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PRELIMINARY REPORT

An Experimental Study of ^{99m}Tc Pertechnetate Abdominal Scans in Jejunal Intussusception: Preliminary Results

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Recent communications have related the diagnosis of small bowel intussusceptions to abnormal accumulations of the radiopharmaceutical ^{99m}Tc pertechnetate on abdominal scans [1, 2]. Considering the pathophysiological alterations attendant to intussusceptions, we have attempted an experimental model to examine these changes in temporal sequence. This study was initiated to understand the etiology better and to characterize the abnormalities noted on the ^{99m}Tc pertechnetate abdominal scans.

MATERIALS AND METHODS

By utilizing eight mongrel dogs (15–20 kg), surgical nonreducible small bowel intussusceptions were produced. Anesthesia was obtained by intravenous sodium pentobarbital given to effect State III, plane 2 anesthesia. The ventral abdomen was prepared for sterile surgery and a 10-cm right paramedian incision utilized. The omentum was reflected and a segment of small bowel removed from the abdomen. A nonreducible intussusception was produced by stabilizing the distal segment with a surgical tie and employing a toothless thumb forceps to grasp the proximal bowel [5]. With slow continuous manipulation the proximal jejunum was invaginated into the distal segment. By this method intussusceptions of 6–10 cm could be produced. A longer segment could be invaginated by carefully removing the forceps and manually grasping the proximal bowel. Thus, the proximal segment of bowel formed the intussusceptum, and the distal segment formed the intussuscipiens.

When released at surgery, the intussusception would begin to reduce itself spontaneously. It was, therefore, necessary to stabilize the intussusception by suturing the proximal margin of intussuscipiens to the intussusceptum using 000 silk and incorporating the muscularis of both segments of bowel. With the longer intussusception, the blood supply in the mesenteric arcade and horizontal anastomotic vessels were incorporated in the bowel layers between the intussusceptum and intussuscipiens. In two dogs ileocolic intussusceptions were created in much the same manner. It was also necessary to stabilize these intussusceptions with sutures to prevent spontaneous reduction. Following creation of the surgical lesions the abdomen was closed routinely. Postoperatively the animals were supported with systemic lactated Ringer's solution and prophylactic antibiotics.

At various time intervals following the surgical production of the nonreducible small bowel intussusception, abdominal scans were obtained. Initially, ^{99m}Tc pertech-

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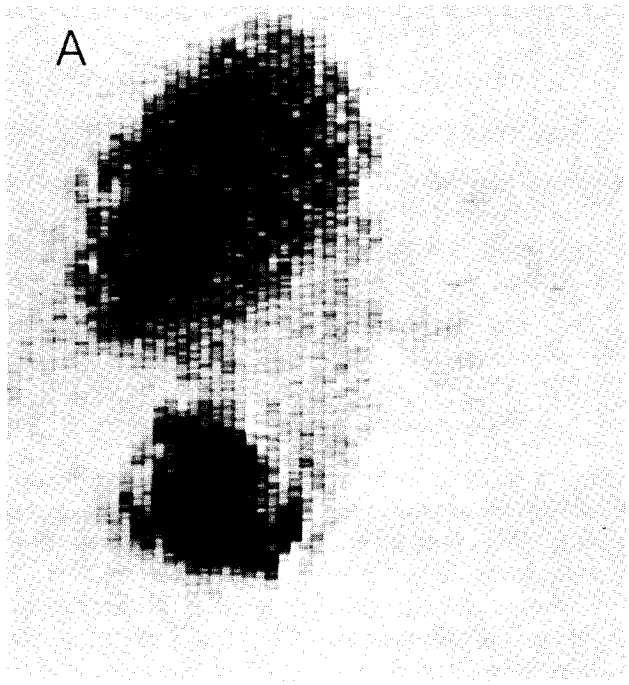

FIGURE 1A.

netate (75 μCi/kg) was utilized as the radiopharmaceutical to reproduce the reported clinical studies. The pertechnetate was administered by intravenous injection. Abdominal scans were obtained employing a rectilinear scanner with a 5-in. NAI (TL) crystal. No contrast enhancement was employed and the scan speed was varied depending upon the count rate. Catheterization of the urinary bladder to empty the contents was necessary to avoid the normal but confusing radioactivity accumulated in the structure. This reflected the biological elimination of ^{99m}Tc pertechnetate.

Abdominal images were recorded 30 min and 4 and 24 hr after radiopharmaceutical injection. Scans were also obtained on normal control dogs that received ^{99m}Tc pertechnetate for other diagnostic studies. At various time intervals 12 (2 animals), 24 (3), and 48 (3) hr the animals were sacrificed and the small bowel removed. The intussusception was resected along with 8 cm of normal bowel proximally and distally. Specimens were clamped or sutured at either end to prevent loss of intraluminal contents. Specimen radiographs were made for orientation and for comparison with the serial abdominal radiographs. Scans were obtained of the pathological specimens in the same configuration and orientation in which the radiographs were taken.

Samples of the intraluminal fluid and tissue samples were selected from the area of the intussusception as well as distally and proximally. These tissue samples were weighed and counted in a well counter to obtain a comparison of the amount of radioactivity per unit weight in each area of the specimen. Histological preparations were also made.

RESULTS

Although the clinical studies for the diagnosis of jejunal intussusception have been quite enthusiastic regarding the specificity and sensitivity of this test [1, 2], we were seldom able to obtain a characteristic abnormal image. In the animals (3 of 8 dogs) with positive studies (Figs. 1A and B), the specimen scan and concomitant radiograph revealed that we were not visualizing the

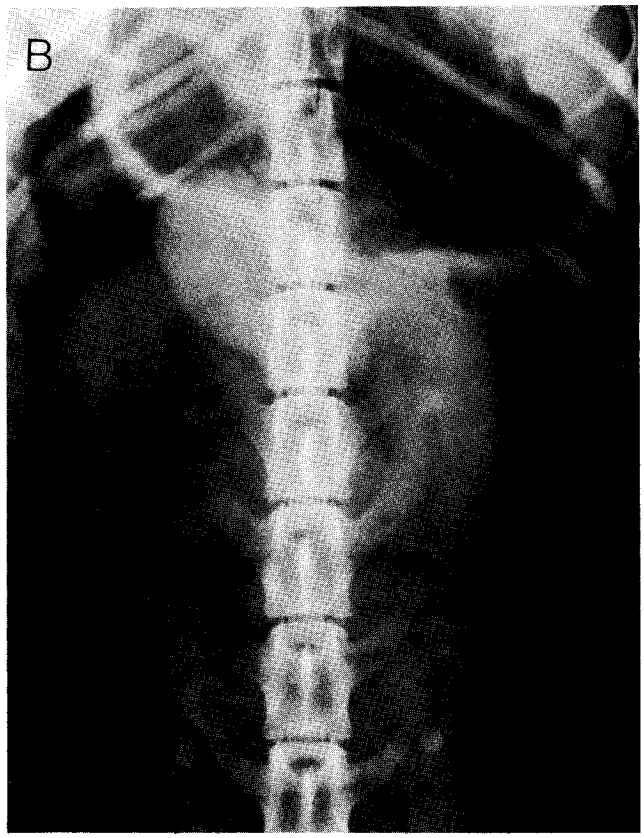

FIG. 1. (A), Abdominal scan (1 mCi of ^{99m} Tc Na pertechnetate 24 hr after surgical production of jejunal intussusception) obtained 30 min after intravenous injection of radiopharmaceutical. Normal accumulation in the stomach of radioactive substance as well as abnormal radioactivity just inferior to the stomach. (B), Abdominal radiograph: Soft tissue density just below gas filled stomach was found at surgery to represent jejunal intussusception.

intussusception itself (Figs. 2A and B) but bowel proximal to the intussusception. The scan abnormality was manifest by greater concentration of radioactivity in the area of the small bowel proximal to the intussusception. This finding was substantiated by comparison of the amount of ^{99m}Tc pertechnetate (cpm/g) contained in the bowel wall for the different areas. In addition, we found that the major concentration of the radioactivity was in the intraluminal fluid proximal to the surgically induced intussusception. When the bowel contents were emptied and the specimen scan repeated, the differences in radioactive accumulation between the area of the intussusception and the proximal bowel were qualitatively not as great. The scans on normal dogs showed accumulation of radioactivity in the stomach and urinary bladder as well as occasional visualization in the area of the duodenum. Despite catheterization, the urinary bladder was often visualized. The majority [3] of animals never showed a characteristically specific abnormal scan at any of the time periods. Transient slight accumulations were present but not consistent on subsequent studies. These animals proved to have a characteristic intussusception at autopsy but had less dilatation of the small bowel than the animals with positive studies.

DISCUSSION

The first successful operation for intussusception was reported by Peterson in 1908.

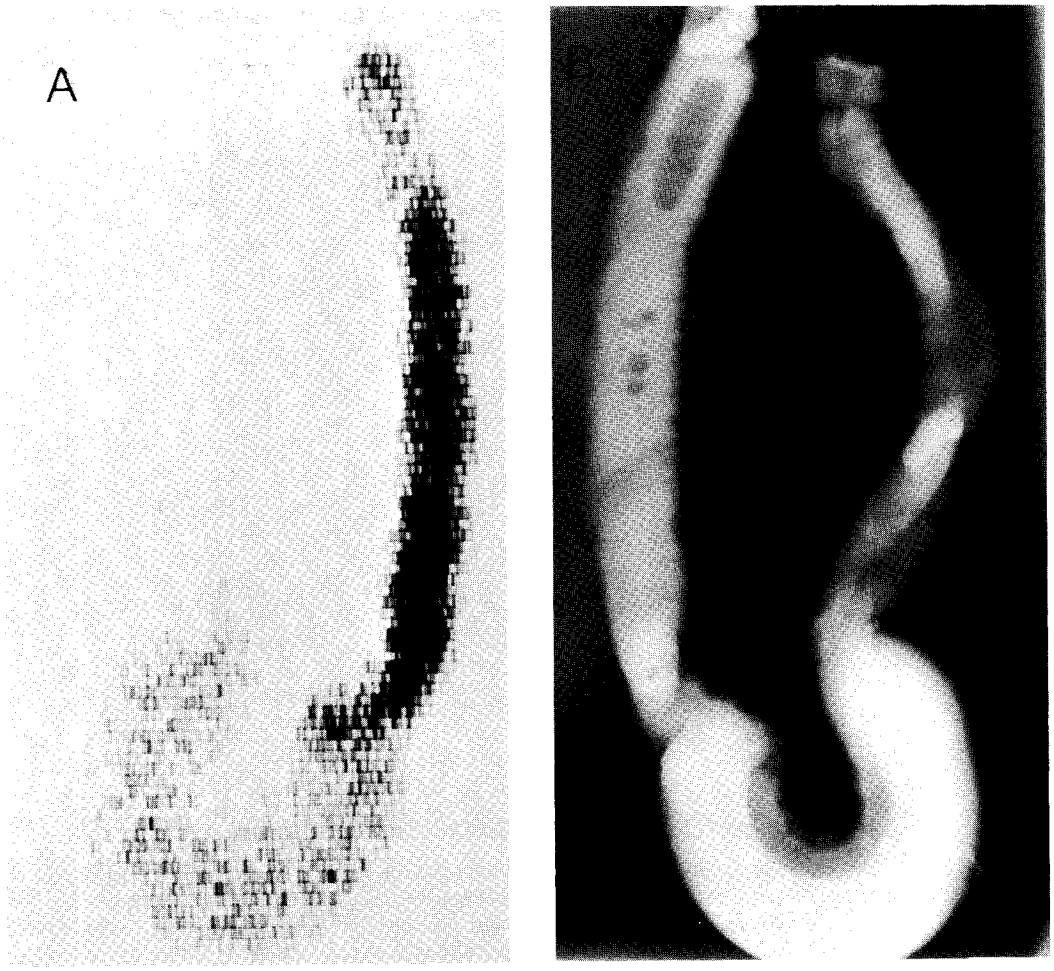

FIG. 2. (A), Specimen scan: Concentration of radiopharmaceutical proximal to intussusception when correlated with concomittant specimen radiograph obtained in same orientation. (B), Specimen radiograph: Jejunal intussusception soft tissue density inferior with proximal (right) and distal (left) small bowel.

Reduction by hydrostatic methods have gained favor, and 60% of these were intussusceptions reduced in this manner [5]. The operative mortality for those intussusceptions that cannot be reduced by barium enema is low. However, morbidity can be decreased by early diagnosis. This study was instituted in an attempt to offer some insight into the specificity and sensitivity of a proposed new diagnostic modality.

As an intussusception is formed the mesenteric arterial supply as well as the venous return may be entrapped between the bowel layers. This occurs especially in intussusceptions that involve a large length of bowel [4]. It has been proposed that bowel engorgement occurs because the arterial supply is less susceptible to absolute or relative obstruction to intraluminal blood flow from external mechanical force than the venous. Initially arterial blood thus reaches the bowel wall of the intussusception, but venous return is impaired. Technetium pertechnetate is concentrated in the stomach and secreted into the bowel. Thus, it should be expected that technetium would accumulate in the intraluminal contents of the small bowel proximal to an area of obstruction [3]. This has been previously reported by others and was tested by us.

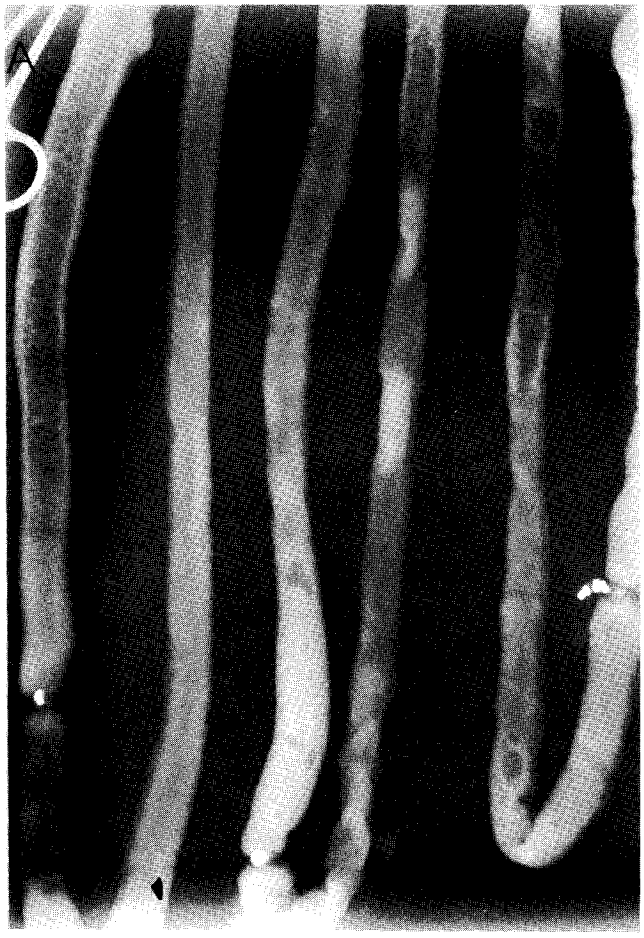

FIG. 3. (A) Specimen radiograph of dog's small bowel in which three mechanical obstructions were created (radiopaque ties). Clamp in left upper part of figure marks proximal bowel. (B), Specimen scan of small bowel (1.5 mCi of ^{99m}Tc pertechnetate iv 24 hr after surgery) reveals selective accumulation of radiopharmaceutical just proximal to each surgically produced obstruction.

Multiple mechanical obstructions of the jejunum and ileum were surgically created and the same studied performed. Again just proximal to each mechanical obstruction selective concentration of the radiopharmaceutical was present [3] (Figs. 3A and B).

The findings from this study are in some variance with the clinical observations regarding the sensitivity and specificity of abdominal scans in patients with intussusception. Because of this, we altered the temporal relation between surgical creation of the intussusception and the intravenous radiopharmaceutical injection with no apparent increase in sensitivity. Recognizing that the surgical creation of a fixed intussusception does not specifically reconstruct the clinical sequence of pathophysiological events, we intend to modify the experimental model [5]. To do this we intend to create a localized inhomogenity of the bowel wall as suggested by Reymond [6].

Radionuclide studies offer a potentially innocuous diagnostic modality to study bowel lesions that affect the blood supply. We intend to evaluate the use of radiopharmaceuticals that are primarily confined to the intravascular compartment as well as selective intra-arterial injections with radioactively labeled particles. However, the results

FIGURE 3B.

from this preliminary study suggest that the abdominal scan abnormalities in patients with intussusception are not caused by visualization of the lesion but are due to the attendant bowel obstruction.

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