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Ultrasound: A Diagnostic Tool

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a diagnostic tool

On the first floor of VHUP, centered in one of the rooms of the cardiology suite, stands the two-dimensional imaging and Doppler blood flow velocity ultrasound machine. This unit, complete with computer keyboard, video monitor, stereophonic amplifier, video recorder, and strip chart recorder, permits clinicians a close look at the heart and abdominal organs of cats and dogs. This ultrasound machine, shared by cardiology, is facilitating diagnosis of many animal diseases.

Ultrasound, a non-invasive procedure, uses the reflection of high frequency sound waves from the interface of tissues with dissimilar density to create an image on the video screen, hence the term echogram. The technique lets the clinicians observe the internal structure of organs, unlike radiographs which provide only a silhouette. Furthermore, ultrasound imaging makes it possible to observe an organ like the heart in motion, providing additional information about its function. Waves are projected into the body from a transducer placed on the surface of the patient's body; the transducer also acts as a receiver of the reflected waves, and the echoes are assembled by a computer into a two-dimensional image corresponding to a slice through the organ along the sound beam. The picture can be frozen on the video screen for a closer look and videotaped in motion for later review by clinicians and students. The machine at VHUP also combines Doppler blood flow measuring capability with the two-dimensional images. The Doppler phenomenon accounts for the change in frequency of a sound wave when it encounters a moving object. The frequency shift occurs in the audible range and is directly proportional to the velocity of the moving target (blood cells). Blood velocity is calculated from the Doppler shift by a computer, and the audio component of the unit assists the examiner in locating the area where flow is maximal.

The use of ultrasound does have its limits. Bone is highly reflective and will obstruct the view of an area behind it. Air is very absorbent of the waves; thus, the lung will also block this view. "When using ultrasound to diagnose heart disease, we must look for a 'window'," said Dr. David Knight, associate professor of medicine at the Veterinary School of the University of Pennsylvania. "A space has to be found between the ribs where the waves are not blocked by bone or lung." He explained that the best image is obtained when the heart is close to the chest wall as it usually is when it is pathologically enlarged. "Ultrasound does not eliminate the traditional diagnostic steps," said Dr. Jeffrey Wortman, assistant professor of radiology. "Rather it complements them and enables the clinician to provide a more in-depth evaluation."

In the case of a patient with suspected cardiac disease, the clinician still takes a history, performs a thorough physical exam, has chest radiographs taken, and records an ECG. Echocardiography then is used to expand the data base. "We can observe the changes in cardiac geometry during contraction and relocation and make measurements of the velocity of blood as it flows through the heart," said Dr. Knight. "From this information it is possible to calculate various indices of cardiac performance, which allow us to be more specific in our assessment than is possible with the conventional clinical evaluation. Of particular interest

are the blood pressure gradients across abnormal communications between chambers of the heart or across the heart valves. This can be calculated from the Doppler echocardiogram. Previously, information of this type could only be obtained by performing a cardiac catheterization."

Dr. Knight explained that in many cases the information once obtained from cardiac catheterization and angiography can be obtained from the Doppler echocardiogram. "Angiography is an invasive procedure, and there is some risk involved. Echocardiography now can provide similar information with less risk to the patient. Physicians, prior to performing surgery on patients with aortic stenosis, now commonly accept echocardiographic data and do not require angiography to be performed."

Dr. Knight pointed out that it is much easier to view a diseased heart by ultrasound than a healthy heart. "Diseased hearts usually are larger and are closer to the chest wall. However, we need to collect more data from normal hearts to establish valid reference criteria." He mentioned that the machine can be used for very young, small animals for diagnostic purposes.

The radiology department also uses the ultrasound machine as an additional diagnostic tool. "Soft tissue structures do not radiograph well," said Dr. Wortman. "A lot of detail is lost, and by utilizing ultrasound we have been able to diagnose a multitude of problems." A look at the log shows a great variety of soft tissue disorders identified through the use of this non-invasive procedure.

Clinicians are able to detect abnormalities of the spleen, find blood clots in bladders, calcified areas in kidneys, and masses within the body cavities and a variety of organs. Ultrasound can be used to confirm suspected uterine infection or pregnancy. Clinicians utilize the diagnostic potential to examine the prostate, kidney, and even the eye. In one case a detached retina was detected.

Another important use of ultrasonography is for biopsies. "We use it to guide the needle exactly to the spot from where the biopsy is to be taken," said Dr. Wortman. "A biopsy done this way is much safer and truly a minor procedure with very little discomfort to the animal."

VHUP's ultrasound machine is very much in use, not only for diagnostic purposes but also for teaching. Dr. Knight explained that the diagnostic value of the technique is dependent on the skill of the ultrasonographer. The quality of the study must be constantly evaluated if dependable results are to be obtained. This must be done while the examination is in progress since later it may be impossible to verify that optimal signals have been obtained.

Penn was the first veterinary school to obtain a Doppler unit. "Now they are at a number of other schools, and the way technology progresses, more advanced models are already available," said Dr. Knight. He pointed out that the unit at VHUP could be adapted to incorporate features of the newer machines.

Owners of companion animals have come to expect sophisticated diagnostic equipment. They accept the costs of modern technology and look for the latest methods when their pet is in distress. The Doppler ultrasound unit at VHUP enables clinicians to perform a more complete examination and to provide better patient care. The machine at VHUP has proven this many times during the one year it has been in use.

IEDSU Update

A new electron microscope was installed for the Inherited Eye Disease Studies Unit. The purchase of the instrument was made possible through funds from NIH, and a $10,000 contribution from the Frances V. R. Seebe Trust through Mr. and Mrs. W. Kenton Musgrave.

The new microscope will be used by the IEDSU in the research of eye diseases, particularly inherited disorders. "We are continuing our work on PRA," said Dr. Gustavo Aguirre, director of the unit. "We are looking for methods of early detection of these diseases and for carrier identification."

Researchers at Penn had established earlier that PRA is not one disease but a group of diseases which are different in each breed. PRA-affected animals show the same clinical abnormalities and signs in the course of the disease: night blindness, progressive loss of day vision, and eventual blindness.

"Although the same clinical signs are present in all PRA-affected animals, the age of onset of the disease differs among breeds, and this difference is breed specific," said Dr. Aguirre. "For example, PRA-affected Irish setters and/or collies have clinical signs between six months to one year of age, while, on the other hand, miniature poodles or Labrador retrievers do not show similar signs until 3–5 years of age. Work done by our group over the past 7–8 years has shown that the diseases present in collies, Irish setters, Norwegian elkhounds, and miniature poodles, although clinically

similar and called PRA, are unique disorders which are different in each of the breeds."

Recently Drs. Acland and Aguirre found that the Norwegian elkhound breed can have two types of PRA. It had been known that individuals in this breed have rod dysplasia which can be diagnosed by ophthalmoscopy after three years of age. The second type of PRA, early retinal degeneration, can be diagnosed by ophthalmoscopy as early as six to eight months of age in affected animals. This disease causes advanced retinal degeneration by one year of age. Electroretinography tests show that these two diseases are functionally different. The ERG identifies affected dogs much earlier than conventional methods, and it enables the clinician to diagnose the specific form of PRA in affected Norwegian elkhound puppies.

Dr. Aguirre and his colleagues have been conducting morphological and biochemical studies of canine progressive, rod-cone degeneration. They have found that the rate of renewal of these visual cells differs in the various stages of the disease. It was discovered that renewal is much slower when the disease is advanced. "We are now looking at phagocytic cells which appear in large numbers during the advanced stages of the disease," Dr. Aguirre said. "We are looking at their role and are trying to find the signal which causes these cells to appear when the photoreceptor cells degenerate."

The IEDSU holds clinics twice a month. Many breeders bring litters for ERG to find out whether the puppies have PRA. In addition to the clinic and the research, Dr. Aguirre also works closely with other specialists at the hospital. "When a dog with sudden blindness is presented, we have been able to establish in a number of cases that the retina was normal," he said. "In several cases it turned out that blindness was due to an intracranial tumor."

Other members of the IEDSU are Drs. Gregory Acland, Larry Stramm, Kenneth Long, and Lester McGregor; Mr. C. Fahlman and Mrs. K. Notarfrancesco, S. Nitroy and L. Schwartz. The work of the unit is supported by NIH, the C.E.R.F. PRA Research Fund, and contributions from local and national breed clubs.

—H.W.