Abstracts for the Technologist Section Scientific Papers:
31st Annual SNM Meeting Program—Los Angeles, California, 1984

A Note on the Scientific Papers

The Scientific and Teaching Sessions Committee of the Technologist Section, Society of Nuclear Medicine, is pleased to present the abstracts of the scientific papers for the 31st Annual SNM Meeting. The scientific papers will be presented on Wednesday, June 6, in simultaneous sessions that will begin at 8:30 am.

I urge you to attend the scientific paper sessions, support your fellow technologists, and share the knowledge these excellent papers afford.

—Kathryn N. Wilkins, Chairman

Wednesday, June 6, 1984

SCIENTIFIC PAPERS I
Clinical/NMR

8:30-10:00am **Room 208**

Moderator: Author J. Hall, CNMT
Co-moderator: Debra L. Loge, CNMT

SCINTIGRAPHIC APPEARANCE OF THE PEDIATRIC STERNUM. K.M. Brooks, C.A. Sharkey, H.T. Harcke, G.A. Mandell, Alfred I. duPont Institute, Wilmington, DE.; B. Jara, M.A. Gainey, St. Christopher's Hospital, Philadelphia, PA.

The normal developmental changes of the sternum in childhood and adolescence produce a variety of appearances on bone scintigraphy. It is important to distinguish these normal variations from the pathologic changes which can occur in the sternum.

To establish scintigraphic patterns and variations in sternal development, multiple sternal views were obtained in 42 patients undergoing bone scintigraphy for non-sternal indications. Seventeen patients were male and 25 were female; they ranged in age from 13 days to 27 years. These data were categorized according to sex and age, and reviewed with those of 10 patients who had positive bone scintigraphy for sternal pathology.

An adequate scintigraphic examination of the sternum requires a minimum of 3 planar views: anterior, right anterior oblique, and a left anterior oblique. An obliquity of 20-30 degrees projects the sternum off the thoracic spine. A standard gamma camera with a high resolution collimator was used to obtain 200,000 to 400,000 count images depending on patient size.

Developmental landmarks for the sternum involve recognition of ossified segments (13 days to 1 year), presence of horizontal bands of increased activity (2-20 years) and appearance of the xiphoid process (15 months-15 years). Wide variation in all of these landmarks was noted. In general the maturation changes were observed earlier in females than in males.

A recognition of the developmental patterns and variations in the normal sternum should eliminate confusion with sternal pathology.

TECHNICAL PROBLEMS IN AEROSOL IMAGING. A.L. Ryan, C.M. Sherry, P.E. Yost, R.F. Brecklin, W.L. Hubble, J.A. Hemkens and D.J. Phegley. St. Louis University Medical Center, St. Louis, Missouri.

Lung imaging on patients who cannot be brought to the nuclear medicine department or patients who need to be ventilated in multiple views have always been a problem for the nuclear medicine technologist.

A method of scanning has been developed using 99m-Tc DTPA Aerosol. We decided to perform 133 Xenon gas, 99m-Tc DTPA Aerosol and 99m-Tc HAM imaging on as many of our patients as possible to truly evaluate the advantages and disadvantages of the 99m-Tc DTPA Aerosol versus the 133 Xenon gas.

The patients either came to the nuclear medicine department or the lung imaging was performed at bedside in the patient's room. There were multiple restrictions due to each patient's medical problems.

The results are still being evaluated but we have discovered multiple technical problems that each nuclear medicine technologist needs to be aware of when setting up a method of imaging using 99m-Tc DTPA Aerosol. These problems involve tubing length, tubing diameter, air flow and air pressure as well as cost and the performance of this procedure in intensive care units with respirators.

NEW APPLICATION FOR LYMPHOSCINTIGRAPHY (LS). W. Lepeak, A. Omdahl, M.K. Dewanjee, H.W.Wahner, Mayo Clinic, Mayo Foundation, Rochester, MN.

LS has been used in the past for detection of lymph node metastasis using feet, hands, substernal or perianal area as injection sites. A new application is presently under study to evaluate its usefulness in patients with 1° or 2° lymphedema of the limbs. In contrast to previous applications, where impaired uptake by lymph nodes was the useful criterium, in this method the distribution pattern of the injected particles is evaluated and the rate of particle disappearance is quantitated. The test has a potential usefulness for selecting patients for microsurgery, connecting lymph vessels to neighboring veins and for lymph vessel transplantation. It aids in the differential diagnosis of lipedema and chronic venous disease which may present with swollen extremities. The procedure is similar to the usual LS. Only Tc-99m-Sb2S3 has the optimal particle size (30-120 A°). 0.4-0.5 mCi is injected subcutaneously (3-5 mm deep) into the interdigital space (0.2-0.5 ml). Images and computer data acquisition is started immediately and at 0.5, 1, 2, 4, 6 hrs. The following parameters are examined. (1) Clearance from the injection site (2) Appearance time in axillary or inguinal lymph nodes (3) Cross-over at these sites (4) Appearance rate and total uptake in the liver. In 13 patients with lymphedema (10 normal, 13 abnormal limbs) the following image patterns were noted: (1) Normal (2) Large-collaterals (3) Cutaneous collaterals (4) No evidence for removal. Quantitative studies showed (1) Normal (2) Delayed and (3) Severely delayed or no clearance and hepatic uptake. Lipedema and chronic venous stasis showed, a normal pattern.Correlation of patterns with outcome of surgery is under study.

THE USEFULNESS OF RESPIRATORY GATING IN MAGNETIC RESONANCE IMAGING. A.J. Cammack, V.M. Runge, J.A. Clanton, and C.L. Partain. Vanderbilt University Medical Center, Nashville, Tn.

Imaging time for a single MR image can range from 2 to 10 minutes, these scan times giving rise to artifact caused by respiratory motion. Gating of the data aquisition with changes in chest wall position has been suggested as a means of reducing, and in some cases, eliminating the motion problem due to respiration. Five volunteers and ten patients were studied, gating being performed at the end-expiratory portion of the respiratory cycle.

Gating was initiated by chest wall motion using pressure sensitive bellows wrapped around the patient's chest. The changes in pressure were transmitted outside the room via plastic tubing to a pressure transducer. The voltage output from the transducer is monitored electronically and set to send a digital trigger to the MR imager at end-expiration. At the onset of inspiration, the trigger is released and acquisition is terminated. In some cases, respiratory and cardiac gating were combined to establish possible further improvement in image detail.

Gating eliminated gross motion artifact from abdomen and chest images. Fine detail such as peripheral hepatic blood vessels were also better resolved. The studies reveal that both respiratory and cardiac gating are feasible and highly successful at increasing the quality of images. With improved image detail, the diagnostic potential of magnetic resonance may be significantly improved.

MAGNETIC RESONANCE OF CANINE BRAIN ABSCESSES. A.J. Cammack, J.A. Clanton, V.M. Runge, W.A. Herzer, A.C. Price, C.L. Partain. Vanderbilt University Medical Center, Nashville, Tn.

A canine brain abscess model was studied using MR to observe the change in appearence of the induced lesion with time. The abscess development was studied pre and post administration of an I.V. paramagnetic contrast agent, Gadolinium-DTPA.

Brain abscesses in six dogs were surgically induced by the intracerebral injection of a culture of alpha streptococcus. The dogs were imaged at 24 hours (early cerebritis) and 8 days (late cerebritis) after surgery using a Technicare 0.5 tesla superconducting imager. Prior to imaging, the dogs were anesthetized with pentobarbital and intubated. Pre-contrast images included: T_1 weighted images (TE = 30 msec, TR = 500 msec) through the brain to locate the desired area of pathology, with T_2 weighted images (TE = 120, TR = 1 sec) and calculated T_1 images taken of the region of interest. The dogs were then injected I.V. with Gd-DTPA and imaged with a protocol including multiple T_1 weighted and calculated T_1 scans.

On precontrast day one images, the lesions were subtle but recognizable. By day eight, a large area of pathology was clearly demonstrable. Further detail could be seen post contrast and an area of ring enhancement identified in animals at the late cerebritis stage. The area of enhancement was significantly smaller than the lesion seen on T_2 weighted studies providing differentiation between the abscess itself and surrounding edema.

Gd-DTPA enhanced the abscess area suggesting its application in the diagnosis of brain abscesses and cerebral neoplastic disease, demonstrating specifically, the breakdown of the blood-brain barrier.

PATIENT POSITIONING AND LESION LOCALIZATION IN NUCLEAR MAGNETIC RESONANCE IMAGING. C.R. Crandall, W.S. Yamanashi, P. D. Lester, City of Faith Medical and Research Center, Tulsa, OK.

Nuclear Magnetic Resonance Imaging (NMRI) is a rapidly growing modality. To date few publications have focused on the problems of patient positioning. This paper is presented to aid in this area.

In comparing NMRI and CT images, duplication of levels in necessary. CT scanning is done in axial projection with either head flexion or gantry angulation. Since NMRI has a fixed gantry, head flexion is the only alternative to produce comparable images, however, some patients cannot attain or maintain this flexed position for the time required for NMRI data aquisition and therefore image levels from CT cannot always be duplicated in NMRI.

In NMRI, where lesion localization often is difficult, the described method has proven helpful. The CT scan is reviewed and a level selected for axial cuts, a short saturation recovery sequence is employed sequentially until the level of the lesion is localized. At this point, the other planes may be studied. Using the projection-reconstruction method, a DC artefact which corresponds to the precise center of the receiving coil is visualized. By using this artefact and the distance measurement functions of the cursor slice offset coordinates may be calculated. When the lesion is localized in all three planes the pulse sequence may be altered to achieve the desired tissue contrast.

We conclude that operator knowledge of system parameters is essential for correct slice offset calculations. This approach has proven both time efficient and clinically accurate.

SCIENTIFIC PAPERS I
Quality Assurance/Cardiac

8:30–10:00am **Room 202**

Moderator: Dayton A. Rich, CNMT
Co-moderator: Elpida S. Curtis, CNMT

TECHNICAL CONSIDERATION OF I-123 PERFUSAMINE^{Tm} BRAIN IMAGING. J. Patel, D. Cassel, M. Madsen, M. Thakur, C. Park. Thomas Jefferson University Hospital, Philadelphia, PA.

I-123-d, 1-N-isopropyl-P-iodoamphetamine hydrochloride (Perfusamine^{Tm}) is lipid soluble radiopharmaceutical which is able to cross the intact blood-brain barrier. Its uptake by the brain tissue is believed to be proportional to the regional cerebral blood flow. Medi-Physics, Inc. has synthesized I-123 Perfusamine^{Tm} and a controlled study is being conducted. Thomas Jefferson University Hospital is one of the participating institutions for this study and we found that a strict quality control program for planar and single photon emission computerized tomography (SPECT) imagings is essential for successful studies. These include;

1. Determination of I-124 contamination.
2. Determination of free radioiodine
3. Uniformity, sensitivity and resolution for the planar imaging.
4. Field uniformity, offset error check and grid size measurement for the SPECT imaging.
5. Proper choice of the collimator.

Methodology for checking the quality control items listed above will be discussed in detail and examples will be shown to emphasize the importance of quality control in I-123 Perfusamine^{Tm} imaging.

COMPARISON OF GAMMA CAMERA RESPONSE TO I-123 (p, 5n) AND I-123 (p, 2n). P.W. Kasulis, T.C. Hill, R.G. Lee and M.E. Clouse. New England Deaconess Hospital and Harvard Medical School, Boston, MA.

Recent development of promising new images agents labeled with I-123 led to investigation into gamma camera response to this radionuclide.

There are two commercial methods by which I-123 is being produced in the United States:

I-127 (p,5n) Xe-123- (7 hr) $\rightarrow$ I-123
Te-124 (p,2n) I-123

Using a LEAP collimator and the same imaging parameters, 5M-count images were made using Schramm phantoms filled with 2 mCi of either I-123 (p,5n) or I-123 (p,2n) in water. The image sequence was then repeated with a medium-energy collimator and I-123 (p,2n). The images obtained with I-123 (p,5n) were of acceptable clinical quality, but neither set of I-123 (p, 2n) images were acceptable.

Radionuclide produced by the (p,5n) reaction yields a 159 keV gamma photon and $<1\%$ I-125 radiocontamination at the time of calibration. Its photopeak is near that of Tc-99m. With only minor adjustments, this preparation can be utilized by all single photon imaging devices. Unfortunately, resources for producing I-123 by this reaction are not readily available. Carrier contamination of I-123 (p,2n) with I-124, although $<5\%$ degraded the images beyond clini-

cal utility. We attribute this response to collimator septal penetration or cross-over of I-124 605-keV photons. With the medium-energy collimator, the I-123 (p,2n) images were appreciably improved due to decreased septal penetration, but this gain was at the expense of decrease sensitivity.

QUALITY CONTROL FOR MULTIDETECTOR INHALATION REGIONAL CEREBRAL BLOOD FLOW SYSTEM (RCBFS): A DYNAMIC PHANTOM. W.M. Oswald, W.L. Dunn, P. Caskey, H.W. Wahner. Mayo Clinic, Mayo Foundation, Rochester, MN.

Principle sources for potential malfunction in RCBFS are (1) internal valve malfunction (2) inoperative scintillation detectors, and (3) Xenon administration system failure. Detection of these malfunctions is difficult without the use of a simulator. Recognition of malfunction by performing a trial study on volunteers is unacceptable as a quality control procedure. A phantom has been developed for this purpose. The device includes a hollow chamber connected to a piston and pump assembly for simulating respiration. The piston is driven by a variable speed motor and is operated at 8 cycles per minute. Stroke volume is 500 ml. The cylindrical lucite chamber has a volume of 2.5L. An opening in the chamber allows connection to the inhalation rebreathing unit of the RCBFS. A smaller blower motor mounted on the chamber insures a uniform distribution of Xenon within the cylinder. The Mayo dynamic phantom simulates the patient's lungs and brain in the inhalation study. The action of the piston causes circulation of air and Xenon between the chamber and the RCBFS; producing air activity curves. Head detectors, on either side of the chamber, generate Xenon clearance curves. Individual head detector flow values are quite consistent (CV=3% N=32). The phantom is used for system evaluation after malfunction and weekly for routine quality control. The device does not test accuracy of rCBF measurements, but was designed only as a device to test system performance.

INTER-INSTITUTION VARIABILITY IN EJECTION FRACTION AND VOLUME DETERMINATION. D.Loge,D.Cox,B.Greenberg,G.Krishnamurthy, B.Massie, University of California, San Francisco, CA. and University of Oregon, Portland, OR.

We undertook a study to validate the inter-institution reproducibility of quantitative analyses of left ventricular (LV) function and size measurements. Ejection fraction (EF) and LV counts were determined in blood pool scintigrams obtained in the best-septal LAO view at the University of Oregon in 23 aortic insufficiency patients with a mean age of 48 years (range 22 to 76). Copies of these studies were sent on magnetic tape to San Francisco for independent data analysis on a similar computer system. At each institution, independently trained technologists analyzed the rest (R) and peak exercise (Ex) studies using a semi-automatic LV edge-tracking program. Regions of interest and background regions were manually altered when necessary. EF and LV end-diastolic and end-systolic counts (EDC,ESC) which were subsequently converted to volume units, were determined, and the two readings were compared for reproducibility by linear regression analysis.

	R EF	Ex EF	R EDC	R ESC	Ex EDC	Ex ESC
R value	0.97	0.95	0.96	0.96	0.98	0.99
SEE(absolute)	.018	.034	2276	1146	797	440
SEE(% of mean)	2.9	5.4	7.2	9.6	6.7	9.4

These results demonstrate the reproducibility of the quantitative analysis of blood pool scintigrams given the current computer software. We have also shown that it is possible for two separate nuclear medicine labs with similar computer systems to exchange ejection fraction data and LV volume measurements if similar methods are used, thus making collaborative studies feasible.

ACCURACY OF RADIONUCLIDE LEFT VENTRICULAR (LV) EJECTION FRACTION (EF) AND VOLUME MEASUREMENTS IN CLINICAL PRACTICE. S. White, R. Palac, D. Cox, M. Eklem, H. Smith, G.T. Krishnamurthy. VA Medical Center, Portland, OR

This study was undertaken to compare the clinical application of non-geometric radionuclide left ventricular volume measurement with the geometric contrast ventriculography technique. Between April, 1982 and October, 1983, 370 patients underwent radionuclide ventricular function testing for clinical reasons. Twenty-two of those patients also underwent contrast ventriculography within 20 days of the radionuclide procedure without an intervening untoward medical event. Multiple technologists performed the nuclear data acquisition and calculation of results, while multiple physicians calculated the catheterization results.

The time interval between the two procedures (Time), the LV EF, and LV end diastolic and LV end systolic volumes by the two methods were recorded and compared.

CORRELATIONS BETWEEN RADIONUCLIDE AND CONTRAST LV FUNCTION RESULTS BY MULTIPLE OBSERVERS

Time	# of Patients	Correlation Coefficients LVEFs	LV Volumes
0-20 days	n=22	.903	.741

Good correlation between radionuclide LV EF and angiographic LV EF was maintained despite multiple participants in an institution. This was not the case with LV ED and ES volumes. Out of 22 patients, three had reduced radionuclide LV volumes when compared to contrast LV volumes due to pharmacologic intervention (1) and the presence of LV anuerysm and thrombus (2); six had expanded radionuclide LV volumes and are being reviewed for technical sources of error.

LEFT VENTRICULAR VOLUME RESPONSE TO EXERCISE IN NORMALS AND CORONARY ARTERY DISEASE PATIENTS. P.D. Purves, M.A. Darragh, V. Gebhardt, W.J. Kostuk, University Hospital, London, Canada.

Fifteen male volunteers (mean age 44) with no evidence of cardiac disease (N) (asymptomatic with normal rest ECG and treadmill stress test) underwent radionuclide angiography (RNA) at rest (R) and during maximum graded supine exercise (MAX). Fifteen patients with documented coronary artery disease (CAD) without previous myocardial infarction also underwent RNA while on no medications. Using nongeometric, count based left ventricular volume program developed in our lab (correlation to bi-plane cineangiography R = .98), the following parameters were obtained: (EDVI = end diastolic volume index, ESVI = end systolic volume index, SVI = stroke volume index, CI = cardiac index, HR = heart rate, Indices in mls/sq m ± SD, EF = ejection fraction).

	N		CAD	
	Rest	Max	Rest	Max
EDVI	77±19	81±18	76±23	87±12
ESVI	28±8	24±10	34±18	35±13
SVI	49±13	57±12	43±8	51±9
CI	3.3±1	7.5±8	3.1±1	5.3±1
EF	65±6	72±7	59±10	62±13
HR	67±12	132±18	72±13	105±12

These results indicate that SVI response to exercise in N and CAD is maintained by different mechanisms. In N, SVI increases by a decrease in end systolic volume with little change in EDVI. In CAD, SVI is maintained by dilatation of EDVI as compensation for the inability to decrease end systolic volume. The greater CI for N is secondary to the higher HR achieved.

A TECHNIQUE TO ANALYZE STABILITY OF GAMMA CAMERA UNIFORMITY. M. Tuscan, W.L. Rogers, N. Clinthorne, J.E. Juni. The University of Michigan Medical Center, Ann Arbor, MI.

The stability of regional detector sensitivity over time is a critical concern for accurate uniformity correction, especially when applied to transaxial tomographic imaging. Conventionally, a high count digital reference image of uniformity is stored and used to correct future incoming gamma camera data. This method is valid only when no change in detector regional sensitivity has occured between the time the reference image was recorded and the time of data correction. We have developed a technique which allows quantitation of regional changes of detector sensitivity and identifies the stability of the detector over time.

The procedure requires that an initial reference uniformity image is stored and that a uniformity test image is stored later in time. Analysis is performed by first surveying the reference image to find the mean pixel value. This value is compared to each pixel in the reference image and a correction factor is determined and applied to the corresponding pixel in the test image. Next, the corrected

test image is surveyed to determine it's mean pixel value. This value is compared to each pixel in the corrected test image and the absolute difference is categorized as percent difference from this mean value. A functional image is created by assigning a pre-determined intensity to each pixel category.

This technique has proven useful in evaluating long and short-term detector regional uniformity. The procedure has also proven valuable in the analysis of the accuracy of the uniformity correction procedure and in establishing the frequency at which a new reference image is required for adequate uniformity correction.

SCIENTIFIC PAPERS II
Monoclonal Antibodies/Clinical

10:30am-12:00pm **Room 208**

Moderator: Author J. Hall, CNMT
Co-moderator: Debra L. Loge, CNMT

MONOCLONAL ANTIBODIES: LOCALIZATION OF RENAL CELL CARCINOMA XENOGRAFTS. S.E. Mittelstadt and R.B. Shafer. VA Medical Center, Minneapolis, MN.

Although selective GI tumors have been successfully imaged with radiolabeled monoclonal antibodies (Mabs), imaging renal cell tumors (RCC) has been hindered by lack of specific antibody and suppression of background caused by unbound antibody or circulating antigen-antibody complexes. We have successfully produced radiolabeled Mabs to RCC with low cross reactivity and high specific activity eliminating the need of background subtraction. A screening system of immunocytochemistry tissue staining was used to preselect the Mabs for radiolabeling from the library of antibodies produced at this institution.

The model used is nude mice implanted with RCC, testicular and endometrial tumor xenografts. Fifty mice were injected with 20-40 μCi of I-131 labeled A6H (RCC). Imaging was performed at 24-48 hours after injection on a Siemens Pho Gamma V with pinhole collimator and a Modumed computer. We acquired 10,000 counts per image (time per image was usually about 5 minutes). The RCC xenografts ($\geq$ 80mg) were clearly visualized whereas the control tumors were not discernable from body background. Following imaging, mice were sacrificed, tumors and selective tissue excised and radioactivity measured. Tumor:blood ratios were as high as 20:1 in RCC with no appreciable uptake in the testicular or endometrial tumors. Uptake was increased in thyroid (free I-131), remaining tissue was $<$ .3.

Comparison between intensity of immunocytochemistry staining and tumor:blood RAI ratios showed high correlation. We conclude that specific antibody (A6H) labeled with high specific activity is practical for clinical diagnosis without requiring subtraction techniques or complicated computer application.

METHOD OF COMPUTER QUANTITATION OF I-131 LABELED $F(ab')_2$ FRAGMENTS OF MONOCLONAL ANTIBODY IN PATIENT IMAGES. M.R. Beardsley, P.J. Moldofsky, N.D. Hammond, C.B. Mulhern. Fox Chase Cancer Center and Jeanes Hospital, Philadelphia, PA.

We have quantitated from patient images the amount of I-131-labeled $F(ab')_2$ fragments of an anticolorectal carcinoma monoclonal antibody localized in tumor and liver as a function of time. The method utilizes regions-of-interest (ROI) drawn around tumor and liver in pairs of conjugate views (modification of method of Thomas SR, Radiology 1977;122:731-737) such as anterior-posterior or RAO-LAO. The data were obtained daily for up to 7 days post-administration of approximately 37 MBq (1 mCi) of I-131-$F(ab')_2$ fragments. Counts in ROI's from these diametrically opposed views eliminate the need to correct for depth of tumor or organ. The method has been validated using an abdominal imaging phantom with known amounts of activity inserted into hollow organs and hollow tumors. These data suggest for hepatic metastases that peak ratio of tumor to background (liver) occurs at 72-96 hours. The absolute percentage of administered dose that localizes in tumor in patients was calculated and is found to be small, i.e. less than 0.01% per gram of tumor at any imaging time from 24 to 168 hours.

SCINTIGRAPHIC OPTIMIZATION OF TECHNIQUES FOR LOCALIZING I-125 MONOCLONAL ANTIBODIES IN THE NUDE MOUSE. M.E. Hearne, K.T. Perillat and A.B. Snyder, University of California, San Francisco, CA.

Scintigraphic imaging is promising for imaging radiolabeled tumor specific antibodies (MOAB) in the nude mouse. A variety of approaches have been used with variable results, depending on technique and computer processing. The purpose of this study was to evaluate choices of instrumentation and computer processing in order to find the ideal combination for localization of tumors (human breast carcinomas) using I-125-tagged MOAB in the nude mouse. The instrumentation used was a standard scintillation camera equipped with pinhole and parallel hole collimators and a rectilinear scanner equipped with focused collimators. Adjustments in distance, acquisition time, data density and photographic variables were made to obtain the best images. Tumor uptake of the MOAB was estimated in vivo using counts obtained from images and in vitro from dissected tumors. Localization of the tumor was enhanced using region of interest analysis, radio-markers and simultaneous transmission images. Location of the tumor implant was critical in assessing uptake due to intense hepatic activity. Data was obtained from a comparison study using phantom images and nude mice images. Based on our results, the best combination of imaging device, collimator and image processing was assessed. The I-125 MOAB offers significant promise for tumor imaging in nude mice using these techniques.

RAPID DIAGNOSIS AND IMPROVED ACCURACY IN LOCALIZING INFECTION IN DIABETIC OSTEOARTHROPATHY USING In-111 LEUKOCYTES. M. Kollmann, E. Bigley, P. Circe, P. Fanning, L.C. Knight, and A.H. Maurer. Temple University Health Sciences Center, Philadelphia, PA.

In-111 autologous leukocyte imaging (LI) was compared to Tc-99m MDP three-phase skeletal scintigraphy (TPSS) in 7 diabetic patients (pts) with neurotrophic changes on x-ray and clinical infections suspicious for osteomyelitis. After 30 min to sediment the red cells from 50cc of heparinized blood, leukocytes were separated from the cell-rich plasma by centrifugation. The leukocytes were resuspended in saline and 600 uCi In-111 oxine was added and agitated for 20 minutes. After washing, the cells were resuspended in cell-free plasma and 250 uCi were injected. LI was performed at 4 hours and 24 hours after injection and within 48 hours of TPSS. Pts had at least three months of clinical and x-ray follow-up (n=4) or surgical biopsy (n=3) for final diagnosis. TPSS demonstrated marked increased blood flow, hyperemia, and bone activity consistent with infection in areas of uninfected neurotrophic bone in 6/7 pts. LI correctly localized soft tissue infection (n=5), was negative (n=1), and abnormal in neurotrophic bone in only the one case of documented osteomyelitis. All pts with abnormal LI were positive by 4 hours. We conclude that LI accurately localizes infection in patients with neurotrophic osteoarthropathy and avoids the difficulities in interpreting TPSS in neurotrophic bone which shows marked hyperemia and reactive bone even when not infected. LI is diagnostic as early as 4 hrs after injection.

NEUTROPHIL SEPARATION: EVALUATION OF DIFFERENT APPROACHES, PURITY, VIABILITY, and PHAGOCYTOSIS OF ^{111}IN BACTERIA. M. L. Thakur, S. McKenney, C. Seifert, D. L. J. Youngkin, C. H. Park. Thomas Jefferson University, Philadelphia, PA.

Following the availability of In-111 as a tracer, much attention has been drawn to the in vivo kinetic studies of human neutrophils (PMN) in which their separation, purity and functional integrity are of vital importance. This study was designed to compare the efficacy of several density gradient media of PMN separation and to evaluate the functional ability of separated PMN in vitro.

Ficoll/Hypaque (FH), Percoll (PL), Flow Laboratory (FL) media and English Ficoll:Hypaque (EPH) media were evaluated. Isolated PMN were counted, contamination with lymphocytes and erythrocytes was checked and PMN structural integrity was examined. PMN were allowed to phagocytose In-111-staphylococcus aureus in a 10:1 proportion. Unengulfed bacteria were lysed with lysostaphin.

Results tabulated indicated that PL rapidly produced the highest number of neutrophils with the best viability and phagocytic ability, but were heavily contaminated with erythrocytes.

Media	PL	FH	FL	EFH
% Phagocytosis	51	25.8	44.6	26.3
(% PL, N=12)	100	50.5	87.4	51.5
Viability, N=3	100	77.3	100	99.3
Recovery (10^6),N=3	34.2	14.1	24.3	7.6
(% PL)	100	41.2	71	22.2
% Erythrocytes, (10^6),N=3	52	1	1.7	1.0
% Mononuclear, N=3	2	0	3.3	2.0
Time (min.) N=3	10	40	35	25

DISTRIBUTION OF N-ISOPROPYL-p-(131)-IODOAMPHETAMINE IN GLIOBLASTOMA BEARING MICE. M. Jannasch, L.P. Kasi, C. Stephens, E. Kim, A. Gobuty, M. Jahns, H. Glenn, T.P. Haynie. The U.T. M.D. Anderson Hospital and The U.T. Medical School, Houston, Texas.

We evaluated the tissue uptakes of N-Isopropyl-p-(131)-Iodoamphetamine (131-IMP) in healthy Hale-Stoner (20 g) mice and compared them to the uptakes in mice bearing glioblastoma in the brain. Tumors were induced by intracranial injections of glioblastoma tumor cells in young healthy mice. In vivo distribution studies were performed at 30 mins, 1 hr, 2 hrs, and 24 hrs after injecting a dose of 1 mg/kg 131-IMP via the tail vein. All the major organs, brain, and 0.1 ml blood were removed at the given time intervals and the percent uptake of total injected dose per gm tissue was determined. Results indicate that the initial uptake was maximum in the lung at 30 mins (30.3% per gm in normals and 48.8% per gm in tumor-bearing mice) which decreased by 1 hr. During the same time period uptakes decreased in the liver (40%), spleen (40%) and brain (30%) in healthy mice, whereas a considerably different uptake in tumor-bearing animals showed an increase in uptake by 55%, the spleen an increase by 110% and the brain plus diffuse tumor an increase by 121% (from 6.13% per gm to 13.5% per gm). Uptakes in all organs, both in normal and tumor-bearing mice, decreased from 1 hr to 2 hrs post injection. At 24 hrs negligible activity was observed, which was confirmed by whole body retention studies. Retention was found to be 90% of injected dose at 2 hrs which dropped to 5% at 24 hrs. These results indicating a significant increase in brain plus diffuse tumor from 30 mins to 1 hr after injection could be due to tumor related hypervascularity. Further pharmacological evaluation of radioiodinated IMP is indicated.

SCIENTIFIC PAPERS II
Radiation Protection/Q.A./Cardiac

10:30am-12:00pm **Room 202**

Moderator: Dayton A. Rich, CNMT
Co-moderator: Elpida S. Curtis, CNMT

TRANSPORTATION OF SPENT NUCLEAR FUEL: THE ILLINOIS EXPERENCE. K.L. Barat, J. Cooper, D. Padovani, J. Papendorf. Illinois Department of Nuclear Safety, Springfield, IL.

Recently the Illinois Department of Nuclear Safety has been involved in a program of spent fuel inspections. This program encompasses the inspection of spent fuel cast, escorting shipments through the State, and providing technical support in case of a transportation incident.

The Department has been involved in over 80 such shipments. Both survey meter and smear analysis are performed by field representatives.

Activity transported averages 170,000 Curies; dominant radionuclides are Pu-239, Cs-137, Sr-90. G.M. survey readings show a surface range of 1 to 15 mR/hr. Beta smear analysis is usually under 2500 dpm/100 cm^2, and under 10 dpm/100 cm^2 for alpha's.

The majority of shipment difficulties revolve around security or political considerations. In conclusion, the transportation of spent fuel through the State of Illinois at this time does not represent a health hazard to the public.

TRANSMISSION CT DATA ACQUISITION WITH A SPECT SYSTEM. K. Greer, R. Jaszczak, D. Osborne, C. Harris, L. Hedlund and E. Coleman. Duke University Medical Center, Durham, NC.

Phantom and animal experiments were performed to evaluate the ability of a camera-based SPECT system to perform transmission CT scans. One specific goal was to determine system linearity as a function of changing object density. An application for these data is more accurate determination of attenuation coefficients for SPECT image compensation. Such data should be linear with changes in object density and exhibit resolution comparable to the SPECT images.

The photon source was a specially constructed rectangular, water-filled slab containing Tc-99m. This source was mounted on one camera of our otherwise unmodified dual detector SPECT system. The phantoms scanned included eight density calibrated rods, 3 cm in diameter, with a range of 0-1045 mg/cc, a 5 mm diameter metal rod, solid lucite spheres and solid lucite rods with diameters from 4.8-12.7 mm. Thoracic scans in canines were acquired and visually compared to x-ray TCT images.

A plot of image ROI values versus actual density had a correlation coefficient of 0.997. Values measured for FWHM (FWTM) were 10.8 (20.5) mm.

Resolution and statistical limitations preclude use of this technique as a purely diagnostic tool, but could be useful for determining anatomical references for later SPECT scans. In view of phantom results, we conclude the exhibited characteristics can be exploited to provide relatively accurate and precise attenuation coefficients. Advantages include 1) avoidance of beam hardening effects present in x-ray TCT sources, 2) use of our existing hardware and 3) potential for generating non-constant coefficients for attenuation compensation.

A METHOD TO INTERCHANGE TWO SIMILAR RADIOGRAPHIC FILMS AND PRESERVE ESTABLISHED EXPOSURE TECHNIQUE. P.W. Kasulis, T.C. Hill, R.G. Lee, and M.E. Clouse. New England Deaconess Hospital and Harvard Medical School, Boston, MA.

We have developed a method for changing from one medical imaging film to another that reputedly has similar characteristics. This technique can be used with any diagnostic imaging modality that exposes film off a cathode ray tube (CRT) with a multiformat camera. The technique was devised to change films from Kodak NMB to Fuji MI-NC. Both films are orthochromatic, green sensitive and single-coated with similar characteristics and spectral sensitivity curves.

Each film is exposed to analog images on a CRT screen. The collection parameters should be kept consistent during the trial exposures. To optimize image duplication, a flood image can be used. The films are processed in an automated unit after temperature and chemical quality control checks. Photodensitometer reading of the processed films are compared, and a determination is made to open or close the lens aperture (decrease or increase the F stop). Another films is exposed and processed. This trial method is repeated until densitometer readings for both films become equal. Usually no more than three trials are necessary.

An optical change, unlike an electronic intensity change, is a linear function and does not distort the image. Consequently, when an optical change has been made to match a film's response to that of another, the photographic technique remains valid and one can perform imaging under the same techniques that have been previously established. Quality of the resulting image is comparable to previous studies. By eliminating the need to develop a new technique chart, hours of time are saved and the likelihood of less-than-optimum clinical images is reduced.

HOW DOES YOUR GAMMA CAMERA RESPOND TO Ga-67, In-111 AND Tl-201? P.W. Kasulis, T.C. Hill, R.G. Lee and M.E. Clouse. New England Deaconess Hospital and Harvard Medical School, Boston, MA.

Manufacturers of nuclear medicine imaging systems generally document a machine's performance with Tc-99m. In addition, daily quality control in clinical settings is almost exclusively done with this same radionuclide. Although approximately 90% of all nuclear medicine imaging is performed with Tc-99m, 10% of studies are performed with other radionuclides with different characteristics.

We examined the Siemens 3700S gamma camera's response to

Ga-67, In-111 and Tl-201. Both intrinsic and extrinsic floods were collected in a 256 x 256 digital matrix and stored on a magnetic tape. The intrinsic floods were acquired by using a point source containing 200 uCi of radionuclide. The extrinsic floods were acquired by imaging a large field of view sheet source phantom that was fitted with a bubble trap and filled with a mixture of 2 mCi of radionuclide and water. Intrinsic bar resolution and Schramm phantom images were also obtained. All images were collected utilizing the appropriate photopeak setting and a symmetrical energy window with Z circuit correction when appropriate. The extrinsic images were collected by using the optimum collimator to fit the situation.

Review of the images revealed that the response of the gamma camera was quite varied when images were obtained using the same collection parameters but different radionuclides. Not only did sensitivity, resolution and uniformity change with the radionuclides, but there was an obvious difference in these areas when other gamma cameras were compared. We plan to repeat these tests periodically as part of our quality control program.

CORRELATION OF INFERIOR HYPOKINESIS BY RADIONUCLIDE VENTRICULOGRAPHY AND ELECTROCARDIOGRAPHIC CRITERIA FOR MYOCARDIAL INFARCTION: USE OF LEFT POSTERIOR OBLIQUE VIEW. A.J. Rousseau, G.V. Heller, R.A. Carleton, Memorial Hospital & Brown University, Pawtucket and Providence, RI

Transmural inferior myocardial infarction (IMI) has been associated with the formation of Q waves on the electrocardiogram and inferior wall motion abnormalities. However the relationship between the ECG diagnosis and wall motion abnormalities by radionuclide ventriculography (RVG) has been poorly described. We evaluated 104 consecutive patients in which RVG and standard 12-lead ECG's had been obtained. The RVG was performed using the anterior (ANT) and 40 degree left anterior oblique (LAO) views using a multipurpose parallel-hole collimator. An additional view, the 70 degree left posterior oblique (LPO) was used to visualize the inferior wall. Interpretation of the ECG and RVG's were blinded. Inferior wall motion activity was interpreted on both the ANT and LPO view and was categorized as normal, abnormal (hypokinetic to akinetic) or uninterpretable.

In 86 patients, inferior hypokinesis was not observed on either view. Seven ECG's (8%) were diagnostic for IMI; 12 for inferior ischemia (ST-T changes). Twenty-eight patients were noted to have inferior wall motion abnormalities. All were seen on the LPO projection while only 16 (59%) by the ANT view (6 were normal, 6 uninterpretable due to right ventricular interference). The ECG's of the 28 patients with inferior abnormalities revealed 24 (85%) with IMI or inferior ischemia, 3 were uninterpretable and only one normal.

Conclusion: Inferior hypokinesis is highly associated with ECG evidence of infarction or ischemia. The LPO view greatly increases the ability of the RVG to diagnose inferior wall motion abnormalities in patients with IMI.

EXERCISE GATED BLOOD POOL SCANS TO EVALUATE VENTRICULAR FUNCTION IN AORTIC VALVULAR DISEASE. L. Little and M. Osbakken. The Pennsylvania State University, Hershey Medical Center, Hershey, PA.

Sequential rest-exercise gated blood pool scans (GBPS) were performed to evaluate left ventricular (LV) function in 7 patients with aortic regurgitation (AR) (4 males and 3 females, mean age 38 $\pm$ 16), to evaluate use of this test to provide information helpful in determination of therapy. Exercise was performed, in the semi-erect position (LAO 45 view) on a bicycle ergometer, to symptom-limited maximum. Ejection fraction (EF), regurgitant fraction (RF), and pulmonary blood volume (PBV) were determined from GBPS on two occasions for each patient (4-16 months apart). Mean rest (R) and exercise (E) EF (determined by a routine MUGE algorithm) did not change significantly with time in our patients (R-EF1 = 58 $\pm$ 12; R-EF2 = 55 $\pm$ 4; E-EF1 = 61 $\pm$ 9; E-EF2 = 58 $\pm$ 8). RF, determined by a phase analysis algorithm, did not change significantly (RF1 = 4.6 $\pm$ 4; RF2 = 5.1 $\pm$ 4.3), where PBV (apex/base ratio of count activity) decreased significantly in one year (PBV1 = .8 $\pm$ .2; PBV2 = 1.05 $\pm$ .18, $p<.05$). 3 patients had a decrease in R-EF2, diminished LV reserve function determined by a decrease in EF on exercise, and an increase in PBV2, without a significant change in RF on the second GBPS and were recommended to have a cardiac catheterization even though they were relatively asymptomatic. These patients were found to have significant AR and had subsequent aortic valve replacement. In conclusion, patients with aortic valvular disease can be followed with routine R-E gated blood pool scans to determine pathophysiological changes which result from the volume overload; these parameters can be used as a guide to type of therapeutic intervention.

SCIENTIFIC PAPERS III
RIA/Labeling Techniques

1:30-2:30pm **Room 208**

Moderator: Author J. Hall, CNMT
Co-moderator: Debra L. Loge, CNMT

ADAPTATION OF A RENIN PROTOCOL FOR USE IN THE NEONATE. S. Weiss, L. Fong, R.A. Cohn, and J.J. Conway. The Children's Memorial Hospital, Chicago, IL.

Specimen requirements for radioimmunoassay and other laboratory tests often preclude their use in pediatrics, particularly in the neonate. Routinely 2 to 3 ml. of whole blood is collected to provide a minimum of 1 ml. of patient plasma or serum required for most procedures. Pediatric phlebotomy techniques frequently include heal stick and capillary tube collection which reduces the volume of patient specimen obtained. Additionly, obtaining the usual patient specimen volume is not recommended for a neonate since it represents a significant portion of the total blood volume, particularly if serial or multiple studies are required. We modified the Renin RIA protocol so that it could be performed with a significantly reduced specimen volume in order to perform Angiotensin I level determinations in the neonate population. The patient whole blood specimen requirement was reduced to a maximum of 500 ul which is easily obtained by heal stick. To validate the modified procedure, parallel studies were performed utilizing both the standard and modified protocols on adult specimens and known standards. Accuracy and precision of the modified protocol was determined to be in the acceptable range. The C.V.% range of 8 to 12 for the neonate plasma analyzed were considered acceptable for our purposes. The quality control study data will be presented as well as the modifications of the assay procedure.

TSH LEVELS IN PREGNANT WOMEN. V.A. Walton, B.J.Kasecamp, B. Corbett, S. Hendricks, P.E.Dibos. Franklin Square Hospital, Baltimore, MD.

The purpose of this ongoing study is to evaluate thyrotropin (TSH) levels early in the first trimester of human pregnancy.

All sera from women having positive HCG pregnancy tests were selected for TSH testing. From October 1982 to the present, there were 1087 true positive pregnancy tests. TSH serum levels determined by radioimmunoassay (RIA) were performed in all 1087 cases and the results were:

Number of TSH Cases

Normal (8.3uIU/ml)	1050	(96.6%)
Borderline (8.3-10.0uIU/ml)	16	(1.5%)
Abnormal (10.0 uIU/ml)	21	(1.9%)
Total	1087	(100%)

Of the twenty-one cases with abnormal TSH levels, there were six cases showing significant elevation (range of 22 to 50 uIU/ml). The remaining fifteen cases showed only modest TSH elevation (range of 10.5 to 13.7 uIU/ml). Free T4 levels and clinical evaluations were subsequently done in the patients with high TSH levels. Two patients were overtly hypothyroid (hitherto unrecognized) and were started on T4 replacement therapy.

We conclude that significant elevation of serum TSH levels are infrequent in early pregnancy. The significance of borderline elevation of TSH is uncertain and is being studied further.

METHODOLOGY FOR LABELING DONOR PLATELETS WITH INDIUM-111 OXINE. S. Barth, R. Siegel, N. Petry, R. Reba, and R.E. Coleman. George Washington University Medical Center, Washington, D.C. and Duke University Medical Center, Durham, NC.

Autologous platelets labeled with In-111 oxine adhere and identify deep venous thrombosis (DVT). This technique has shown promise as a non-invasive means for screening high risk patients. However, labeling autologous platelets from a single patient is time consuming (4-5hours), requires considerable platelet manipulation by a highly trained technologist, and is inconvenient for outpatient use since it requires 5 hours of waiting time between blood draw and reinjection.

Type O Rh(-) donor platelets were labeled with indium to achieve a more efficient method of dose preparation. Using this modified labeling procedure, one unit of donor platelets can produce 6 patient doses in a single 1½ hour preparation. The shorter preparation time and simpler technique increases ease of instruction to staff technologists. This method is suitable for use in both inpatients and outpatients, since it requires only one venipuncture.

Labeled donor platelets have been used to study 159 patients following GYN oncologic surgery and 104 orthopedic patients who had undergone total hip or total knee joint replacement. Twenty-eight of 31 patients who had DVT by scan were confirmed by venography. No patient with a negative donor platelet study subsequently developed signs of DVT. This technique has demonstrated accuracy similar to that reported in our previous experience using autologous platelets in the detection of DVT. Labeling donor platelets is an efficient and effective method of multiple dose preparation useful in screening high risk patients for DVT.

MODIFICATION OF THE IN-VITRO RED BLOOD CELL LABELING TECHNIQUE USING THE BROOKHAVEN NATIONAL LABORATORY (BNL) KIT. M.L. Cianci, W.E. Eckelman, H. Schultz, V.M. Varma, P.S. Yolles. George Washington University Medical Center, Washington, D.C.

Recently Srivastava et. al. described alterations in the BNL In-Vitro red blood cell (RBC) kit that allows labeling of whole blood with 99mTc(1). Our institution has been using the BNL RBC kit which requires separation of the plasma after pretinning of the RBC(2). Low yields using one lot of RBC kits prompted investigation of the techniques described below to increase the yield and reproducibility of the radiolabeling process. The procedure for radiolabeling was that recommended by BNL(2) with the exception that 1.0 ml of 4% EDTA (1% final conc.) or 1.0 ml of 1% EDTA (.25% final conc.) was added to 3 ml of saline to constitute the 4 ml saline wash usually employed before centrifugation and addition of 99mTc pertechnetate. Labeling yield was determined by performing a hematocrit of the final solution in capillary tubes followed by counting in a dose calibrator. A significant increase in yield using EDTA prompted further study of the labeling parameters. Specifically the concentration of EDTA did not appear to affect the labeling yield in those cases involving normal hematocrits, however, in cases of low hematocrit, the 1% EDTA solution gave greater radiochemical yield than the 0.25% EDTA. Data will be presented which shows a correlation with the volume of RBC used for radiolabeling and the labeling yield and comparisons of RBC labeling yields from random patients which revealed a mean of 83.2% (N-19) for the BNL method and 97% (N=25) for the 1% EDTA modified method. The modification described is a simple, practical method for increasing the labeling yield of the BNL, RBC In-Vitro labeling kit.

SCIENTIFIC PAPERS III
Cardiac/Clinical

1:30-3:00pm **Room 202**

Moderator: Dayton A. Rich, CNMT
Co-moderator: Elpida S. Curtis, CNMT

A MOMENTS METHOD FOR REGION OF INTEREST INDEPENDENT RIGHT VENTRICULAR EJECTION FRACTION. J.A. Siegel, M.D. Harpen, A.H. Maurer, and K.M. Blasius. Temple University Health Sciences Center, Philadelphia, PA.

A new method for region of interest (ROI) independent right ventricular (RV) ejection fraction (EF) was validated and compared to first pass ROI dependent RVEF's. The EF is calculated in closed form by initially assuming a step function input which is constant over the duration of the bolus. Zero (M_0), first (M_1), second (M_2), and third (M_3) order time-moments of the count rates from the ventricular time activity curves generated from multiple ROIs within the ventricle were used to derive an expression for the EF of the form:

$$EF = 1/HR \times (2M_0^3/(2M_1^3 + M_0^2M_3 - 3M_0M_1M_2))^{1/3}$$

where HR = heart rate.
The method was first validated for the left ventricle by comparing routine equilibrium EFs (EF_{EQ}) to moment EFs (EF_{MO}). The correlation obtained was:
EF_{MO}= 1.1EF_{EQ}- 0.8 (r=0.94; SEE=6.0) for 11 patients
Gated (G) and beat to beat (BB) images derived from an RAO serial mode acquisition were used to derive RVEFs. The correlations were:

EF_{MO} = 1.2EF_G + 0.6 (r=0.74; SEE=9.6) and
EF_{MO}=1.3EF_{BB}+ 14.9 (r=0.76; SEE=9.4) for 10 patients

We conclude that the moments technique for EF is particularly suited for determining RVEF since it is ROI independent, obviating the need for exact delineation of the RV during first pass studies.

CALCULATION OF FIRST PASS LEFT VENTRICULAR EJECTION FRACTION BY LINEAR REGRESSION ANALYSIS USING PAIRS OF END-DIASTOLIC AND END-SYSTOLIC DATA POINTS. J.A. Siegel, K.M. Blasius, A.H. Maurer, and M.D. Harpen. Temple University Health Sciences Center, Philadelphia, PA.

By rearrangement of the terms in the expression for ejection fraction (EF) (EF = (end-diastolic counts (ED) - end-systolic counts (ES))/ED, it can be shown that a straight line relationship is obtained between ES and ED where the slope is equal to 1-EF. We obtained time activity curves from first pass left anterior oblique images of the left ventricle using a dynamic acquisition of 0.1 sec/image in 9 patients. A region of interest was drawn around the left ventricle and a beat to beat time-activity curve was generated. Pairs of end-systolic and end-diastolic points were obtained for a minimum of 5 cardiac cycles. The slope of the line obtained by plotting these points was obtained from linear regression analysis and the ejection fraction (EF_{RA}) was calculated (EF=1-slope). The EFs were compared to standard left anterior oblique equilibrium images (EF_{EQ}). The correlation obtained was:

EF_{RA} = 0.87 EF_{EQ} + 5.8 (r = 0.99; SEE = 2.2).

We conclude that the regression technique is accurate for the determination of left ventricular EF during a first pass study.

QUANTITATIVE COMPUTERIZED RADIONUCLIDE VENTRICULOGRAPHIC PHASE ANALYSIS. L Struble, DA Schultz, RL Wahl, JE Juni, M Tuscan. University of Michigan Hospitals; Ann Arbor, MI

Gated radionuclide ventriculographic phase analysis is a method used to analyze patients with ischemic, congenital, conductive, valvular, cardiomyopathic, and rheumatic heart disease. Phase analysis is based upon the computerized analysis of the time-activity curve for every pixel in the ventriculogram. The first harmonic of the Fourier transform can be used to generate a color-coded image which depicts the timing of ventricular contraction. Mean pixel phase angles of operator-generated regions of interest can be flagged. Using regions of interest, quantitative and statistical analysis can be obtained based on ventricular, atrial, or other regions of interest.

Of primary concern is the method of obtaining a region of interest. Unlike automatic edge-detecting algorithms used for calculating ejection fractions which can be entirely automated by the computer, the operator is of considerable importance in generating a region of interest. All of the following can be used in this generation of a region of interest: the dynamic phase display (Ciné), amplitude image, phase angle pixel histogram, and dynamic display of the radionuclide ventriculogram. Subsequently, regions of interest of a portion of the heart can be used to generate a histogram of the pixel distribution. This histogram can subsequently be used to calculate the mean,

standard deviation, standard error of the mean, skewness, and kurtosis of a region in one patient for comparison with other patients. Careful attention to these technical factors will yield reliable and useful phase analysis in nuclear cardiology.

EVALUATION OF ASYMPTOMATIC MALE PATIENTS USING THE MULTI-GATED ACQUISITION METHOD. L.M. Holt, W.M. Allen, G.M. McGranahan, Jr., T.D. Kay, D.L. Johnson, D. Romo, J.L. Hodge, and T.A. Pena. USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

The use of Exercise Multi-Gated Acquisition (MUGA), First-Harmonic Phase Analysis (FHPA), and Wall Motion (WM) studies as screening tests for Coronary Artery Disease (CAD) in asymptomatic male patients were evaluated prospectively.

Exercise MUGA studies were obtained prior to Coronary Angiography (CA) in 64 asymptomatic male aircrew members being screened for CAD (Mean age: 41.8 ± 7.0 years). This study excluded all patients with mitral valve prolapse, aortic insufficiency, left bundle branch block, Wolff-Parkinson-White conduction abnormality, or patients being reevaluated for CAD. Forty-six of the patients had no CAD found at CA, the remaining 18 patients had CAD with lesions of 50% or greater.

The Ejection Fraction results obtained were 11.1% sensitive and 89.1% specific for the detection of significant CAD. FHPA results were 22.2% sensitive and 91.3% specific. The WM evaluations were found to be 11.1% sensitive and 97.8% specific.

The study results indicate that Exercise MUGA studies were extremely insensitive, but very specific, in the detection of significant CAD in an asymptomatic male population.

THE KIDNEY/LIVER RATIO AS AN IDENTIFIER OF NORMAL GLOMERULAR FILTRATION RATES IN CHILDREN. M.S. Lerner, and T. Fearon. Children's Hospital, Washington, DC.

Calculation of Glomerular Filtration Rates (GFRs) using the three blood sample technique has been proven to be a reliable method of evaluating renal function. This technique, however, is unpleasant for children due to the need for multiple venipunctures. Our objective was to identify patients with normal GFRs so that they do not have to undergo this test.

Toward this purpose we retrospectively analyzed the renal scans and GFRs of 100 patients, aged 2 to 18 years, all possessing two functioning kidneys. The GFRs were normal in 60, and abnormal in 40 patients. Normal GFRs were defined as 125 ± 15ml/min/1.73sqm in males and 115 ± 15ml/min/1.73sqm in females.

We analyzed the renal scan images using the following technique. Computor images from one to two minutes after injection of the tracer were summed. A region of interest was positioned over each of the kidneys and liver. The Kidney/Liver (K/L) ratio was computed from the average pixel counts (APC) found in the regions. The K/L ratio= (Left Kidney APC/Liver APC + Right Kidney APC/Liver APC)/2.

Our analysis of the calculated K/L ratios indicate that patients with normal GFRs had a range of values of 1.3 to 3.6 and a mean of 2.1; while patients with abnormal GFRs had a range of 0.8 to 1.6 with a statistically significant lower mean of 1.2. In addition, regression analysis demonstrates a linear relationship between GFRs and K/L ratios (r=0.8). Therefore, we contend that these findings support the use of the K/L ratio as an identifier of patients with normal GFRs.

THE IMPORTANCE OF THE REGION OF INTEREST SELECTION ON THE RADIONUCLIDE RENOGRAMS. M.E. Hopkins, M.V. Kulkarni, S.C. Johnson, J.A. Patton and C.L. Partain. Vanderbilt University Medical Center, Nashville, Tennessee.

The radionuclide renogram is performed to evaluate relative function of the kidney as well as to follow patients who have obstructive or nonobstructive renal disease and are undergoing treatment. Due to poor spatial resolution of nuclear medicine studies using I^{131} hippuran, the separation of the renal parenchyma from the intrarenal collecting system is rather difficult. The selection of a region of interest (ROI) significantly affects the time activity curve (TAC) which is used to compare renal function. This is mainly due to the portion of the collecting system included in the ROI.

We evaluated fifty patients who had undergone bilateral renograms using I^{131} hippuran. Two sets of TAC's were drawn using two different ROI's. The routine ROI's flagged both kidneys in their entirety. The additional processing was performed by drawing ROI's only in the peripheral part of the kidney with exclusion of the renal collecting system. Background subtraction was performed in both TAC's. These curves were compared by three observers independently. The TAC derived from the peripheral ROI's correlated better with parenchymal renal function quantitated visually than the TAC from the ROI's drawn around the entire kidney.

Hence, we conclude that the TAC to evaluate parenchymal renal function more accurately reflects the function when the ROI's are drawn peripherally so as to exclude the collecting system. This is very helpful in determining the parenchymal function in patients who have dilated collecting systems.

SCIENTIFIC PAPERS IV
Clinical

3:30-4:30pm **Room 208**

Moderator: Author J. Hall, CNMT
Co-moderator: Debra L. Loge, CNMT

UTILIZATION OF RADIONUCLIDE CEREBRAL ANGIOGRAPHY FOR DETERMINING CEREBRAL DEATH IN A SMALL COMMUNITY HOSPITAL AND A LARGE TEACHING HOSPITAL. S. L. Carichner and C. E. Nagle. William Beaumont Hospitals. Royal Oak and Troy, Michigan.

For approximately two years radionuclide cerebral angiography (RCA) has been offered on a 24 hour, seven day a week basis for determining cerebral death at both a 200 bed community hospital and a 950 bed university-affiliated teaching hospital. Utilizing a previously published protocol, five RCA's were performed at each hospital during that period. We compared the clinical utilization of RCA in patients suspected of being brain dead at the respective hospitals.

We first reviewed the reasons the referring physicians utilized the RCA in their determination of brain death. 100% of the RCA's for brain death at the large teaching hospital were correctly ordered after brain death was determined to be present clinically. Whereas, 40% of the RCA's at the small community hospital were performed without previous clinical documentation of brain death.

The primary reason at the large teaching hospital for obtaining the RCA was to confirm the clinical impression of brain death in order that organ donation could be handled expeditiously. At the small community hospital there were no decisions for organ transplantation made. Each hospital had a 60% positive (no cerebral flow) rate. These patients had a mean age of 23 years and all had head injuries resulting from trauma. The 40% of studies at both hospitals which were negative (had cerebral flow) were in older patients who were being evaluated for non-traumatic medical problems.

RCA is utilized by clinicians for the determination of brain death with varying degrees of appropriateness and in different clinical situations.

PARALLAX ERROR IN PINHOLE THYROID SCINTIGRAPHY: A CRITICAL CONSIDERATION IN THE EVALUATION OF SUBSTERNAL GOITERS. W. L. McKitrick, H. M. Park, J. E. Kosegi, Indiana University Medical Center, Indianapolis, Indiana.

Recently pinhole thyroid scintigraphy (PTS) has gained wide acceptance as an accurate, reliable imaging modality for evaluating the thyroid gland. The pitfalls of PTS, however, have been recognized.

Routine PTS can lead to a potentially serious error if this modality is used to diagnose substernal goiter (SSG) in workup of patients with upper mediasternal mass. This is due to the parallax phenomenon and minification effect of the pinhole collimators when objects are located off center and further away from the pinhole.

Using a standard thyroid phantom filled with 1 mCi of Tc99m04 and multiple Lucite blocks as tissue equivalent spacers, the effects due to variations in depth and due to off center locations were demonstrated. Increasing the thyroid to collimator distance by 4 and 6 cms, for instance, reduced the image size to 60% and 46% of the original size respectively. A point source placed directly under the "suprasternal notch" (SSN) marker at 4 and 6 cms, for instance, appeared 5 and 8 mm cephalad to the SSN marker respectively. Two clinical cases demonstrating this important pitfall will be presented.

This error in evaluation of SSG can be avoided by 1) centering the pinhole collimator over the SSN, 2) using a parallel hole collimator or 3) utilizing a rectilinear scanner.

In summary, another pitfall in PTS is demonstrated. Unless one is aware of this pitfall, a substernal extension of the thyroid may not be realized or be seriously underestimated in it's size and extent.

ADRENAL MEDULLA IMAGING WITH I-131 METAIODOBENZYLGUANIDINE. L.J. Meyers, J. Glowniak, J.C. Sisson, B. Shapiro, D. Wieland, W.H. Beierwaltes. The University of Michigan Medical Center, Ann Arbor, MI.

I-131 metaiodobenzylguanidine (I-131 MIBG) is an iodinated derivative of the guanethidine analogue benzylguanidine. Like guanethidine, MIBG is taken up by adrenergic tissues and pheochromocytomas (PC). Uptake of I-131 MIBG is normally seen in salivary glands, liver, and faintly in spleen. Since the tracer is excreted in urine, the bladder is routinely outlined. Intensity of heart uptake is variable and is inversely correlated to the plasma norepinephrine level. The tracer is also seen in the large bowel to a variable extent.

0.5 mCi I-131 MIBG is administered intravenously over 15 seconds. Imaging is performed on a wide field of view gamma camera with a high energy parallel hole collimator. A 30% window centered about the 364 keV gamma is used. All images are acquired on computer in 64 x 64 word mode. The patient is imaged from the base of the skull to the pelvis, inclusive, the regions in which primary PC occur, for the first time at 24 hours. Subsequent images are obtained at 48 and 72 hours. Three images of 100K or 20 minutes-whichever comes first-are sufficient to cover the area of interest. Any abnormality detected on these images may be more accurately located by the scintigraphic portrayal of adjacent organs such as kidney, liver, bone, or heart by administration of the appropriate Tc-99m compound.

Use of I-131 MIBG in approximately 400 patients to date at The University of Michigan in patients suspected of having PC has shown that I-131 MIBG has a sensitivity of 90% in identifying patients with PC and is especially useful for detecting ectopic and metastatic lesions.

ADRENAL MEDULLA IMAGING WITH I-123 METAIODOBENZYLGUANIDINE. L.J. Meyers, J. Glowniak, J.C. Sisson, B. Shapiro, D. Wieland, W.H. Beierwaltes. The University of Michigan Medical Center, Ann Arbor, MI.

I-123 metaiodobenzylguanidine (MIBG), an analog of norepinephrine concentrates in pheochromocytomas (PC). I-131 MIBG is the first clinically useful radiopharmaceutical for the routine detection of (PC), especially extra-adrenal and multiple lesions. In spite of the usefulness of I-131 MIBG there are disadvantages to its use. 1) I-131 produces significant beta emissions which irradiate tissue but are useless for imaging and thus limit the amount of tracer which can be injected, 2) because of the small amount of I-131 MIBG (0.5 mCi) which is given, target to background ratios may not produce positive images until 48 and sometimes not until 72 hours, 3) the 364 keV gamma of I-131 has a poor detection efficiency by gamma cameras, and 4) I-131 has a long (8 day) half life further increasing tissue exposure. I-123 has no beta emissions with a short (13.3 hour) half-life, and a 159 keV gamma. Thus, 10 mCi of I-123 MIBG produces about the same radiation dose to tissues as does 0.5 mCi of I-131 MIBG. The dose is injected intravenously over 2-3 minutes. Initial images are obtained 2-3 hours post-injection with delayed images at 17-24 hours. A wide field of view gamma camera with a high energy collimator is used due to the fact that 13 of the 16 patients done to date have had concurrent I-131 MIBG studies for comparison. A 20% window is centered about the 159 keV gamma. Patients are imaged from head to pelvis inclusive, on computer for 1000K-3000K or 20 minutes per image, whichever comes first.

In our experience I-123 MIBG produces significantly better quality images of PC and images more lesions in metastatic PC than I-131 MIBG.

TECHNICAL CONSIDERATIONS FOR GATED TOMOGRAPHIC BLOOD POOL IMAGING. R. Ackermann, M. Tuscan, J.E. Juni, L.C. Bean, J. McMeekin, R. Wahl. The University of Michigan Medical Center, Ann Arbor, MI.

Single Photon Emission Tomography (SPECT) may be readily applied to gated cardiac blood pool imaging. Standard planar imaging results in overlap and poor separation of adjacent cardiac structures. Gated tomographic images clearly define individual chambers and demonstrate the 3-dimensional structure and motion of the heart. We have developed a protocol to obtain high quality gated tomographic blood pool images of end diastole (ED) and end systole (ES).

Acquisition timing parameters to identify for ED and ES are obtained prior to tomography by analyzing the left ventricular volume curve which is derived from a conventional planar gated blood pool study. The acquisition length of the ED and ES frames and the delay times from the electrocardiogram R-wave trigger to the ED and ES intervals are determined. 64 projections of 6 seconds each of the ED and ES intervals are obtained over 180° of rotation. Total study time is approximately 20 minutes. ED and ES images are acquired simultaneously into separate files. Reconstruction of both files is automatically executed using identical parameters. The transaxial data can be sorted to display not only along standard reference lines (sagital, coronal) but also along oblique planes which include the long and short axis of the left ventricle.

Gated blood pool SPECT is easily and quickly performed. Our technique reliably produces high quality images of 3-dimensional cardiac structure and function at ED, ES or at any point in the cardiac cycle. Application of this technique may permit determination of absolute ventricular volumes.

TECHNICAL ADVANCES IN HEPATIC ARTERIAL PERFUSION STUDIES (HAPS). DS Lahti, HA Ziessman, RL Wahl, JE Juni, M Tuscan University of Michigan Medical Center. Ann Arbor, MI

Since 1980 we have performed over 750 TcMAA HAPS studies to evaluate infusion patterns in patients receiving intra-arterial chemotherapy for liver cancer. 77% have had surgically placed catheters with implanted infusion pumps (Infusaid) and 23% external angio catheters. Our study technique has evolved from a single anterior view to an exam using multiple projections, computer analysis, and selected ancillary techniques to ensure complete perfusion of the liver and lack of extrahepatic abdominal perfusion (EHP) or significant A-V shunting to the lung. EHP and A-V shunting result in decreased chemotherapy delivery to the tumor and potential drug toxicity. Computer subtraction techniques have been developed for multiple injections during intraoperative studies after catheter repositioning and on routine HAPS in pts with 2 catheters. Quantitation of lung uptake (% shunt index [PSI]) is calculated from computer drawn ROIs. PSI = lung counts/lung counts + liver counts x 100. In 84 pts the mean PSI was 6.3% $\pm$ 4.2 SD with no significant difference between surgically placed or external angio catheters. Since EHP is associated with a high incidence (45-71%), of adverse symptoms (nausea, vomiting, abd. pain) the detection of EHP is important, though not always easy to determine. We have developed a flexible protocol to simplify its detection: Multiple projections (ant, post,LL, RL) are obtained; when gastric perfusion is suspected, the ingestion of efferescent granules and/or TcDTPA can aid in stomach localization. SPECT has also proved useful. These advances in our technique have made HAPS a more clinically valuable method to evaluate catheter placement, blood flow distribution, A-V shunting and EHP.

EFFECTS OF NORMAL HEART RATE VARIABILITY ON DIASTOLIC FUNCTION MEASUREMENT IN GATED RADIONUCLIDE VENTRICULOGRAMS. J. Botti, J. Juni, S. Pitt., J. Froelich, A. Buda, A. Rocchini. The University of Michigan Medical Center, Ann Arbor, MI

Diastolic function measurements in gated radionuclide ventriculograms (GRV) are valuable in the early detection of cardiac disease. To examine the effects of normal heart-rate variability on parameters of diastolic function, we evaluated 25 patients who demonstrated a normal sinus rhythm (NSR) on a 1 min ECG recorded prior to acquisition.

Simultaneous data acquisition was performed using two computer algorithms. One performed a standard acquisition with post-beat rejection of data from cycles falling outside a 20% R-R interval. The other algorithm used only cycles falling within a predetermined 5% R-R interval window. Left-ventricular time-activity curves were then generated for each study, using a fixed region over each of the 32 frames. Time to end-systole (TES) and end-systolic counts were determined from the minimum value produced by fitting the end-systolic portion of the curve to a quadratic equation. The rapid diastolic filling phase was identified by an automated routine and fitted with a third order polynomial. This polynomial was then differentiated to determine peak diastolic filling rate (PFR) and the time to the occurrence of PFR, (TPFR).

Both algorithm demonstrated similar TES values ($r = 0.92$). However, PFR values generated by the two techniques differed radically ($r = .32$) as did TPFR ($r = .55$). Thus measurements of TPFR and PFR are significantly affected by normal heart rate variability. To reduce this artifact, rejection of cycles of unusual length is essential.

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