

Abstracts of Scientific Presentations

Society of Gastrointestinal Radiologists' Fifteenth Annual Meeting

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1. Bowel Cancer Characteristics in Patients with Regional Enteritis. T. Miller, J. Skucas, D. Gudex and C. Listinsky (University of Rochester Medical Center, Rochester, NY)

Ten bowel malignancies in 8 patients with regional enteritis were identified. Six of the cancers occurred in regions of radiographically obvious regional enteritis while the others developed in otherwise normal appearing bowel. The cancers developing in disease-free segments had a typical radiographic appearance of malignancy. The cancers developing in sites involved by regional enteritis infiltrated intramurally in a diffuse and poorly defined pattern, with the overall impression of severe, long-standing regional enteritis. In 3 patients the malignancy was diagnosed only by eventual histologic evaluation.

We conclude that although patients with regional enteritis can develop typical-appearing cancers in nondiseased bowel, the cancers occurring in diseased bowel have atypical radiologic and pathologic appearances.

2. The Radiographic and Colonoscopic Detection of Dysplasia and Cancer in Patients with Chronic Ulcerative Colitis. J.R. Hooyman, R.L. MacCarty, H.A. Carpenter, K.W. Schroeder and H.C. Carlson (Department of Radiology, Mayo Clinic, Rochester, MN)

During the past 5 years, 170 patients with chronic ulcerative colitis (CUC) have been undergoing surveillance for cancer with double-contrast barium enemas and colonoscopy with multiple biopsies. Dysplasia, ranging from mild to severe in grade, without carcinoma was present in 26 of these patients and 8 of these patients had colectomies. An additional 17 patients over the same time period were newly diagnosed with cancer complicating their CUC. All cancer patients had colon radiographs and colectomies, and many also had colonoscopy. The histologic, colonoscopic, and gross specimen findings where possible, from both the surveillance and cancer CUC patients, were correlated with the colon radiographs. Preliminary results indicate that dysplastic changes were seen in grossly normal (flat) mucosa most often. Macroscopically visible dysplasia ranged from a discrete nodule or polyp to a grouping of multiple nodules, sometimes with the sharply angulated margins previously described in the radiologic literature. The radiographic appearance of dysplasia was not specific, however, and could not be reliably differentiated from inflammatory changes. Although the barium enema was found to have obvious limitations in detecting dysplasia, it played a necessary and complementary role to colonoscopy in detecting the 17 patients with cancer.

3. The Fate of Colonic Aphthae in Crohn's Disease. H.I. Goldberg and X.Y. Ni (University of California, San Francisco, CA)

The fate of colonic aphthae in 14 patients was determined by evaluation of single- and double-contrast barium studies over several years. The number and location of aphthae on the first examination were compared with the number and size shown on subsequent examinations. The appearance of the bowel area containing aphthae and bowel not containing aphthae was also evaluated. No correlation was found between changes in the appearance of the bowel and the number and location of aphthae. Aphthae can remain in the same position and number in the colon for years despite worsening or lessening of disease in other segments of bowel. In some instances, the bowel containing aphthae became frankly diseased in others, the aphthae disappeared and surrounding tissue appeared normal. The detection of aphthae in colon does not necessarily herald progression of disease.

4. Colonic Lymphoid Follicles Associated with Colonic Neoplasms. S.N. Glick and S.K. Teplick (Hahnemann University, Philadelphia, PA)

We previously reported 4 patients with colonic carcinoma and radiographic demonstration of diffuse colonic lymphoid follicles involving >50% of the colon. In a retrospective series of 300 consecutive double-contrast barium enemas in patients over 50 years of age, this pattern was identified in 4 other patients, 2 of whom had recurrent polypoid colonic lesions and 2 of whom had previous resections of colonic carcinoma.

Based on our observations we performed an extensive prospective evaluation on all patients over 40 having double-contrast enemas and identified lymphoid follicles in any colonic segment. We identified 53 patients with this pattern. Twelve patients had no current radiographic evidence or history of colonic neoplasms (23%). One of these had a sister with colon cancer. Twenty patients had definite polypoid lesions on contrast study. Six of these were histologically benign, the remainder lost to follow-up. Two of these had previous resection for colonic carcinoma.

Our data suggest that there is a high association between the radiographic demonstration of lymphoid follicles and colonic neoplasms. This may serve as a radiographic indicator when the neoplastic lesions are subtle. In addition, identification may aid in the differential diagnosis of colonic lesions. Finally, further study is required to determine whether the presence of these follicles may predict the development of future neoplasms.

5. Reevaluating the Role of Radiology in Hemocult Screening Programs. P. Feczko and R.D. Halpert (Henry Ford Hospital, Detroit, MI)

During a recent regional fecal occult blood (Hemocult) screening program, we had the opportunity to evaluate 98 patients with positive results of the Hemocult test. In these 98 patients, 6 carcinomas were identified. Twenty-one other patients with polyps were also identified (37 polyps total).

Double-contrast colon examination (DCBE) had a high degree of accuracy that was comparable to endoscopic studies, detecting all carcinomas and 92% of polyps, although it had some limitations in patients with severe diverticulosis. It was also the most cost-effective procedure. Colonoscopy dramatically increased screening costs, and there was no evidence to support its use in all Hemocult-positive patients. Evaluation of the upper gastrointestinal tract had a very small yield and is not routinely warranted. We recommend that radiology should be the initial diagnostic test for Hemocult-positive patients, to be supplemented in select patients by flexible sigmoidoscopy or colonoscopy, based on pathology evident at DCBE as well as clinical circumstances.

6. Endoscopy or Barium Meal for Dyspepsia: A Study on Patient Preference. R.A. Frost, D. Lamping, S. Somers and G. Stevenson (McMaster University, Canada)

New developments in technology are increasingly providing more than one imaging technique to answer clinical problems. Costs, risks, and accuracy guide selection of the appropriate test, but when these are similar, patient preference should be a decisive factor.

A randomized controlled study has been devised to assess preference for barium meal or endoscopy in patients referred with dyspepsia. The patients had both tests in random order, performed by different physicians, and completed questionnaires (administered by research assistants) before and after each test, and 1 week after completion of the second test. Sixty-four patients were studied and preference results were statistically significant. Overall preference results were (definitely prefer = D, slightly prefer = S):

	Prior to meal	Prior to endo	1 wk. post studies	Would choose again
Prefer endosc.	5D, 6S	6D, 3S	29D, 8S	E 41
No preference	34	29	6	3
Prefer meal	9D, 10S	12D, 14S	9D, 12S	BM 20

The shift in preference to endoscopy is significant, and individual physicians' skill and sedation were variable factors. There was a nonsignificant trend favoring endoscopy for accuracy.

7. Sensitivity of Single- and Double-Contrast Barium Enema for Detection of Colonic Polyps Relative to Polyp Size. D.J. Ott, Y.M. Chen, D.W. Gelfand, W.C. Wu and H.A. Munitz (Bowman Gray School of Medicine, Winston-Salem, NC)

A total of 139 patients had 234 polyps documented by colonoscopy. Single-contrast barium enema (SCBE) done in 54 patients (mean age: 70) and double-contrast barium enema (DCBE) in 85 patients (mean age: 59) produced the following sensitivities relative to polyp size.

Size	SCBE	DCBE
5-9 mm	38/53 (72%)	84/96 (88%)
≥ 10 mm	30/32 (94%)	51/53 (96%)
Totals	68/85 (80%)	135/149 (91%)

In summary, SCBE is as effective as DCBE in detecting colonic polyps 1 cm or larger and is a satisfactory examination for older patients in whom detection of smaller polyps is less crucial.

8. Reactions to Oral or Rectal Barium. M.L. Janower (St. Vincent Hospital, Worcester, MA)

It has been reported that anaphylactic and allergic reactions following double-contrast studies of the gastrointestinal tract can occur. A survey was conducted of the members of the Society of Gastrointestinal Radiology to establish the incidence and severity of reactions of the above type. An attempt was made to isolate offending agents.

9. The Barium Enema Scout Film: Cost Effectiveness and Clinical Efficacy. F.J. Schwab, S.N. Glick and S.K. Teplick (Hahnemann University, Philadelphia, PA)

We prospectively studied 1023 consecutive double-contrast barium enema examinations to determine the efficacy of the preliminary film. The scout film was evaluated for clinically significant abnormalities or an unsatisfactory amount of residual feces. The contrast study was independently evaluated in a double-blind manner for the presence of clinically significant extracolonic abnormalities and satisfactory colonic preparation.

We found that the routine use of the scout films slightly increases patients' costs, patients' radiation exposures, and radiology department costs. Clinically significant abnormalities present on the scout film were in almost all cases independently discovered on either the contrast study or previous radiologic examinations.

10. Base Line Tenting - A Sign of Duodenal Ulcer Disease. C.C. Lu, J. Murakami, T. Barloon, S.R. Ell and E.A. Franken (University of Iowa Hospitals and Clinics, Iowa City, IA)

Indirect signs such as clover-leaf deformity, pseudodiverticula formation, eccentric location of pyloric channel, and flattening of the fornix are of considerable value in the radiologic detection of ulcer crater. We have found another indirect sign, base line tenting (BLT), to be very useful in the detection and diagnosis of duodenal ulcer disease. It is characterized by interruption of the base line of the bulb, with 2 associated perpendicular lines extending from the base and converging to a point in the duodenal bulb. After we had observed this sign in multiple patients with peptic ulcer disease, a prospective investigation was performed involving 62 patients with duodenal ulcer disease over a period of 2 years. We found the BLT sign in 52 of 62 (83.8%). There has been, as of this date, no false-positive case identified. We concluded that BLT is a most valuable sign in the radiologic identification of duodenal ulcer disease.

11. Gastrointestinal Plasmacytomas. J. Farman, E. Balthazar, B.R. Javors and B. Bashist (Downstate Medical Center, New

York University Medical Center, North Shore University Hospital, St. Luke's-Roosevelt Medical Center, Cornell University Medical College, Columbia University College of Physicians and Surgeons, New York, NY)

Sixteen cases of plasmacytomas involving the GI tract are presented. One involved the esophagus, 10 the stomach, 2 the small bowel, and 5 the colon. Fourteen of the 16 patients were male with an average age of 60.

The esophageal lesion was a large, bulky, polypoid mass. The gastric lesions were predominantly submucosal nodules or soft lobular infiltrating masses, which were sometimes ulcerated. The antrum was spared in all cases. The small bowel lesions were mainly polypoid and 1 presented with intussusception. Two "bullseye" lesions were seen as well as an annular constricting mass. The colon lesions were extrinsic or submucosal masses.

Half of all patients had multiple sites of involvement. These findings were not pathognomonic, but resembled lymphoma radiographically. When bone lesions were not present (2/14) it was not possible to make the diagnosis based on radiographic criteria alone.

12. Radiation Therapy of Esophageal Carcinoma: Correlation of Clinical and Radiographic Findings in 17 Patients. M.S. Levine, J. Langer, M. Kligerman and I. Laufer (Hospital of the University of Pennsylvania, Philadelphia, PA)

Seventeen patients with esophageal carcinoma treated by radiation therapy (RT) at our hospital between 1981 and 1984 had initial diagnostic esophagrams and 1 or more repeat esophagrams after completing RT. Total regression of the tumor was observed radiographically in 10 patients (59%) with a normal esophagus or benign-appearing residual stricture at the site of the previous lesion. Partial regression was observed in 4 patients, and progression of the tumor in 3. No correlation was found between the size or stage of the lesion and its response to therapy. Although local recurrences were relatively uncommon, patient survival was often limited by the development of distant metastases. Fourteen of 15 patients with clinical follow-up initially had significant relief from dysphagia as the tumor regressed. However, 9 of those patients subsequently had recurrent or worsening dysphagia over a 3-9-month period following RT. Exacerbation of symptoms did not necessarily indicate recurrent carcinoma, since it could also result from opportunistic infection of the esophagus or other complications of RT readily detected on esophagography.

13. Accuracy of Ultrasound and Computed Tomography in Predicting Resectability of Liver Neoplasms. R.L. Bree and R.E. Schwab (William Beaumont Hospital, Royal Oak, MI)

The role of ultrasound (US) and CT in predicting resectability of solitary or unilobar liver lesions was assessed in 18 patients undergoing 19 operations that attempted to resect the lesions. Two patients had hepatocellular carcinoma, 1 a primary hepatic leiomyosarcoma, and the remaining 15 patients had metastatic adenocarcinoma from the colon. In the colon carcinoma group, the mean time from original diagnosis to the detection of the metastasis was 13 months.

Imaging studies performed included dynamic US, dynamic CT, and, in a few patients, CT angiography. Dynamic US was most useful for evaluating the relationship of the mass to the hepatic veins, while CT angiography was useful in finding small masses not visible by standard CT techniques. This study con-

sists of patients seen over a 5-year period; some imaging studies have improved during this period of time.

In 14 of 19 operations, the lesions were resectable. Both US and CT correctly predicted resectability in 13. In 5 patients, the lesions were not resectable. This was predicted by CT and US in only 1 and the surgeon elected to explore that patient anyway. In 4 patients, US and CT did not detect small lesions in the other lobe or extrahepatic disease. The overall accuracy of CT and US in predicting resectability was 75%.

14. The Anatomy of "Eee." S.E. Rubesin and B. Jones (The Johns Hopkins Medical Institutions, Baltimore, MD)

Double-contrast gastrointestinal examinations require adequate distension for proper interpretation. Routine double-contrast radiographs of the pharynx at rest show inadequate distension and poor separation of structures. One hundred double-contrast studies of the pharynx at rest and distended by phonation were analyzed to determine methods of elucidating anatomic detail. Phonation with "Eee" proved superior in demonstrating the lateral view of the tongue base, the palatine tonsils, the valleculae, the epiglottis, and the mucosal surface of the pharynx. The anatomical basis of phonation will be illustrated. Examples will be shown of tonsillar, tongue, and hypopharyngeal masses poorly seen at rest but well-demonstrated with phonation. Phonation is a useful maneuver for the double-contrast lateral examination of the pharynx.

15. Limitations of Endoscopy in Detection of Lower Esophageal Mucosal Ring (LEMR). D.J. Ott, Y.M. Chen, H.A. Munitz, W.C. Wu and D.W. Gelfand (Bowman Gray School of Medicine, Winston-Salem, NC)

Radiographic and endoscopic sensitivity are shown in 60 patients with LEMR:

Ring caliber	Total	X-ray (%)	Endoscopy (%)
≤ 13 mm	22	20 (91)	18 (82)
14-19 mm	26	25 (96)	14 (54)
20-25 mm	12	12 (100)	3 (25)
Totals	60	57 (95)	35 (58)

Full-column examination detected 57/60 (95%) LEMR versus 18/39 (46%) by double-contrast technique. Endoscopic detection depended on ring caliber and on the instruments used with poorer detection (47%) for the narrower endoscopes.

In summary, radiographic examination more accurately detects LEMR and should be the initial study done in patients with dysphagia and suspected lower esophageal narrowing.

16. Radiographic Features of Inoperable Gastric and Esophageal Carcinoma Treated by Transendoscopic Neodymium: YAG Laser Therapy. E.L. Wolf, D. Frager, J. Frager, L.J. Brandt, L.H. Bernstein and T.C. Beneventano (Albert Einstein College of Medicine, Montefiore Medical Center, Bronx, NY)

Transendoscopic lasers are now being increasingly used as a palliative technique to treat malignant obstructions of the esophagus and gastric cardia. Laser therapy is an attractive palliative method of treatment because of the poor survival with traditional methods of therapy. In addition, advantages

of laser therapy include: (1) general anesthesia can be avoided, (2) no systemic side effects are produced, and (3) treatment can be repeated whenever necessary.

From 1983 to 1985, 25 patients with carcinoma of the esophagus and gastric cardia underwent YAG laser therapy. Patients were considered for laser therapy if they had symptomatic lesions and were not candidates for surgical therapy. Some patients had previous and/or concomitant radiation therapy.

Radiographic improvement is apparent after successful tumor ablation with increase in luminal diameter. Tumor nodularity generally persists, but in some cases the esophagus returns to a more benign appearance.

Complications in this series included 1 tracheoesophageal fistula, 1 perforation, 1 pneumopericardium, and 1 pneumoperitoneum, but no leak. The complication rate was 2/189 total treatments (2.1%).

17. Secondary Neoplasms of the Esophagus: Critical Analysis of 15 Cases. F.P. Agha (University of Michigan, Ann Arbor, MI)

Esophageal involvement by metastatic tumors in 15 patients is presented. A critical review of clinical and radiographic features identified certain distinctive features highly suggestive of a metastatic tumor to the esophagus. Radiologically the most common feature was a short segment of progressive stricture formation with normal to minimally irregular mucosal pattern (8 of 15 patients). The average length of the stricture was 2.5–3 cm and it was eccentrically located. Four patients had longer strictures that were difficult to differentiate from benign strictures. Other features consisted of ulcerative mass with esophagopulmonary or esophagobronchial fistula, secondary achalasia, and esophageal dysmotility ranging from severe dysmotility to aperistalsis. This spectrum of radiologic features is important to be aware of when examining patients with dysphagia and a known primary malignancy elsewhere in the body. Since endoscopy and biopsy have low diagnostic yield, radiologic diagnosis plays a key role in suggesting the diagnosis of metastatic esophageal neoplasm. Representative examples with esophagram, computed tomographic, and pathologic correlation will be presented.

18. CT of Gastric Carcinoma: A Review of 60 Patients. A.J. Megibow, D.H. Hulnick and E.J. Balthazar (New York University Medical Center, New York, NY)

CT scans of 60 patients (56 preoperative and 4 postoperative) with gastric carcinoma were reviewed and categorized by the TNM system. Histologic proof was present in all; surgical correlation was available in 45.

Among the patients, 55/56 presented with T₃ or T₄ lesions. The average wall thickness was between 0.6 and 8.0 cm (average 1.4 cm). Lesions in 16 patients were considered N₀ but of these, 6 had lesions engulfing local lymph nodes. Of 40 patients N₂ lesions were present in 35. In only 5 patients was the nodal involvement restricted to local nodes. Metastases were present in 20 cases (M₁). Common sites (in order of decreasing frequency) included the peritoneal cavity, gastric ligaments, liver, retroperitoneum, ovary, pancreas, and diaphragm. Surgery revealed tumor in lymph nodes in 3 of 10 patients in whom no adenopathy was seen on CT. In 4 cases, direct invasion into the pancreas was found at surgery, although this finding could not be determined on CT.

CT is useful in documenting extent of disease, displaying nodes not seen at surgery, and assessing response to therapy.

19. Computed Tomography of Diffuse Mesenteric Disease. P.M. Silverman, M.E. Baker, C. Cooper and F.M. Kelvin (Duke University Medical Center, Durham, NC)

The mesenteric pathology is only inferentially assessed with barium studies. Although CT evaluation of focal masses has been described, limited information is available characterizing diffuse mesenteric pathology.

A preliminary study of 30 normal patients was performed to characterize the CT appearance of the mesentery. Subsequently, CT findings in 68 patients with diffuse mesenteric disease were studied. Pathological processes included: inflammatory (30): pancreatitis, diverticulitis, Crohn's disease, abscess, typhlitis; malignancy (24): primary carcinoma, metastases, mesothelioma, carcinoid, lymphoma; and edema (14).

In normal patients, segmental mesenteric vessels were consistently visualized coursing in the homogeneous mesenteric fat ($\bar{X} = -117$ HU). Inflammatory processes created increased density in the mesenteric fat, obliterating the mesenteric vasculature. Identification of the extent of mesenteric fluid collections aided in planning percutaneous or surgical therapy. Primary neoplasms demonstrated contiguous mesenteric involvement and metastases were characterized by nodules, diffuse thickening, or rigidity of the mesenteric leaves. Edematous changes in the mesentery included: a diffuse increase in density of mesenteric fat, perivascular and subcutaneous edema, and in 2 cases CT demonstrable superior mesenteric vein occlusion.

The characteristic CT findings and differential features for distinguishing various mesenteric pathologic processes will be demonstrated.

20. CT and Ultrasound of Hepatoma. S. Teehey, D. Stephens, E. James, W. Charboneau and P. Sheedy (Mayo Clinic, Rochester, MN)

The CT scans and sonograms of 37 patients with hepatoma were reviewed to determine the characteristics of the tumor and to compare each modality in terms of its accuracy in defining tumor morphology and ability to predict vascular invasion and extrahepatic spread. At CT, slightly over 50% of the tumors were multicentric, about 40% were solitary, and the rest were diffuse. One-half of the hepatomas were heterogeneous in density before contrast and most enhanced in a nonuniform manner. Twenty-five percent of the tumors either became visible or were better seen after contrast. At sonography, two-thirds of the neoplasms were thought to be solitary and one-third multicentric. The majority had a mixed echotexture. In comparing CT and sonography, although the lesion was identified in all 13 patients who had both studies, at sonography the extent of hepatic involvement was understated in 38% of the cases. Sonography also failed to demonstrate lymphadenopathy detected at CT in 2 patients. Both modalities were effective in identifying vascular invasion. While CT was very accurate in showing the extent of hepatic involvement, it was unable to show direct invasion of neighboring structures. As both techniques are limited in the evaluation of hepatoma, if curative resection is a consideration, both examinations should be performed.

21. Anterior Pararenal Space Revisited. W. Dodds, T. Lawson, R. Darweesh and E. Stewart (Medical College of Wisconsin, Milwaukee, WI)

The anterior and posterior renal fascia are believed to divide the retroperitoneum into the anterior pararenal space (APS), perirenal space, and posterior pararenal space (PPS). The APS

contains GI structures, is thought to be bound ventrally by posterior peritoneum and dorsally by anterior renal fascia, and allegedly communicates with the PPS in the iliac fossa. However, computed tomographic (CT) findings commonly conflict with the current notion of APS anatomy: (1) intraabdominal structures, ascites, and APS fluid often extend dorsal to the kidney, without entering the PPS; (2) APS inflammation often spares fat around the dorsal colon; and (3) APS fluid dissecting into the iliac fossa generally does not enter the PPS.

These conflicts are resolved by an analysis of embryology. The fetal renal fascia develop dorsal to the primitive retroperitoneum whereas all GI structures originate between leaves of mesentery. The APS develops as a preretroperitoneal space when the intestine rotates 270° counterclockwise and portions of the right duodenal and colonic dorsal mesentery fold against and fuse with the primitive retroperitoneum. Thus, the adult APS is demarcated dorsally by the primitive posterior peritoneum and ventrally by the left leaf of the pancreatic and colonic mesentery. We have made the following conclusions. The kidneys and renal fascia develop in the domain of the primitive retroperitoneum whereas all GI structures develop in the intermesenteric domain. These domains communicate only at the root of the mesentery. The anterior renal and lateroconal fascia cannot demarcate the APS. The APS is a laminated preretroperitoneal space, bounded by folded leaves of mesentery, that contains distinct subcompartments for the pancreas and parts of colon. The APS and PPS do not communicate caudally.

22. MRI of Liver Metastases: T1-Weighted Pulse Sequences. D.D. Stark, J. Wittenberg and J.T. Ferrucci (Massachusetts General Hospital, Boston, MA)

Currently, T2-weighted spin echo images are considered optimal for the detection of focal liver lesions. We have improved the performance of T1-weighted spin echo and inversion recovery pulse sequences by reducing the TE to 15 msec. The short TE technique showed improved signal-to-noise ratios, increased T1-dependent image contrast, and increased multislice capability. These benefits allowed reduction of TR to 260 msec, averaging of 18 data sets, and simultaneous acquisition of 12 slices with a 10-minute examination time. The most significant benefit of extensive signal averaging and reduction in TE was a reduction in motion artifacts.

We directly compared T1- and T2-weighted pulse sequences in 40 patients with liver metastases. Dramatic improvements in lesion detection with the SE 260/15 technique were confirmed and quantitated by measuring image contrast-to-noise ratios. Furthermore, MRI routinely detected more lesions than CT and never detected fewer lesions.

23. Evaluation by MR Imaging of Patients with Portosystemic Shunts. D.M. Williams, K.J. Cho, A.M. Aisen and W. Martel (University of Michigan Medical Center, Ann Arbor, MI)

Five patients were studied with magnetic resonance imaging (MRI) and angiography, following portosystemic shunt construction. Included were 3 patients with distal splenoportal and 2 with mesocaval shunts. The MRI was performed 1 week to 4 years after shunt procedure, and the time interval between the MRI and angiography ranged from 2 weeks to 2 months. Angiographic studies included high-dose superior mesenteric and splenic angiography. The MRI was performed using the spin-echo technique at 0.35 Tesla and was compared with angiography.

The MRI accurately demonstrated shunt patency in 4 patients and occlusion in 1. Portal vein thrombosis was present

in 1 of the 4 patients with a patent shunt. In 1 patient with upper gastrointestinal hemorrhage following a shunt procedure, MRI was useful in evaluating the cause of the bleeding. In 1 patient with left renal venous hypertension after distal splenoportal shunting, the MR images suggested narrowing of the renal vein at its confluence with the cava. This corresponded to a 16-cm saline gradient documented at angiography. Therefore MRI appears capable of demonstrating portosystemic shunt patency, but with standard spin-echo technique it appears to be limited in assessing shunt function. This is part of an ongoing study on the value of MR compared with angiography in patients with portosystemic shunts; we currently plan to image 4 additional patients within the next 3 months.

24. Biliary Obstruction: CT/MRI Comparison. C.D. Johnson, W.M. Thompson, R. Herfkens and J. Utz (Duke University Medical Center, Durham, NC)

Magnetic resonance imaging in 6 mongrel dogs with surgically ligated common bile ducts was investigated to assess the ability of magnetic resonance imaging (MRI) to detect intrahepatic and extrahepatic bile duct dilatation. In addition, specific T1, T2, and chemical shift data were obtained in both hepatic parenchyma and bile to assess changes in these parameters with biliary obstruction.

Enhanced computed tomographic (CT) and MRI scans were obtained prior to surgical ligation of the common bile duct, and 72 hours, 9–10 days, and 30 days postligation. A postmortem cholangiogram documented the bile duct obstruction. Liver tissue was analyzed pathologically as well as for fat and water content.

MRI was more sensitive than CT in the detection of early and peripheral intrahepatic bile duct dilatation. Extrahepatic biliary dilatation was seen equally well by both CT and MRI. Calculated T1 values from the hepatic parenchyma decreased significantly with time (baseline T1-702 and T2-35; 30 day post ligation T1-480 and T2-31). Chemical shift analysis showed correlative changes in fat and water content over the same time period. These results suggest MRI may play an important role in the evaluation of patients with biliary obstruction.

25. Concepts in Design of MR Contrast Agents for the Alimentary Tract. D.D. Stark and J.T. Ferrucci, Jr (Massachusetts General Hospital, Boston, MA)

Recent software advances have greatly reduced magnetic resonance (MR) artifacts due to physiological motion, allowing MR to become competitive with computed tomography (CT) for liver imaging. Anatomical resolution for retroperitoneal diagnosis is now limited only by poor contrast with the small bowel. A variety of agents have been effective in improving MR contrast for the stomach and duodenum including water, gas, and dilute iron solutions. Similarly, retrograde introduction of contrast agents into the rectum and colon has had limited success. Unfortunately, water and gas do not reach the small bowel and soluble paramagnetic aqua-ions ("T1 agents") have been ineffective due to altered solvation by complex secretory and absorptive processes. Accordingly, we have developed particulate iron containing "T2" agents which are nontoxic and non-absorbable for use in the small bowel. Considerations such as contrast-to-noise theory, paramagnetic relaxation mechanisms, and preparation of particulate suspensions will be discussed. Our preliminary data indicate that colloidal suspensions of crys-

talline magnetic (Fe_3O_4) aggregates are powerful and uniquely suitable GI contrast materials.

26. Initial Experience with Gadolinium-DTPA as a Contrast Agent in Magnetic Resonance Imaging of the Liver. K.J. Wolf, B. Hamm, T. Roemer, R. Felix, and H.-J. Weinmann (Freie Universität Berlin and Research Laboratories of Schering, Berlin, Federal Republic of Germany)

We investigated the use of gadolinium-DTPA (Gd-DTPA) as an intravenous contrast agent in magnetic resonance imaging (MRI) of 20 patients with liver tumors. Doses of 0.1 and 0.2 mmol/kg were compared using T1 weighted spin echo and inversion recovery sequences. Nine patients were imaged on a 0.35 T and 11 patients on a 0.5 T superconducting system (Magnetom).

In all patients enhancement was noted in the liver tumors, with a more pronounced enhancement with the higher dosage (0.2 mmol/kg) of Gd-DTPA. Slightly increased signal intensity of normal liver parenchyma was also noted. Maximum enhancement was noted on IR 1500/400/35 images. Contrast-enhanced MRI exhibits better detection of necrotic areas of the lesion and good demarcation of dilated bile ducts. However, the contrast between the tumor and liver tissue was reduced. A pronounced time dependence (5' to 30' p.i.) of the enhancement was not detected. There were no side effects using Gd-DTPA.

27. MRI Contrast Agents for Metastatic Liver Cancer: Gd-DTPA and Magnetite Iron Particles. S. Saini, D.D. Stark, J. Wittenberg and J.T. Ferrucci (Massachusetts General Hospital, Boston, MA)

We studied the capability of prototype MRI contrast agents to enhance the detectability of liver metastases. Early clinical trials with paramagnetic Gd-DTPA for liver cancer MRI detection have suggested little effect in improving tumor-liver contrast due to extracellular distribution in both liver and tumor. We recently proposed iron ferrite particles (Fe_3O_4) or "magnetite" as a superparamagnetic liver MR contrast agent because of its high specificity for the reticuloendothelial system. Ten rats bearing implanted hepatic adenocarcinoma were imaged (1.4 T) before and after the administration of Gd-DTPA (0.05 mmol) and magnetite (1 mg). Gd-DTPA increased signal intensity (SI) from both liver and tumor (SE 250/15) but diminished tumor-liver contrast. On the other hand, magnetite caused dramatic diminution in SI from normal liver with negligible effects on SI from tumor. Following magnetite, tumor-liver contrast was significantly enhanced on all pulse sequences but most dramatically on the T2-weighted pulse sequences. We conclude that magnetite is vastly superior to Gd-DTPA improving the detection of metastatic liver cancer by MRI.

28. Intraoperative Hepatic Ultrasonography in Metastatic Colon Carcinoma: A Method for Monitoring Cryosurgical Therapy. R. Kane, G. Onik, G. Steele, U. Khettry, B. Cady, W. McDermott, R. Jenkins, M. Clouse, J. Katz, J. Gilbert and B. Rubinsky (New England Deaconess Hospital, Boston, MA)

Cryosurgery (freezing of tissue in situ) has been used successfully to treat a variety of neoplastic lesions, most of which are superficial in location. Its use in deep tumors has been limited because of the inability to monitor the cryogenic lesion relative to the area of neoplasia. It has been demonstrated in porcine liver that the freezing edge of a cryogenic lesion appears

as an intensely hyperechoic rim with posterior acoustic shadowing. In addition, once normal liver tissue has been frozen and thawed, it appears hypoechoic relative to the surrounding liver.

We have used intraoperative ultrasonography to guide the placement of a liquid nitrogen cryoprobe (-196°C) within focal hepatic metastatic lesions in 5 patients with colon carcinoma, and to monitor the cryosurgical lesion to ascertain that the freezing has extended beyond the tumor margins. The specimens were subsequently resected for gross morphologic and microscopic assessment of the cryosurgical lesions.

29. Diagnosis and Treatment of Small Hepatocellular Carcinoma Using Echo-Guided Puncture. M. Ohto, N. Sugiura, M. Ebara and K. Kimura (First Department of Medicine, School of Medicine, Chiba University, Japan)

Real-time echography was the most useful for detecting small hepatocellular carcinoma (hepatoma) less than 2 cm and echo-guided histologic biopsy was the most effective for making definitive diagnoses of them.

We tried absolute ethanol injection into the tumor under echo guidance as a method of treatment in 22 patients with such small hepatomas. The therapeutic effects were studied histologically in 4 patients on the resected tumors after the injection therapy. They were mostly necrotized and had no remaining carcinomatous cells. After the treatment, all the tumors disappeared or were greatly reduced on imaging pictures; and none of them showed growth again in a long course of observation.

Echo-guided puncture could be clinically essential for the diagnosis and treatment of small hepatomas.

30. Flexible Cholelithotomy for Removal of Biliary Calculi. P.J. Weyman (Mallinckrodt Institute of Radiology, St. Louis, MO)

Flexible cholelithotomy (FC) has been advocated for both intraoperative and postoperative examination of the biliary tree. Since we acquired FC, 38 patients have been referred to us for removal of calculi. Calculi were present in 36 patients and were successfully removed in 35. FC was used for duct inspection or removal of calculi in 16 patients, often after difficulty was encountered with fluoroscopic extraction. In 2 patients "pseudocalculi" were easily examined.

Although most retained calculi after cholecystectomy are easily removed using fluoroscopy, FC has simplified removal of intrahepatic and ampullary calculi. Via T-tube or transhepatic tracts, FC has been particularly useful in 3 cases of hepatolithiasis in which up to several hundred calculi have been removed.

Advantages of FC include: easy inspection and removal of residual fragments following stone extraction; availability of a wider variety of instruments for stone extraction; and simplified evaluation of noncalculous defects by direct visualization and biopsy. This technique has been most useful when performed with fluoroscopic monitoring and in conjunction with other fluoroscopic techniques.

31. Diagnostic and Therapeutic Percutaneous Gallbladder Procedures: Laboratory and Clinical Experience. E. van Sonnenberg, G.R. Wittich, G. Casola, A.F. Hofmann, S.A. Wilson and V.W. Wing

This paper describes our experience in animals and our first 30 patients with a variety of percutaneous procedures involving

the gallbladder. Laboratory evaluation consisted of methods to optimize gallbladder puncture by real-time ultrasound (US) monitoring and to assess catheter designs and safety of gallbladder puncture. In patients, diagnostic (14 pts) and therapeutic (16 pts) studies were performed using US, computed tomography, or fluoroscopic guidance; these procedures included diagnostic cholecystograms (10 pts) after failed conventional PTC in nondilated systems, gallbladder biopsy (4 pts), gallstone dissolution and removal (6 pts), gallbladder abscess drainage (2 pts), and cholecystostomy for drainage (8 pts). The indications for percutaneous cholecystostomy (14 pts) included relief of hydrops and empyema (6 pts), gallstone dissolution (5 pts), gallstone removal (1 pt), and drainage for malignant obstruction (2 pts). Gallstone dissolution has been successful with both methyl-tert-butyl ether and monoctanoic.

All procedures in our patients were successful, although there were technical limitations, and complications including vagal hypotension and cholecystitis; however, bile peritonitis did not occur. We will discuss our results and methods, since specific technical considerations are germane for interventional gallbladder procedures.

32. The Transcholecystic Approach to Biliary Disease: Procedures and Complications in 24 Patients. S.K. Teplick, P.H. Haskin and J. Sammon (Hahnemann University, Philadelphia, PA)

A transcholecystic approach to the biliary system was used in 24 patients for diagnosis and/or treatment of a variety of biliary disorders, including cholecystitis (5 patients), choledocholithiasis (13 patients), malignant biliary obstruction (4 patients), and stone chemolysis (2 patients). Eleven patients required indwelling gallbladder tube drainage because cystic duct patency could not be established on initial transcholecystic contrast injection, or because known cholelithiasis was to be treated with monoctanoic. In this group 1 complication of bile peritonitis occurred when the tube was inadvertently dislodged from the gallbladder. Thirteen patients required only thin (20 or 22 gauge) needle puncture to exclude cystic or common duct obstruction. Two patients in this group developed mild right upper quadrant pain lasting 2–4 hrs, but showed no significant signs of peritonitis. Bile for microbiological analysis was easily obtained in all patients.

Until recently the possibility of bile peritonitis has deterred us from use of percutaneous puncture and manipulation of the gallbladder. We believe that with appropriate technique, the complications from percutaneous gallbladder manipulation are infrequent and that the transcholecystic approach is a relatively easy and safe route for the diagnosis and treatment of a variety of biliary disorders.

33. Natural History of the Obstructed Appendix: An Experimental Model for Appendicitis and Appendiceal Mucocele with Sonography and CT Correlation. A.H. Dachman, J.B. Nichols, D.H. Patrick and J.E. Lichtenstein (Uniformed Services University of the Health Sciences, Bethesda, MD)

“Mucocele of the appendix” describes mucous accumulation distending the appendix, caused by obstruction of the lumen. The cause of internal echoes, septations, and polypoid excrescences occasionally seen on sonography or computed tomography (CT) has not been explained. We attempted to reproduce mucoceles experimentally by ligation of rabbit appendices. We studied the natural history of the obstructed appendix by correlating the sonographic, CT, gross, and microscopic findings.

In 12 rabbits double ligation that prevented recanalization resulted in a spectrum of pathologic findings ranging from suppurative with mucosal hyperplasia to true mucocele formation. This varied mucosal response correlated with sonographic and CT findings ranging from anechoic to complex lesions. The finding of persistent mixed inflammatory response suggests that the controversial entity “chronic appendicitis” may exist. The echogenic foci within these mucoceles were due to the associated mucosal inflammatory response.

34. The Evaluation of Hepatic Hemangiomas: Contribution of SPECT Imaging. L.G. Hanelin and M.E. Lee (The Mason Clinic, Seattle, WA)

The purpose of this study was to determine the contribution of SPECT imaging for the detection of hepatic hemangiomas (HH). Thirty-six patients (pts) were studied. Twenty-seven pts had a total of 40 HH; 24 were initially evaluated by ultrasound and 3 by computed tomography (CT). Of the remaining 9, 6 had multiple metastases: 1 focal nodular hyperplasia (FNH), 1 hematoma (HE), and 1 liver cyst (LC). The diagnosis of HH was confirmed by clinical follow-up (3–18 months) in 19 pts, surgery in 5, and angiography in 3. Two hours after the injection of in vitro labeled RBCs (20 mCi Tc-99m 04), 1 million count planar images were obtained followed immediately by SPECT imaging. A positive study for HH was defined as a focal area of increased uptake greater in intensity than normal liver. Minimal areas of increased uptake were considered nondiagnostic.

Twenty-three of 40 (58%) HH were clearly identified with planar imaging; average size 4.2 cm. SPECT identified 36 of 40 (90%); average size 3.2 cm. The increased sensitivity was due to detection of smaller lesions, the smallest being 15 mm in diameter. Of the nondetected lesions, 3 were less than 15 mm and 1 was adjacent to the portal vein (PV). Metastases, FNH, LC, and HE did not sequester red blood cells. We concluded that SPECT is a very sensitive modality for the identification of hepatic hemangioma. Lesions smaller than 15 mm in diameter or close to the PV should be evaluated by other methods.

35. Digital Imaging of the Gastrointestinal Tract. P.J. Feczko, R. Halpert, D. Kastan, L. Ackerman and J. Clark (Henry Ford Hospital, Detroit, MI)

The gastrointestinal tract lends itself to digitization rather easily since images can be obtained directly during fluoroscopy. We analyzed multiple features using both direct digitization at fluoroscopy and digitization of films using a laser film scanner (DuPont). Utilizing these methods, matrix sizes from 512 × to 2048 × (12 bits) could be obtained. Both patients and phantoms were imaged for evaluation. The following areas were analyzed:

1. Matrix size – resolution requirements were much less than expected, and most pathology was evident at 512 × ;
2. Simple filtering – perception of pathology could be enhanced by various methods such as gray-scale adjustment and edge enhancement;
3. Radiation – dosages were equivalent to high-speed screen-film systems.

Digital radiography had some other advantages including acquisition of images, immediate review of the study, picture processing, and costs, although modification of current technology is necessary to make it practical.

36. Bacteremia Following T-Tube Cholangiography: Hand Injection vs. Gravity Infusion Technique. J.M. Messmer, J.J. Bradley, S.R. Cho and M.A. Turner (Medical College of Virginia, Richmond, VA)

A prospective study of 23 patients was performed to evaluate whether the method of T-tube cholangiography determined if bacteremia would occur. Thirteen patients had hand injection cholangiography and 10 patients had gravity infusion cholangiography. Injection pressures were monitored and blood and bile cultures were obtained. Five patients (38%) had positive blood cultures following the hand injection technique and no patients had positive blood cultures following the gravity infusion technique. There was a correlation between the injection pressure and positive blood cultures. In two patients the same organisms were isolated from the bile and the blood. Biliary ductal visualization was complete in all cases. The authors conclude that the gravity infusion technique is associated with lower injection pressures than the hand injection technique and high pressures are related to the development of bacteremia. The lower pressures generated during the gravity infusion technique may obviate the need for prophylactic antibiotic coverage.

37. CT Following Uncomplicated Esophageal Sclerotherapy. M.A. Mauro, T.M. Swankowski, E.V. Staab and E.M. Bozyski (University of North Carolina, Chapel Hill, NC)

Esophageal sclerotherapy (ES) is a well-established technique for the control of variceal hemorrhage. Computed tomographic scans (CT) of the mid and distal esophagus were obtained immediately before and the morning following elective ES in 9 patients.

All 9 patients had a routine post-ES course and were discharged from the hospital immediately following their post-ES CT. ES was performed by endoscopic intravariceal injection of sodium morrhuate.

Changes following ES included: esophageal wall thickening (9 of 9); low-density regions within the thickened esophagus (8 of 9); new or increased bilateral pleural effusions (7 of 9); new and marked mediastinal effusion (8 of 9) with density similar to that of pleural fluid.

Routine and uncomplicated ES causes severe changes within the esophagus, surrounding mediastinum, and pleural cavity.

38. Sclerosing Cholangitis Due to FUDR Intraarterial Therapy for Hepatic Tumors: A New Entity. W. Shea, H.I. Goldberg, D. Hohn, B. Demas and R. Kerlan (University of California, San Francisco, CA)

The radiographic features of irregular segmental narrowing of intrahepatic ducts and common hepatic duct were noted on ERCP PTC in 17 patients receiving FUDR infused in the hepatic artery for metastatic tumors. The development of these changes was associated with elevated liver function tests, but serial computed tomographic (CT) examinations of the liver showed no progression of tumor. The radiographic features did not involve the common bile duct below the level of the cystic duct, although the cystic duct itself was frequently involved. Operative biopsies and autopsy findings showed a process of dense fibrosis of the portal triad and common hepatic duct indistinguishable from primary sclerosing cholangitis. Preliminary studies show this process to be related to FUDR itself rather than to ischemia of peribiliary plexus.

39. Biliary Obstruction in the Porta Hepatis: CT Evaluation. T.H. Reiman, D.M. Balfe and P.J. Weyman (Mallinckrodt Institute of Radiology, St. Louis, MO)

Between July 1980 and July 1985, 75 patients with biliary obstruction in the porta hepatis underwent upper abdominal computed tomography (CT). We performed retrospective review of the available clinical, radiographic, and pathologic material in these patients to determine the ability of CT scanning to identify the precise level and cause of biliary obstruction in this complex anatomical region. Findings analyzed included mass effect (number, size, spatial relationship to hepatic ducts and portal veins), distribution of dilated intrahepatic ducts, infiltration of periportal fat, and ancillary findings (liver metastases, portal vein thrombosis, lymphadenopathy, etc.). Malignant neoplasm was the predominant cause of obstruction in the porta hepatis. The CT was able to distinguish between direct extension of malignancy arising in an adjacent structure (liver, gallbladder, pancreas, stomach) and nodal metastases from other primary sources (colon, breast, lymphoma). Cholangiocarcinoma could, in some cases, be differentiated from nodal metastases. Benign causes included calculi, posttraumatic/postcholangitic strictures, sclerosing cholangitis, and portal sclerosis related to intraarterial chemotherapy. These conditions could not be differentiated from one another, but could be distinguished from malignancy using criteria applied to the CT scan. Computed tomography is a reliable means of detecting and characterizing biliary obstruction in the porta hepatis, and, in some cases, yields unique information about the exact pathology producing obstructive jaundice.

40. The Role of Ultrasound in the Evaluation of Patients with Question of Pancreatic Mass on CT. M.J. Ormson, J.W. Charboneau, D.H. Stephens (Mayo Clinic, Rochester, MN)

In this study, we assessed the role of ultrasound in patients who had a question of a pancreatic mass on computed tomography (CT). Although CT is reliable in detecting or excluding pancreatic pathology in most cases, in some patients normal variations in size and shape of the pancreas may simulate a mass on CT. Other patients with focal pancreatic pathology may exhibit normal pancreatic size and shape on CT. To resolve these difficult cases, various complementary but invasive methods such as ERCP, THC, angiography, percutaneous biopsy, or surgical exploration may be used. Another imaging alternative is ultrasonography which is readily available, noninvasive, and highly sensitive to parenchymal changes in echotexture.

We reviewed our recent experience with 25 patients who had CT scans in which a pancreatic mass was questioned but CT findings were inconclusive. Ultrasonographic display of the pancreas was optimal in these cases. In 9 cases, ultrasound detected a focal hypoechoic mass in the region of concern on CT. Pathologic confirmation at surgery revealed a pancreatic adenocarcinoma in 7 cases and focal chronic pancreatitis in 2. In the remaining 16, ultrasound revealed normal pancreatic morphology and echotexture. All 16 of these patients are alive and have no clinical evidence of pancreatic disease. This study demonstrated that when CT findings from a pancreatic mass are inconclusive, the analysis of the parenchymal echotexture by ultrasonography is valuable to confirm or exclude pathologic changes.

41. Triage Implications of Noninvasive Imaging for Biliary Obstruction. R.K. Zeman, L.R. Clark, P.L. Choyke, M.H. Jaffe,

E.G. Grant, H. Ziessman and S.B. Benjamin (Georgetown University Hospital, Washington, DC)

Although numerous studies have focused on the relative merits of the noninvasive biliary imaging techniques, few have considered their cost-effectiveness and ultimate clinical impact in managing the patient with suspected biliary obstruction. The medical records of 77 patients imaged with ultrasonography, computed tomography, and ^{99m}Tc DISIDA scintigraphy were reviewed with respect to developing triage recommendations.

Among 44 patients who had not undergone prior cholecystectomy, 37 were proven to have biliary obstruction. Computed tomography (CT) and biliary scintigraphy proved equally sensitive (92% and 91%) in detecting obstruction. Sonography was least sensitive (81%). Sonography and CT were comparable in determining the level and cause of malignant obstruction, but CT was superior in benign obstruction. Twenty-two patients went on to contrast cholangiography.

The remaining 33 patients in the series had undergone prior cholecystectomy. Utilizing the same criteria of obstruction as

the noncholecystectomized group resulted in sensitivity beyond 90% for all 3 modalities, but only scintigraphy resulted in adequate specificity (88%). Twenty-seven patients underwent contrast cholangiography (ERCP in 25).

The implications in the noncholecystectomy and cholecystectomy groups were quite different but strikingly clear. Ultrasound is effective in detecting malignant biliary obstruction, but often fails to detect or characterize benign obstruction. Biliary scintigraphy can diagnose all types of obstruction, but does not characterize their nature, while CT best diagnoses and characterizes all obstructing lesions. Despite its great per procedure cost, it best prompted surgery for benign disorders, eliminated surgery for nonresectable malignant causes of obstruction, and reduced the need for cholangiography in our series. If prior cholecystectomy had been performed, the results of CT and ultrasound stimulated but never eliminated the need for ERCP. They were therefore superfluous as ERCP was the clinical endpoint regardless of the noninvasive findings. Biliary scintigraphy did avert ERCP in 6 patients. A cost analysis of this group will be presented.