Spinal Descent of Cerebral Spinal Fluid in Man. G. DiChiro, M. K. Hammock, and W. A. Balyer. *Neurology* 26: 1–8, 1976.

Information on the normal downward migration of cerebral spinal fluid (CSF) from the point of secretion is indispensable for the study of alterations of CSF circulation under pathologic conditions. Interpreting data on cerebral metabolites from lumbar CSF withdrawals depends heavily on a knowledge of CSF flow. From primate investigations, the authors believe that CSF emerging from the ventricular system separates into a component descending by way of the foramen of Magendie and a component ascending by way of the foramina of Luschka and Magendie. The authors investigated a group of 10 patients, six men and four women, who had malignancies with documented histories of meningeal involvement. To facilitate the administration of intrathecal chemotherapy, all had indwelling ventricular catheters with subcutaneous reservoirs. All patients had received intrathecal chemotherapy and some had received external radiation therapy. At the time of the studies the spinal fluid of each patient was free of malignant cells. Previous scintigraphy had been performed in seven patients and was found to be normal. In one patient the study was technically unsuccessful. In the other two patients EMI scans showed the ventricles to be minimally dilated in one and normal in the other. In eight of the patients, 500 μCi of ^{99m}Tc-HSA was injected percutaneously into the subcutaneous reservoir of a right lateral ventricular catheter. Radionuclide images were obtained with a scintillation camera and digital analysis of the tracer movement was accomplished by means of a small dedicated computer. For two patients data were not obtained for the computer; one of these received ^{99m}Tc-HSA and the other received pertechnetate. Imaging was begun immediately after administration of the radionuclide and the camera was progressively lowered to the thoracic–lumbar area.

Sequential computerized flow studies of the spine were performed at 30-min intervals. Clearance of the radiopharmaceutical from the ventricular system began in the first minute after its introduction into the lateral ventricle. Passage through the foramen of Magendie and the onset of the downward flow in the region of the cervical spine preceded the exit from the foramina of Luschka. Descent of the radiopharmaceutical proceeded rapidly, reaching the lower-cervical high-thoracic area in 10–20 min. At 30–40 min the entire thoracic area and the thoracolumbar segment contained significant levels of radioactivity. Intense concentration of activity in the lumbosacral region was obtained at 60–90 min. By this time and later (120 min), the endocranial activity had proceeded to the level of, or barely beyond the tentorial incisura, progressing toward the sylvian fissures. The computerized flow data indicated the most active downward progression of the radionuclide occurred in the first 30–40 min and a steady state had been reached by 90–120 min. At 5 hr the cranial ascent was near completion, and much later (16 hr) spinal accumulation of the tracer was general in the lower thoracic and lumbar area with a gap of diminished activity between the endocranium and the lower spine.

Results of Brain Scanning with Different Radioisotopes (^{99m}Tc-PP, ^{99m}Tc-DTPA, ^{67}Ga citrate). Part I: Study of Meningiomas. F. Amici and W. Salvolini. *Neuroradiology* 9: 157–162, 1975.

This investigation compared the results obtained in brain scanning of meningiomas with a nonspecific tracer (^{99m}Tc-DTPA) with those obtained with tracers that have a high selective affinity for bone (^{99m}Tc-polyphosphate and ^{67}Ga-citrate). Ten patients with meningiomas were scanned with all three agents. In all subjects the type of tumor was confirmed surgically and histologically. Each patient received successively 15 mCi of ^{99m}Tc-DTPA, 5 mCi of ^{99m}Tc-polyphosphate, and 2.5 mCi of ^{67}Ga-citrate. The polyphosphate revealed an affinity for the areas of altered bone metabolism in association with the meningioma. The authors used the ^{67}Ga-citrate data to evaluate how much of the nonspecific activity found with ^{99m}Tc-DTPA was due to tumor tissue. With respect to meningiomas, the authors did not find any sufficient accumulation above normal by tissue that was non-neoplastic. Since this finding was at variance with other reports, the authors believe that statistical evaluation of other tumors should be attempted.

Cerebral Blood Flow in Dementia. V. C. Hackinski, L. D. Iliff, E. Zilhka, G. H. DuBoulay, V. L. MacAllister, J. Marshall, R. W. Russell, and L. Symon. *Arch Neurol* 32: 632–637, 1975.

Decrease of total hemispheric blood flow in dementia of diverse origins has been recognized since 1950, and more recently disturbance of regional blood flow, particularly in the frontal and temporal areas, has been emphasized. The present study sought to relate the clinical type and severity of dementia to total hemispheric and regional cerebral blood flow (rCBF) and to study the reactivity of the cerebral blood vessels in this condition. The underlying causes are obscure in most cases of dementia, and the authors classified this large group as either "multiple infarct" or "primary degenerative." The multiple-infarct group showed atherosclerotic disease of the vessels with numerous small infarcts, and the primary degenerative group showed an excess of senile plaques and neurofibrillary tangles. No distinction between the two could be made on the basis of age, and no clear difference could be found between primary degenerative disease (Alzheimer) and that of senium (senile).

Twenty-four patients of comparable age, blood pressure, and degree of dementia were assigned by an "ischemia score" based on clinical features into either the multiple-infarct or primary degenerative group. Regional cerebral blood flow was measured by the intracarotid ^{133}Xe method. Both groups showed a decreased proportion of rapidly clearing brain tissue (largely gray matter). Cerebral blood flow per 100 gm of brain per minute was normal in the primary degenerative group and below normal in the multi-infarct group. Thus, blood flow was probably adequate for the brain's metabolic needs in patients with primary degenerative dementia but inadequate for patients with multi-infarct dementia. No correlation could be established between the degree of dementia and cerebral blood flow in the primary degenerative group, but an inverse relationship was found in the multi-infarct group. Cerebral vascular CO_2 reactivity

was tested in most patients. A considerable reduction in mean hemispheric blood flow occurred in response to the fall in pCO_2. Reactivity was slightly less in the multi-infarct group compared to the primary degenerative group. Foci of diminished reactivity occurred in both groups, always in areas of low flow.

The Neuropathology of Stroke. J. H. Garcia. *Hum Pathol* 6: 583–598, 1975.

Vascular circulatory derangements affecting the function of the central nervous system may result in parenchymal lesions that are hemorrhagic, ischemic, or mixed. The author states that the causes of strokes are as follows: cerebral infarction, 80%; cerebral hemorrhage, 10%; subarachnoid hemorrhage, 7%; and miscellaneous, 3%. Omitting trauma, vascular anomalies, viral encephalitides, and blood dyscrasias, most spontaneous episodes of intraparenchymal brain hemorrhage occur in patients with anatomic evidence of hypertensive disease. Hemorrhages occur in the cerebral hemisphere (85%), cerebellum (10%), and pons (5%), and the vascular system shows hypertensive arteriolar sclerosis.

In normotensive subjects parenchymal changes may occur in the brain whenever the systolic blood pressure falls below 60–70 mm Hg. The ischemia may result from serious impairment of the arterial supply or the venous drainage. The mechanisms may be defined as occlusive (either arterial or venous) and nonocclusive (which includes hypotensive shock or contusion). Global ischemia occurs after serious impairment of the cerebral circulation, as in severe hypotensive situations, increased intracranial pressure, thrombosis of the superior sagittal sinus, and such externally applied occlusions as strangulation. The factors that influence the type of tissue damage in global ischemia are body temperature, speed and duration of the ischemic event, and the anatomic conditions of the cranial cerebrovascular structure.

In regional cerebral ischemia the resulting parenchymal lesion will vary depending on whether the blood flow is interrupted near the aortic arch, proximal to several collateral anastamotic sites, or beyond the major junction for collateral circulation. After a middle cerebral artery occlusion, only a fraction of the neurons show structural evidence of irreversible injury. The involvement of multifocal nerve cells resembles that seen after occlusion of a coronary artery. In regional ischemia the disorder evolves through a stage of acute encephalomalacia, followed by leukocytic inflammation at 3–4 days, with resolution beginning about the tenth day after arterial occlusion. A number of excellent electron-microscopic illustrations show the changes in the nerve tissue after ischemia. (This is an excellent review paper for those interested in the pathologic mechanisms of strokes.)

Gallium-67 Citrate and Cerebral Infarction. K. P. Poulose, R. C. Reba, and M. Goodyear. *Invest Radiol* 11: 20–23, 1976.

Since recent reports have suggested that brain scanning with ^{67}Ga-citrate might be useful for differentiating cerebral tumors from such vascular lesions as infarcts or hemorrhage, the authors evaluated ^{67}Ga scanning in patients presenting with central nervous system symptoms. Cerebral scans were obtained in 30 "stroke" patients, first with $^{99m}TcO_4^-$ and subsequently with ^{67}Ga-citrate. Twenty-six of these patients gave an abnormal static ^{99m}Tc scan. In 17 of these 26 patients, the ^{67}Ga scan also showed the abnormality unequivocally (65%). In the four patients with normal static images, the dynamic radionuclide cerebral angiogram was abnormal. In none of these patients was there increased concentration of ^{67}Ga compared to the activity in surrounding normal structures. In one patient with initial negative ^{99m}Tc and ^{67}Ga studies, repeat scans 1 week later were positive for both nuclides. In no case was the concentration of gallium in the infarcted area greater than that observed with technetium. The authors conclude that for brain scanning ^{67}Ga-citrate is nonspecific and inadequate for the differentiation of stroke and tumor.

Accuracy of ^{99m}Tc-Diphosphonate Bone Scans and Roentgenograms in the Detection of Prostate, Breast and Lung Carcinoma Metastases. J. D. Osmond III, H. P. Pendergrass, and M. N. Potsaid. *Am J Roentgenol Radium Ther Nucl Med* 125: 972–977, 1975.

This report is an analysis of the relative accuracy of ^{99m}Tc-diphosphonate bone scans and x-ray skeletal surveys in the detection of metastatic bone disease in patients with primary carcinoma of the breast, prostate, or lung. The subjects were 259 patients with histologically proven carcinoma in whom x-ray and radionuclide studies were carried out within a 2-week period: 118 patients with breast carcinoma, 87 with prostate carcinoma, and 54 with carcinoma of the lung. The patients were categorized as follows: positive scan and x-ray, with an equivalent number of lesions on both studies; positive scan and x-ray, with more lesions on the radionuclide studies; positive scan and negative x-ray; negative scan and positive x-ray; negative scan and x-ray; equivocal scans; and equivocal x-rays. In 42 cases the number of metastases visualized by the two diagnostic modes was the same, and in 35 cases the scans revealed more metastases. In 48 cases x-rays did not reveal any metastases despite positive radionuclide studies. In their series of 137 patients with evidence of bony spread of tumor, 36% had false-negative x-ray studies. Of these 137 patients, 83 gave more information by the radionuclide method, which represented a significant improvement in the sensitivity in detecting metastatic disease. Of 26 patients with equivocal bone scans, 20 were eventually diagnosed as having nonneoplastic disease and four subsequently showed progressive spread of tumor. Of 20 patients with equivocal x-rays, 18 followup x-rays were negative. Four patients with equivocal x-rays showed increased uptake in the same area on the bone scan, interpreted as being secondary to metastases. X-rays in six patients indicated metastases while the scans were interpreted as not showing tumor. Three of these patients had received radiation therapy to the areas in question, two were misinterpreted, and in the remaining patient the lesion was obscured by activity in the urinary bladder. The authors point out that, in retrospect, patients with extensive metastases showed decreased or absent renal activity.

Bone Scan in Chronic Dialysis Patients with Evidence of Secondary Hyperparathyroidism and Renal Osteodystrophy. W. M. Sy and A. K. Mittal. *Br J Radiol* 48: 878–884, 1975.

This report described the ^{99m}Tc-polyphosphate bone-scan findings in 14 patients with end-stage chronic renal failure. The findings were graded and correlated with the duration of dialysis and with the clinical and laboratory data. The patients were six men and eight women, ranging in age from 23 to 64 years. The mean duration of dialysis was 43.5 months. Skeletal surveys were obtained in all patients, and all showed biochemical evidence of secondary hyperparathyroidism at that time. The bone scans were found to be abnormal in 13 of 14 patients. Symmetric increased activity was noted in the calvarium, mandible, sternum, shoulders, vertebrae, and the distal aspects of the femora, tibia, and pelvis. No activity was observed in the urinary tract in

any patient. The authors believe that the abnormal scans were most likely the result of secondary hyperparathyroidism. Earlier investigations had suggested that bone uptake occurred in patients with primary hyperparathyroidism. The authors concede, however, that co-existing osteomalacia, giving rise to abnormal activity, may not be excluded in some of the patients. Osteoporosis was probably present in some of their patients, but it appeared differently on the scan. Osteosclerosis was not detected by radiographic examination. Positive scan findings, particularly the mandibular activity, were pronounced and appeared earlier than the radiographic changes. The degree and extent of abnormal activity correlated with the length of dialysis and the level of the serum alkaline phosphatase.

^{99m}Tc-Diphosphonate Uptake in Skeletal Muscle: A Quantitative Index of Acute Damage. B. A. Siegel, W. K. Engel, and E. C. Derrer. *Neurology* 25: 1055–1058, 1975.

This study evaluated the localization of a ^{99m}Tc-labeled phosphate compound in damaged skeletal muscle. Ischemic myopathy was induced in adult rats by ligation of the abdominal aorta above its bifurcation, followed several days later by intraperitoneal injection of 5-hydroxytryptamine (5-HT). This procedure elicits the development in skeletal muscle of microscopic foci of ischemic infarction which are similar histologically to early lesions in patients with Duchenne muscular dystrophy. The distal hind-limb muscles (gastrocnemii) are less severely affected than the proximal muscles (quadriceps). The plasma concentrations of muscle enzymes increased rapidly and peaked 12 hr after the intraperitoneal injection of 5-HT.

One day after 5-HT administration, the animals received ^{99m}Tc-diphosphonate, and 2 hr later samples of quadriceps femoris, gastrocnemii, and undamaged forelimb muscle (triceps brachialis) were removed and assayed for radioactivity. The concentration of ^{99m}Tc-diphosphonate was higher in the quadriceps muscle than in the gastrocnemii, and both had considerably higher concentrations than found in the triceps. No differences in tracer concentration were observed in the triceps and hind-limb muscles in untreated animals or in animals who had received either aortic ligation or 5-HT administration alone. A direct relationship between muscle ^{99m}Tc-diphosphonate uptake and plasma creatine phosphokinase (CPK) levels was observed. The CPK levels reflect enzyme release from both damaged cardiac and skeletal muscle, but the two sources cannot be differentiated. An inverse relationship was found between muscle ^{99m}Tc-diphosphonate uptake and potassium ion concentration. In the gastrocnemius and quadriceps muscles of treated animals, potassium ion concentration was lower than in corresponding controls; potassium ion concentration was the same for the triceps muscle in control and treated animals. The authors believe that their results reflect a reliable method to quantitate the extent and location of skeletal muscle necrosis occurring in Duchenne muscular dystrophy, polymyositis, and rhabdomyolysis.

Increased Reactivity of Rat Alpha Foetoprotein with Corresponding Antiserum after 125 I Labelling. C. Dambuyant and P. Sizaret. *J Immunol Methods* 8: 289–294, 1975.

The authors studied two rat alpha-fetoproteins (AFP) with similar physicochemical properties. The AFP No. 1 was prepared by dissociation of an immune complex, employing as the antigen the AFP found in ascitic fluid from rats who had AH70B hepatoma transplants. The AFP No. 2 was obtained from rat amniotic fluid whose non-AFP proteins were removed by chromatography by means of insoluble anti-normal rat serum proteins. Iodination of the AFPs with ^{125}I yielded specific activities of 35,000–50,000 cpm/ng AFP. After labeling, precipitation with 10% trichloroacetic acid yielded 90.1% for AFP No. 1 and 95.3% for AFP No. 2, indicating more nonprotein contaminants in the former. Precipitation of ^{125}I-AFP No. 1 by rabbit anti-rat AFP in a double-antibody system amounted to 71.5% with a dose–response curve slope of 13.6%. For AFP No. 2 the corresponding percentages were 89.3% and 18.1%, respectively, again indicating its greater purity and the increased avidity of the antiserum.

Radioimmunoassay of Myoglobin in Human Serum—Results in Patients with Acute Myocardial Infarction. M. J. Stone, J. T. Willerson, and C. E. Gomez-Sanchez. *J Clin Invest* 56: 1334–1339, 1975.

The authors report the development of a radioimmunoassay for measuring serum myoglobin. Myoglobin was isolated from human heart at autopsy within a few hours of death, antisera to the protein were prepared in rabbits, and iodination was accomplished with ^{125}I. The RIA, performed on 10–50 μl of serum, had a sensitivity of 0.5 ng of myoglobin. No significant cross-reactivity with hemoglobin, other intracellular proteins, or serum proteins was indicated. In a single assay, triplicate determinations agreed within 5%. Six measurements made on different days on aliquots of the same sample of pooled normal human serum yielded a coefficient of variation of 11%. The assay was unaffected by freezing and thawing of serum samples and by hemolysis or lipemia. All sera from normal adults yielded detectable levels of myoglobin. In a group of 92 normal subjects, myoglobin levels were 28.9 $\pm$ 17.3 ng/ml (mean $\pm$ 1 s.d.). A range of 6–85 ng/ml was observed and values above 85 were considered abnormal.

Eighteen of 20 patients with acute myocardial infarction, whose blood samples were drawn within 12 hr of hospital admission, had abnormal myoglobin levels. The average concentration for the 20 patients was 380 $\pm$ 53 (s.e.) ng/ml (range 22–788). When the blood samples were drawn 12–24 hr after admission, only 45% of the group had abnormal values and the mean value fell to 195 $\pm$ 45 ng/ml. Only one out of 21 patients with chest pain but without myocardial infarction had an abnormal myoglobin level. Those patients with angina pectoris or coronary insufficiency had a mean myoglobin level of 41 ng/ml. The authors conclude that radioimmunoassay of myoglobin appears to be a useful and sensitive test for the early detection of myocardial infarction and has potential for sizing infarcts.

Angiography and Ultrasonography—A Comparative Study of Abdominal Aortic Aneurysms. W. E. Wheeler, M. C. Beachley, and K. Ranniger. *Am J Roentgenol Radium Ther Nucl Med* 126: 95–100, 1976.

The presence of laminated thrombus lining the wall of an aortic aneurysm may lead to significant underestimation of the maximum diameter of a noncalcified aneurysm. For this reason, as well as the more invasive nature of aortography, the authors undertook to compare contrast aortography and ultrasonography for detecting abdominal aortic aneurysms. Standard gray-scale ultrasound techniques were employed and echo-free areas were verified by A-mode. At low sensitivity settings only the outer wall of the aorta was identified; increased gain settings showed internal echoes from the intraluminal thrombus.

This study included 30 consecutive patients investigated

by both diagnostic modalities. In 15 patients the aneurysm was greater than 3 cm in diameter, and in 11 of these 15 the diameter of the aneurysm correlated well on both studies. In four cases, the ultrasound scan showed an aneurysm larger than that visualized on the aortogram, and the ultrasound findings correlated better with the calcification observed on abdominal radiograms than with the aortography findings. Ultrasound showed a normal aorta in 15 patients. Five of these patients had normal aortograms and one showed an ulcerated plaque. Aortography was deferred in eight others, after demonstration of an abnormal aorta by ultrasound.

Some 55–85% of patients with abdominal aneurysms show calcification on abdominal radiograms. In the absence of calcification, however, false-negative studies may be seen in aortography because of thrombus lining the lumen of the aneurysm. The authors also provide information on the survival rate with respect to the diameter of the aneurysm and the probability of rupture. Ultrasonography is unable to reveal the relationship of an abdominal aortic aneurysm to the renal artery and confirm or disprove involvement of these vessels; however, more than 90% of abdominal atherosclerotic aneurysms originate below the renal arteries. The technique is valuable as a screening procedure and may well obviate the hazards of aortography in the poor-risk patient.

Ultrasonography: An Aid in the Diagnosis of Masses in Pediatric Patients. B. B. Goldberg, H. M. Pollack, M. A. Capitanio, and J. A. Kirkpatrick. *Pediatrics* 56: 421–428, 1975.

A comprehensive review of masses examined by ultrasound in 100 pediatric patients is presented with a brief description of the sonographic techniques and criteria employed. In 41 cases a cystic ultrasonic pattern was observed, in 30 a solid pattern, and in 29 a complex ultrasonic picture. In 59 patients the masses were retroperitoneal, and in 29 intraperitoneal. The ultrasonic pattern did not correlate with the pathologic findings in only four instances.

In 14 Wilms' tumors that produced complex ultrasound patterns, 12 ultimately proved to have large areas of hemorrhage or necrosis as a basis for the findings. Two cases showed complex patterns, but the tumors proved to be entirely solid. A complex pattern with few scattered internal echoes was recorded from a mass which ultimately proved to be a lymphoma. The difficulties of ultrasonographic diagnosis in these entities has previously been reported in adults. Representative cases with clinical histories and corresponding ultrasonograms were presented of bilateral hydronephrosis, Wilms' tumor, and a distended gallbladder. A pelvic kidney was identified on the ultrasonic scan, and review of a previous urogram confirmed the finding, which had not been appreciated on the initial examination of the radiographic study. In an 8-year-old boy a cystic pelvic mass was identified and surgery revealed a Mullerian duct cyst. The accuracy of determining size, shape, and internal composition of abdominal masses in pediatric patients by ultrasonic techniques approaches the accuracy previously reported in adults (~95%).

Diagnostic Ultrasound of the Urinary Tract. W. M. Green and D. L. King. *J Clin Ultrasound* 4: 55–62, 1976.

A comprehensive review of the current status of renal ultrasonography is presented. Since the intravenous urogram is considered more efficient as a screening device, ultrasound is not recommended for that purpose. Position and scanning methods are discussed for optimal visualization of both kidneys in adults and children. The normal ultrasonographic appearance of the kidneys is described and illustrated. Indications for renal ultrasonography include delineation of position, size, shape, and volume of the kidney as well as localization for radiotherapy, biopsy, cyst puncture, or percutaneous nephrostomy. The technique is particularly valuable for the azotemic patient in whom renal function precludes a satisfactory urogram.

Ultrasonic examination of the unilateral nonfunctioning kidney is of great value in differentiating hydronephrosis from tumor or compressing hematoma. Serial examination of the transplanted kidney, beginning in the postoperative period, is found to be of value both in determining volumetric changes and in detecting perirenal collections of fluid, blood, or pus. The normal patterns of renal volumetric changes are described. The authors describe the entire spectrum of hydronephrosis, ranging from minimal distortion of the central-collecting-system echoes to multiple cyst-like echo-free areas. The similarity between the appearance of hydronephrosis and that of polycystic disease is noted, and additionally the technique allows simultaneous evaluation of liver parenchyma for concomitant hepatic cystic disease.

The differentiation between cystic and solid renal masses has been previously documented. Correlation with intravenous urography, radionuclide study, angiography, nephrotomography, and cyst puncture is deemed essential. Criteria for the differentiation are thoroughly outlined; any lesion which does not meet all the criteria for a simple cyst should be considered a possible neoplasm and evaluated further. Based only on the ultrasonic criteria for renal cyst, the diagnostic accuracy of differentiating cyst from tumor ranges from 75% to 96%; adding the other available techniques brings the diagnostic accuracy to nearly 100%. A brief discussion of the evaluation of bladder and prostate by ultrasonographic methods is included.

Posterior Fossa Cyst: Prenatal Diagnosis by Ultrasound. T. G. Lee and B. W. Newton. *J Clin Ultrasound* 4: 29–30, 1976.

Previous reports have documented antenatal diagnosis of such abnormalities as polycystic kidney, microcephaly, and hydrocephalus. The authors present the hitherto unreported fetal abnormality of a posterior fossa cyst, successfully identified and diagnosed by ultrasonography. In a 21-year-old woman, gravida 1, para 0, 3 weeks beyond term by dates, the fetal biparietal diameter measured 10.5 cm. The fetal trunk, however, measured approximately 9 cm, this disproportion being a previously reported sign of abnormally large fetal head. Four fluid-filled intracranial spaces were identified by ultrasonography and were believed to represent dilated lateral ventricles, third ventricle, and a cystic structure in the posterior fossa. Transvaginal decompression of the fetal head yielded 600 cm^3 of xanthrochromic fluid, after which fetal heart tones disappeared within 3 hr. At autopsy, the ultrasound diagnosis of a posterior fossa cyst was confirmed, and in addition an acute massive intracranial hemorrhage was present. Third-ventricular dilatation was not found, and the ultrasonographic finding was thought to be due to an acute intradural hemorrhage. The findings are presented to encourage a more vigorous attempt at antenatal diagnosis of fetal abnormalities by ultrasonography.

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