Scintigraphic Screening Prior to Visceral Arteriography in Acute Lower Gastrointestinal Bleeding

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We evaluated the effect on the diagnostic yield of visceral arteriography in patients with acute gastrointestinal bleeding of a protocol requiring a positive ^{99m}Tc-red blood cell scintiscan before the performance of arteriography (scintigraphic screening). **Methods:** A retrospective review was conducted of 249 scintiscans and 271 arteriograms obtained over 99 mo, with scintigraphic screening implemented during the final 18 mo. **Results:** Before the implementation of scintigraphic screening, arteriograms detected bleeding at a rate of 22%. After its implementation, 53% of the arteriograms detected bleeding. This represented a statistically significant increase (0.53 versus 0.22, p = 0.015). **Conclusion:** Scintigraphic screening appears to increase by a factor of 2.4 the diagnostic yield of arteriography by screening out patients who are not actively bleeding at the time of the examination, thus sparing them the risks and costs of a nondiagnostic invasive study.

Key Words: scintigraphic screening; gastrointestinal bleeding; technetium-99m-red blood cell scintigraphy; arteriography

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Gastrointestinal bleeding is a major source of morbidity and mortality in the U.S., accounting for approximately 800,000 hospital discharge diagnoses each year (*1*). The diagnosis of gastrointestinal bleeding, an estimation of the rate at which bleeding is occurring and a determination of whether the source of bleeding is in the upper or lower gastrointestinal tract are made on clinical grounds. The key role for medical imaging lies in the precise localization and, if possible, characterization of the bleeding source. Most upper gastrointestinal bleeds are evaluated endoscopically. When bleeding occurs distal to the ligament of Treitz, however, radiology plays a major role.

The rationale for localizing as precisely as possible the site of bleeding stems from the need for surgical intervention to control bleeding in approximately 15% of acute cases (*2*). The intraoperative localization of a bleeding source can be difficult because inspection of the serosal surface of the bowel requires time and often fails to identify the site of bleeding. As a result, the wrong segment of bowel may be resected, or a longer segment may be resected than would have been necessary if more precise localization had been possible. This is associated with increased morbidity.

The greatest difficulty in localizing the source of bleeding radiologically is the fact that gastrointestinal bleeding is an inherently capricious phenomenon, stopping and starting unpredictably. A patient who is actively hemorrhaging at one time may not be bleeding minutes or hours later. Because radiologic techniques can detect the source of bleeding only during active extravasation, the radiologic localization of the bleeding source will be impeded if the patient happens not to be bleeding at the time of the examination.

The two principal radiologic means of bleeding localization are the ^{99m}Tc-red blood cell (RBC) scintiscan and visceral arteriography (*3,4*). Traditionally, the scintiscan has been regarded as the more sensitive of the two, detecting bleeding at rates as low as 0.1–0.5 ml/min, whereas arteriography has been limited in most clinical situations to 0.5–1.0 ml/min. Note, however, that the use of provocative techniques such as heparin and urokinase infusion can increase the sensitivity of arteriography (*5*). Moreover, scintigraphy enables imaging over as long a period as 24 hr, the length of time during which the radiotracer continues to circulate in the bloodstream. By contrast, arteriography can detect bleeding only during the 20 sec or so of contrast injection. The scintiscan also is less invasive and less expensive than arteriography.

On the other hand, arteriography is superior to scintigraphy in precisely localizing and characterizing the source of bleeding because of its higher spatial resolution and superior depiction of vascular anatomy and hemodynamics. Moreover, catheter placement offers therapeutic possibilities that scintigraphy does not, such as selective vasoconstrictor infusion and transcatheter embolization of the bleeding vessel (*6*).

From the foregoing, two conclusions may be drawn: First, from the surgeon's point of view, the arteriogram is superior in preoperatively localizing and characterizing bleeding lesions. Second, a significant percentage of arteriograms are likely to be negative (i.e., no bleeding detected) because the patient may not be actively bleeding at the time of contrast injection. As previously noted, the use of provocative techniques can significantly decrease the number of negative arteriograms, but not all institutions are comfortable actively promoting hemorrhage. These conclusions suggest that, at least at institutions where provocative techniques are not routinely used, the number of negative arteriograms can be reduced by using scintigraphy as a screening examination before arteriography (*7*). Despite the potential promise of scintigraphy as a screening tool for arteriography, we have found that clinicians who request an urgent visceral arteriogram often express reluctance to obtain a scintiscan first. In objecting to the scintiscan, they cite the fact that it will typically delay the arteriogram for 2 hr or more. They also point out that, even if the scintiscan proves positive, an arteriogram is likely to be indicated in any case. When clinical confidence that the patient is actively bleeding is high, they ask, Why not proceed directly to the arteriogram? This study was designed to answer that question.

MATERIALS AND METHODS

Between January 1, 1986, and March 30, 1995, 249 ^{99m}Tc-RBC scintiscans and 271 arteriograms were performed on patients at the University of Chicago to evaluate acute gastrointestinal bleeding.

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For the purposes of this study, these may be regarded as independent populations because we made no effort to coordinate the performance of both studies in any patient, and the majority of patients did not undergo both studies.

During the final 18 mo of this period, a policy of scintigraphic screening was implemented. Each time an arteriogram was requested for a patient who was thought to be actively bleeding, the clinical service was informed that it was departmental policy to evaluate such patients scintigraphically first and then to perform arteriography only when the scinti-scan was positive. We compared the rates at which arteriograms detected bleeding before and after the implementation of scintigraphic screening.

To maximize the positive predictive value of a positive scintiscan, all scintiscans were actively monitored by a radiologist or nuclear medicine physician, and the angiography team was alerted to the possibility of an imminent arteriogram. If extravasation was scintigraphically detected, the patient was taken to the angiography suite as quickly as possible. When no extravasation was detected over the first 90 min, the clinical service was informed that the patient was not actively bleeding and were offered the option that the patient could be reimaged sequentially over the ensuing day or the scintiscan could be repeated at the next clinical indication of active bleeding.

No patients undergoing scintigraphy were followed sequentially over a period as long as 24 hr, which may have caused us to underestimate the sensitivity of the scintiscan. In fact, in more than 95% of the patients whose scintiscans were positive, bleeding was detected within the first 120 min of imaging. Factors that led us not to image patients continuously for periods of many hours included patient instability, limitations on how long the intensive care unit team could remain in the nuclear medicine department and the performance of many studies after hours, when the cost of keeping a technologist in the department for continuous monitoring is often prohibitive.

With regard to the arteriograms, our angiographers do not typically pursue gastrointestinal bleeding as aggressively as do some in other institutions. The majority of negative examinations consisted of a single celiac artery injection, with double injections of both the superior and inferior mesenteric arteries. Provocative techniques such as heparin infusion and thrombolysis in an effort to convert a negative arteriogram to a positive arteriogram were performed only rarely. The arteriograms were performed with cut-film, digital subtraction angiography, or both, and newer catheters and imaging techniques were not used during the early years of the period under study. Hence, the sensitivity of our arteriography in detecting bleeding was likely not to be as high as that reported by some other investigators (*8*).

RESULTS

Over the period studied, ^{99m}Tc-RBC scintigraphy was positive at an overall rate of 46% (115 of 249 scintiscans). Most of these patients did not undergo additional imaging studies and were not operated on, so we cannot assess the true sensitivity and specificity of scintigraphy in our institution, although 46% is within the range reported by other investigators (*9*). Criteria for a positive scan included the detection of activity in the region of the bowel that increases over time and moves with peristalsis.

Of the 271 arteriograms performed during this period, 24% (n = 66) were positive. Arteriograms were counted as positive only if extravasation was detected, thereby excluding lesions such as angiodysplasia. Before the implementation of scintigraphic screening, arteriograms detected bleeding at a rate of 22% (56 of 256). When the protocol of scintigraphic screening was strictly adhered to (no arteriogram in the absence of an immediately preceding positive scintiscan), the rate of extravasation detection by arteriography increased from 22% to 53% (8 of 15). This represented a statistically significant increase in the yield of arteriography compared with the yield of arteriography before the implementation of scintigraphic screening (0.53 versus 0.22, $p = 0.015$).

DISCUSSION

These results support the hypothesis that scintigraphic screening is an effective means of increasing the yield of visceral arteriography in patients with acute gastrointestinal bleeding. Strict adherence to the protocol of scintigraphic screening appears to increase by a factor of 2.4 the proportion of patients who are actively bleeding at the time of arteriography and spares patients who are not bleeding the risks and costs of a nondiagnostic invasive study. If scintiscans in the acutely bleeding population are positive at a rate of 46%, then the percentage of patients who could be spared nondiagnostic arteriography may be as high as 54%.

At institutions where provocative arteriographic techniques are not in routine use, we believe that only the strongest evidence of active bleeding should be regarded as sufficient to warrant bypassing scintigraphy and proceeding directly to arteriography (e.g., a patient who is becoming hemodynamically unstable and losing large amounts of bright red blood per rectum). In all other cases, the scintiscan should be obtained first because it effectively prevents the performance of nondiagnostic arteriograms in more than half the cases in which arteriography is requested.

It is conceivable and in fact likely that, because of the intermittent and unpredictable nature of gastrointestinal bleeding, a small percentage of patients whose arteriograms would have been positive had arteriography been performed immediately will instead have negative arteriograms because of the delay imposed by scintigraphic screening. For example, if a patient begins a 2-hr episode of bleeding at the time an arteriogram is requested but instead a scintiscan is performed, the first arteriographic injection will prove to be negative if it takes place 121 min or more later. In this case, an arteriographically detectable episode of acute gastrointestinal bleeding will have been missed, and the positive predictive value of the scintiscan will be lowered.

Despite the fact that such cases may at least in theory occur, we believe that their number is low. We remain convinced that scintigraphic screening is an appropriate policy because its benefits (a 53% rate of positive arteriograms) appear to far outweigh those of the alternative (a 22% rate of positive arteriograms when it is not used).

Another potential objection is the possibility that scintigraphy may actually miss episodes of extravasation that arteriography would detect. Appearing at first glance to support this possibility is the fact that, in our experience, two arteriograms performed after a negative scintiscan were positive. In each of these cases, however, the arteriogram was performed at least 1 day after the scintiscan, by which time any predictive value of the scintiscan was lost. Given the strong experimental and clinical evidence of the superior sensitivity of scintigraphy as compared with arteriography, it seems reasonable to suppose that, had scintigraphy been performed immediately before these arteriograms, it would have been positive.

Close monitoring of the scintiscan is necessary if the full value of scintigraphic screening is to be realized. If the intervals between imaging exceed more than an hour, even the finding of mobile activity within the intestinal lumen begins to lose its significance because one cannot say when or where the extravasation actually occurred. Only if the activity is actively

accumulating at its most proximal position in the intestinal lumen could one confidently diagnose bleeding. Otherwise, the extravasation may have occurred hours previously and may have merely moved to its present position by peristalsis. In the latter circumstance, both the positive predictive value of the scintiscan and its value in localization would be compromised.

Considered in aggregate, our data would tend to support the conclusion that scintigraphy is approximately twice as sensitive as arteriography in the detection of active gastrointestinal bleeding, although we do not know its true sensitivity. If this is correct, then no matter how effectively scintigraphic screening is implemented, approximately one-half of arteriograms will prove nondiagnostic. At institutions such as ours, scintigraphy will always overestimate the number of arteriographically detectable bleeds. It is possible that further refinements in the interpretation of scintiscans may provide greater discrimination in this regard. For example, episodes of extravasation detected shortly after a radiotracer injection or those in which activity progresses rapidly through the bowel may indicate more rapid bleeds, with higher probabilities of arteriographic detection.

Our estimate of the number of arteriograms prevented by arteriography is probably too low, although we do not have sufficient data to quantify this reliably. In some percentage of patients, the scintiscan is so floridly positive and the site of extravasation so well localized (e.g., a profuse and clearly cecal bleed) that surgeons feel comfortable taking the patient directly from the nuclear medicine department to the operating room for a hemicolectomy. Of course, lost in such cases is not only the opportunity for arteriographic localization but that for catheter-directed therapy as well. Insofar as preventing an unnecessary arteriogram is a benefit to scintigraphic screening, we have probably underestimated its beneficial impact.

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