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Factors affecting surgical outcomes after superior mesenteric artery thromboembolism

Superior mezenterik arter tromboembolisi sonrası cerrahi sonuçları etkileyen faktörler

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ABSTRACT

Background: In this study, we aimed to evaluate the operative results of superior mesenteric artery thromboembolism and influential factors for mortality in patients undergoing surgery for acute mesenteric ischemia.

Methods: Between January 2011 and December 2016, 28 consecutive patients (15 males, 13 females; mean age 71.2±10 years; range 48 to 89 years) diagnosed and operated for acute mesenteric ischemia were included in the study. The results of open revascularization procedures and influential factors for mortality were retrospectively analyzed.

Results: Abdominal pain was the major complaint, followed by nausea and vomiting. The diagnosis was confirmed by computed tomography angiography and Duplex ultrasonography. Thromboembolectomy was performed in the majority of the patients, while autologous saphenous vein bypass and transposition were performed in eligible patients. Revascularization procedures prevented bowel resection in 10 patients. The mortality rate was 35.7% due to respiratory, renal, and cardiac pathologies. Postoperative respiratory failure and admission to hospital later than six hours after the onset of abdominal pain were identified as the factors affecting mortality.

Conclusion: Our study results showed that postoperative respiratory failure and late admission after the onset of abdominal pain were associated with postoperative mortality, whereas intestinal resection requirement did not contribute to the mortality rates. Based on our study results, we suggest that exploratory laparotomy and thromboembolectomy are essential in evaluating the viability of the bowel and in continuation of the mesenteric perfusion.

Keywords: Embolectomy; mesenteric ischemia; superior mesenteric artery.

ÖZ

Amaç: Bu çalışmada, akut mezenterik iskemi nedeniyle ameliyat edilen hastalarda superior mezenterik arter tromboembolisinin ameliyat sonuçları ve mortaliteyi etkileyen faktörler değerlendirildi.

Çalışma planı: Ocak 2011 - Aralık 2016 tarihleri arasında akut mezenterik iskemi tanısı konan ve ameliyat edilen ardışık 28 hasta (15 erkek, 13 kadın; ort. yaş 71.2±10 yıl; dağılım 48-89 yıl) çalışmaya alındı. Açık revaskülarizasyon işlemlerinin sonuçları ve mortaliteyi etkileyen faktörler retrospektif olarak değerlendirildi.

Bulgular: En sık şikayet karın ağrısını takiben bulantı ve kusma idi. Tanı, bilgisayarlı tomografi anjiyografi ve Dupleks ultrasonografi ile doğrulandı. Hastaların çoğunluğunda tromboembolektomi yapılırken, uygun hastalarda otolog safen ven baypas ve transpozisyon uygulandı. Revaskülarizasyon işlemleri 10 hastada bağırsak rezeksiyonunu engelledi. Solunum, böbrek ve kalp patolojilerine bağlı mortalite oranı %35.7 idi. Ameliyat sonrası solunum yetmezliği ve karın ağrısı başlangıcından sonra altı saatten daha geç hastaneye başvuru, mortaliteyi etkileyen faktörler olarak bulundu.

Sonuç: Çalışma sonuçlarımız ameliyat sonrası solunum yetmezliği ve karın ağrısı başlangıcından sonra geç başvurunun ameliyat sonrası mortalite ile ilişkili olduğunu gösterirken, bağırsak rezeksiyon gereksiniminin mortalite oranlarına bir etkisi gözlenmedi. Çalışma sonuçlarımıza göre, keşif amaçlı laparotomi ve tromboembolektominin, bağırsak canlılığını değerlendirmede ve mezenterik perfüzyonun devamında önemli olduğu kanısındayız.

Anahtar sözcükler: Embolektomi; mezenterik iskemi; superior mezenterik arter.

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Acute mesenteric ischemia (AMI) occurs due to the lack of blood perfusion to the superior mesenteric artery (SMA). Patients usually admit with complaints of acute severe abdominal pain, followed by reduced pain due to hypoperfusion of the intestinal wall.[1] In this critical and rare clinical situation, suspicion of the clinician, rapid diagnosis, laboratory testing, and early decision for surgery are of vital importance. Diagnosis is usually confirmed by computed tomography (CT) or Duplex ultrasonography. The delay in diagnosis, extent of intestinal ischemia, and revascularization are decisive in the prognosis.[2] This rare, but life-threatening clinical condition is associated with a high mortality ranging between 24 to 96% in the literature.[3,4]

In this study, we aimed to evaluate the operative results of SMA thromboembolism and influential factors for mortality among the patients undergoing surgery for AMI.

PATIENTS AND METHODS

Between January 2011 and December 2016, 28 consecutive patients (15 males, 13 females; mean age 71.2±10 years; range 48 to 89 years) diagnosed and operated for AMI were included in this study. A total of 34 patients were operated for AMI in the study period. However, we excluded patients with mesenteric venous occlusion or non-occlusive mesenteric ischemia. We retrospectively evaluated the results of open revascularization procedures and outcomes of these 28 operations. The study was approved by the Institutional Ethics Committee (No: 247/2016). A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients admitted to hospital with complaints of a sudden-onset abdominal pain, nausea, and vomiting and suspected for AMI were evaluated initially by the surgery consultant in the emergency service. Decision for surgery for AMI was considered based on radiological findings. Revascularization was planned prior to bowel surgery. Patients were operated under general anesthesia and laparotomy was performed through a vertical midline incision. The omentum and transverse colon were retracted. The peritoneum crossing the mesentery of the small intestine was incised. The SMA is found at the junction of small intestine and transverse mesocolon. The SMA was dissected and palpated. Maximum care should be given to avoid injury to the superior mesenteric vein. After the administration of heparin (5000 IU), thromboembolectomy was performed through the transverse arteriotomy. If good inflow and back bleeding was able to be maintained, the arteriotomy was closed primarily.

If the SMA was severely atherosclerotic, SMA was revascularized using autologous saphenous vein bypass. The intestines were checked for viability. The color, dilatation, and peristaltic motion of the intestines were evaluated. The presence of mesenteric ischemia due to superior mesenteric artery occlusion was the main indication for revascularization. Open revascularization was performed with the evaluation of the mesenteric vasculature, thromboembolectomy, SMA transposition or bypass grafting using a saphenous vein graft with the evaluation of the intestinal viability. The areas with signs of viability were not resected. Localized or extended resections were performed by the colorectal surgeon. Localized resection was described as the remaining length of small intestine longer than 150 cm. The patients underwent a second-look operation approximately two days after the first procedure to control the borderline areas based on the decision of the colorectal surgeon. Heparin infusion was continued for the three days after surgery. Routine arterial blood gas analysis and hemodynamic follow-up were continued in the intensive care unit.

The main complications in the postoperative period included acute renal failure requiring hemodialysis, myocardial infarction, gastrointestinal system bleeding, and respiratory failure. Acute renal failure was described as creatinine >1.5 mg/dL in patients with normal preoperative renal function. Respiratory failure was described as intubation time longer than 72 hours in the intensive care unit. Myocardial infarction was diagnosed via electrocardiogram changes in the postoperative period and elevation of cardiac enzymes. Postoperative stroke was diagnosed by neurological examination in combination with cerebral CT alterations.

Statistical analysis

The Statistical Package for the Social Sciences (IBM SPSS) version 22.0 software (IBM Corp., Armonk, NY, USA) was used. Median (min-Max) values and mean ± standard deviation (SD) and number and percentage were used as descriptive statistics. Differences between the patients were analyzed using the Mann-Whitney U test for continuous variables, when normal distribution of measurable data with single sample Kolmogorov-Smirnov test showed abnormal distribution. The Yates-corrected Pearson chi-square (χ^2) and Fisher's chi-square test were used for the qualitative data. Variables with a p value of ≤0.1

Table 1. Demographic characteristics of patients with acute mesenteric ischemia

	n	%	Mean±SD	Range
Age (year)			71.2±10	48-89
Gender				
Male	15	53.6		
Female	13	46.4		
Hypertension	14	50		
Hyperlipidemia	3	10.7		
Atrial fibrillation	11	39.3		
Smoking history	12	42.9		
Diabetes mellitus	4	14.3		
Coronary heart disease	10	35.7		
Peripheral vascular disease	2	7.1		
Chronic renal insufficiency	1	3.6		

SD: Standard deviation.

in the binary comparison were included in the logistic regression analysis. A p value of <0.05 was considered statistically significant.

RESULTS

Demographic variables in patients with AMI are listed in Table 1.

Abdominal pain was the major complaint, nausea, and vomiting subsequently. Laboratory evaluation revealed moderate leukocytosis in 20 patients (71.4%) and highly elevated leukocytosis in four patients (14.3%), serum amylase levels were elevated in seven patients (25%), and metabolic acidosis in 27 patients (96.4%). Only eight patients (28.6%) were admitted to hospital within the first six hours after the onset of abdominal pain. Diagnosis was confirmed by CT angiography in 23 patients (82.1%) and Duplex ultrasonography in five patients (17.9%). We did not use digital subtraction angiography in any patient in the study group.

Thromboembolectomy was the procedure of choice in the majority of the patients. Operative characteristics and procedures in patients with AMI are listed in Table 2. Resection of bowel tissue during the initial surgery was necessary in 18 patients, while revascularization procedures recovered blood perfusion, ensured intestinal viability, and prevented bowel resection in 10 patients. Second-look laparotomy was performed in five patients, and no additional bowel resection was required during second-look operations.

Major complications in the postoperative period are summarized in Table 3. Thirty-day mortality in the study group was observed in 10 patients (35.7%). Mortality was 1/8 (12.5%) among the patients who were admitted to hospital within the first six hours after the onset of abdominal pain. The mean intensive care unit stay was 6.2±2.3 days in the remaining 18 surviving patients. The patients were discharged from the hospital at 22.7±6.4 days. Unfortunately, we were unable to achieve the exact patency rates of the study group. In addition, we did not perform a routine control CT angiography to all patients during the first-year follow-up visit.

The factors affecting mortality after AMI surgery were also assessed. Demographic variables, and operative and postoperative data were compared

Table 2. Operative features and procedures in patients with acute mesenteric ischemia

	n	%
Thrombectomy/embolectomy	23	82.1
Autologous saphenous vein bypass	4	14.3
SMA transposition	1	3.6
No bowel resection	10	35.7
Localized resection	12	42.9
Extended resection	6	21.4
Second look operation	5	17.9

SMA: Superior mesenteric artery.

Table 3. Postoperative complications

	n	%
Acute renal failure	6	21.4
Respiratory failure	5	17.9
Myocardial infarction	2	7.1
Gastrointestinal bleeding	1	3.6
Stroke	3	10.7
Mortality	10	35.7

Table 4. Analysis of factors affecting mortality

Factors	Group 1		Group 2		
	n	Mean±SD	n	Mean±SD	*p*
Age (year)		72.7±10.7		70.7±9.8	0.701
Gender					0.705
Male	6		9		
Female	4		9		
Hypertension	6		8		0.693
Hyperlipidemia	1		2		1.000
Atrial fibrillation	6		5		0.125
Smoking history	4		7		1.000
Diabetes mellitus	3		1		0.116
Coronary heart disease	5		5		0.412
Peripheral vascular disease	0		2		0.524
Chronic renal insufficiency	0		1		1.000
Late admission to hospital	8		0		0.001
No resection	4		6		1.000
Localized resection	3		9		0.434
Extended resection	3		3		0.634
Postoperative acute renal failure	4		2		0.147
Postoperative acute myocardial infarction	2		0		0.119
Postoperative gastrointestinal system bleeding	1		0		0.357
Postoperative stroke	2		1		0.284
Postoperative respiratory failure	5		0		0.003

SD: Standard deviation.

between the non-survivors (Group 1, n=10) and survivors (Group 2, n=18). There were no statistically significant differences in the demographic variables and operative procedures between the groups. Postoperative complications were also evaluated for their possible contribution to the mortality rates. Respiratory failure in the postoperative period and admission to hospital later than six hours after the onset of abdominal pain were found to be the influential factors associated with postoperative mortality (Table 4).

DISCUSSION

Thromboembolic occlusion of the SMA has the greatest impact on the development of AMI. The collaterals between celiac trunk, inferior mesenteric artery, SMA, and internal iliac arteries are important in compensation of bowel perfusion after SMA occlusion.[5] Acute occlusion of the inferior mesenteric artery may remain asymptomatic due to its small caliber and collaterals from SMA. Ottinger separated the SMA into four parts: origin, main trunk with the origin of the middle colic artery, main trunk after middle colic artery to ileocolic artery, and the peripheral portion of the SMA and concluded that impact of proximal occlusion location was important in determining prognosis.[6] In our study group, 67.9% (19/28) of arterial occlusions were in the main SMA trunk, including the origin of the middle colic artery, and 32.1% (9/28) were distal to the middle colic artery. The more proximal the level of arterial occlusion is, the more extensive ischemia will be present. Although eight of the in-hospital deaths occurred within the first group, the difference was not statistically significant.

Acute mesenteric ischemia can be defined as the abrupt lack of blood flow to the SMA and results in intestinal ischemia. Similarly, abdominal pain, nausea, and vomiting were the most common complaints in our study. The abdominal pain is usually sudden-onset and with minimal findings at examination, may reduce in intensity initially, followed by an increase, indicating a progression to peritonitis.[5] The most common cause of AMI is embolism due to atrial fibrillation.[7] In our study, cardiac thromboembolism was also the most common cause of mesenteric ischemia (39.3%) and nearly one third of others were atherosclerotic vascular disease, aortic aneurysm, aortic dissection, arteritis, decreased cardiac output from congestive heart failure, and embolism from fragments of proximal aortic thrombus of patients had coronary heart disease.

Usually routine laboratory tests or plasma markers are not diagnostic for AMI.[8] Patients have elevated D-dimer, leukocytosis, high lactate levels, but none of them are diagnostic for AMI. Dynamic CT angiography with three-dimensional reconstruction and Duplex ultrasonography are particularly helpful for AMI diagnosis.[9] Biphasic contrast CT scanning is the gold standard in the diagnosis of AMI.[10,11] Due to non-specific symptoms and clinical manifestations, accurate diagnosis may be delayed, and this delay may increase the mortality and morbidity rates. In our study, we diagnosed the AMI patients by dynamic CT angiography and we recommended it for all patients suspected for AMI.

Although several treatment options are available for AMI including endovascular techniques, the most common technique is surgical laparotomy and thrombectomy.[12,13] Our main treatment strategy was an emergency laparotomy operation involving surgical thromboembolectomy with or without resection of affected intestinal segment. The majority of the patients were operated by using thromboembolectomy technique. In four patients with long-segment stenosis at SMA, we preferred bypass procedure by the autologous saphenous vein graft. We used SMA transposition in only one patient that had a short-segment stenosis at SMA, and we re-inserted further distally into the infrarenal aorta. Even with thromboembolectomy alone, bowel resection was relieved in approximately one third of the patients.

Structural changes start after 15 min of ischemia and transmural necrosis and gangrene occurs at six hours.[14] Intestinal wall gangrene develops due to the mucosal barrier destruction which allows bacterial translocation, that may cause peritonitis.[15] In our study group, mortality occurred in only one patient among the patients admitted to hospital within their first six hours after the onset of abdominal pain. Surgical revascularization prior to intestinal wall gangrene development is critical in patients with SMA thromboembolism. In our study group, mortality was 45% (9/20) among patients with delayed mesenteric ischemia which makes the efficacy of embolectomy questionable in those cases. Prompt diagnosis and aggressive treatment are important before deterioration becomes irreversible, regardless of the etiology.

Early diagnosis prior to bowel necrosis is one of the most important prognostic factors.[2] In our study group, admission to hospital later than six hours after the onset of abdominal pain was directly associated with an increased postoperative mortality. Boley et al.[16] reported a mortality rate of 88%, when diagnosis was made later than 24 hours, but a reduction to 57%, if patients were diagnosed earlier. Unalp et al.[17] also emphasized on the importance of late admission after the onset of abdominal pain and reported it as an independent risk factor for mortality in the postoperative period. Age over 60 years is a predictive risk factor for mortality.[3] In our study group, although the mean age was higher in the non-survivors, it did not reach statistical significance.

Park et al.[3] reported that bowel resection at the first-look procedure was a factor associated with an improved survival rate. In our study group, although the survival rate was higher in the bowel resection group, it did not reach statistical significance. Postoperative complications may also increase the mortality rate. Arthurs et al.[18] reported that, in the postoperative period, acute renal failure and pulmonary failure were significantly associated with postoperative mortality. In our study group, postoperative respiratory failure was associated with the increased mortality. Although the survival rate was lower in the patients with acute renal failure, it did not reach statistical significance.

Despite advances in diagnostic and therapeutic options in AMI, mortality rates are still high. Early diagnosis, restoration of blood perfusion, removal of non-viable intestine and supportive treatment in the intensive care unit may contribute to the lower mortality rates.[19] The most common complications in the postoperative period were acute renal failure and respiratory failure. In our study, we observed a mortality rate of 35.7%. This ratio may be due to the high mean age of the study group and comorbidities. A total of 15 patients (53.6%) were over 70 years of age. Also 3/6 of the patients (50%) operated for extended bowel resection and 5/12 (41.7%) of the patients operated for localized bowel resection were unable to survive. The mortality rate in our study group is consistent with the recent reports in the literature.[20,21]

In conclusion, morbidity and mortality rates from Acute mesenteric ischemia are still high. The initial diagnosis is based on the high suspicion of the clinician and computed tomography findings in this rare clinical situation. Exploratory laparotomy is essential in patients with acute mesenteric ischemia in evaluating the viability of the bowel, and thromboembolectomy plays an important role in continuation of the blood flow through superior mesenteric artery in this fatal problem. Mesenteric revascularization should be performed prior to bowel surgery. Thromboembolectomy is still a good treatment choice, while autologous saphenous vein bypass can be considered in terms of severely atherosclerotic SMA. With early surgery and

revascularization, the length of resection of the small intestine may be reduced or prevented, but this does not reduce mortality. Postoperative respiratory failure and late admission after the onset of abdominal pain are associated with postoperative mortality.

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