Postprandial Blush in Multiphase Bone Scanning

Gerald A. Mandell, H. Theodore Harcke, Colleen Sharkey, and Linda Cooley

Department of Medical Imaging, Alfred I. duPont Institute, Wilmington, Delaware

The presence of transient soft-tissue activity in the left side and the lower midportion of the abdomen on the early phases of the multiphase bone scan represents postprandial physiologic hyperemia of the small intestine. The bowel uptake was present in all 33 patients ingesting food between 15 min and 3.5 hr before scanning. In those patients who had not eaten within 4 hr of the study, only 25% demonstrated bowel activity. The observation of bowel uptake is important in differentiating a physiologic phenomenon from pathologic accumulations of activity. Pathology should be ruled out when bowel activity is not located in the usual left flank and lower mid-abdomen, or is present in a fasting individual.

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The presence of transient bowel activity on the blood flow and blood-pool phases of the multiphase bone scan has been previously attributed to bowel disease or vascular malformation. This common occurrence can be correlated with the ingestion of food prior to scanning, and represents normal physiologic bowel hyperemia associated with the digestive process.

MATERIALS AND METHODS

The anterior abdominal scintigrams of the blood flow and blood-pool phases of 42 three-phase bone scans were evaluated for abdominal soft-tissue activity. Multiphasic bone scintigraphy is routine in our predominantly pediatric population. In this study, there are 18 females and 24 males with an age range from 3 yr and 3 mo to 56 yr. The majority of the patients were being evaluated because of low back or hip pain. A detailed gastrointestinal history (abdominal pain, inflammatory bowel disease, constipation, etc.) was obtained to establish any predisposing causes for intestinal hyperemia. Each patient was questioned as to the time and composition of any food ingestion during the 4 hr before receiving the injection of the bone tracer.

The triphasic scintigraphic images were acquired on a computer-assisted gamma camera equipped with a low-energy, all-purpose collimator. Each patient received a 200-μCi/kg intravenous bolus of technetium-99m methylene diphosphonate ([^{99m}Tc]MDP). The flow portion of the study was acquired as 30 2-sec images of the anterior abdomen. Blood-pool images of the abdomen varied from 500,000 to 1,000,000 counts per image and were performed almost immediately following the vascular phase. The delayed images were begun ~2 hr post-injection of the radiotracer.

In assessing the multiphase images, nonosseous activity in the abdomen was characterized as bowel or non-bowel when it appeared transiently on the flow and/or blood-pool images. Soft-tissue activity other than the aorta, spleen, kidneys, and liver was considered to be bowel. This uptake was assessed on the early vascular (up to 24 sec) and blood-pool images with respect to its location and intensity. The intensity of bowel activity on the anterior abdominal images was compared with the kidney intensity and visually characterized as equal to renal activity (++), less than renal activity (+) or the same as body background (0). Time of ingestion of food was compared with presence, location, and intensity of abdominal bowel activity. Type of food intake (liquid or solid) and quality (carbohydrates versus mixed carbohydrate, fat, protein) was correlated with intensity of uptake.

RESULTS

As expected, bowel activity was predominantly located on the left and lower midportions of the abdomen in the distribution of the small intestine. Bowel activity was seen to be relatively more intense in the vascular than the "blood-pool" phases (Fig. 1). In no case was the bowel activity visualized on delay images. The intensity of the bowel blush appeared to be more dependent on the time of ingestion than the volume of ingestion. The most intense postprandial patterns were visualized 1–2 hr after eating (Fig. 2). In 100% of patients ingesting food between 15 min and 3.5 hr before scanning, there was definite identification of transient bowel activity. The nonfasting pattern was

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For reprints contact: Gerald A. Mandell, MD, Alfred I. duPont Institute, P.O. Box 269, Wilmington, DE 19899.

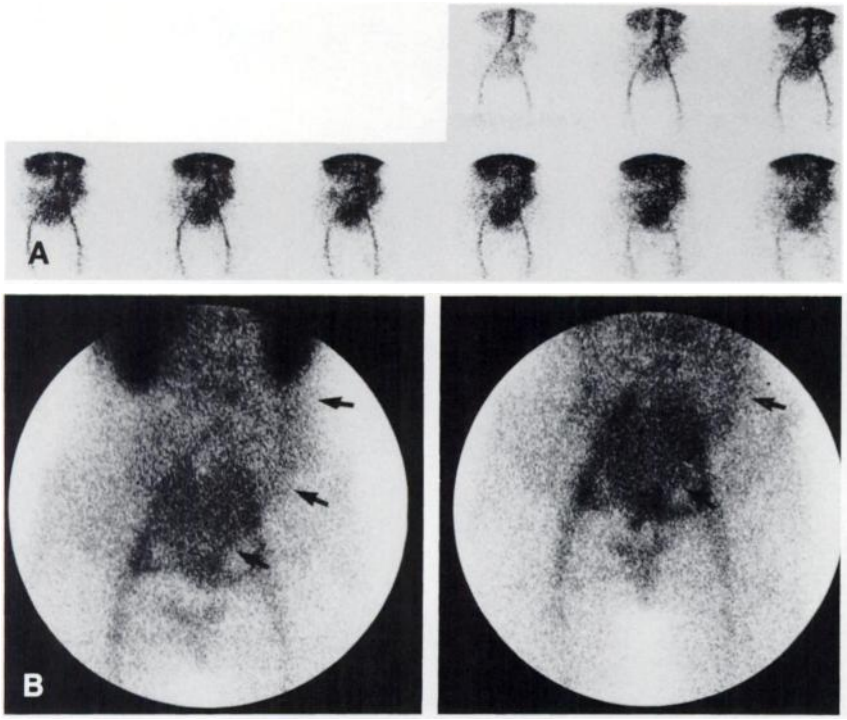

FIGURE 1
A, B: Initial flow images of anterior abdomen with intense bowel hyperemia in distribution of superior mesenteric artery. "Blood-pool" image with similar soft-tissue activity but less well defined (arrows).

similar in patients older than 18 yr (ten patients) with a ratio of + to ++ activity of 1.0 and the younger age group (24 patients) with a ratio of 1.4. In those patients who had not eaten within 4 hr of the study (Fig. 3) only two (one in each age group) of the eight (25%) exhibited bowel activity. The ingestion of liquid or solid food did not significantly influence the intensity of their bowel uptake in the 34 patients with bowel activity (Table 1). Carbohydrate meals produced generally less hyperemia (Table 2) than complex (protein–fat–carbohydrate) meals.

There was intense bowel uptake in one fasting patient with a negative history for inflammatory bowel disease. Perhaps this mildly retarded patient falsely denied eating. We are otherwise unable to account for this. The other fasting patient with slight bowel activity had a history of constipation. In one patient, who was scanned 0.5 hr after eating, there was bowel activity in an abnormal location; the right lower quadrant of the abdomen (Fig. 4). This was the only patient in the series with a history of bowel disease. He has irritable bowel syndrome.

DISCUSSION

The observance of areas of increased soft-tissue activity in the abdomen on the early phases of the multiphase

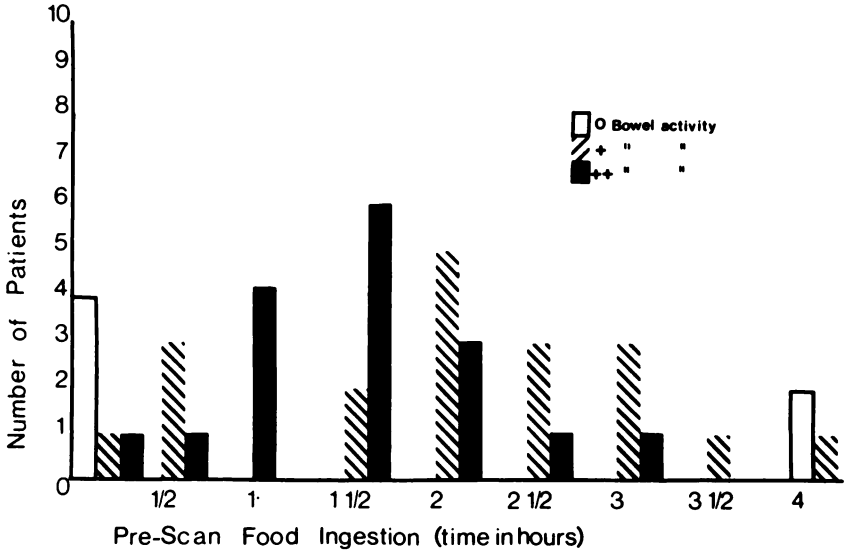

FIGURE 2
The intensity of the superior mesarteric artery activity appears to peak at 1 to 2 hr after food ingestion.

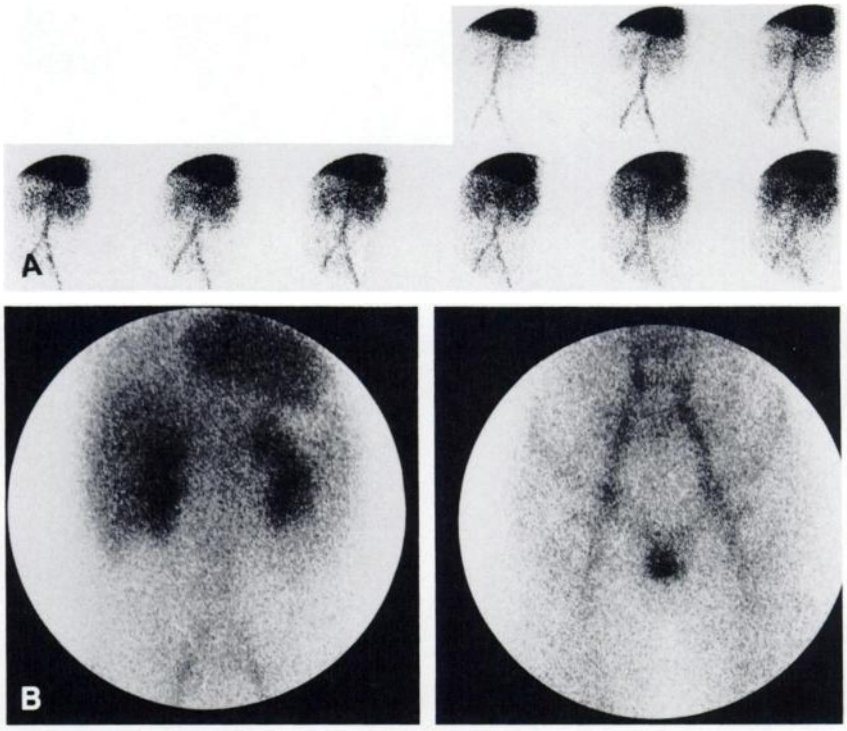

FIGURE 3
A, B: Blood flow and blood-pool images of fasting patient showing lack of bowel activity in abdomen.

bone scan might be attributed to possible pathology, including inflammatory bowel disease, diverticulitis, appendicitis, abscess, hemangioma, and arteriovenous malformation. Such increases in bowel uptake have been observed when scanning for Meckel's diverticulum with technetium-99m pertechnetate (*1*). The importance of recognizing hyperemia of the bowel secondary to digestion, therefore, is critical in differentiation of a normal physiology from a significant pathologic process.

The postprandial blush in bowel characteristically appears as a localized collection of activity on the left side of the abdomen extending to the midline. The right side of the abdomen is devoid of this increased soft-tissue activity. It is usually first visualized on flow images with the aorta, kidneys, iliac vessels, and spleen. Hepatic activity appears a few seconds later. Optimal visualization of the bowel activity is usually during the first 24 sec of the vascular phase. On the "blood-pool" images, the bowel activity appears less intense in degree. This reflects its early transient nature and relative insignificance in comparison to the overall count contributions by the kidneys, liver, and spleen.

The extent of the postprandial blush on the early phases of the multiphase bone scan, from the left side to the lower midabdomen reflects the distribution of the superior mesenteric artery. The superior mesenteric artery predominantly supplies the small bowel. Animal experiments have shown that the superior mesenteric blood flow does not increase until 30 min following intragastric food placement. The increased blood flow persists for at least 3 hr. Our visualization of the postprandial blush was similarly present in all patients having ingested food 15 min–3.5 hr prior to scanning. No increased activity appeared on the right side of the abdomen (the position of the right colon), except for one patient with irritable bowel syndrome. This finding is supported by animal studies showing a lack of increased blood flow to the colon following intragastric placement of food (*2*).

Our study demonstrated the relationship of food

TABLE 1
Consistency of Meal Versus Intensity of Postprandial Blush*

Consistency	Intensity +	Intensity ++
Fluids	3	2
Solids†	16	13

* Exclusive of patients with no bowel activity.
† Mixture of fluids and solids.

TABLE 2
Composition of Meal Versus Intensity of Postprandial Blush

Composition	Intensity +	Intensity ++
Complex*	12	14
Carbohydrate	6	2

* Protein–fat–carbohydrate.

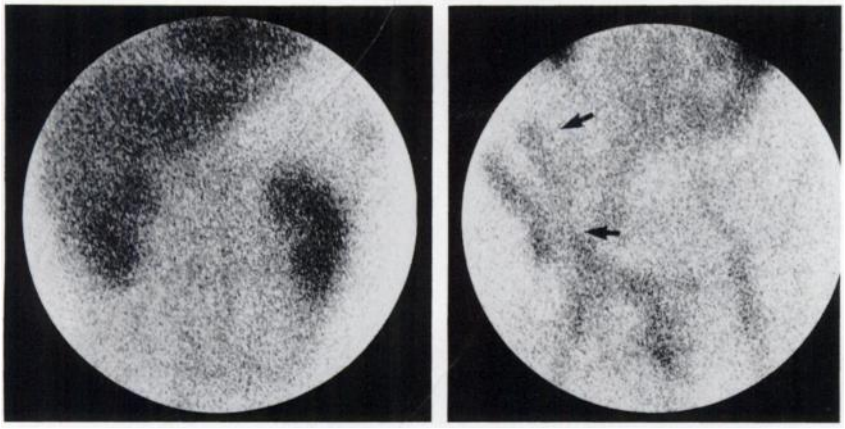

FIGURE 4
Blood-pool images of patient with irritable-bowel syndrome showing activity in the right lower quadrant (arrows).

ingestion to hyperemia of the bowel. The pattern of left-sided abdominal activity varied only in one instance in which the patient admittedly had a long history of irritable bowel disease. The intensity of bowel activity was more closely related to time of ingestion than to the quality of food ingested. In human subjects, a protein-rich meal has a 35% increase in splanchnic blood flow, whereas, glucose has no effect (*2*). In our study, only 33% of carbohydrate meals produced ++ activity compared with 54% of complex meals. Normal saline solution does not induce bowel hyperemia in animals (*2*). Plain water can be used for hydration of patients without affecting the early phases of the bone scan.

We report our observation of physiologic hyperemia on early phases of bone scintigraphy to differentiate it from pathologic collections of activity in the abdomen. Pathology should be considered when the hyperemic pattern is different than described, such as right sided instead of left sided, or when a patient that claims not to have eaten exhibits bowel activity within the abdomen.

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