes away particulate debris and bacteria from the ocular surface[1].

Recently, a computed tomographic appearance of normal canine lacrimal glands has been published[2] (see Fig.1). However, to the best of the author's knowledge, there are no publications on CT appearance of pathologic conditions of those glands in veterinary literature.

The canine nasolacrimal system is a thin wall conduit carrying the tears from the conjunctival sac into the nasal cavity[3]. It consists of the lacrimal puncta, the lacrimal canaliculi, the lacrimal sac and the nascolacrimal duct[3,4,5]. The lacrimal puncta (superior and inferior) are small openings located at

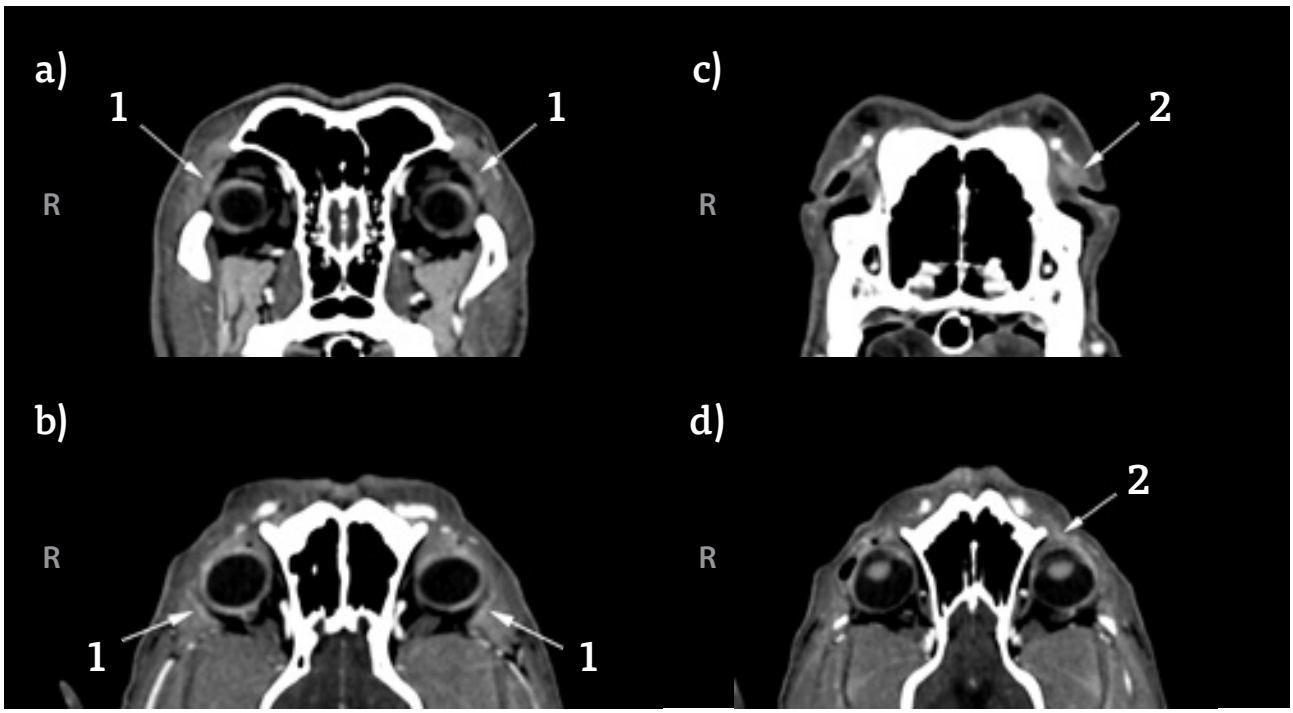


Fig.1. Transverse (a and c) and dorsal (b and d) plane 1 mm thickness post-contrast maximal intensity projection CT images showing location of the lacrimal gland (1) and the accessory lacrimal gland of the third eyelid (2). Both lacrimal glands are usually well visualized on post-contrast CT images. The lacrimal gland (1) is located under the orbital ligament. The accessory gland of the third eyelid (2; 'nicitans gland') conforms to the rostromedial aspect of the globe (2). It should, however, be acknowledged that lymphoid tissue and cartilage of the third eyelid are indiscernible from the glandular component on CT.
The images were reconstructed with a soft tissue filter and displayed with window level (WL) of 110 HU and window width (WW) of 200 HU.

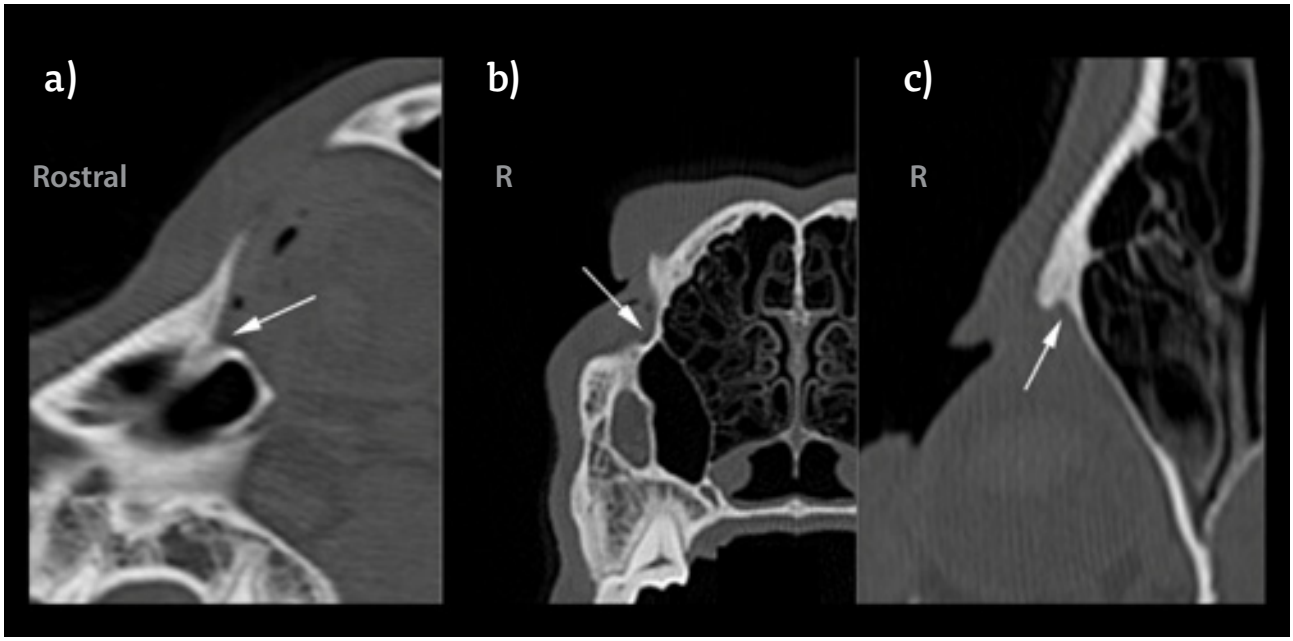


Fig.2. Sagittal (a transverse (b and dorsal c) plane 0.5 mm thickness maximal intensity projection CT images depicting the location of the fossa of the lacrimal sac (fossa sacci lacrimalis).
The images were reconstructed with a bone filter and displayed with WL of 740 HU and WW of 3500 HU.

the edge of the upper and lower eyelids that lead the tear film into the upper and lower lacrimal canaliculi, respectively. The lacrimal canaliculi pass through the orbicularis oculi muscle and join together at the lacrimal sac[1]. The canine lacrimal sac is not a particularly prominent structure[3,6], and in fact it represents only a small dilation of the proximal portion of the nasolacrimal duct[4]. The sac resides within a small depression (fossa sacci lacrimalis) in the centre of the lacrimal bone[4] (see Fig. 2. and 3.).

The nasolacrimal duct passes rostrally within the lacrimal canal. The narrowing of the nasolacrimal duct as it traverses the lacrimal and maxillary bones predisposes to retention of any foreign material with a development of dacryocystitis being a likely sequela[3]. Rostral to the conchal crest the naso-lacrimal duct is no longer contained within the bony canal but courses deep to the nasal mucosa. It ends by opening onto the ventrolateral floor of the ventral nasal vestibule (see Fig. 4. and 5.). In approximately 50% of dogs the nasolacrimal duct has another opening ventrally to the ventral nasal concha, at the level of the root of the maxillary canine tooth[4]. As the distal aspect of the nasolacrimal duct is not protected by bone it appears susceptible to invasion by nasal neoplasms[6]. The length of the nasolacrimal duct depends largely on skull conformation, with brachycephalic breeds having very short ducts and oftentimes drain the tears into the pharynx[3].

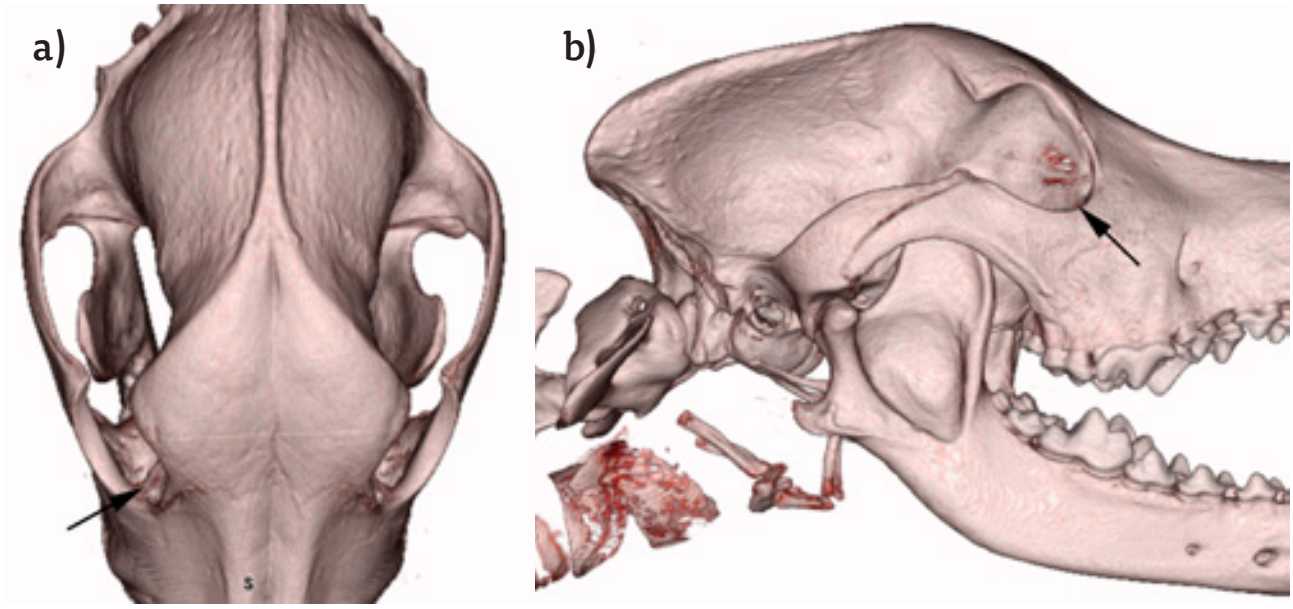


Fig.3. Dorsal (a) and right lateral (b) 3D-volume rendered images showing the location of the fossa of the lacrimal sac (black arrows).

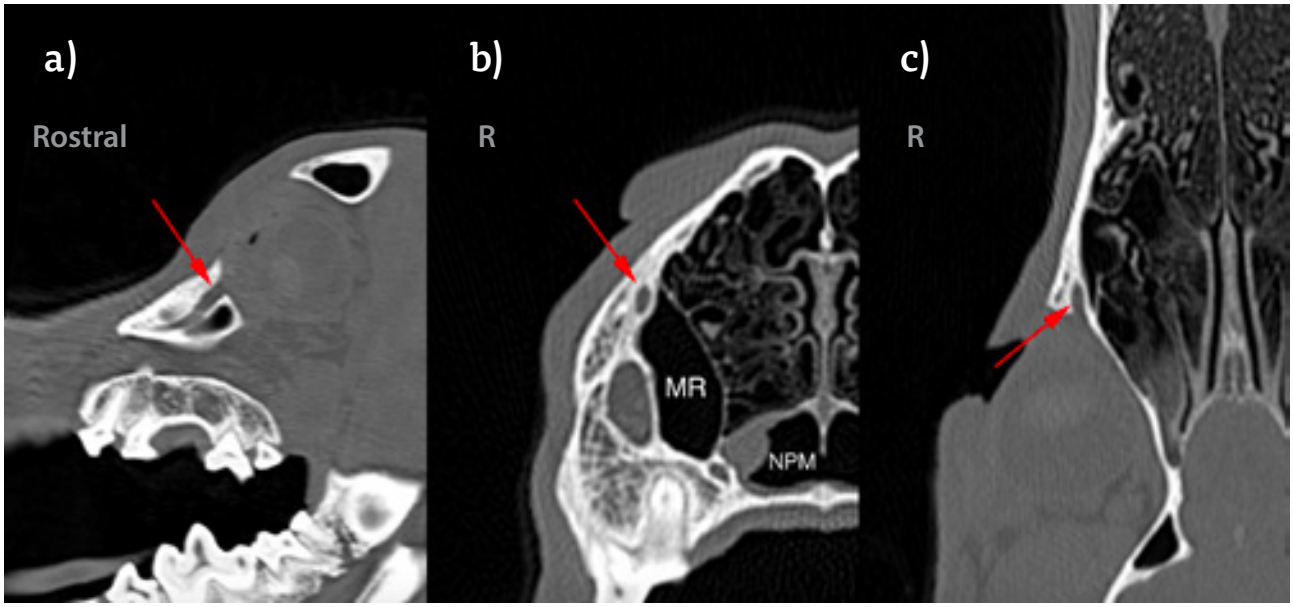


Fig.4. Sagittal (a transverse b and dorsal c) plane 0.5 mm thickness maximal intensity projection CT images depicting the location of the proximal aspect of the nasolacrimal canal (red arrows). MR - maxillary recess; NPM – nasopharyngeal meatus.
The images were reconstructed with a bone filter and displayed with WL of 470 HU and WW of 3300 HU.

The medical conditions of the nasolacrimal system in the dog are reportedly limited to lack of patency and inflammation[3]. Clinically, they can manifest as epiphora; mucopurulent punctal, conjunctival, and nasal discharge; swelling of the ventral medial canthal region; punctal foreign bodies; and draining fistula in the medial canthal region[3]. Several ophthalmologic procedures can be utilized to diagnose obstruction and/or inflammation of the nasolacrimal system. These include (but are not limited to): Schirmer tear test, cytology and microbial culture, fluorescein dye passage test (Jones' test) as well as normo-/retrograde cannulation and lavage/flushing[3]. Only a limited number of diagnostic imaging procedures has been reported in cases of suspected disease of the nasolacrimal system in the dog with conventional radiography, dacryocystorhinography[6] and computed tomography[7,8] being most commonly utilized. Recently, use of ultrasound for visualization and retrieval of the foreign material from the lacrimal sac has been reported[9].

Use of magnetic resonance imaging and scintigraphy among other forms of imaging has also been described in human medical literature[10], but, to the best of the author's knowledge, no equivalent publications exist in with reference to the canine nasolacrimal system. However, a cadaveric study of magnetic resonance dacryography in the horse has just recently been published[11].

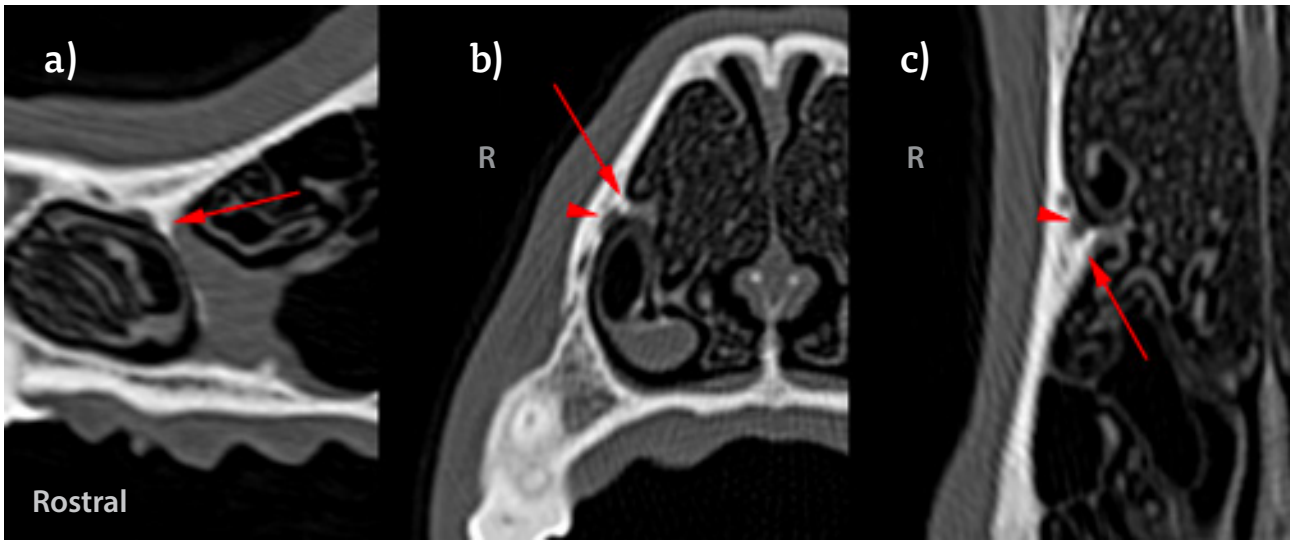


Fig.5. Sagittal (a)) transverse (b)) and dorsal (c)) plane 0.5 mm thickness maximal intensity projection CT images depicting location of the conchal crest (red arrows) under which the nasolacrimal duct leaves the nasolacrimal canal (red arrowheads). Rostrally to that point the nasolacrimal duct courses to its' opening onto the floor of the nasal vestibule covered only by the nasal mucosa.
The images were reconstructed with a bone filter and displayed with WL of 740 HU and WW of 3500 HU.

Case Description

A 6.5-year old, intact male Bichon Havanese presented to our ophthalmology service at AniCura Veterinärhuset Ängelholm in August 2018 with a 3-month history of right sided ocular discharge. The dog had previously been seen at three different veterinary clinics. Cytologic evaluation of the conjunctival discharge had been performed at one of those institutions and the results had been consistent with inflammatory process and presence of cocci. Culture of the expressed material had yielded Pasteurella sp. The patient had undergone various forms of medical treatment including flushing of the tear canals, topical as well as systemic antibiotics and anti-inflammatory medications. The above-mentioned therapeutic measures provided only temporary improvement. At the moment of initial presentation to our ophthalmology service the patient was undergoing treatment with oral meloxicam (Metacam chewable tablet. 1 mg) 0.074 mg/kg once a day and chloramphenicol eye drops (Chloramphenicol Santen 5 mg/ml) applied three times daily in the the right eye.

Ophthalmologic examination revealed right-sided blepharospasm, mild-to-moderate muco-purulent and slightly haemorrhagic epiphora associated with depigmentation of the surrounding skin. The right-sided conjunctiva was moderately hyperaemic and chemotic. The right sclera also appeared slightly hyperaemic. Fluorescein staining revealed mild stippling of the right cornea. At that point topical antibiotics were discontinued and tear substitution (Aptus SentrX EYE DROPS) three times daily was added to the treatment regimen. On a recheck appointment two days later the right eye seemed less irritated and no fluorescein staining could be appreciated. However, due to recurrence of mild purulent epiphora, the right-sided nasolacrimal system was further evaluated under general anaesthesia a week later. Samples for bacterial culture were taken and flushing of the nasolacrimal system with a sterile 0.9% saline were performed. The irrigation of the lacrimal system showed a clear passage of saline between the dorsal and ventral puncta as well as its' appearance at the nares.

The dog was discharged with instructions to continue tear substitution whilst awaiting the culture results (which later showed no bacterial growth).

Approximately two months after the initial presentation (October 2018) no substantial improvement in the dog's clinical signs was noticed during a recheck examination. The conjunctiva was still intermittently inflamed with intermittent purulent and slightly haemorrhagic discharge. The nasolacrimal system was flushed several times and a new cytology sample was taken, which showed presence of septic purulent inflammation as well as intracellular cocci. Ophthalmic cyclosporine ointment (Optimmune 2 mg/g) twice daily was started, however, the symptoms recurred anyway. During the following couple of months a variety of other topical anti-inflammatory medications were tried, unfortunately, none of them provided a complete resolution of clinical signs and intermittent epiphora persisted. In May 2019 a small fistula was noticed in the area of the superior lacrimal punctum. Flushing of the superior lacrimal canaliculi resulted in haemopurulent discharge being expelled from the lower lacrimal punctum accompanied by the patient's discomfort. Decision was made to proceed with a computed tomographic evaluation of the patient's nasolacrimal system and the dog was referred to AniCura Djursjukhuset Hässleholm.

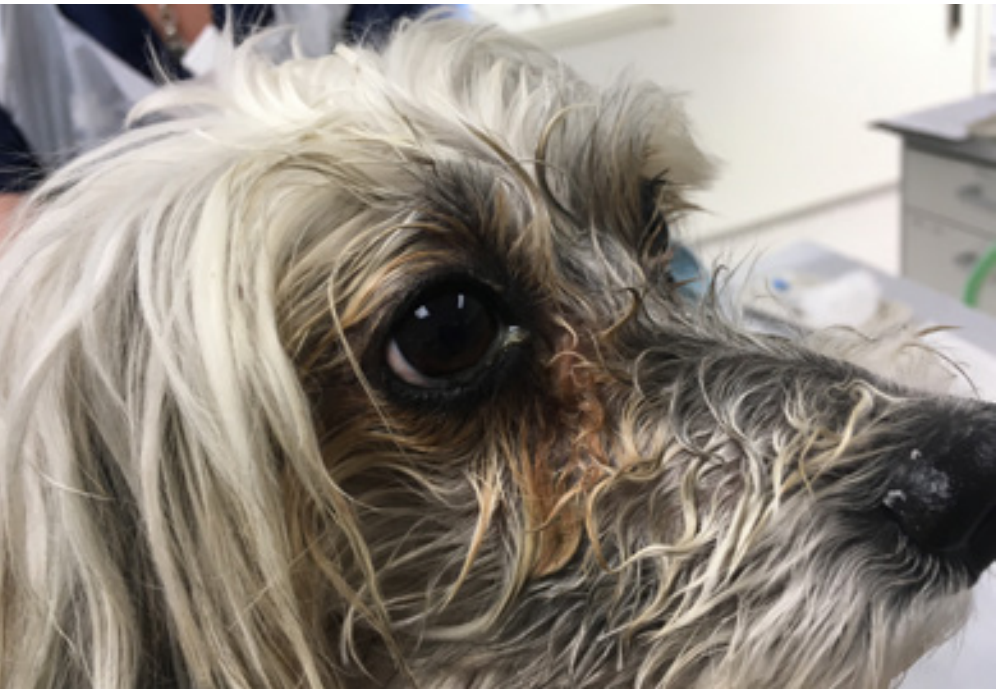


Fig.6. Patient on initial presentation to our ophhtalmology service at AniCura Veterinärhuset Ängelholm. Marked right-sided epiphora can be easily appreciated.

A CT examination of the head was performed under intravenous sedation with combination of dexmedetomidine 10 mcg/kg, butorphanol 0.2 mg/kg, midazolam (Midazolam Hameln 1 mg/ml) 0.2 mg/kg and propofol (Propofol-Lipuro 10 mg/ml) given intravenously to effect (in total 10 ml of propofol were used during the whole examination).

The patient was positioned in sternal recumbency on the CT table of a third-generation, 80-row, multidetector scanner (Aquilion Lightning SP, Canon Medical Systems). The study consisted of pre-contrast, post i.v. contrast as well as CT-dacryocystorhinography series. Scanning parameters for all the series were the same: tube current 250 mA, tube voltage 120 kV, collimation 80 x 0.5 mm; helical acquisition mode, tube rotation time of 1.5 s and pitch factor of 0.637. The pre-contrast data was reconstructed using 512 x 512 matrix with both a soft tissue and a sharp bone filter with 1.0 mm and 0.5 mm slice thickness, and 0.8 mm and 0.3 mm reconstruction interval, respectively. Subsequently, 12.0 ml of iodinated, non-ionic contrast medium (Omnipaque 350 mg I/ml) was injected by means of a dual-barrel power injector at 3.0 ml/s, followed by injection of 10.0 ml of sterile saline (Sodium Chloride 9 mg/ml) at the same speed. The post-contrast images were acquired 80 s after the start of injection. Post-contrast images were reconstructed with the soft tissue filter only, exactly in the same manner as described for the pre-contrast study. Images were analysed using a commercially available DICOM viewer.

Analysis of the images revealed presence of a moderately-sized expansile fluid-to-soft tissue attenuating mass in the region of the lacrimal sac (see Fig 7. and 8.). This mass resulted in resorptive deformation of the adjacent lacrimal and maxillary bones (see Fig. 7., 8., 9. and 10.).

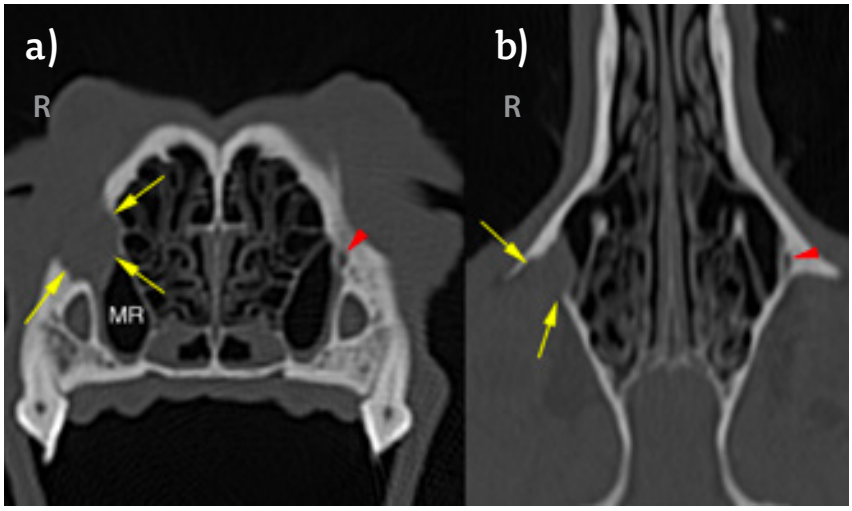


Fig.7. Transverse (a) and dorsal (b) plane 0.5 mm thickness maximal intensity projection computed tomography images depicting location of osteolysis of the right lacrimal as well as maxillary bones (yellow arrows). The proximal portion of the left nasolacrimal canal is indicated by red arrowheads. MR – maxillary recess.

The images were reconstructed with a sharp bone filter and displayed with WL of 1180 HU and WW of 4650 HU.

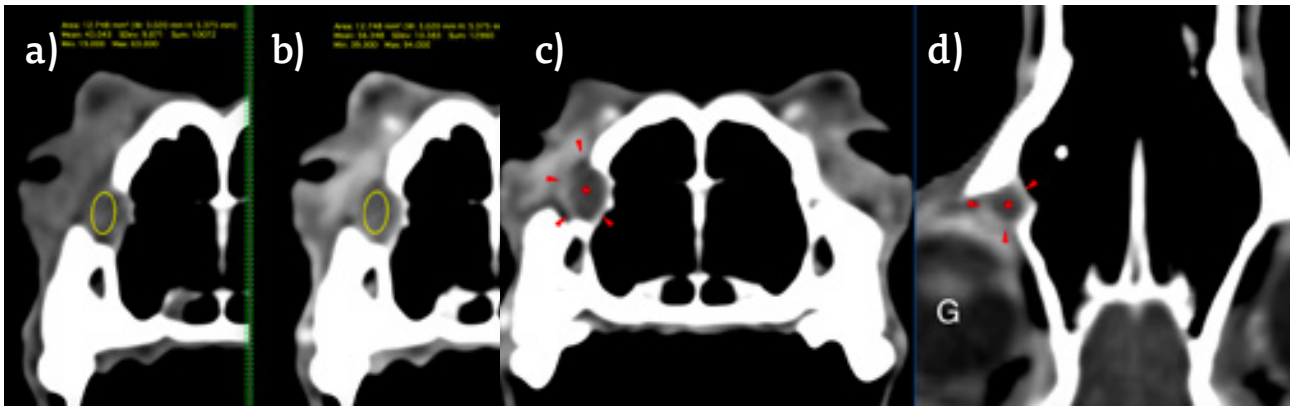


Fig.8. Soft tissue filter 1.0 mm thickness maximal intensity projection CT images of the right lacrimal sac area (approximately the same location as in Fig. 7). The images a), b) and c) are transverse plane and the image d) is a dorsal plane image. There is a fluid-to-soft tissue opacity structure within a bony defect of the right lacrimal and maxillary bones (delineated by red stars on images c) and d)) that shows clear ring enhancement pattern (red arrowheads on images c) and d). The central part of the lesion is displaying a marginal contrast enhancement (+ 13 HU; from 43 HU on image a) which is from the pre-contrast series to 56 HU on image b) which is from the post-contrast series). G – the right globe.
All images displayed in WL of 110 HU and WW of 200 HU.

The osteolytic process did not have aggressive appearance and was interpreted as pressure atrophy. The mass extended slightly rostro-medially into the nasal cavity and caused slight deformation of the dorsal aspect of the maxillary recess. The proximal portion of the right nasolacrimal canal could not be identified. Its mid-and distal parts were clearly visible but appeared slightly larger than the left-sided counterparts (Fig. 11.). On the post-contrast study the mass showed mild-to-moderate peripheral enhancement (Fig. 8.). Most likely differentials at that point included an abscess, granuloma or less likely neoplasia of the lacrimal sac. No other abnormalities within either the orbit or nasal cavity could be appreciated. Multifocal periodontal disease was documented, including the roots of the two right-sided maxillary molars (Fig. 11.). However, no appreciable extension into the region of the lacrimal sac could be seen. The right retropharyngeal lymph node was slightly larger than the left one. This was interpreted as either a reactive change or a possible anatomic variant, as the size of the node was still within normal limits.

Thereafter, the same type of radiographic contrast medium, however at lower concentration (Omnipaque 240 mg I/ml), was injected manually into the left inferior lacrimal punctum through an 25G intravenous catheter.

The CT scan was performed after the arrival of contrast at the external nares (approximately 2.0 ml of the contrast agent was required for that purpose). Post-dacryocystorhinography images were reconstructed with a Bone filter only, using the same reconstruction parameters as previously described. The first dacryocystorhinogram, which confirmed patency of the left-sided nasolacrimal duct, served as a reference for the right-sided procedure[7].

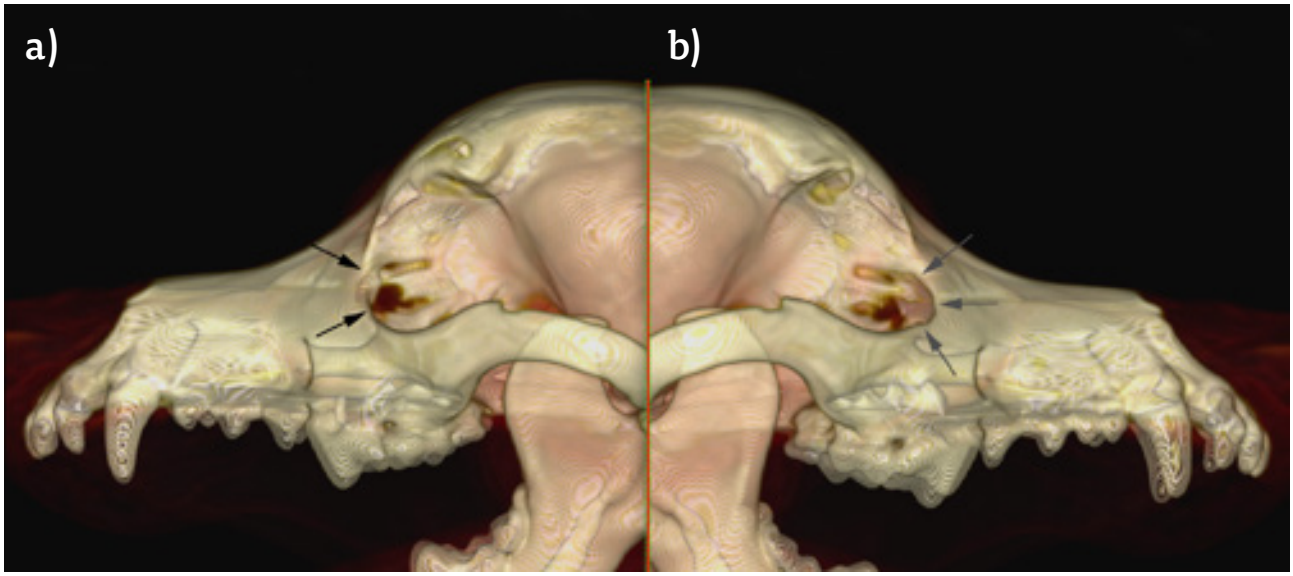


Fig.9. 3-D volume rendered images showing the left (black arrows in a)) and right (grey arrows in b)) fossae of the lacrimal gland. Notice osteolysis of the right lacrimal and maxillary bones. Compare with Fig. 7.

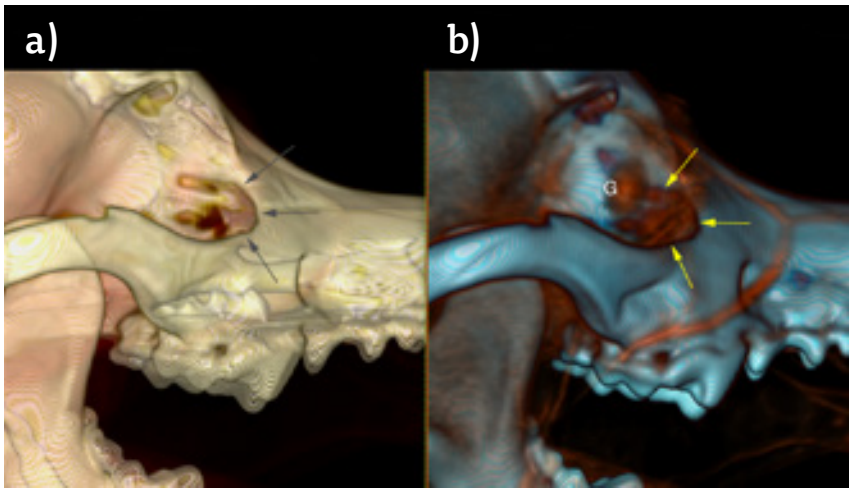


Fig.10. 3D volume rendered pre- (a) and post i.v.contrast (b) images of the affected side. Grey arrows in a) highlight osteolysis of the lacrimal and maxillary bones. The oval orange structure delineated by yellow arrows in b) corresponds to the soft-tissue attenuating, peripherally contrast-enhancing structure in Fig. 8. G- right globe.

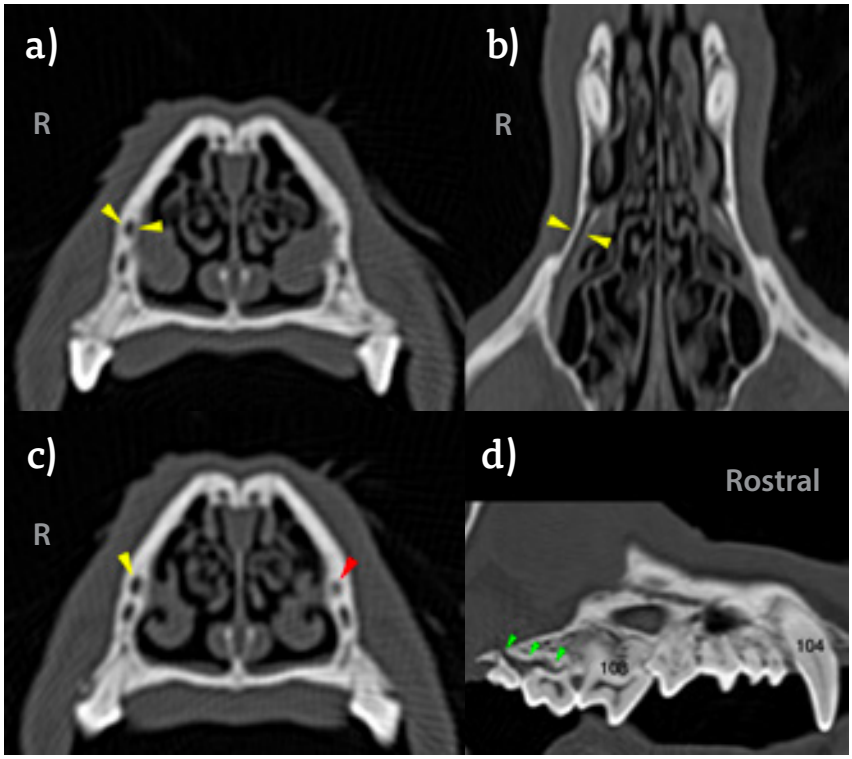


Fig.11. Transverse(a) and dorsal (b) plane 0.5 mm thickness maximal intensity projection computed tomography images. The mid- as well as distal portion of the right nasolacrimal canal can easily be identified (yellow arrowheads in a) and b)). On closer inspection the diameter of the right-sided nasolacrimal canal (yellow arrowhead in c)) is greater than its' counterpart on the contralateral side (red arrowhead in c)). Image d) is a part of a curved multiplanar reconstruction of the upper dental arcade ('panorama view') and shows areas of alveolar bone loss around the right-sided maxillary molars (green arrowheads). 104 – the right maxillary canine tooth; 108 – the right forth maxillary premolar tooth.
The images were reconstructed with a bone filter. Images a, b and c are displayed in WL of 910 HU and WW of 3875 HU. Images d is displayed in WL of 1110 HU and WW of 4200 HU.

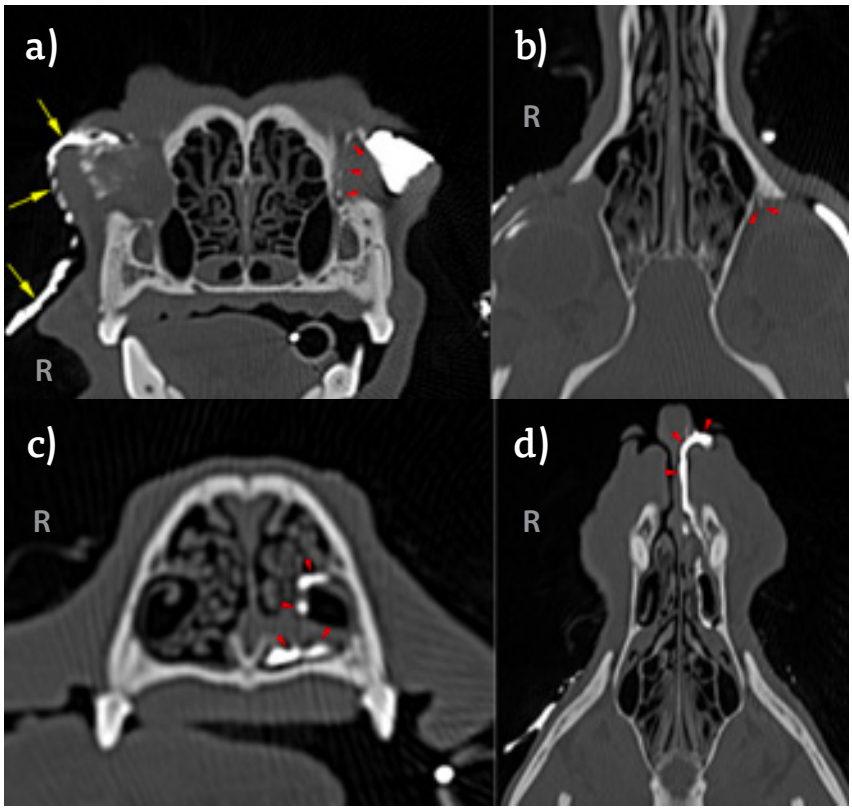


Fig.12. Transverse (a and c) and dorsal (b and d) plane 0.5 mm thickness maximal intensity projection computed tomography images after dacryocystography. The contrast column is seen entering the left nasolacrimal duct through the left inferior lacrimal canaliculus (red arrowheads on images a and b). On the contralateral side there is substantial spillage of the contrast medium outside the conjunctival sac (yellow arrows on image a). No contrast material could be appreciated either within the lacrimal canaliculi, lacrimal sac, nasolacrimal canal or nasal cavity on the right side. On the other hand, pooling of contrast material within the left nasal cavity as well as it's presence in the left naris can easily be seen (red arrowheads in c and d). This confirmed patency of the left-sided nasolacrimal system, even though the contrast material could not be appreciated within the nasolacrimal duct itself. The images were reconstructed with a sharp bone filter and displayed in WL of 1050 HU and WW of 4150 HU.

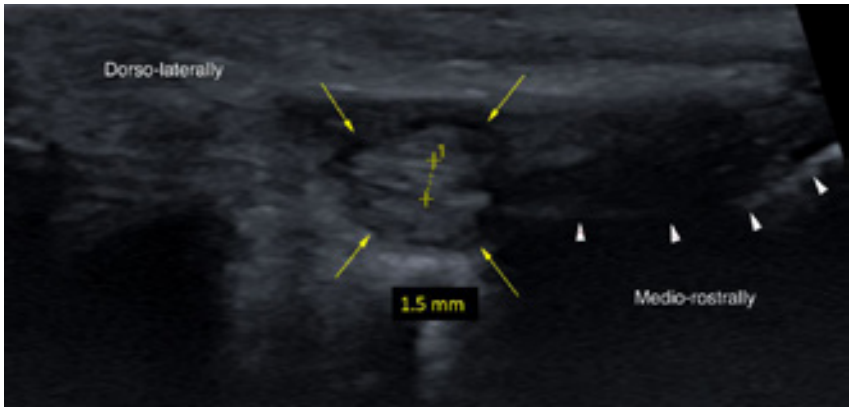


Fig.13. Ultrasound images of the foreign material (between the callipers) within the right lacrimal sac (between yellow arrows). This corresponds to the area delineated by red arrowheads in Fig.8. The ultrasound probe was positioned obliquely in order to visualize the contents of the lacrimal sac. White arrowheads indicate the osseous margin of the orbit.

However, injection into the right-sided inferior lacrimal punctum resulted in nearly immediate spillage of the contrast medium outside the conjunctival sac. No appreciable opacification of either the right lacrimal sac or the nasolacrimal duct (see Fig.10.) could be seen. This was interpreted as a complete obstruction to flow at the level of the soft tissue mass. Attempts at cannulation of the superior lacrimal puncta were unsuccessful bilaterally.

The animal was transferred to the ultrasound room and the area of the medial canthus of the eye was imaged with an ultrasound machine, operating at 12 MHz. The probe was positioned at an oblique angle (in dorso-lateral to rostro-medial direction in relation to the long axis of the skull), as this approach provided the best visualization of the lacrimal sac area. The ultrasound examination revealed presence of a hypoechoic oval area containing a few (two to four, the exact number could not be determined) tubular structures, 1.2-1.5 mm diameter with hyperechoic parallel walls (see Fig. 11).

Although neither apparent hypoechoic 'halo' nor acoustic shadowing could be seen, these structures were interpreted as lacrimal sac foreign bodies, most likely of plant origin. After a thorough discussion with the owner, a surgical exploration of the lacrimal sac was recommended.

A few days later a surgical approach to the right-sided lacrimal sac was performed by the same veterinary ophthalmologist that had referred the patient for the CT-DCG. At the time of surgical intervention the dog was being treated with chloramphenicol eye drops, meloxicam and tear substitution. The dog was anaesthetized and positioned under an operative microscope in dorsal recumbency in a vaccum cushion.

The incision overlied an urinary catheter that had previously been placed in the right inferior lacrimal canaliculus. A substantial amount of purulent material was noticed upon entrance into the lacrimal sac. After thorough exploration of the lacrimal sac a few pieces of plant foreign material were removed. The surgical field was thoroughly lavaged with sterile saline and the urinary catheter was inserted further rostrally into the nasolacrimal lacrimal system exiting at the nasal punctum within the nasal vestibule. The nasolacrimal system was closed with 5-0 poliglecaprone 25 in simple interrupted manner.

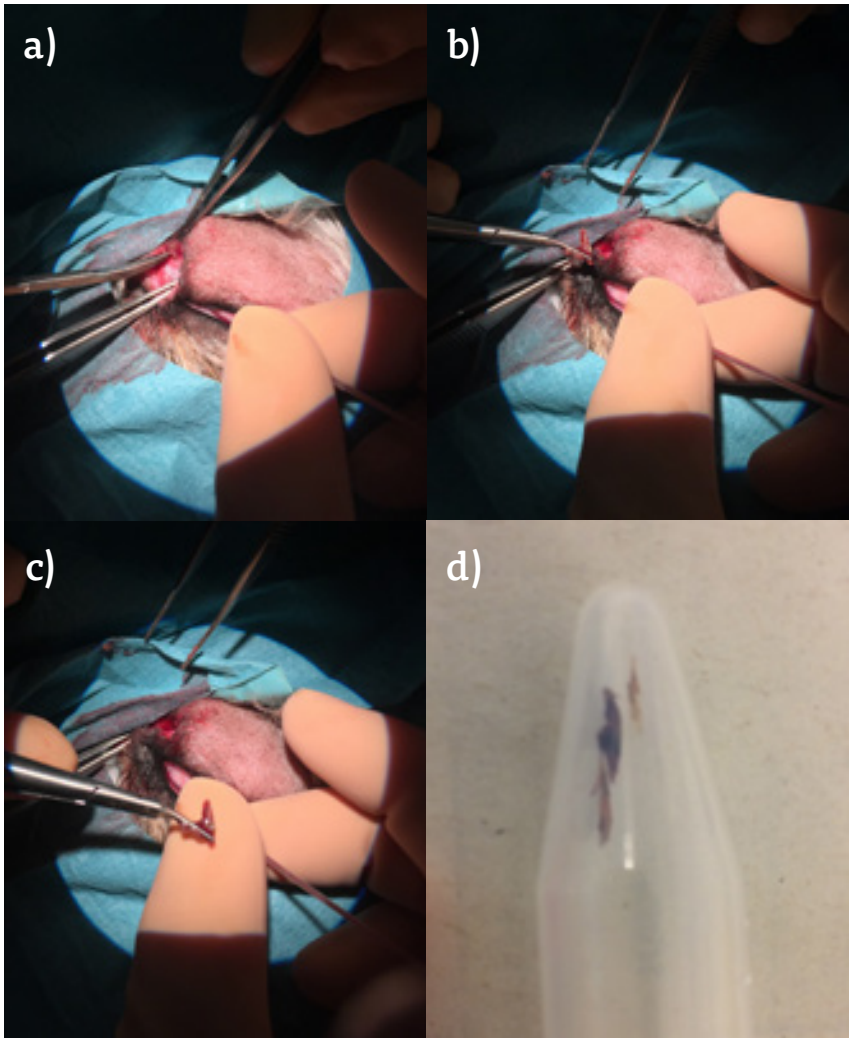


Fig.14 Intraoperative photographs showing: a) exposure, b) exploration and c) removal of the plant-based foreign bodies from the right lacrimal sac. The removed pieces of plant material can be seen within the plastic tube (d).

The subcutaneous tissues were apposed with the same suture material in simple continuous fashion, followed by skin closure with 3-0 nylon with simple interrupted pattern.

The nasolacrimal catheter was maintained for 3 weeks postoperatively at which time the patient was wearing a protective collar. Rostral is to the left on image a). The right side of the patient is to the left on images b) and c). Intraoperative bacterial cultures taken from the lacrimal sac yielded growth of Pasteurella canis, which was sensitive to chloramphenicol and tobramycin, so a week after the surgery the systemic antibiotics were discontinued and chloramphenicol eye drops restarted and given for additional 2 weeks. After removal of the catheter the lacrimal drainage system worked successfully without any recurrent epiphora.

Fig.15. Post-operative photographs with the catheter in place(a)) and after its' removal (b)) from the nasolacrimal drainage system. No epiphora in present.

Discussion

Diagnostic imaging procedures of the lacrimal system are carried out relatively infrequently in veterinary medicine. Diagnostic imaging features of disorders of the secretory component have not yet been published. A few examples of the CT features of nasolacrimal system diseases are provided in some publications and established veterinary advanced imaging texts[12,13]. Although the nasolacrimal apparatus (the 'conduit component') has received more attention, veterinary studies directly comparing usefulness of different imaging modalities are still lacking. Technical aspects of and clinical utility of dacryocystorhinography by means of conventional x-rays[6] and computed tomography[7,8] have, however, been described. Dacryocystorhinography implies injection of a positive, iodinated contrast agent into the lacrimal punctum with imaging of the region of interest shortly thereafter (usually after the contrast agent has arrived at the nares). Various contrast agents and their concentrations have been reported[6,7]. Unfortunately, due to technical and anatomical factors, the diagnostic value of conventional (x-ray-based) dacryocytorhinograms can be disappointing, particularly in brachycephalic subjects[6,9].

CT is an excellent approach for performing dacryorhinocystography to evaluate the patency of the lacrimal duct and identify obstruction[13], although determination of the cause of the obstruction may require utilization of other imaging modalities or even surgical exploration. Unfortunately, due to the effects of gravity, in some cases it is impossible to maintain a continuous contrast column in the nasolacrimal duct without a continual injection[7]. Utilization of lipid-based contrast agents can help overcome this disadvantage[6,11]. Regardless of those technical difficulties computed tomography dacryocystorhinography has been found very useful by some authors and should probably be considered for every patient with symptoms of nasolacrimal dysfunction[14]. Computed tomographic dacryocystorhinography is considered helpful due to its' ability to: confirm nasolacrimal obstruction, rule out nasal, orbital, and skull abnormalities likely to cause secondary nasolacrimal involvement and reveal bony lysis suggestive of osteomyelitis or pressure necrosis[15]. Not infrequently, however, as illustrated in this case and discussed by some authors[15], a combination of imaging methods must be implemented in order to overcome certain inherent weaknesses of various modalities.

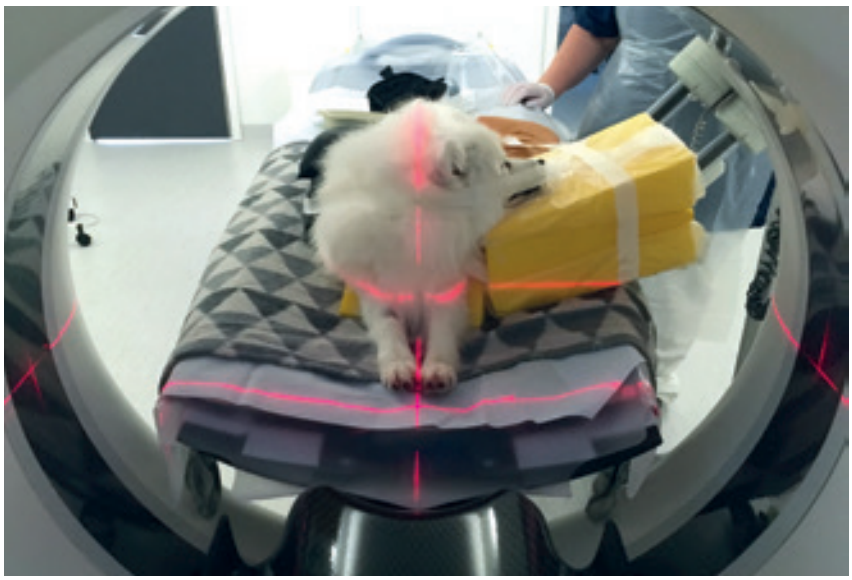
The nasolacrimal ducts are vulnerable to traumatic laceration, erosion, or compression by infectious processes or nasal tumours[3]. Damage to the nasolacrimal system may also occur secondary to facial trauma or dental disease, with the second and third maxillary pre-molars being most often involved. Injury may result in impingement and subsequent obstruction to flow, erosion of the duct itself or laceration due to adjacent fracture or soft tissue damage[12]. Computed tomography is extremely useful to confirm compression and occlusion of the nasolacrimal duct system and determine the extent of primary disease within the nasal cavity, dental apparatus and orbit[3,6,7]. In case of dacyocytsitis CT can reveal presence of osteomyelitis within the surrounding bone[7]. To the best of author's knowledge, no case of a lacrimal sac foreign body-induced epiphora/dacryocystitis with corresponding CT images has been published in the veterinary literature to date, although, possible features of such condition have been mentioned[12]. These include:

- alterations in nasolacrimal duct diameter, most likely dilatation
- presence of fluid to soft tissue attenuating structure, likely with peripheral contrast enhancement and osteolysis of surrounding bony structures
- obstruction to flow on a dacryocystorhinogram
- the foreign body itself may or may not be visible on a non-contrast study depending on its' attenuation characteristics, alternatively a filling defect may be appreciated on a dacryocystorhinogram

Similar CT features have, however, been descirbed in a case of nasolacrimal cyst[13].

In human medicine a whole armamentarium of imaging modalities has been utilized in cases of lacrimal system disease. These include computed tomography (CT), singe-photon emission computed tomography (SPECT), magnetic resonance imaging (MRI), dacryocystograpgy (DCG), fluoroscopic dacryocystography, computed tomography dacryocystography (CT-DCG), three-dimensional computed tomography dacryocystography (3D CT-DCG), magnetic resonance imaging dacryocystography (MR-DCG), three-dimensional magnetic resonance imaging dacryocystography (3D MR-DCG), dynamic magnetic resonance imaging dacryocystography (dMR-DCG), lacrimal scintigraphy, ultrasonography and dacryoendoscopy[10].

The primary concern regarding the use of CT in people is the negative effect of ionizing radiation, however, no other imaging modality provides as clear anatomic detail of the bony lacrimal drainage system. CT is considered to be particularly useful before any surgical intervention, particularly when one takes advantage of 3D reconstructed images. Three-dimensional models acquired on new multidetector computed tomography scanners with isotropic resolution and modern reconstruction capabilities can aid in surgical planning and communication between different specialists. However, because of irradiation concerns associated with CT, particularly in young individuals, there is increasing amount of reports on the use of MRI for the evaluation of the nasolacrimal system. Unfortunately, the signal loss of the bony canal is a major disadvantage of the use of MRI. Frankly speaking, the choice between CT and MRI is not always straightforward since both imaging modalities complement each other and their indications can overlap.



A dog being scanned with Canon Medical's Aquilion Lightning SP, at the Anicura animal hospital in Hässleholm, Sweden.

Only recently, a cadaveric equine study on the use of magnetic resonance dacryocystography (MDR) has been published in veterinary literature[11]. In this study injection of a pharmacological olive oil resulted in better filling and sharper definition of the nasolacrimal system in comparison with gadopentetate dimeglumine. Oil-based contrast media may provide 'dual contrast' on MRI images, acting as a positive contrast agent on T1W images and a negative contrast medium on fat-suppressed images. This feature could be used on fat-suppressed T1W images after intravenous contrast administration in cases of small lesions of the wall or surrounding tissues[11]. Moreover, an oil-based contrast agent (Lipiodol), has been previously recommended for performing conventional dacryocystorhinography in small animals[6]. However, safety studies are recommended before use of pure oil in clinical patients[11].

Epiphora, a fairly common reason for an ophthalmology referral can be caused by variety of nasolacrimal system disease, including both congenital (such as punctal, canalicular saccular or nasal lacrimal atresia, micropunctum), developmental and acquired (trauma, dacryocystitis, obstruction caused by foreign bodies or invasion/compression by neoplasm) conditions[3]. Dacryocystitis refers to inflammation of the lacrimal drainage system, frequently associated with either partial or complete obstruction of the nasolacrimal apparatus, as alternation to lacrimal flow may result in tear stagnation and secondary infection. Obstruction of the nasolacrimal system include numerous causes, including: congenital diseases (such as cystic dilations), trauma, neoplasia, chronic inflammation and fibrosis, intraluminal foreign bodies and granulation tissue. In a paper by Storm[15] et al. describing 16 cases of nasolacrimal obstruction the causes included: a foreign body (n=5), dacryocystitis (n=4), stenosis secondary to fibrosis (n=3), granulation tissue (n=1), or granulation tissue in association with a small foreign body (n=1); no cause was identified in 2 dogs. Identification and treatment the underlying cause of obstruction via cannulation, surgical removal of the offending material, or surgical rerouting of the tear pathway are typically required for resolution of clinical symptoms.

It has been hypothesized that narrowing and relative or complete stasis can exacerbate inflammation with worsening stasis, leading to permanent scarring, fibrosis, or stricture and that a stenting procedure may possibly break this stasis-inflammation-cicatrization cycle[15].

A dog being scanned with Canon Medical's Aquilion Lightning SP, at the Anicura animal hospital in Hässleholm, Sweden.

Clinical manifestations of dacryocystitis and nasolacrimal duct foreign bodies include epiphora, purulent conjunctival discharge, punctal foreign bodies and draining skin fistulas ventral to the medial canthus[3]. Dacryocystitis in the dog is usually caused by foreign bodies that have lodged within the nasolacrimal sac[16] and these must be removed or at least bypassed for effective therapy. One of the diagnostic challenges in the management of dacryocystitis is to understand whether a foreign material is present[9]. Assessment of presence of foreign bodies within the nasolacrimal system can prove problematic as their detection rate on computed tomography studies depends on the attenuation characteristics of the material itself as well as that of the surrounding tissues. Ultrasonography is considered superior when the foreign object is embedded within the superficial tissues and has low attenuation values. Ultrasound examination proved simple and effective in documenting presence of foreign material in our case. Typical ultrasonographic features of a plant-based foreign body such as tubular or spear shape and hyperechoic walls, were clearly appreciable in our patient.

In obstructive disease of the nasolacrimal system, the goal of any intervention is to establish patency of the outflow system to prevent persistent epiphora or dacryocystitis. Removal of the foreign material from the lacrimal sac is typically performed by means of an open surgical procedure (dacryocystotomy)[3], as described in the case herein. The osteolysis of the lacrimal and maxillary bones obviated the need for burring or removal of bony elements for surgical exposure. It has been suggested that the nasolacrimal duct system is cannulated with a silastic tube and treated with topical broad-spectrum antibiotics for approximately 3 weeks after the surgery[3]. Intraosseous approach to the canine nasolacrimal duct for removal of a foreign body has also been discussed[16].

Various surgical technniques to create an alternative tear passage have been described. These include both 'classic' procedures, such as conjunctival rhinostomy, conjunctival sinusostomy and conjuctival buccostomy as well more advanced surgical interventions[14,16,17,18,19]. Recently use of ultrasound for both diagnosis and minimally invasive removal of the plant-based material from the lacrimal sac has been reported[9]. In that paper four cases with clinically suspected plant-based foreign material in the lacrimal sac underwent its' removal by means of Hartmann alligator forceps inserted thorough the upper lacrimal puncta under ultrasound guidance. All identified foreign bodies were successfully removed by this technique providing resolution of clinical symptoms. Ultrasound represents a fast, simple, non-invasive, and low-cost alternative for the assessment of foreign-body induced dacryocystitis. One of its' main limitations, however, is the fact that the nasolacrimal canal cannot be evaluated under normal circumstances (namely without presence of bone loss).

Recently, a novel, multidisciplinary, fluoroscopy-guided approach to the canine nasolacrimal system obstruction has also been published[15]. Sixteen client-owned dogs with confirmed nasolacrimal obstruction of various aetiologies were included. CT-DCG, rhinoscopy and lacrimoscopy were used as diagnostic measures and the affected nasolacrimal ducti were stented whenever possible (achievable in 88% of the patients, 14/16). CT-DCG confirmed a complete obstruction in six of

those 16 patients. Lacrimoscopy was performed with use of a miniature flexible telescope that was inserted through one of the lacrimal puncti whilst irrigation was performed through the other punctum. This procedure was possible in 88% of patients (14/16), with adequate visualization in 86 % of those (12/14). However, in most dogs it was not possible to reach beyond the nasolacrimal sac. Above-mentioned, minimally invasive approach requires a lot of patience and manual dexterity, the median duration of anaesthesia for imaging and stenting was 3.25 hours (range, 2.25 to 5.25 hours). The study reported high success rate, which is particularly encouraging given the fact that the patient population had been previously treated by board-certified veterinary ophthalmologists and had failed standard therapy. It is important to note that the study was performed at the academic institution by authors having a considerable experience in minimally invasive, image-guided procedures.

Summary

Epiphora or presence of purulent ocular discharge is a relatively common reason for an ophthalmologic consultation. Oftentimes, the diagnosis can be straightforward, although in some cases, in-office examination procedures (such as lacrimal irrigation) are inadequate to diagnose the underlying problem. A wealth of information can be obtained via lacrimal imaging, however, this still seems to be an underutilized tool, even in human medicine. Early imaging is recommended especially in atypical or recurrent cases[10]. Computed tomography, particularly in combination with dacryocystorhinography (CT-DCG) is an invaluable method for assessment of surrounding bony structures and confirming the level of obstruction. Different corrective techniques can be utilized to address the problem, nevertheless the choice between them is not always clear. Emergence of new, minimally invasive alternatives seems very appealing; however, the cost of the equipment and steep learning curve will probably limit their widespread use. //

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BIT datacenter Netherlands.

VISIONS spoke with Dr. Hendrik-Jan Kranenburg. Clinical Director, Evidensia Veterinary Hospital Nieuwegein, The Netherlands.

Cloud Storage in Veterinary Diagnostic Imaging

The Evidensia Veterinary Hospital "EDZ Nieuwegein", in the Netherlands, is a newly established veterinary facility within the IVC Evidensia Group, which is also the latest of the Group's clinics to integrate the Cloud Storage solution from Vital Images.

IVC Evidensia is Europe's largest veterinary care provider. It has an expansive network of clinics, hospitals and emergency centers across 11 European countries. Providing a full range of high quality general, surgical and specialist veterinary care to thousands of animals every year demands top quality imaging equipment, post processing and image management software. To meet the challenge of a growing workload and increasing need to integrate a burgeoning amount of data associated with this, IVC Evidensia Hospitals in the Netherlands. has chosen Vital Images, a Canon Group company, as a solutions provider for image management in its clinics in The Netherlands.

The EDZ has 55 staff and treats around 6,000 animals every year, most of which are dogs and cats. It offers a wide spectrum of specialisms, including Veterinary Cardiology, Orthopedics, Surgery, Dentistry and Behavior Therapy. With this number of specialisms and 15 specialist staff, high quality imaging is key. The Hospital performs around 350 CT scans, 2,000 X-Rays and 1,000 Dental scans, each year.


PHOTOGRAPHY BY JAN BUTEIJN

"Ease-of-use and fast image transfer have become priorities as our practice has grown."

Dr. Hendrik-Jan Kranenburg. Clinical Director, Evidensia Veterinary Hospital Nieuwegein, The Netherlands.

What is Vital's Cloud Archiving?

- *Cloud archive, no need for local installations and on premise hardware.*
- *Web based, easy for peer review, second opinion or remote access.*
- *Secure, Vital Images adheres to the safety and regulations that are common practice in human healthcare such as ISO 27001.*
- *Versatile: the solution provides a viewer with diagnostic quality and the tooling to review all clinical images in one platform and environment.*

This level of imaging generates around 400 GB per year, for the Dutch Evidensia sites this number adds up to over 1.3TB annually. Expectedly this volume will increase year by year.

Cloud archiving

"We are in the transition of moving our significant volume of data into the cloud," said Hendrik-Jan Kranenburg, Orthopedic Surgean and Clinical Director of the Veterinary Hospital. "Previously, all IVC Evidensia hospitals and clinics used on-premises servers, but with this, we were very limited in how we could transfer our key imaging data. For example, we experienced connectivity issues between equipment and archives. Ease-of-use and fast image transfer have become priorities as our practice has grown, and since we anticipate the number of examinations to only increase in the next coming years, we chose to upgrade and extend our image management capabilities through the cloud."

"Vital Images is providing us with a Cloud Storage solution and reading station," he continued. "While we have only just started implementing this at Nieuwegein, other IVC Evidensia hospitals in Barendrecht, Waalwijk and Arnhem in The Netherlands, are already successfully using the Cloud storage solution. Both this clinic and our colleagues are very content with the solution provided, so far. The storage solution and diagnostic reading station allows us when necessary to have a radiology specialist from another location assist the specialists in the hospital", said Dr. Kranenburg.

Integrating data

Veterinary Practice Management Software, like IDEXX Animana, is already used by many veterinary clinics, which makes it more easy for reading purposes and clinical evaluation since it is context sensitive and you do not have to look for the images in two different systems.

Vital Images

Vital, a Canon Group company, has a legacy of leadership in healthcare imaging using smart algorithms and techniques of innovation spanning 30 years. As the premier provider of an enterprise imaging (EI) solution focused on interoperability, Vital transforms and seamlessly connects disparate PACS and other data into an efficient, perceptive and interoperable EI solution. Through modular and scalable enterprise message orchestration, enterprise visualization and enterprise analytics solutions, Vital's Vitrea Enterprise Imaging solution makes data accessible across the entire enterprise anytime, anywhere, and in any standardized form.

PHOTOGRAPHY BY JAN BUTEIJN

"Integrating the Vital Imaging system with our Practice Management System (PMS) will be of utmost importance. It will be crucial to be able to access all patient data from within the PMS. The images need to be integrated into our workflow and accessible from within the patients file," added Dr. Kranenburg. "Integration with the Animana software will hopefully be shortly available for the Enterprise solution provided by Vital Images."

Secure cyber center

Vital's Cloud Storage Solution for Dutch clients is hosted in a cyber center in the Netherlands that has one of the highest graded security levels. This offers the best possible levels of reliability.

Day-and-night access to updated records

Just like a normal medical hospital, the work of the EDZ Nieuwegein is 24/7.

"Access to updated patient data that is available in a standardized form at any time of the day or night is essential for our key specialists, who sometimes work remotely from each other.

This is especially important in emergency cases. Reliability, speed and continuity are fundamental elements that led us to opt for the Vital solution," concluded Dr. Kranenburg. //

Heart Disease in Small Animals

Canon Medical's High-end Ultrasound technology supports the Veterinary specialist Dr. Andreas Kosztolich (Vienna, Austria) in diagnosing the real, but sometimes hidden reason behind heart disease in small animals.

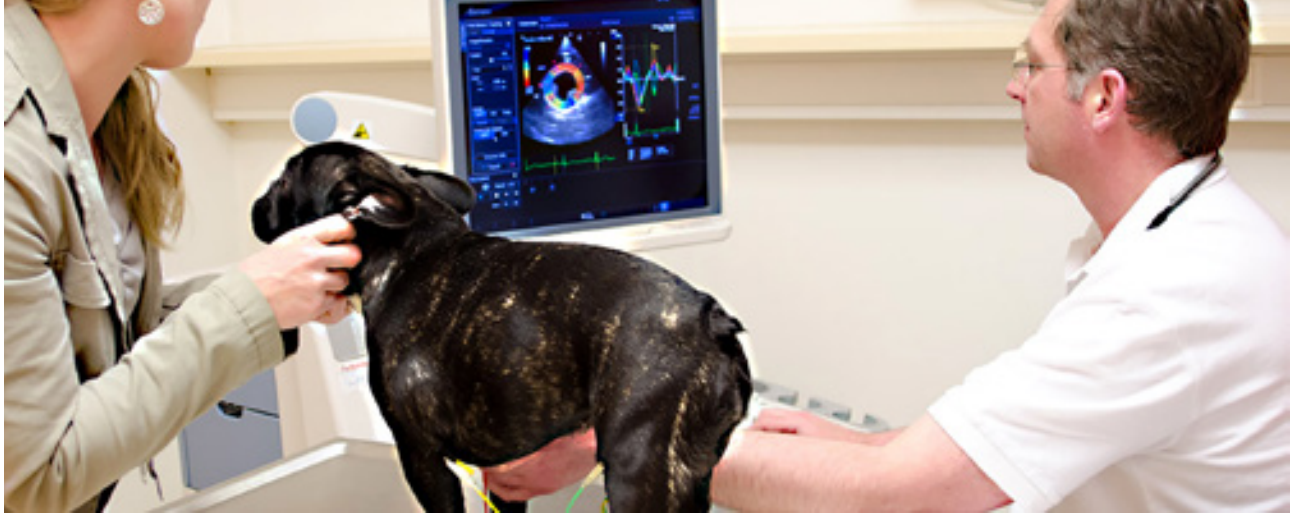
Diagnosis and treatment of cardiovascular diseases have long been of secondary importance in veterinary medicine. Very few patients appeared to suffer from such often life-threatening illnesses. The technical development of diagnostic options has shown that heart and circulatory diseases in dogs and cats as well as in many other small animals such as rats, ferrets or rabbits are quite common, as originally thought. With the aid of modern diagnostic methods, it is possible to track down congenital and acquired diseases and, if necessary, to initiate efficient therapy. How best to do this is described by Dr. Kosztolich.

You operate a cardiology practice for small animals in Vienna. What is a typical day in your practice like from a clinical point of view?
I work on the basis of referrals from veterinarians, whereby a substantial proportion comes to us by recommendations. The cardiological examination methods consist of clinical examinations as well as specialised examinations such as ECG, blood pressure, laboratory examination, ultrasound and Holter ECG. Advanced imaging techniques, such as classic chest x-ray or thoracic CT / MRI examination, are performed by the referring physician or specialist clinics. All examinations are carried out in accordance with internationally valid, standardised guidelines for the diagnosis and treatment of heart disease in small animals (European College of Veterinary Medicine, American College of Veterinary Medicine, Internat. Guidelines for Veterinary Cardiology). The therapy is then taken over again by the referring physician and we keep a check on the illness at regular intervals.

What kind of patients are referred to you?
Small animals, especially dogs and cats, are suspected of having heart disease. This is particularly necessary for cardiac sounds, signs of impaired performance, respiratory problems, discoloration of the mucous membranes, circulatory problems / history of collapse or classical breeding examinations that exclude congenital heart disease. In addition, we are involved in drug monitoring when it comes to monitoring therapeutic success.

How common are heart problems with dogs?
Very common! There are breed dispositions for heart diseases, such as the Great Dane, the Irish Wolf, the Doberman, or the Cavalier King Charles Spaniel. Purebred cats are presented to us just like normal domestic cats. We can now diagnose a heart problem very well, but it is still a chronic disease process, the clinical course of which is not always "straightforward" because of additional illnesses such as, orthopedic complaints and neurological or internal problems in the aging patient.

What was your objective to choose the Artida high-end Ultrasound system from Canon Medical?
My main concern was my need for a robust volume calculation in the heart before and during therapy. Canon Medical's Speckle Tracking Technology is the only one that provides direct visual and quantitative access to 2D regional myocardial motion and provides a high quality 2-DE resolution.



Dr. Andreas Kosztolich (Vienna, Austria).

You were the first Veterinary specialist using this high-end technology in a clinical environment for small animals. What is the advantage compared to other systems?
The referring physicians call for precise diagnostics and a therapeutic roadmap as a guideline for implementation. They do not want technical details, but a complete package that quickly gets to the point: What is wrong with an animal, how best to treat it and how can success be measured? The added value for me is more of a personal nature. I would like to develop myself with the technical challenge. I use 2D matrix technology for every clinical issue and can make better and safer diagnoses on this basis. It makes a difference whether I interpret a systolic function parameter with a lot of experience, or just several. The technical possibilities of the device allow me more security in diagnostic validity. I can, for example, make volume calculations using several methods (Teichholz, Simpson, speckle tracking, 3-DE) and, depending on the current study situation, draw my conclusions from the results. I have made significant progress with the device, especially in terms of monitoring. For example, the detection of systolic and diastolic dysfunctions has become simple and valid. Especially for difficult patients, like cats, the resolution of our Ultrasound system is unsurpassed. Despite all this device technology, clinical examination is still important in our field because our patients cannot speak. The credo is still to find a cost-effective way to maximum diagnostic safety.

What diagnostic benefits would you expect for a 3D matrix?
The search for intra- and extracavitary tumors is certainly an issue. More precise volumetric calculations, 3D-based regional wall motion analysis in different cardiomyopathies or for exampkle, after transient ischemic attack as a differential diagnosis to epileptiform attacks or clinically significant arrhythmia - even on the right ventricle.

What recommendations do you have for colleagues interested in education and training?
In the university sector, recognised training courses already offer a cardiology curriculum and advanced training is also very possible in Austria and abroad. When I dealt with echocardiographic diagnostics 25 years ago, there was not enough of what I had to offer, and we had to rely on results from human medicine for specific questions. At that time as well as today however the following was important: You have to learn the business yourself, because the inter-medical and pathophysiological basics of heart disease / or drug therapy must be the basis of a medical decision. Every clinical case is different, and after a certain routine, your own experience comes to the fore.

What are your expectations in terms of further developments in ultrasound diagnostics?
We have special requirements in veterinary medicine, because the patients are anatomically very differently built. Above all, it needs valid sound technology, which allows an assessment in a short time. Furthermore, I regularly review my own diagnoses, so it's important for me to have matching workstation applications that allow for reviews and proper archiving. Digital interfaces are already standard today. All together, of course, a reasonable price-performance ratio.

What is important to you when working with device manufacturers?
In addition to the support of a competent company, you also need a very good expert network to discuss specific details. For me, cooperation with human medicine was and is very important here. I have received a lot of input from radiologists, vascular physicians or cardiologists, which I can also transfer to my field of work. A short training on methodology is also important to me. This is the only way I can immediately and consistently provide the best for patients. My motto is "per aspera ad astra" (through hardships to the stars)!

Where do you see the trend in imaging diagnostics going?
It's difficult to say. Seven years ago, veterinarians had not seriously thought about 3D / 4D images. I still expect radical developments in transducer technology, smaller transducers tuned to the acoustic window we naturally have. For me it is important to have a network of tech-savvy contacts. In addition to the results of current cardiological research on small animals, I am able to get the maximum out of certain issues. But that is not so much a question of innovation as communication. //

Revealing the Secrets of Animal Mummies with Canon Technology

Merijn de Bakker, Mike Richardson, Berend Stoel, Irene Hernández-Girón, and Lara Weiss.

The Rijksmuseum van Oudheden (National Museum of Antiquities, RMO) in Leiden has one of the ten most important collections of the ancient Egyptian culture worldwide, among which are several animal mummies. In order to reveal their secrets, the RMO has teamed up with Canon Medical Systems Europe in Zoetermeer, the Netherlands, computer scientist Berend Stoel and physicist Irene Hernández-Girón (Leiden University Medical Center), and Leiden University biologists Michael Richardson and Merijn de Bakker. The 3D-digitization and interactive visualization of CT allow digital autopsies without any damage to the ancient artefacts!

Mike Richardson (Biologist at Leiden University), Lara Weiss (National Museum of Antiquities, RMO), Ravi Somaroe (European Clinical Specialist CT at Canon Medical Systems Europe) and Berend Stoel (Computer Scientist at the LUMC).

Why animal mummies?

The ancient Egyptians were full of the joys of life and they sought to extend it into eternity. Already during their lifetime they invested heavily into tomb building, and eventually, after death, mummification. Only an intact body could survive in the afterlife. Occasionally Egyptian pets were also mummified to keep their owners company, yet most animals mummified were not domestic animals. They were bred in the temples of the gods. The animals were killed, mummified and then sold to temple visitors, who bought these so-called 'votive mummies' in order to donate them to the gods in return for their favour. This practice flourished on an almost industrial scale from the 6th century Before Common Era to the 2nd century Common Era. The ancient Egyptians thus did not worship animals per se, but the idea was that some divine powers could manifest themselves in animal form. For example, the power of dangerous animals such as crocodiles or snakes could be converted and used as a protective force.

The underworld god Anubis was a jackal god. Perhaps he became a protector of the deceased, because wild dogs were frequently seen on the desert plateaus where tombs of the deceased were located. Other animal forms are less evident. The god Thoth was associated with the art of writing and wisdom. He could appear as ibis-headed human, as ibis, or as baboon. The fertility goddess Bastet could appear cat-headed or as a cat, sometimes with several kittens. At Saqqara, about 30 km south of modern Cairo the so-called necropolis of the sacred animals was situated. This was an area of underground catacombs, several temples and shrines. The mummified ibises, baboons, falcons, and dogs were buried in separate catacombs, whereas at Saqqara cat mummies mostly appear in reused earlier tombs.

Digital autopsy

The RMO has a large collection of mummies, because the museum did not unwrap them. The very first director of the museum had already realized in the 19th century that the unwrapping of the more than 2000-year old mummies meant destroying them forever. This was a very wise decision although it would take some patience and time to learn more about the Leiden mummies. X-rays had been discovered in 1895 by Wilhelm Röntgen and started to be used as a non-invasive method to obtain medical images of the interior of the human body one year later. It took until the 1960s to apply radiographs to investigate the first Leiden mummies. X-ray imaging allowed non-destructive investigation of the hidden interior of the ancient remains. In 1972 the first commercial computed tomography (CT) system was released for clinical use, and almost a decade later, the first Leiden animal mummies were scanned (1981). The 1990s saw CT scanning of the whole mummy collection in collaboration with the Amsterdam Medical Center (AMC)[1].

In 2016 two Leiden mummies – a man and a crocodile – were CT scanned again in cooperation with AMC. It was now possible to digitally unwrap the mummies layer by layer in a 3D-model. The latest developments in Computed Tomography image reconstruction, based on deep learning methods, have the potential to boost overall image quality by reducing noise, enhancing edge sharpness while minimizing artifacts[2,3] compared to previous iterative reconstruction methods. Therefore, in this study, the deep learning reconstruction technology developed by Canon Medical Systems, called Advanced intelligent Clear-IQ Engine (AiCE), was used in combination with one of their latest CT systems (Aquilion ONE / PRISM Edition) to unveil the secrets of the Leiden animal mummy collection.

Lara Weiss (National Museum of Antiquities, RMO) with the Ibis mummy.

Inside and out: what's under the wrappings

On February 19th, 2020, seven animal mummies were scanned at Canon Medical Systems Europe B.V. in Zoetermeer as a first test case of the ideal settings of the Aquilion ONE / PRISM Edition scanner, applying the latest reconstruction method available, AiCE. Some of the mummies had been previously scanned in other CT systems and using other medical modalities, such as conventional X-ray imaging, so prior to scanning no big surprises were expected.

In this particular study, in which the mummies are old and fragile, the imaging protocols had an associated dose at a similar level as used in clinical practice with patients.

Despite the initial modest expectations, the high resolution of the new scans, even on the reconstructed axial slices with AiCE, already allowed the identification of structures inside the mummies not seen in the previous studies.

Additionally, the high resolution of the scans combined with Global Illumination software at the Vitrea workstation from Vital, enabled the creation of highly detailed 3D-models of the mummies. Applying thresholding, the visualized tissues could be custom selected, and the full control over the visualization angle and rotation of the mummies in space, allowed us to virtually unwrap layer after layer of fabric from the mummies without any damage.

Ravi Somaroe (European Clinical Specialist CT at Canon Medical Systems Europe) and Berend Stoel (Computer Scientist at the LUMC) scanning the mummies.

Crocodile mummy Leiden inv. no. AMM 16h

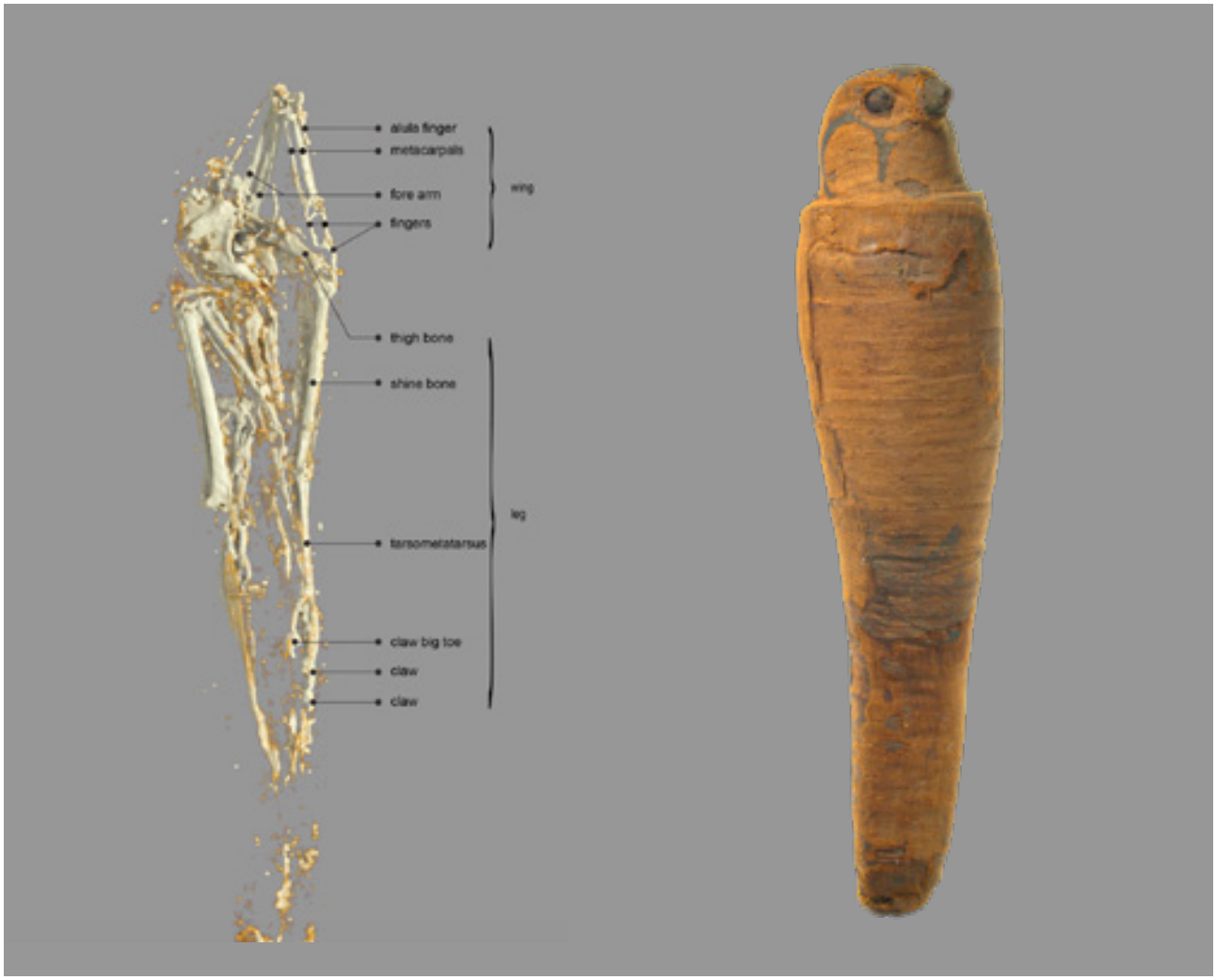
This crocodile mummy's wrapping was designed with a lot of attention for detail. Inside is not a juvenile crocodile, but only a skull, without lower jaw, of an adult crocodile. It seems to have been somehow attached to a stick extending through the whole mummy.

Head of a dog mummy - Leiden inv. no. AMM 16m

The mummified dog head is a nice example of how a CT scan help understanding what kind of objects we are dealing with. It was purchased by the museum as an animal of unknown type in 1828, and long thought to be an ibis mummy, until a scan on 15 May 2000 revealed it was actually the head of a dog. It is odd that the head was mummified separately, which is highly unusual. The question is therefore whether it was a gift for the jackal god Anubis, the protector of the deceased and god of mummification, or whether the parcel was meant to look like an ibis mummy, in which case it would be an ancient 'fake' mummy.

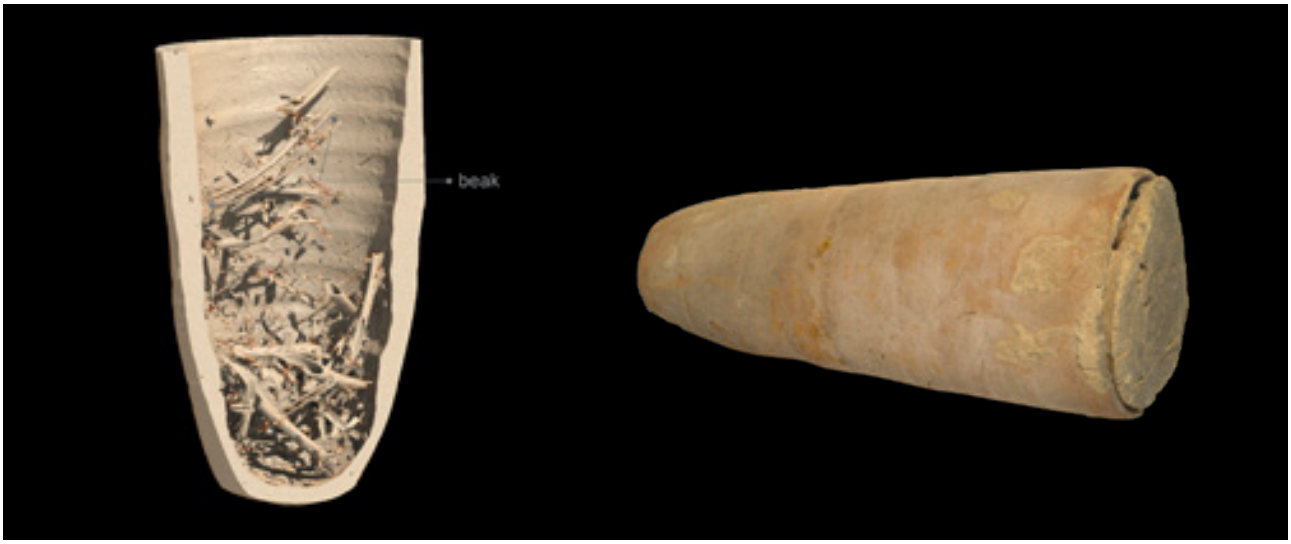
Fish mummy - Leiden inv. no. CI 259

This mummy has its own fish-shaped coffin. Inside is a small fish, identified as Nile perch in earlier publications, of which the head points to the tail end of the coffin. Nile perch were associated with rejuvenation since they lived in the primeval waters of the river Nile. Yet the determination of the fish species is difficult. Nile perch adults can weigh over 100 kg, so while it may be a juvenile Nile perch it could as well be almost any other fish. The coffin seems to have the shape of a Nile tilapia, but this is not indicative. Christian Tudorache and Merijn Bakker did not see any vertebra only a few fin rays of which it is unclear if they are pelvic, pectoral or anal, and what seems to us the head is pointing to the tail end of the coffin. None of its characteristics points to a specific species of fish endemic to the Nile. For a better identification of the fish we would need information of the head and the kind of teeth the fish had, which are invisible in the current scan. We are therefore greatly looking forward to further technical developments by Canon Medical which will improve image quality even further, and will potentially reveal even more information about our mummy collection, and maybe other museum collection items.



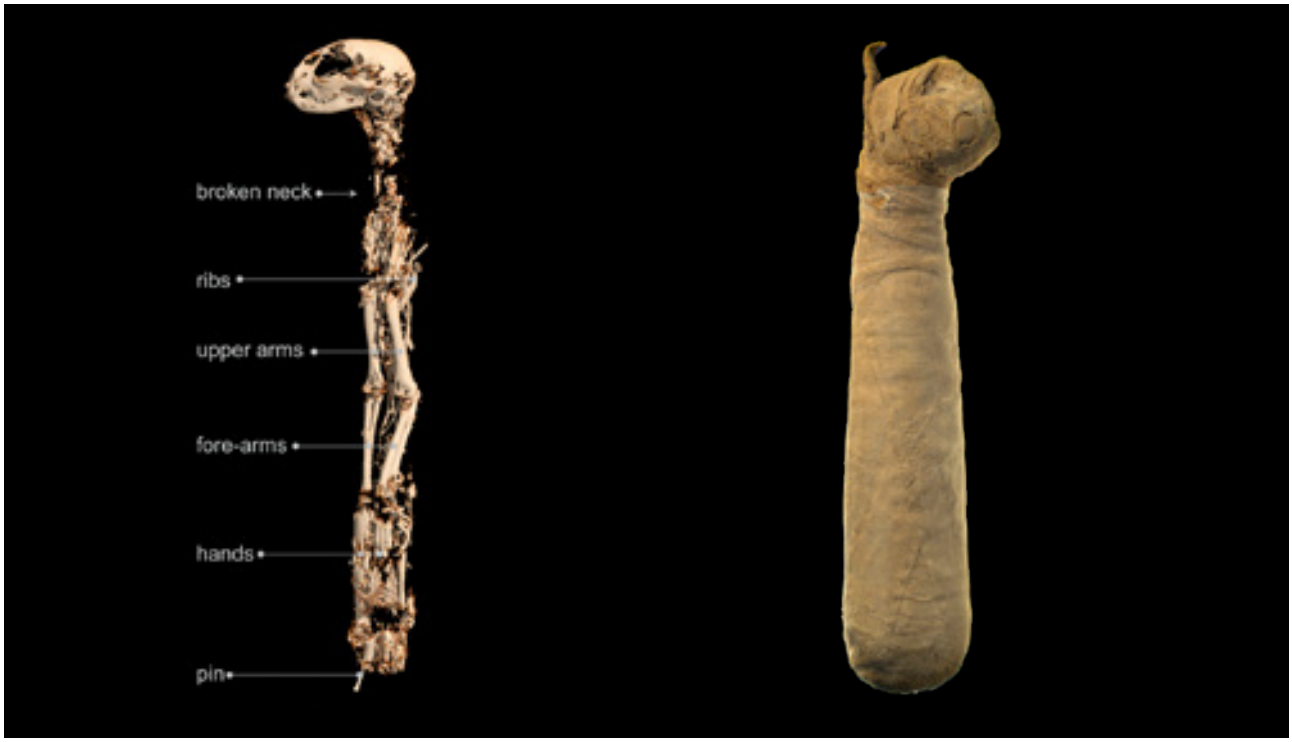
Falcon mummy - Leiden inv. no. F 1982/12.10

In an earlier publication, scholars were uncertain if the mummy was a falcon or a sparrow-hawk. The former has now kindly been confirmed by Hanneke Meijer. The falcon mummy consists mainly of its limbs but is missing most other bones, including its head. This does not mean it was a fake since in Egyptian religion, one part could symbolize the whole (pars pro toto).



Ibis mummy in ibis pot - Leiden inv. no. H.III EEE 3

Other typical examples of ibis mummies are little vases known as 'ibis pots'. The bird mummy inside this ibis pot is incomplete, but the curved beak, the bones of both upper and lower beak, in the top of the pot identify it as an ibis. At the bottom of the pot is a collection of mainly broken hollow long bones from the wings and legs. This specimen was different to the others, from the scanning point of view, as the vase has a high X-ray attenuation, similar to dense bone. Despite of this, the images show a high level of detail and sharpness, depicting all the small bone chips remaining of the ibis.



Cat mummy - Leiden inv. no. AMM 16 cm

Cat mummies were gifts for the tutelary goddess Bastet. This relatively young and otherwise healthy animal was killed by breaking its neck. It is mummified in an unnatural upright position with its arms alongside its body. The body is also squashed flat and the ribs are out of position, you can also see some of them between the fore-arms. As a part of modern restoration, the animal was fixed with modern pins.

Ibis mummy - Leiden inv. no. F 1956/10.4

This complete juvenile ibis was mummified with its head bend down between its legs (the long hollow bones typical for birds). The curved upper and lower beak are clearly visible at the bottom.

Acknowledgements

We should thank Hanneke Meijer (University of Bergen, Norway) for her help in analysing the bird mummies and Christian Tudorache (Leiden University, Netherlands) for analysing the fish mummy. //

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Improving 'Standards of Care' in CT for Animals: Split-Bolus Single-Pass Multi-Phased Abdominal CT

Aquilion CT scanner enables specialist veterinary practice in the Netherlands to develop an innovative split-bolus contrast technique with the potential to become a new standard in veterinary medicine.

Veterinary medicine has advanced enormously in recent years. With veterinarians now able to diagnose and treat a broader range of diseases than ever, specialist practices, like 'De Kompaan' – a referral-only clinic in Ommen, the Netherlands – must stay on top of new developments in imaging. Investing in a refurbished Aquilion 16-slice CT scanner from Canon Medical Systems has brought many benefits to the clinic, its patients and their owners.

Notably, it has enabled Rob Gerritsen, Veterinary Internist and Owner of De Kompaan, to develop an innovative split-bolus contrast technique, which combines multiple phases into a single scan. Positive results from initial trials suggest that this technique has the potential to become a new standard in veterinary medicine.

A promising new advanced technique

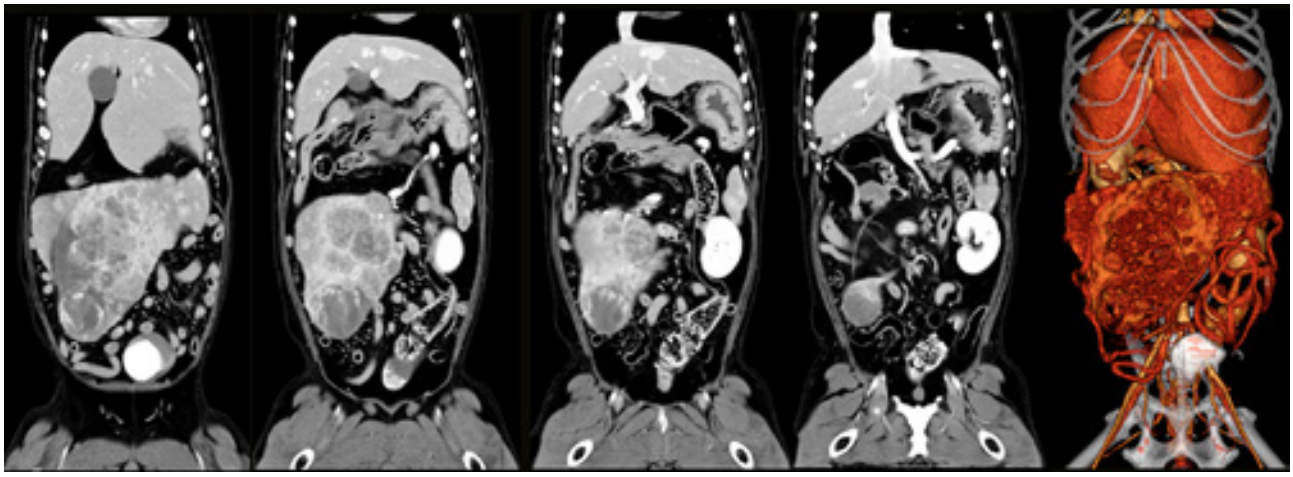
Multi-phasic contrast-enhanced abdominal CT is used routinely in human medicine to visualize hyper- and hypo-vascular tumors, hemangiomas and urinary-tract disease. In human applications, the technique involves administering a bolus of contrast to the patient and performing multiple scans at set time-points.

Unfortunately however, this procedure is complicated to perform on animals. Repositioning the scan table takes time and poses a problem, especially with small animals, because general anesthesia is required, preferably with respiratory arrest ('breath hold') to ensure high-quality imaging.

As a result, a single phase scan only is often performed in veterinary practice (with the exception of university clinics that might scan for research purposes).

Rob realized that a modified split-bolus contrast technique, already used in human medicine, combining multiple phases into one single scan, could eliminate these problems for veterinarians. He developed a weight-related veterinary protocol for 'split-bolus single-pass bi- and tri-phasic CT' at De Kompaan, together with John van Gulik, Application Specialist at Canon Medical Systems Europe. While research into this new application continues, the initial results are promising.

Rob anticipates that visualizing multiple hemodynamic phases in a single scan using this 'new' technique could become a standard in veterinary medicine in the near future.



Some first results of a split-bolus single-pass triphasic CT-scan in an 11 yr old mixed breed (Bernese mountain dog).

Rob Gerritsen, Veterinary Internist and Owner of De Kompaan, Ommen, the Netherlands (right) and John van Gulik, European Application Specialist, Canon Medical Systems Europe (left).

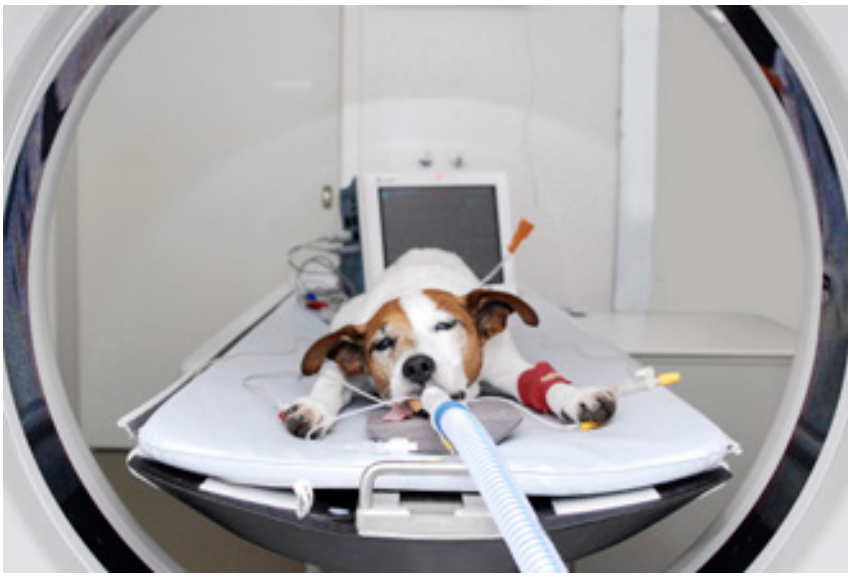
"Our protocol could be particularly useful in diagnosing and treating animals with oncology issues," he said, "since the full hemodynamic spectrum of a tumor process is revealed, as opposed to current conventional single phase scanning, which shows either the (hepatic) arterial -, the portal venous -, or the delayed phase.

Of course, the split-bolus single-pass contrast technique can contribute to improved diagnosis, treatment and more reliable prognoses for animals with vascular anomalies or pulmonary embolism too."

Veterinary CT: A tool 'here to stay'

Alongside advancing research, the Aquilion CT scanner offers many additional benefits in daily practice at De Kompaan. Animals with suspected neurological disease, thoracic or pulmonary problems or malignancies benefit the most from the availability of the system at Rob's clinic.

In these cases, CT scanning completes the diagnostic work-up. Teleradiology services provide a possibility for CT-scans to be interpreted long-distance and at short notice by veterinary radiologists. They can help veterinary internists solve puzzles and enable veterinary surgeons to prepare operations and procedures with greater accuracy. On top of this, incidental scan findings can shed light on possible breed-specific problems that have existed for a long time, and consequently lead to new hypotheses.

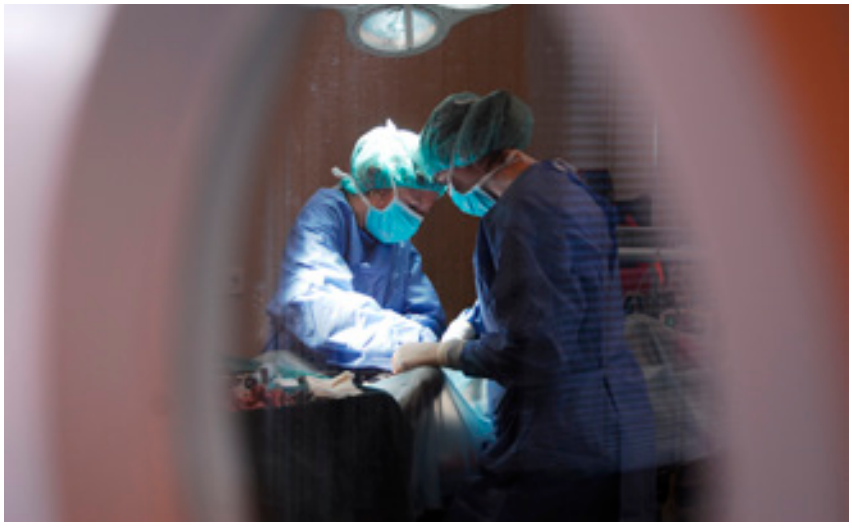


Jack Russell terrier diagnosed and treated for renal tumor.

Importantly, they also give pet owners the opportunity to make better informed decisions. Pet healthcare insurance in many European countries, including the Netherlands, is still an exception to the rule. As a result, for many owners, proper treatment and examination of a seriously ill pet remains something of a cost-benefit trade-off, no matter how much they love their pets. It is essential for a referral-only clinic, like De Kompaan, to provide a diagnostic overview and results to referring colleagues and their clients quickly, so that the owner's (financial and emotional) budget is spent wisely and the best result possible is obtained under the circumstances. In addition, to gain time and start treatment as early as possible, a significant part of the diagnostic work-up at De Kompaan is completed the day of the admission.

Diagnostics: Never stop questioning

It was quite a decision for Rob to invest in the Aquilion CT scanner in 2014. However, he was well aware that taking his practice to 'the next level' required advanced equipment and a willingness to explore adjacent disciplines.



At that time, the Aquilion was the most advanced veterinary CT scanner used in the Netherlands, and Secondlife (a refurbishment program of Canon Medical Systems Europe) made acquisition of the system possible.

"CT has been around for a while in veterinary medicine, especially in diagnostics for horses and companion animals, but the Aquilion CT scanner brings us brand new possibilities and enables us to do much more exciting work than just routine imaging," Rob concluded.

De Kompaan

Rob Gerritsen began practicing as a Veterinary Specialist (dipl KNMvD) in the early 1990s. He founded 'De Kompaan' (Dutch for 'companion') as a referral-only veterinary clinic in 1997, at a time when specialist veterinary services for pets were still rather rare. His curiosity early on took him from echo(cardio)graphy to blood-banking, and from gastro-intestinal examinations to CT. His clinic offers a full spectrum of internal medicine services as well as thoracic- and soft tissue surgery. De Kompaan is one of a few veterinary clinics in the Netherlands to offer pacemaker implants and is about to start interventional cardiology. //

General guidelines for authors

Works are generally classified into two categories: Full length articles (e.g. clinical added value of new/special applications & technologies) and Short contributions (e.g. system testimonials, case reports, technical notes).

All articles should be double-spaced.

Full length articles
Full length articles should generally include the following:
- Author's full name and highest academic degree, employer medical institution
- Author's biography (150 words)
- Author's passport-size photograph (suitable for publication); (image of 300 dpi)
- 200-word abstract
- Text including headline, sub-title, introduction and sections like: materials & methods (which should include a full description of equipment used), results, discussion and references
- Text approx 4 to 5 pages or 12.000 to 14.000 characters (not including figures, tables and photographs)
- Correspondence address
- Literature (no more than 10 references)
- Separate, continuous numbered image- and table captions

Short contributions
Short contributions should generally include the following:
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- Text including headline, sub-title, introduction and full description of methods & materials/equipment used
- Case Report or description of system improvements (Technical Notes)
- Correspondence address
- Literature (no more than 10 references)
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Text
The article should be saved in Microsoft Word (PC format) if possible, and, if not, in text only.

Please indicate the software program and version used (Microsoft Word 2007, etc.) and whether it is a PC or Macintosh formatted document. If e-mailing, make sure to send it as an attachment, rather than embedded in the e-mail message.

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Symbols, Greek letters superscripts/Subscripts must to be identified clearly. Furthermore, the figure 1 (one) and the letter l (el) as well as the capital letter O and the figure 0 (zero) should be easy to differentiate.

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Cite all figures and tables in text, preferably in consecutive order. Please include a caption for each figure. All captions for each figure, should be separate from the text, at the end of the manuscript on a separate page. Captions should avoid duplication of text material. Credit lines for artwork can appear at the end of the corresponding caption by stating: (Provided by first initial, last name). Black out (or give clear instructions which parts should be blackened out) of the images to not violate any data protection regulations (e.g. patient data)

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All manuscripts should be written in a third-person style, unless the article is specifically an editorial or first-hand review.

References
A maximum of 10 references is suggested. Complete references should be listed in order of citation in text, NOT alphabetically. Up to four authors will be listed; if there are five or more authors, only the first three will be listed, followed by et al. Within the text, reference numbers should appear as footnotes in parentheses or in superscript text at the end of each appropriate citation. Please do not use Microsoft Words endnote feature, as this causes major problems in the editing phase.

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Book example
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