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2nd Department of Radiology, Skubiszewski Medical University of Lublin

MAREK PASŁAWSKI, JACEK GWIZDAK, JANUSZ ZŁOMANIEC

The diagnostic value of different imaging modalities in evaluation of bowel obstruction

As other imaging techniques have emerged in diagnostic radiology, the role of the plain abdominal radiograph has diminished. In patients presenting with an acute abdomen, however, plain radiographs remain one of the most valuable initial investigations. Ultrasound, computed tomography (CT) and MR are used increasingly in cases where there is diagnostic difficulty or clinical uncertainty. The presence of bowel gas is useful in assessing the diameter and position of the bowel and the amount of fluid therein (1, 2, 4, 5, 6). The most common etiology of small bowel obstruction include adhesions, Crohn's disease, neoplasm, hernia. The CT enable not only diagnosing of obstruction but often determine the etiology (1, 2, 7).

The aim of the study was to analyse the diagnostic value of different imaging modalities in evaluation of patients with bowel obstruction.

MATERIAL AND METHODS

Material comprises a group of 47 patients with diagnosed acute abdomen. There were 21 women and 26 men aged between 15 and 89 years of age. Erect radiography, and radiographs in supine and left lateral patients' position, US and CT examination were performed in those patients. CT examination was performed in 5-mm and 10-mm thick axial sections before and after administering the contrast agent. In 6 patients small barium enema was performed. In 5 cases water-soluble contrast was administered orally.

RESULTS

In 6 cases on plane radiographs the presence of high ileal obstruction was found (Fig. 1). In 3 cases the level of small bowel obstruction was in the distal ileum. On plain radiographs multiple dilated ileal loops with fluid levels form terrace-like appearance (Fig. 2). In 12 patients the obstruction of large bowel was seen on plain radiographs (Fig. 3). In 4 of them lower parts of abdomen showed higher density suggesting the presence of intensive ascites (Fig. 4). In 3 patients intussusception of sigmoid bowel was stated (Fig. 5). The mesenteric ischemia was found to be a reason of bowel obstruction in 5 cases. On CT section soft tissue mass with irregular contrast enhancement was found, reflecting ischemic intestinal loops (Fig. 6). In 2 patients the gall stone small bowel obstruction was observed. In one of them the presence of gas in the biliary tree was seen on CT images (Fig. 7).

Fig. 1. The air/fluid levels in high small bowel obstruction on plain radiographs

Fig. 2. Multiple air/fluid levels with terrace-like appearance in lower small bowel obstruction

Fig. 3. Air/fluid levels in large bowel obstruction on plain radiographs

Fig. 4. Air/fluid levels in large bowel obstruction on plain radiographs. Lower part of the abdomen showing higher density due to ascites

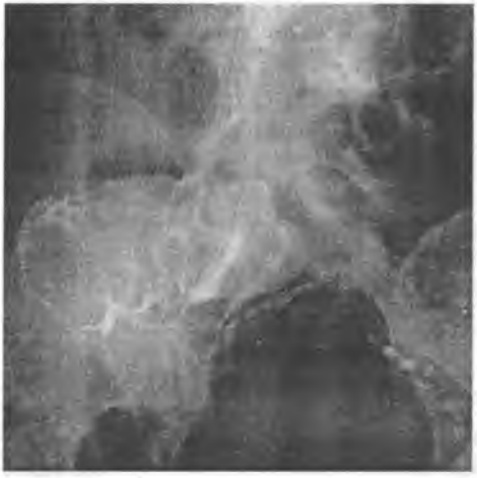

Fig. 5. Intussusception of sigmoid colon on double contrast examination

Fig. 6. Soft tissue mass with irregular contrast enhancement referring to ischemic intestinal loop

Fig. 7. Gas in the biliary tree in the patient with gall stone bowel obstruction

DISCUSSION

Air and fluid are normal contents of the small bowel and short fluid levels are not abnormal. Three to five fluid levels less than 2.5 cm in length may be seen, particularly in the right lower quadrant, without any evidence of intestinal obstruction or paralytic ileus. However, more than two fluid levels in dilated small bowel (calibre greater than 2.5 cm) are abnormal and usually indicate paralytic ileus or intestinal obstruction. Fluid levels at different heights in the same loop of small bowel do not help differentiate obstruction from paralytic ileus and may occur in normal people (4, 6).

Large bowel calibre is very variable and there is a considerable overlap between the normal and the abnormal. A diameter of 5.5 cm has been suggested as the upper limit of the normal range for the transverse colon in colitis and above this toxic megacolon should be diagnosed. The caecum is easily distensible but a diameter of 9 cm is a critical dimension beyond which danger of perforation exists (4).

When a radiograph shows dilated bowel it is important to try to determine whether it is small or large bowel or both. Useful differentiating features depend on the size and distribution of, and markings on, the loops and are summarized in Table 1 (4).

Table 1. The distinction between small bowel and large bowel dilatation*

	Small bowel	Large bowel
Haustra	absent	present
Valvulae conniventes	present in jejunum	absent
Number of loops	many	few
Distribution of loops	central	peripheral
Radius of curvature of loop	small	large
Diameter of loop	30–50 mm	50 mm+
Solid faeces	absent	may be present

*According to R. Garnier et al. (4)

The presence of solid faeces is the only reliable sign, the others being sometimes misleading. Problems in distinguishing the lower ileum from the sigmoid colon are relatively frequent as both may be smooth in outline and occupy a similar position, low in the central abdomen.

Haustra may be absent from the descending and sigmoid colon but can usually still be identified in other parts of the colon, even when it is massively distended (4).

The small bowel folds or *valvulae conniventes* form thin, complete bands across the bowel gas shadow, prominent in the jejunum but becoming less marked as the ileum is reached (4).

In small bowel obstruction, it is unusual for its diameter to be much greater than 5 cm; in large bowel obstruction it is unusual for the large bowel calibre to be less than 5 cm. Mechanical obstruction of the small bowel normally causes small bowel dilatation, with an accumulation of both gas and fluid and a reduction in the calibre of the large bowel. The amount of gas present in the large bowel depends on the duration and the completeness or otherwise of the obstruction. *Valvulae conniventes* are more prominent in the jejunum than the ileum, and this fact allows to determine the site of obstruction. Plain radiograph changes may appear after 3–5 hours if there is complete small bowel obstruction, and are usually marked after 12 hours. With incomplete obstruction, changes on the plain radiograph may take hours or days to appear (4).

The dilated gas-filled loops of the small bowel are readily identified on the supine radiograph; multiple fluid levels are present on the erect radiograph. Dilated fluid-filled loops of small bowel may also be identified as sausage-shaped, oval or round, soft-tissue densities that change position in different views. The string of beads sign, due to bubbles of gas trapped between the *valvulae conniventes* is seen only when very dilated small bowel is almost completely filled with fluid, and is virtually diagnostic of small bowel obstruction (4).

In small bowel obstruction, normal or equivocal initial radiographs may result in a delayed diagnosis. There may be no gas or fluid visible in the small bowel of patients with high jejunal obstruction because of vomiting. As the bowel diameter cannot be assessed the plain radiographic diagnosis is difficult or impossible. If there is persistent diagnostic difficulty, follow-up plain radiographs taken a few hours later will often resolve the problem and, if not, a barium study or CT may be performed (2, 4, 8, 9).

Ultrasound can detect fluid-filled loops of small bowel, in which case the diameter and peristaltic activity of the loops may be assessed. Ultrasound is not usually helpful in diagnosing the cause of the obstruction (4, 5). If there is clinical doubt, partial obstruction, or when conservative management is planned, CT has a valuable role (1, 2, 4, 6, 8).

CT will demonstrate dilated small-bowel loops, whether fluid or gas filled, and will add further information regarding the site and level of obstruction, the mesentery, intraluminal or extraluminal masses, the presence of ascites and, importantly, whether there is strangulation of a small-bowel loop.

Where there is malignancy, additional staging information is gained with the detection of lymphadenopathy and metastases. CT can give a sensitivity of 94% and specificity of 96% in the detection of small bowel obstruction. Errors are mainly due to the presence of ileus. Adhesions are not visualized with certainty by any imaging technique, and are usually diagnosed on the basis of clinical history and exclusion. The CT sensitivity for adhesions is around 73% (1, 2, 4, 8).

Strangulating obstruction is a mechanical small bowel obstruction caused when two limbs of a loop are incarcerated, by a band or within a hernia, in such a way as to compromise the blood supply by compression of the mesenteric vessels. The closed loop may fill with fluid and be palpable. It may be visible on a radiograph as a soft-tissue mass or 'pseudotumour'. The strangulated loop may contain gas, and the arms of the loop, separated only by the thickened intestinal walls, may resemble a large coffee bean. If gangrene occurs, linear gas shadows may be seen in the wall of the small bowel. CT signs of a closed loop include small bowel dilatation, V-shaped or radial fluid-filled loops, mesenteric vessels converging towards the point of obstruction, and a triangular loop with or without a whirl or beak. Where there is strangulation the loop becomes thickened, there may be high attenuation in its wall due to haemorrhage, pneumatosis, and congestion of the mesentery attached to the loop (2, 4, 6, 8).

Volvulus of the small intestine may occur as an isolated lesion or in combination with obstruction due to adhesive bands. It is often associated with anomalies of the mesentery and there is frequently malrotation. Impairment of the blood supply frequently occurs in small-bowel volvulus so that intramural gas or 'thumb-printing' may be seen. It is not usually possible to distinguish between simple obstruction, strangulating obstruction, or small bowel volvulus on plain radiographs alone (4).

Gallstone ileus is a mechanical intestinal obstruction caused by impaction of one or more gallstones in the intestine, usually in the terminal ileum, but rarely in the duodenum or colon. The gallstone passes into the duodenum by eroding the inflamed gallbladder wall. Over half the patients will have evidence of intestinal obstruction and about one third will have gas present in the biliary tree. Gas in the biliary tree can be recognized by its branching pattern with gas being more prominent centrally. Gas in the portal vein, from which it must be distinguished, tends to be peripherally located in small veins around the edge of the liver. Visualization of the obstructing gallstone on plain radiographs may be difficult because the gallstone is frequently composed almost entirely of cholesterol with only a thin rim of calcium within it (4).

The incidence of intussusception varies considerably in different countries but in general, it is most frequently seen in children under 2 years of age. In children it usually commences in the ileum as a result of inflammation of the lymphoid tissue. The enlarged lymphatic patches are forced into the lumen by peristaltic movements and, acting as a tumour, one part of the lumen is pulled into another and finally pulled into the colon (4).

Plain radiographs may show evidence of small bowel obstruction or the intussusception itself may be identified as a soft-tissue mass, sometimes surrounded by a crescent of gas, and situated most commonly in the right hypochondrium. The 'target sign' consists of two concentric circles of fat density lying to the right of the spine in infants and children with intussusception. The crescent and target signs are of equal accuracy, being more accurate than the mass sign though the latter is found more frequently, and the target sign is more than twice as common as the crescent sign. A barium enema is frequently required to establish a definite diagnosis of intussusceptions. In adults CT demonstrates the intussusception, a characteristic feature being the intussusceptum bringing mesenteric fat along the lumen of the thickened intussuscipiens. The intussusception appears as a sausage-shaped mass or a target mass depending on its orientation in relation to the CT plane (2, 4, 8, 9).

Intestinal infarction is a most serious abdominal condition caused by thrombosis or embolism of the superior mesenteric artery. The clinical diagnosis is often uncertain. Gas-filled, slightly dilated loops of small bowel with multiple fluid levels, or fluid-filled, loops of small bowel, are frequent plain radiographic findings. The walls of the small bowel loops may be thickened owing to submucosal

haemorrhage and oedema. Linear gas streaks may be seen if there is gangrene, and free gas may be present if perforation has occurred. Colonic distension may also be present if general peritonitis has occurred. Intraluminal gas in the mesenteric veins or portal vein may be seen in advanced cases. These features can be readily demonstrated on CT. Unlike the small bowel obstruction due to adhesive bands is very uncommon in the colon. Common causes of colonic obstruction include tumour, abscess, diverticular disease, volvulus and, more rarely, extrinsic compression from a pelvic tumour. Obstruction is much more common on the left side of the colon than the right. The plain radiographic findings depend on the site of obstruction and whether or not the ileocaecal valve is competent (2, 4).

In a minority of patients the ileocaecal valve remains competent and, in spite of increasing intracolonic pressure and marked distension of the caecum, the small bowel is not distended. In the majority, small bowel distension is caused by the closed ileocaecal valve. In another group of patients, the ileocaecal valve is incompetent, the caecum and ascending colon are not distended, and there is marked small bowel distension. The obstructed colon almost invariably contains large amounts of air and can usually be identified by its haustral margin around the periphery of the abdomen. When both small and large bowel dilatation are present, the radiographic appearances may be identical to those seen in paralytic ileus. A left lateral radiograph, however, may help to prove the diagnosis of obstruction by demonstrating the absence of gas in the rectum (4).

CONCLUSIONS

The determining the level of the obstruction is facilitated on plain radiographs, erect and in supine and left lateral patient's position.

In small bowel obstruction, normal or equivocal initial radiographs may result in a delayed diagnosis. As the bowel diameter cannot be assessed, the plain radiographic diagnosis is difficult or impossible. If there is persistent diagnostic difficulty, follow-up plain radiographs taken a few hours later will often resolve the problem and, if not, a barium study or CT may be performed.

Orally administering of water-soluble contrast agent, diluted barium, barium enema are also helpful in differentiating the character and etiology of obstruction.

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SUMMARY

The aim of the study was analysing of the diagnostic value of different imaging modalities in evaluation patients with bowel obstruction. The material comprises a group of 47 patients with diagnosed acute abdomen. Erect radiography, and radiographs in supine and left lateral patients' positions, US and CT examination were performed in those patients. CT examination was performed in 5 mm- and 10-mm thick axial sections before and after administering the contrast agent. In 6 patients small barium enema was performed. In 5 cases water-soluble contrast was administered orally. In 6 cases on plane radiographs the presence of high small bowel obstruction was found. In 3 cases the level of small bowel obstruction was in the distal ileum. In 12 patients the obstruction of large bowel was seen on plain radiographs. In 3 patients intussusception of sigmoid bowel was found. The mesenteric ischemia was found to be a reason of bowel obstruction in 5 cases. On CT section soft tissue mass with irregular contrast enhancement was found, reflecting ischemic intestinal loops. In 2 patients the gall stone small bowel obstruction was found. In one of them the presence of gas in the biliary tree was seen on CT images. The determining of the level of the obstruction is facilitated on plain radiographs, erect and in supine and left lateral patients' position. In small bowel obstruction, normal or equivocal initial radiographs may result in a delayed diagnosis. As the bowel diameter cannot be assessed the plain radiographic diagnosis is difficult or impossible. If there is persistent diagnostic difficulty, follow-up plain radiographs taken a few hours later will often resolve the problem and, if not, a barium study or CT may be performed. Orally administering of water-soluble contrast agent, diluted barium, barium enema are also helpful in differentiating the character and etiology of obstruction.

Wartość diagnostyczna różnych metod obrazowania w ocenie niedrożności jelit

Celem pracy była ocena wartości diagnostycznej różnych metod obrazowania w ocenie pacjentów z niedrożnością mechaniczną jelit. Materiał stanowiła grupa 47 pacjentów z rozpoznanym ostrym brzuchem. U pacjentów tych wykonano radiogramy jamy brzusznej w pozycji stojącej oraz w ułożeniu na wznak i na lewym boku, badanie USG i TK. Badanie TK wykonano w przekrojach grubości 5 i 10 mm przed i po podaniu dożylnym środka kontrastowego. U sześciu pacjentów wykonano wlewkę doodbytniczą. U pięciu pacjentów podano doustnie rozpuszczalny w wodzie środek kontrastowy. W sześciu przypadkach na zdjęciach przeglądowych jamy brzusznej stwierdzono wysoką niedrożność jelita cienkiego. W trzech przypadkach stwierdzono niedrożność dystalnego odcinka krętnicy. W 12 przypadkach stwierdzono niedrożność jelita grubego. U trzech pacjentów stwierdzono wgłobienie esicy. Niedokrwienie krezki było powodem niedrożności w pięciu przypadkach. W TK stwierdzono miękkotkankowe obszary o nieregularnym wzmocnieniu kontrastowym, odpowiadające niedokrwionym pętlom jelitowym. U dwu pacjentów stwierdzono niedrożność spowodowaną kamieniem żółciowym. U jednego z nich stwierdzono w TK gaz w drogach żółciowych. Określenie poziomu niedrożności ułatwiają zdjęcia przeglądowe jamy brzusznej w pozycji stojącej oraz w ułożeniu na wznak i na lewym boku. W niedrożności jelita cienkiego prawidłowe lub niejednoznaczne zdjęcia rtg mogą opóźnić postawienie prawidłowego rozpoznania. Gdy nie ma możliwości oceny średnicy pętli jelitowych, rozpoznanie na podstawie radiogramów jamy brzusznej jest trudne lub niemożliwe. Wskazane są wtedy kontrolne radiogramy kilka godzin później, badanie kontrastowe lub TK. Podanie doustne rozpuszczalnego w wodzie środka kontrastowego, rozcieńczonego barytu, wlewka doodbytnicza są również pomocne w różnicowaniu charakteru i etiologii niedrożności.