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SMALL BOWEL OBSTRUCTION FROM ADHESIONS: VALUE OF CT FINDINGS IN DETECTING COMPLICATIONS

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ABSTRACT

Purpose. To determine the value of known computed tomographic (CT) criteria to differentiate non-complicated from complicated (strangulation, necrosis) small bowel obstruction.

Materials and methods. 43 patients with a definitive diagnosis of small bowel obstruction based on clinical, sonographic, CT, surgical and pathological findings were included. All patients had small bowel obstruction caused by adhesions confirmed at surgery. The obstruction was non-complicated in 28 patients and complicated in 15 patients. The CT examinations from all patients were retrospectively reviewed by three experienced radiologists using a set of pre-defined criteria. Attention was focused on the following signs: reduced enhancement of the small bowel wall, mural thickening, congestion of small mesenteric veins, and ascites. Results were correlated with surgical and/or pathological data.

Results. For the diagnosis of complicated obstruction, reduced bowel wall enhancement had a sensitivity of 57% and a specificity of 100%, a bowel wall thickness greater than 3 mm had a sensitivity of 35% and a specificity of 100% and a bowel wall thickness less than 1 mm had a sensitivity of 35% and a specificity of 93%. Ascites and congestion of small mesenteric veins were not significant. The multivariate analysis showed that the association of bowel-wall thickening and reduced enhancement of the small bowel wall was significant (sensitivity of 71%, specificity 100%, and accuracy 90%).

Conclusion. Among the CT criteria used to diagnose complications from small-bowel obstruction that were evaluated in this study, only three were significant with a high specificity but low sensitivity.

Key words: Intestinal Obstruction. Intestine Small. Adhesions. Retrospective Studies. CT.

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RÉSUMÉ

Occlusion du grêle sur bride : quels critères scanographiques de gravité rechercher ?

Objectifs. Le but de cette étude était de déterminer la valeur des critères scanographiques de gravité connus des occlusions sur brides, permettant de différencier une occlusion simple ou compliquée (strangulation, nécrose).

Matériel et méthodes. Quarante trois patients dont le diagnostic final d'occlusion retenu sur des critères cliniques, échographiques, scanographiques, chirurgicaux et anatomopathologiques, furent inclus dans l'étude. Tous les patients présentaient des occlusions sur bride confirmées par l'intervention chirurgicale avec 28 occlusions simples et 15 compliquées. L'ensemble des examens scanographiques furent relus rétrospectivement par trois radiologues expérimentés dans le cadre d'un consensus préétabli. Les critères scanographiques étudiés étaient l'absence de rehaussement pariétal, l'épaisseur de paroi, la congestion du mésentère, et l'ascite. Les résultats furent confrontés aux données chirurgicales et/ou anatomopathologiques.

Résultats. Dans le cadre du diagnostic d'occlusion sur bride compliquée, l'absence de rehaussement pariétal présentait une sensibilité de 57 % et une spécificité de 100 %, l'épaisseur pariétale supérieure à 3 mm avait une sensibilité de 35 % et une spécificité de 100 %, et l'épaisseur pariétale inférieure à 1 mm montrait une sensibilité de 35 % et une spécificité de 95 %. L'ascite et la congestion du mésentère n'étaient pas significatives. L'analyse multifactorielle a montré que l'association de l'épaississement de paroi avec le défaut de rehaussement pariétal était significative, avec une sensibilité de 71 % et une spécificité de 100 %, la précision étant de 90 %.

Conclusion. Parmi l'ensemble des critères scanographiques connus et utilisés pour faire le diagnostic d'occlusions sur brides compliquées, seulement trois sont significatifs, avec une grande spécificité mais une moindre sensibilité.

Mots-clés : Occlusion intestinale. Intestin grêle. Brides. Étude rétrospective. Tomodensitométrie (CT).

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INTRODUCTION

Small bowel obstruction secondary to adhesions is a frequent cause of hospital admission on surgical floors (1). Small bowel obstruction may be due to a variety of causes (iatrogenic, tumor, inflammatory, metabolic, congenital) and adhesion is the most common etiology (54%) followed by hernia (30%) (2). Treatment options include early surgery or conservative management. There is no consensus regarding the best management option. This is mainly due to the fact that detection of early signs of strangulation or necrosis, two factors that increase the rate of postsurgical complication and death (2), is difficult. Therefore, a precise presurgical diagnosis would be helpful for improved patient management. Over the recent years, CT has been used to diagnose the presence of small bowel obstruction and the underlying etiology (3-11). However, the value of CT for detection of ischemic complications is debated (12-19).

The purpose of this retrospective study of 43 patients with non-complicated or

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complicated small bowel obstruction due to adhesions was to determine the diagnostic value of known CT criteria for detection of ischemic complications.

MATERIALS AND METHODS

Patients were selected from a group of 117 consecutive patients admitted to a surgical unit with bowel obstruction between September 1998 and September 2000. Patients with bowel obstruction due to tumor, inflammatory process, ischemia or hernia were excluded. A total of 43 patients were included. All patients underwent CT followed by surgery (laparoscopy) with confirmation of bowel obstruction secondary to adhesions.

The group of patients included 26 females and 17 males aged from 16 to 98 years (mean age of 61 ± 22.8 years). Two patients had no previous surgical history (3.5%), 17 had one (45%), 11 had 2 (30%), 8 had 3 (20%), one had more than 3 (1.5%), and 4 patients had a previous history of bowel obstruction.

The time delay between onset of symptoms and CT ranged from 6 hours to 5 days (mean of 31 hours). Surgery was performed 3 to 48 hours after CT, with a time delay less than 6 hours for 60% of patients. The CT examinations were performed on a Somatom Plus S40 (Siemens, Erlangen, Germany) (40 examinations) or a CT Pace (GE Medical Systems, Milwaukee, USA) (3 examinations) using a standardized protocol:

— no oral contrast or rectal air;

— precontrast 10 mm sections at 15 mm intervals through the abdomen and pelvis;

— dynamic contiguous postcontrast 5 or 7 mm thick images (27 examinations) or helical contiguous postcontrast 5 mm thick images (16 examinations). A total of 120 cc of Iopamiron 300 (BRACCO, Milan, Italy) was injected IV at 2 cc/sec. Scan delay was 60 seconds;

— two experienced radiologists, blinded to the final diagnosis, independently reviewed all 43 CT examinations in a random order.

At surgery, 35 patients underwent simple lysis of adhesions because there was no evidence of bowel ischemia. The other 14 patients showed evidence of ischemic complications at surgery (discoloration and ileus of the involved small bowel loops, reversal of discoloration after soaking the involved loop in normal saline). Partial bowel resection was performed in 8 patients and the presence of necrosis was confirmed at pathology in all cases.

The CT criteria that were evaluated are those reported to allow differentiation of non-complicated obstruction from complicated or strangulated obstruction:

— **bowel wall thickening** *(fig. 1)*. Because of difficulties related to the precision of this measurement, we have elected to use the 3mm threshold suggested by Bartnicke (20) over the 2mm threshold used by Frager (21).

— **Bowel wall thinning** *(fig. 2)*. This is characterized by a wall thickness less than 1 mm (22).

— **Delayed wall enhancement** *(fig. 3)* (23) of the involved loop compared to the homogeneous enhancement of adjacent normal bowel.

— **Congestion of small mesenteric veins** *(fig. 4)* (12, 14, 24) characterized by enlargement of small serpentine vessels in the mesenteric fat.

— **Peritoneal fluid** (5, 12, 14, 15, 18, 24) of variable amount.

— **Pneumoperitoneum** (24, 25) that can be near the site of perforation or throughout the peritoneal cavity.

— **Bowel wall pneumatosis** (26) characterized by gas bubbles within the bowel wall.

— **Mesenteric thrombosis** (12) or **portomesenteric venous gas** (27) either segmental or with involvement of the entire portomesenteric venous system.

— **Beak sign** *(fig. 5)* (3) characterized by beaking of the bowel loop at the site of obstruction.

Interobserver correlation was evaluated for each criterion (kappa). Correlation was considered excellent when between 0.81-1.0, good between 0.61-0.80, fair between 0.41-0.60, poor between 0.21-.040, and negligible when below 0.19.

Discordant findings between observers were reviewed and a consensus reached. Consensus results were correlated to surgical and pathological results allowing calculation of sensitivity and specificity of each sign for diagnosing complicated obstruction (strangulation and necrosis). Because the purpose of the study was to evaluate CT findings of ischemia and necrosis, both subgroups were combined for statistical analysis.

The Chi-square test was used, with a level of significance set at 5% ($p = 0.05$). This level of 0.05 was selected to not exclude discriminatory signs and because some findings were seldom present. If validity conditions were not verified (theoretical number < 5) the Fisher exact test was used.

A multivariate analysis was also performed on all criteria to determine if the association of 2 or more signs was significant.

RESULTS

Pneumoperitoneum, portomesenteric venous gas, portal vein thrombosis, and bowel wall pneumatosis were present in none of the cases.

Interobserver correlation was good for the presence of peritoneal fluid (0.77), delayed wall enhancement (0.7), bowel wall thinning and congestion of small mesenteric veins (0.63) and poor for bowel wall thickening and beak sign (0.14).

The rate of presence of the different signs by subgroups are summarized in Tables I, II and III. Only the presence of delayed wall enhancement, wall thinning and wall thickening are significantly more frequent in cases of ischemia ($p < 0.05$).

Multivariate analysis shows that only one combination of findings is significant: wall thickening and/or absence of wall enhancement. This was present in 71% of patients with ischemia and/or necrosis, and absent in all patients with non-complicated bowel obstruction, for a diagnostic accuracy of 90% with confidence interval between 82 and 99%.

DISCUSSION

Multiple studies have been published evaluating the role of CT in detecting signs of severity in patients with bowel obstruction (12-19). Results tend to show that there is a relation between CT findings of severity and ischemic complications from small bowel obstruction due to adhesions.

Our study shows that some signs, described by other authors as specific, are infrequent (pneumoperitoneum, portomesenteric venous gas, portal vein thrombosis, and bowel wall pneumatosis). This is probably related to early surgical management (within the first 6 hours in 60% of cases). The beak sign was difficult to detect and had poor interobserver correlation.

Among more specific signs, delayed wall enhancement was 100% specific and had good interobserver correlation (0.63), confirming previously published results by Zalcman (23), Balthazar (12) and Ha (24). The sensitivity of this sign in our study was moderate at 57% but higher than that reported by these authors (25-34%). This finding is due to impaired bowel wall perfusion, best evaluated at 80 seconds post injection according to Zalcman (19). The improved control of acquisition delay on recent scanners could improve the sensitivity of this sign.

Fig. 1: SBO from adhesions with peritoneal signs. Postcontrast CT of the abdomen showing wall thickening of the involved bowel loop (arrows).

Fig. 1 : *Occlusion du grêle sur bride avec signe clinique d'irritation péritonéale.* *Scanner abdominal avec injection de produit de contraste montrant l'épaississement pariétal de l'anse souffrante (flèches).*

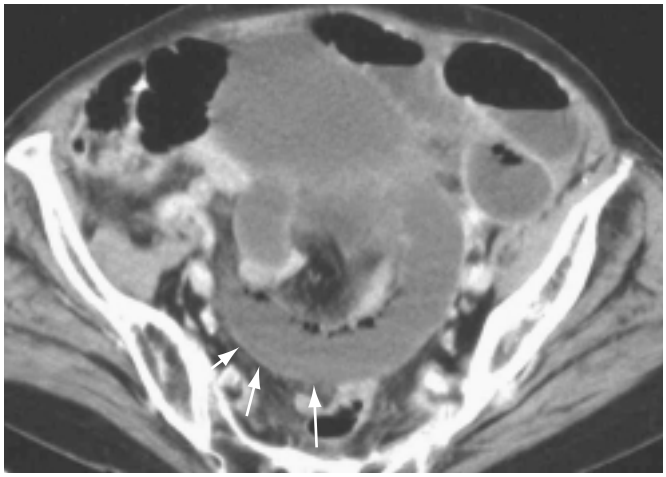

Fig. 2: SBO from adhesions with necrosis. Postcontrast CT of the abdomen showing wall thinning of the involved bowel loop (arrows).

Fig. 2 : *Occlusion du grêle sur bride avec nécrose.* *Scanner abdominal avec injection de contraste mettant en évidence l'amincissement pariétal de l'anse souffrante (flèches).*

Fig. 3: Strangulated SBO from adhesions. Postcontrast CT of the abdomen showing reduced wall enhancement of the involved bowel loop (arrows).

Fig. 3 : *Occlusion du grêle sur bride avec strangulation.* *Scanner abdominal avec injection de produit de contraste objectivant le retard de rehaussement pariétal de l'anse souffrante (flèches).*

Fig. 4: Non-complicated SBO from adhesions. Postcontrast CT of the abdomen showing congestion of small mesenteric veins (arrows).

Fig. 4 : *Occlusion du grêle sur bride non compliquée.* *Scanner après injection de produit de contraste montrant la dilatation des petits vaisseaux mésentériques (flèches).*

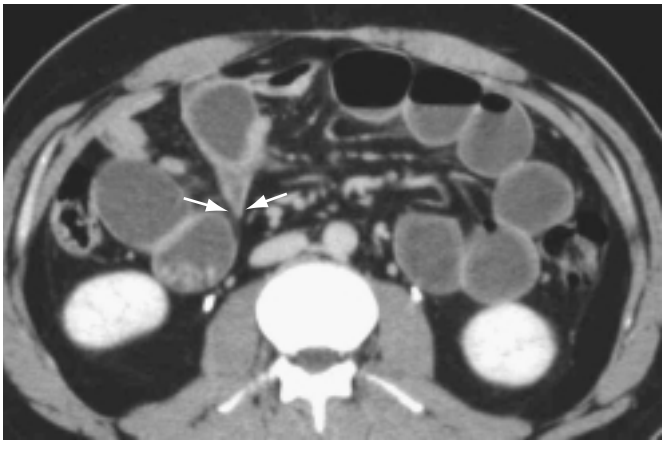

Fig. 5: Postcontrast CT through the mid-abdomen in a patient with non-complicated SBO showing the beak sign (arrows).

Fig. 5 : *Coupe TDM sous-mésocolique avec injection* *chez un patient présentant une occlusion sur bride sans strangulation mettant en évidence le signe du bec (flèches).*

Table I:
Findings present on the CT scans of 43 patients with non-complicated or complicated SBO. Results of the kappa test.
Tableau I :
Recensement des cinq signes étudiés sur les scanners de 43 patients présentant des occlusions simples ou compliquées. Résultats du test kappa.

Sign of gravity	*Nombre of cas (n)*	*Non-complicated SBO (n = 29)*	*Strangulation (n = 6)*	*Necrosis (n = 8)*	*Kappa*
Peritoneal fluid	*26*	*16*	*6*	*4*	*0.77*
Congestion	*21*	*15*	*3*	*3*	*0.63*
Delayed enhancement	*8*	*0*	*2*	*6*	*0.63*
Wall thinning	*7*	*2*	*2*	*3*	*0.63*
Wall thickening	*17*	*0*	*1*	*16*	*0.14*

Table II:
Diagnostic value of CT findings for diagnosis of small-bowel strangulation in 43 patients.
Tableau II :
Valeur diagnostique des signes scanographiques pour détecter une occlusion compliquée chez 43 patients.

Sign of severity	*Sensitivity*	*n*	*CI 95%*
Peritoneal fluid	*0.71*	*14*	*0.47-0.95*
Congestion	*0.43*	*14*	*0.17-0.69*
Delayed enhancement	*0.57*	*14*	*0.31-0.83*
Wall thinning	*0.36*	*14*	*0.11-0.61*
Wall thickening	*0.36*	*14*	*0.11-0.61*

Table III:
Diagnostic value of CT findings for diagnosis of small-bowel strangulation in 43 patients.
Tableau III :
Valeur diagnostique des signes scanographiques pour détecter une occlusion compliquée chez 43 patients.

Sign of severity	*Specificity*	*n*	*CI 95%*
Peritoneal fluid	*0.45*	*29*	*0.27-0.63*
Congestion	*0.48*	*29*	*0.3-0.66*
Delayed enhancement	*1*	*29*	*1-1*
Wall thinning	*0.93*	*29*	*0.84-1*
Wall thickening	*1*	*29*	*1-1*

In the setting of small bowel obstruction, mural thickening is due to congestion or edema of the wall due to local early microvascular effects. With strangulation, ischemia is due to 2 main factors: the first one is mechanical by torsion of the bowel loop, and the second is due to dilatation of the occluded loop causing venous stasis followed by blockage of the arteriovenous microcirculation leading to anoxia (28) and also wall thickness changes. In our series, this sign was 100% specific and 36% sensitive using a threshold of 3 mm. Results in the literature vary with the threshold selected. Donckier (7) reported sensitivity and specificity values of 25 and 86% using a threshold of 2 mm, and Ha (25) reported sensitivity and specificity values of 54 and 88% using a threshold of 5 mm. The low variations in the diagnostic value for this sign using different threshold values underscores the interpretation difficulties of this sign. The negligible interobserver correlation value (0.16) in our series also confirms the unreliable detection of this sign.

Bowel wall thinning described in acute small bowel ischemia (22) corresponds to late mucosal desquamation, and is thus a sign of extreme severity. To our knowledge, this sign has not yet been studied in the setting of small bowel obstruction. This sign has a low sensitivity (35%) but a high specificity (93%) with good interobserver correlation (0.63) and should thus be retained.

All individual signs appear specific but poorly sensitive. However, a multivariate analysis shows that 71% of patients with ischemia or necrosis show the presence of wall thickening with impaired wall enhancement whereas 90% of patients with non-complicated bowel obstruction did not show these 2 signs for a diagnostic accuracy of 90% (confidence interval: 82-99%).

Peritoneal fluid was absent in 28% of patients with complicated obstruction and present in 44% of patients with non-complicated obstruction. Our results indicate the poor specificity of this sign in our patient population. This finding could be due to the presence of associated pathologies. Donckier (13) reported sensitivity and specificity values if 75 and 87% for this sign.

Congestion of mesenteric veins was observed in 6 of 13 cases. Balthazar (3) reported it in 6 of 19 cases and Donckier (13) reported it in 10 of 16 cases. This sign remains of mediocre diagnostic value. This could be secondary to the subtlety of this sign (enlargement of small vessels, serpentine appearance, mild increase in density of the mesenteric fat), and its early presence.

Several studies have tried to show that the presence of signs of severity at CT would have a favorable impact on outcome and would thus be effective in reducing hospital costs (13). However, for many clinicians, the need for surgery is based on the clinical evolution of the patients once a diagnosis is made. Because of improved surgical techniques (29-31), several surgeons prefer early intervention to decrease the number of severe complications. Based on our results, it would appear that CT is not precise enough to identify patients that require surgery. However, it can be helpful in a subgroup of patients with indeterminate results at clinical evaluation or in patients that are high surgical risks. The presence of some bowel wall signs at CT, especially the presence of reduced wall enhancement due to its highest sensitivity, would be helpful for surgical decision-making.

Management of patients with bowel obstruction remains clinically difficult. This relates to the complexity of involved pro-

cesses and their change over time. Most of the pathophysiological steps can be assessed at CT but without adequate sensitivity to detect developing ischemic/necrotic complications. On the other hand, the absence of bowel wall thickening and/or delayed enhancement suggests a favorable outcome.

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