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Comparison of the Computerized Tomography and Intraoperative Findings in Resection Requiring Small and Large Intestinal Ischemia

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Abstract

Objective: We tried to find the correlation between computerized tomography (CT) and intraoperative findings in patients with small and large intestinal ischemia.

Methods: 40 patients operated with the diagnosis of intestinal ischemia in 19 Mayıs University Medical School Hospital between 01 January 2008 and 01 January 2016 were retrospectively evaluated. All the patients having laparotomy were included in the study. The patients who had been clinically observed and with suspicious diagnosis were excluded from the study. CT findings; bowel wall thickness, dilatation, halo or target sign, increased or decreased contrast material in bowel wall, faeces sign, pneumatosis intestinalis, bowel obstruction, congestion, distortion and stranding of mesenteric fat, contributing solid organ ischemia, ascites, superior mesenteric arterial (SMA) thrombus, mesenteric vein thrombus and pneumoporta were reported. All these characteristics were compared with intraoperative findings. Cross tables were formed and Chi-Square Test (SPSS 21.0 version) was used for the statistical analysis.

Results: Contrast loss and SMA thrombus were found as indicators of both small and large intestinal iscemia.. Bowel wall thicknesss was not correlated with the degree of ischemia, especially in colon. Faeces sign and pneumatosis intestinalis were more specific for large intestinal ischemia.

Conclusion: Abdominal CT findings correlate with the intraoperative findings in intestinal ischemia; in the aspect of contrast loss, SMA obstruction, faeces sign and pneumatosis intestinalis.

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Introduction

Mesenteric ischemia is becoming a common mortal disease together with the increasing life period and atherosclerotic vascular diseases. Especially in geriatric population it is one of the main emergent surgical diseases for acute abdomen [1]. Early diagnosis and rapid treatment are life saving [2-4]. We cannot actually comment about the acute and chronic mesenteric vascular occlusion retrospectively. Because we meet the patients generally with gangrenous and necrotic intestinal segments. The difficulty in early diagnosis is the main problem. The most important available diagnostic technique is Computerized Tomography (CT) imaging. Contrast enhanced multidetector computed tomography in the arterial and portal venous phases is an accurate method for detecting vascular pathology and intestinal changes in mesenteric ischemia with a sensitivity of 89% - 100% and a specificity of 90% - 100% [5-7]. We aimed to find the correlation between CT and intraoperative findings in patients with ischemic bowel disease.

Patients and Methods

The records of 40 patients admitted to 19 Mayis University Medical School Hospital between January 2008 and January 2016 and diagnosed with mesenteric ischemia are evaluated. CT imaging was obtained by contrast enhancement in arterial, venous and portal phases (Somaton Definition, ASO4, Siemens Med. Systems). The effected intestinal segment, thickness of bowel wall, dilatation of bowel, halo or target sign, increased or decreased contrast material in bowel wall, faeces sign, pneumatosis intestinalis, bowel obstruction, congestion, distortion and stranding of mesenteric fat, contributing solid organ ischemia, ascites, superior mesenteric arterial thrombus, mesenteric vein thrombus and pneumoporta were reported. 19 Mayis University, Medical School Ethical Committee Approve was obtained before the study. Increased thickness of bowel wall was accepted

Table 1: Small intestinal contrast enhancement.
Crosstab.

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Small intestine	No contrast enhancement	Count	0	0	2	2
		% within small, large int	0%	0%	10,5%	5,0%
	Contrast enhancement	Count	5	16	17	38
		% within smal, large int	100,0%	100,0%	89,5%	95,0%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 2: Large intestinal contrast enhancement.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Large intestine	No contrast enhancement	Count	5	15	11	31
		% within small, large int	100,0%	93,8%	57,9%	77,5%
	Contrast enhancement	Count	0	1	8	9
		% within small, large int	,0%	6,3%	42,1%	22,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 3: Intestinal wall thickness.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Intestinal wall thickness	No present in CT	Count	3	10	18	31
		% within small,large int	60,0%	62,5%	94,7%	77,5%
	Present in CT	Count	2	6	1	9
		% within small,large int	40,0%	37,5%	5,3%	22,5%
Total		Count	5	16	19	40
		% within small,large int	100,0%	100,0%	100,0%	100,0%

Table 4: Halo (Target) Sign.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Halo (Target) Sign	Present in CT	Count	3	13	18	34
		% within small, large int	60,0%	81,3%	94,7%	85,0%
	No present İn CT	Count	2	3	1	6
		% within small, large int	40,0%	18,8%	5,3%	15,0%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

as > 3 mm. It is related with reperfusion. In mesenteric arterial occlusion, bowel wall becomes thinner if there is no hemorrhage or intestinal wall edema. Bowel wall thickness is not related with the severity of ischemia. Dilatation of bowel means; > 2.5 cm for small intestines, > 6 cm for colon, > 8 cm for cecum. It is related with decreased peristaltism. Contrast loss is highly specific for acute arterial ischemia. Contrast enhancement is related with venous ischemia and reperfusion. Delayed contrast enhancement is related with arterial perfusion and differences in venous return. Pneumatosis intestinalis shows transmural ischemia. Mesenteric stranding, congestion and distortion are related with strangulation and venous ischemia. Distortion is also related with arterial ischemia and transmural infarction. Pneumoporta and free intraabdominal gas are signs of transmural infarction. Intraabdominal findings of small and large intestinal resection requırıng ischemia referred as necrosis were determined. Cross tables were formed and Chi-square test (SPSS 21.0 version) was used for the statistical analysis to compare the computed tomography findings and intraoperative small and large intestinal necrosis.

Results

The small intestines were affected more than colonic segments

Table 5: Contrast Loss.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Contrast loss	No present in CT	Count	0	1	0	1
		% within small, large int	,0%	6,3%	,0%	2,5%
	Present in CT	Count	5	15	19	39
		% within small, large int	100,0%	93,8%	100,0%	97,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 6: Faeces Sign.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Feaces Sign	No present in CT	Count	4	13	10	27
		% within small, large int	80,0%	81,3%	52,6%	67,5%
	Present in CT	Count	1	3	9	13
		% within small, large int	20,0%	18,8%	47,4%	32,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 7: Pneumatosis intestinalis.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Pneumatosis intestinalis	No present in CT	Count	3	8	6	17
		% within small, large int	60,0%	50,0%	31,6%	42,5%
	Present in CT	Count	2	8	13	23
		% within small, large int	40,0%	50,0%	68,4%	57,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 8: Intestinal Obstruction.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Intestinal obstruction	No present in CT	Count	5	12	17	34
		% within small, large int	100,0%	75,0%	89,5%	85,0%
	Present in CT	Count	0	4	2	6
		% within small, large int	,0%	25,0%	10,5%	15,0%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

(Table 1).

Bowel wall thicknesss was not correlated with the degree of ischemia, especially in colon (Table 2).

The dilatation of bowel did not correlate with the ischemic segments. The dilatation of the small intestine was more specific than that of colon. The diameter of the colon was more increased in colon necrosis (Table 3).

Halo or target sign was generally negative (Table 4).

Most patients had loss of enhancement (Table 5).

Faeces sign is not correlated with the necrosis. It is not specific. But it was mostly seen in large intestinal ischemia in our patients (Table 6).

Pneumatosis intestinalis is not also specific for necrosis. But it was also mostly seen in large intestinal ischemia in our patients (Table 7).

Contrast loss was present in every patient (Table 8).

Mechanical intestinal obstruction was detected in only 5 patients (Table 9).

Mesenteric fat stranding is not specific. It was present also with

Table 9: Mesenteric Fat Stranding.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Mesenteric fat stranding	No present in CT	Count	3	7	9	19
		% within small, large int	60,0%	43,8%	47,4%	47,5%
	Present in CT	Count	2	9	10	21
		% within small, large int	40,0%	56,3%	52,6%	52,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 10: Solid Organ Ischemia.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Solid organ ischemia	Not present	Count	3	14	10	27
		% within small, large int	60,0%	87,5%	52,6%	67,5%
	Present	Count	2	2	9	13
		% within small, large int	40,0%	12,5%	47,4%	32,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 11: Ascites.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Ascites	No ascites	Count	3	8	10	21
		% within small, large int	60,0%	50,0%	52,6%	52,5%
	Ascites present	Count	2	8	9	19
		% within small, large int	40,0%	50,0%	47,4%	47,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 12: Mesenteric vein thrombosis.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Mesenteric vein thrombosis	Not present	Count	4	15	19	38
		% within small,large int	80,0%	93,8%	100,0%	95,0%
	Present	Count	1	1	0	2
		% within small,large int	20,0%	6,3%	,0%	5,0%
Total		Count	5	16	19	40
		% within small,large int	100,0%	100,0%	100,0%	100,0%

engorgement in 3 patients (Table 10).

In 6 patients there were accompanying solid organ ischemia (Table 11).

Ascites was not specific (Table 12).

Superior mesenteric arterial occlusion was mostly positive. (SMA (Superior Mesenteric Artery)) (Table 13).

Mesenteric vein thrombosis was present in only 2 patients (Table 14).

Pneumoporta was not specific (Table 15).

Discussion

Computerized tomography and intraoperative findings are correlated in the aspect of affected bowel segment. But intraoperative findings revealed intestinal necrosis in longer segments and sometimes additional colonic necrosis was also diagnosed. While contrast enhancement is present in tomography, small intestinal necrosis was seen in 100%, small and large intestinal necrosis was seen in 89.5% of patients. This means, contrast enhancement is predictive for small intestinal necrosis and for also majority of large intestinal necrosis. Because our patients are generally elderly and admitted late to the hospital, their renal functions are mostly not good, so we could not

Table 13: Pneumoporta.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Pneumoporta	Not present	Count	5	15	12	32
		% within small, large int	100,0%	93,8%	63,2%	80,0%
	Present	Count	0	1	7	8
		% within small, large int	,0%	6,3%	36,8%	20,0%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 14: Mortality.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Situation	exitus	Count	1	7	9	17
		% within small, large int	20,0%	43,8%	47,4%	42,5%
	live	Count	4	9	10	23
		% within small, large int	80,0%	56,3%	52,6%	57,5%
Total		Count	5	16	19	40
		% within small, large int	100,0%	100,0%	100,0%	100,0%

Table 15: Mesenteric Arterial Obstruction.
Crosstab

			Small, large intestine			Total
			No necrosis	Small intestinal necrosis	Small, large intestinal necrosis	
Mesenteric arterial obstruction	No present	Count	1	5	1	7
		% within small,large int	20,0%	31,3%	5,3%	17,5%
	Present	Count	4	11	18	33
		% within small,large int	80,0%	68,8%	94,7%	82,5%
Total		Count	5	16	19	40
		% within small,large int	100,0%	100,0%	100,0%	100,0%

give contrast material for the tomography scan, and we could not get help of contrast enhancement. If there was no contrast enhancement only in colon, there was necrosis of small intestine in laparotomy. But when there is contrast enhancement only in colon, the necrosis of small intestine in laparotomy was much less. This means, contrast enhancement is significant for the preoperative diagnosis of necrosis, but no enhancement in colon is not significant for the presence of necrosis both in colon and small intestine in laparotomy. Negative predictive value of loss of contrast enhancement is low. When there was no thickening of bowel wall, necrosis is more in small intestine and colon. When thickening is present, necrosis is less but in small intestine. This may be related with the anatomic thickness of the small intestine. It means that if there is necrosis of colon, no thickening of colonic wall is present.

Although halo (target) sign has a high diagnostic value in ischemia, most of our patients with intestinal necrosis has no halo. Our patients are generally delayed cases with resection requiring necrosis. So, halo may not be significant sign in necrosis, it may be valuable in reversible bowel ischemia. Contrast loss mainly shows bowel necrosis, so the importance of contrast CT is confirmed again. While absence of faeces sign is not significant in necrosis, presence of faeces sign was more significant for colonic necrosis in our patients. Pneumatosis intestinalis is not also valuable as contrast enhancement or loss. But if it was present, it was seen more diagnostic for colonic necrosis in our patients. Bowel obstruction was not generally present in our patients with bowel necrosis. The etiology of necrosis in our patients are generally vascular in origin. CT sign of bowel obstruction is usually present in mesenteric torsion or volvulus. We have seen that mesenteric fat stranding had no diagnostic value in our patients. This finding may be significant in early phases of mesenteric vascular obstruction like reversible ischemia. Accompanying solid organ ischemia was present in patients with small intestinal and colonic ischemia. So, this is generally related with systemic vascular disease including multiple vessels. Ascites was not significant for the diagnosis of ischemia or necrosis. Mesenteric venous thrombosis was detected in only one patient. All of our patients had ischemic bowel disease related with arterial obstruction.

Pneumoporta was not a significant criteria for small bowel necrosis in our study. It is detected significantly in colonic necrosis. It may be related with colonic gas and passage of this gas into portal system in colonic necrosis.

Mortality was related with patient's primary disease, age, functional capacity of the vital organs and sepsis; not with the anatomic location of bowel necrosis.

It was absolutely apparent in majority of the cases that the obstructing lesion inside the mesenteric artery (embolus or thrombus) could be detected in the tomography. In reversible ischemic conditions, this finding would give the chance of vascular management like embolectomy, thrombectomy or reconstruction. CT findings in bowel ischemia were reported in the literature [8,9]. There are no specific diagnostic sign. Differentiating bowel ischemia and necrosis is so much difficult. There are very few reports [10,11]. Intestinal pneumatosis, small bowel feces sign [8,12] and portal venous gas are known as signs of infarction [13,14]. All these signs are not found specific for small intestinal or colonic necrosis in our patients. These may not be a significant sign in delayed infarction and necrosis. Because most of our patients admitted to the hospital in late phases of bowel ischemia, so related mortality is high.

Reduced contrast enhancement of the bowel wall is the most reliable sign of bowel ischemia in many studies [8,9,15-17]. We also determined reduced contrast enhancement in almost all patients. It may be an important indicator of necrosis more than ischemia. It is a significant predictor in multivariate analysis ($p<0.05$), but sensitivity is 67% (18 of 27) [18]. Single phase images could sometimes miss the abnormal contrast enhancement in patients with poor circulation. Two phase contrast acquisitions can determine the decreased bowel wall enhancement. Mesenteric arteries and veins are also important in the aspect of contrast enhancement. Reduced enhancement of mesenteric veins are more sensitive than that of arteries (88%,70% *vs.* 44%,33%) [18].

Engorgement of mesenteric veins was reported in mesenteric ischemia [14,19]. It is more in early stages of ischemia with mild impairment of venous return and a viable bowel. Pathologically, first venous return is impaired. Increased venous and capillary pressure in the bowel wall and mesentery leads to edema, engorgement of the veins, rupture of small vessels, intramural and mesenteric hemorrhage. Arterial insufficiency comes later [14,20]. CT findings reflect these pathologic changes. Reduced bowel wall enhancement, reduced enhancement of mesenteric veins and lack of engorgement of mesenteric veins increase the diagnostic accuracy of the findings. Engorgement of mesenteric veins was a predictor of a viable bowel.

All of our patients had necrotic bowels. We cannot commend about CT findings showing reversible ischemic bowel.

CT findings of slight thickening of the bowel wall, the target sign, engorgement of the mesenteric vasculature, mesenteric edema are early and reversible signs of small bowel strangulation. Bowel infarction or gangrene is indicated with CT findings of high attenuation of the bowel wall, pneumatosis, hemorrhagic changes in the mesentery, gas in the portal vein, and poor or no enhancement of the bowel wall [13,20]. Serrated beak, a large amount of ascites, an unusual course of mesenteric vasculature and mesenteric haziness were the most useful findings for identifying strangulated obstruction. Combination of these findings increases the diagnostic accuracy of CT [21]. CT has a high negative predictive value and is useful for ruling out bowel ischemia in patients with suspicious bowel ischemia. It is related with multidetector CT [22]. Small intestinal segments are mainly involved in our patients. In the patients with colonic involvement, only the right colon till the midpart of the transverse colon was ischemic. This means that the superior mesenteric arterial obstruction is more prominant than the inferior mesenteric arterial obstruction. This may be related with the anatomic position and the blood flow dynamics of the SMA. Compensatory collateral circulation is only enough for the proximal 25 cm - 30 cm long segments of small intestines. The rate of mortality and short bowel syndrome are high in these patients. Bowel wall thickness is not correlated with the severity of ischemia especially in the colon. This may be related with the changes in bowel wall in hemorrhagic, edematous, arterial or venous ischemic conditions. In ischemia with hemorhage or edema or mesenteric venous obstruction; bowel wall may be seen thickened in CT examination. But if there is only arterial ischemia and necrosis of bowel wall it may be seen as a thin wall. Dilatation is also not correlated with the ischemic segments. Because the segments proximal to the ischemic segment may also dilate due to the decreased motility of the ischemic distal segments. Colon is also full of gas, so the dilatation is not specific for colon and the dilatation is more than the small intestine in colon. Halo or target sign is generally negative in our patients. This may be related with late stages of bowel ischemia. Most patients had bowel resection due to irreversible ischemia or necrosis.

We couldn't have an idea about the reversible ischemic changes in nonoperated and observed patients to compare with the intraabdominal exact pathology. This was the limitation of our study.

Conclusion

Contrast loss and SMA thrombus were found as indicators of both small and large intestinal iscemia. Bowel wall thicknesss was not correlated with the degree of ischemia, especially in colon. Faeces sign and pneumatosis intestinalis were more specific for large intestinal ischemia.

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