Does calcium score in great pelvic vessels predict colorectal anastomotic leakage? A prospective study of one hundred anastomoses

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Abstract

Background and study aims : **Anastomotic leakage is one of the most severe surgical complications following surgery. This prospective study was designed to investigate an association between the calcification in the descending aorta and its major branches using a calcium-scoring software and colorectal anastomotic leakage.**

Patients and methods : **From January 2012 to March 2013, one hundred patients underwent surgeries involving colorectal anastomosis procedures. Calcium score in descending aorta and great pelvic vessels was measured using the Syngo-CT 2006G-W software. A questionnaire was completed containing demographic and underlying risk factors suspicious to be associated with anastomotic leakage, in addition to surgical characteristics data.**

Results : **55 males and 45 females entered the study with the mean age of 63.70±7.17 years. The average duration time of surgery was 149.30±20.24 minutes. The type of surgery was elective for 90 patients and emergency for 10 others. The mean calcium score was higher in greater arteries as in abdominal aorta and common iliac arteries in comparison to the other pelvic vessels. Comparing two groups of patients with and without anastomotic leakage, the calcium score was higher in descending aorta and all great pelvic vessels of patients with colorectal anastomotic leakage (P<0.001). One patient (1%) died due to postoperative anastomotic leakage two weeks after the surgery.**

Conclusions : **Atherosclerotic calcification in the descending aorta and its major branches can be considered as a risk factor in the development of colorectal anastomotic leakage.** (Acta gastroenterol. belg., **2016,** 79**, 415-420**).

Key words : anastomotic leakage, calcium score, colorectal.

Introduction

Colorectal anastomotic leakage remains a serious complication after surgery leading to high morbidity rates. Several risk factors have been suggested to be involved in postsurgical anastomotic leakage in surgery such as bacteria (1), prolonged operative time (2-5), high ASA (American Society of Anesthesiologists) score (3,6-8), high body mass index (BMI) (4,9), emergency operation (7), total colectomy (3), prophylactic drainage (4,10), smoking (9,11) and alcohol abuse (11), cardiovascular disease (5), preoperative steroid use (12), preoperative chemoradiotherapy (2,5), type of anastomotic suture (13).

Although various risk factors of colorectal anastomotic leakage have been extensively studied, no significant reduction has been observed over the last years. The incidence rate of this complication is still high and varies from 2.5% to 20% % in the literature (14-19) which means the practical risk factors of colorectal anastomotic leakage have not been well-established yet. Therefore, a better understanding of risk factors for developing anastomotic leakage in surgery is still an important issue for research.

Local ischemia is one of the anastomotic leakage causes after surgery (20,21). Insufficient arterial blood supply caused by atherosclerosis has been suggested to have a negative effect on anastomotic healing (19).

Nowadays, it has become popular to quantify calcification due to atherosclerosis in computed tomography (CT) scan using calcium-scoring software. Recently, there has been interest in the measurement of calcium score in carotid (22-25) and coronary (26-31) arteries to predict the extent and severity of atherosclerosis to predict the prognosis of the patients.

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A retrospective study by Komen et al. has evaluated calcium score in great pelvic arteries as a risk factor for atherosclerosis which can result in colorectal anastomotic leakage (18). This score represents the severity of atherosclerosis in the detecting arteries, as a main predicting factor for ischemia.

Here we designed a prospective cross-sectional study to evaluate calcium score in the descending aorta and its major branches as a probable risk factor for predicting colorectal anastomotic leakage at a preclinical stage. Our null hypothesis is that there would be an association between calcium score in pelvic arteries and colorectal anastomotic leakage risk.

Methods and materials

This prospective cross-sectional study was approved by the local ethics committee of Sina Trauma and Surgery Reseach Center, Sina Hospital, Tehran University of Medical Sciences (TUMS). All patients with rectal or colon cancers undergoing colon resection with colocolic or ileocolic anastomoses regardless of receiving radiotherapy prior to the surgery from February 2012 to May 2014 in Sina University Hospital were recruited in this study. Patients with ileal pouch-anal anastomosis were excluded from the study. All included patients signed an informal consent.

Contrast-enhanced abdominal CT scan with a 5-mm slice thickness was collected from all patients before surgery except in emergency situations in which CT scan was performed postoperatively. Calcium score was subsequently processed to generate using a standard calcium-scoring software (*Syngo-CT 2006G-W software ; Siemens, Forcheim, Germany)* by an expert radiologist based on the preoperative CT scan, in the following arteries ; descending aorta lower than the level of L1-L2, right and left common iliac arteries, right and left internal and external iliac arteries and the superior mesenteric artery. The lower threshold for determining calcium score was considered 500 Hounsfield units. Another abdominal and pelvic CT scan with oral and intravenous contrast was performed only in patients with clinical suspicion of anastomotic leakage to confirm the anastomotic leakage based on their signs and symptoms. Any patient with the diagnosis of abscess in imaging, purulent discharge from the anastomosis site, gastrointestinal discharge from drains or extravasation of contrast in CT scan was considered as a case of anastomosis leakage. In addition, patients requiring surgical or radiological drainage and those who had small abscesses in CT scan and were decided for antibiotic therapy only without drainage were also considered as anastomotic leakage.

Protective loop ileostomy was done for all patients who had received neoadjuant chemoradiotherapy prior to the surgery. A questionnaire containing patient and operation related variables including age, BMI, sex, comorbid diseases like hypertension (systolic blood pressure more than 140 mm Hg or diastolic blood pressure more than 90 mm Hg) and diabetes mellitus, neoadjuvant therapy, use of steroids, smoking, American Society of Anesthesiology (ASA) score, duration of surgery, type of surgery (emergency or elective), type of suture (stapler or hand-sewn), type of anastomotic (end to side or end to end) and anatomical location of the anastomosis was completed.

Mann-Whitney U or chi-square tests in univariate analysis were used to compare between two groups of patients with and without anastomotic leakage. Analysis was performed using *SPSS software version 20 ; SPSS Inc, Chicago, Illinois, USA*. P values less than 0.05 were considered as statistically significant in all analysis.

Results

One hundred patients (55 males and 45 females) with the mean age of 63.7 ± 7.1 years (ranging from 49 to 76) underwent surgeries involving colorectal anastomosis over a 20-month period. As the main outcome, anastomotic leakage was found in 20 cases (20%) diagnosed clinically and confirmed by abdominopelvic CT scan.

ASA score was I for 35 and II for 65 patients. Other patient-related data are shown in table 1. Comparing the two groups of patients with and without anastomotic leakage, the incidence of anastomotic leakage was significantly higher in males, diabetic patients, smokers and in those who received neoadjuant chemoradiotherapy prior to the surgery (p values <0.05) (Table 1).

The mean duration time of surgery was 149.3±20.2 minutes (range from 120 to 200). The type of surgery was elective for 90 patients and emergency for 10 others. Table 2 shows the comparison of other surgical characteristics between the two groups of patients with and without anastomotic leakage. The mean duration time of surgery was higher in patients with anastomotic leakage in comparison to those without leakage (p value <0.05). The incidence of anastomotic leakage was significantly higher in patients with emergency surgeries, end-to-end anastomosis and also in rectal anastomoses (p values <0.05) (Table 2).

The mean calcium score was higher in greater arteries as in abdominal aorta and common iliac arteries in comparison to the other pelvic vessels. Figure 1 shows the mean difference of calcium scores in abdominal aorta and great pelvic arteries for the two groups of patients with and without colorectal anastomotic leakage. One patient (1%) died due to anastomotic leakage two weeks after surgery.

Discussion

Different etiological factors including insufficient arterial blood supply, tension on the anastomosis, hematoma or infection at the anastomotic site, and co-morbid factors of the patient as diabetes and atherosclerosis are known to be related to developing

Table 1 — **Comparison of patient-related data in two groups of patients with and without colorectal anastomosis leakage**

Patient-related data				Anastomosis leakage		P value
				Positive	Negative	
				20 (20%)	80 (80%)	
Demographic data	Age (Mean±SD) (yr)		63.70 ± 7.17	62.7 ± 9.6	63.9 ± 6.4	0.510
	BMI (Mean±SD) (Kg/m^2)		20.44 ± 1.50	19.7 ± 0.9	20.6 ± 1.5	0.118
	Sex	Male	55 (55%)	15 (27.3%)	40 (72.7%)	**0.044**
		Female	45 (45%)	5 (11.1%)	40 (88.9%)	
Underlying data	Hypertension	Positive	60 (60%)	15 (25%)	45 (75%)	0.126
		Negative	40 (40%)	5 (12.5%)	35 (87.5%)	
	Diabetes mellitus	Positive	20 (20%)	0 (0%)	20 (100%)	**0.012**
		Negative	80 (80%)	0 (0%)	80 (100%)	
	Steroid use	Positive	15 (15%)	5 (33.3%)	10 (66.7%)	0.161
		Negative	85 (85%)	15 (17.6%)	70 (82.4%)	
	Neoadjuvant chemoradiotherapry	Positive	25 (25%)	11 (44%)	14 (56%)	**0.040**
		Negative	75 (75%)	9 (12%)	66 (88%)	
	Smoking	Positive	40 (40%)	15 (37.5%)	25 (62.5%)	**<0.001**
		Negative	60 (60%)	5 (8.3%)	55 (91.7%)	

Table 2 — **Comparison of operation-related data between two groups of patients with and without colorectal anastomosis leakage**

operation-related data			Anastomosis leakage		P value
			Positive	Negative	
			20 (20%)	80 (80%)	
Duration of surgery (Mean±SD)(min)		149.30±20.24	157.2±17.3	147.3±20.5	**0.049**
Type of suture	Hand-sewn	40 (40%)	10 (25%)	30 (75%)	0.307
	Stapler	60 (60%)	10 (16.7%)	50 (83.3%)	
Type of surgery	Emergency	10 (10%)	5 (50%)	5 (50%)	**0.012**
	Elective	90 (90%)	15 (16.7%)	75 (83.3%)	
Type of anastomosis	End to side	40 (40%)	0 (0%)	40 (100%)	**0.036**
	End to end	60 (60%)	20 (33.3%)	40 (66.6%)	
Anatomical location of the anastomosis	Ascending (right) colon	15 (15%)	0 (0%)	15 (100%)	**<0.001**
	Descending (left) colon	50 (50%)	5 (10%)	45 (90%)	
	Rectum	20 (20%)	10 (50%)	10 (66.6%)	
	Total colon	15 (15%)	5 (33.3%)	10 (66.7%)	

anastomotic leakage. However, no consensus on the preoperative risk factors exists. CT scan detection of calcium has become a popular technique for assessing atherosclerosis (34). Calcification score actually measures the atherosclerotic load in the vascular route (33,34). Komen et al. retrospectively analyzed calcium score, as a risk factor for colorectal anastomotic leakage, in 122 patients using a CT scan and calcium scoring software. Their results showed that patients with higher calcium scores in the iliac arteries have an increased leakage risk. In their study, calcium score was significantly higher in the left common iliac artery, right common iliac artery, both common iliac arteries together, and the left internal iliac artery. This variable was not significantly different between the two groups of patients with and without Al in Aorta, left external iliac artery, right internal iliac artery, right external iliac artery, left and right internal iliac arteries (18). As it is shown in figure 1, all the calcium scores were significantly different between the two groups in all assessed arteries including abdominal aorta, both common iliac arteries, both external iliac arteries, both internal iliac arteries, superior mesenteric artery and eventually in all trajectory in our study.

Komen et al reported all the three parameters of calcium score, volume and mass as independent risk factors for colorectal anastomotic leakage. However, the data for calcium volume and mass was not available in our study.

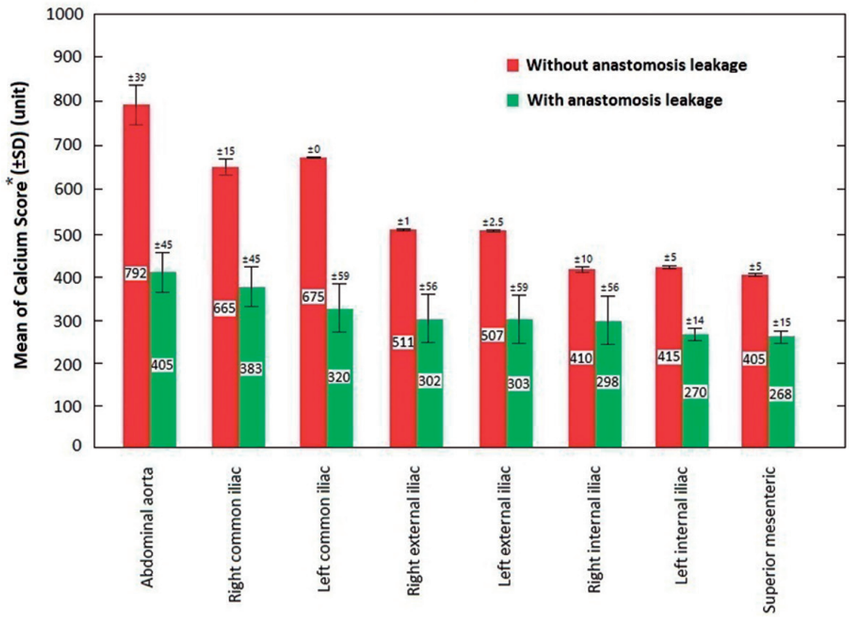

Fig. 1. — Mean of calcium score (±SD) in descending aorta and great pelvic vessels of patients with and without colorectal anastomosis leakage
*All the differences were statistically significant (P values <0.001)

On the other hand, male gender, diabetes mellitus, smoking and neoadjvuant chemoradiotherapy from patient-related factors and duration of surgery, type of surgery (emergency vs. elective), type of anastomosis (end to side vs. end to end) and anatomical location of the anastomosis from the operation-related data were significantly different between the two groups in our study. However, none of the scored patient- and operation-related factors were significantly different between the two groups of patients with and without anastomotic leakage in Komen's. Moreover, the superior mesenteric artery, which has the main part of colorectal region blood supply was not evaluated by Komen et al.

Although this study was designed to measure calcification in great pelvic vessels, some important points should be taking into consideration. First, atherosclerosis of micro vessels is very important in local perfusion and calcification in major vessels might be reflecting vascular diseases in the microvasculature. Second, hypoperfusion might already be present without calcification, since atherosclerosis is not always calcified but do affect perfusion. In addition, atherosclerosis may just reflect the general condition of the patient increasing the risk of leaking anastomoses, without causing a lower blood supply.

The blood supply of the colorectal region is mainly provided by the superior and inferior mesenteric arteries. Calcium scoring was not possible in inferior mesenteric artery due to its small diameter, but we calculated the calcium score in the superior mesenteric, which was not calculated in Komen's study.

We accept that a colorectal anastomotic leakage rate of 20% is far too high which can be mainly due to less experience of the surgeon especially in rectal region. Comparing our anastomotic leakage rate with those of other studies, Komen et al. reported a rate of 9% among their 122 patients while Kingham et al. reported rate of anastomotic leakage ranging from 2.4% to 19% in different studies although experienced colorectal surgeons often quote 3% to 6% as an acceptable overall leakage rate (35). Kingham also emphasizes that emergency operations are at greater risk for anastomosis breakdown than those procedures performed electively, as in our patients, from ten emergency surgeries, five (50%) had anastomotic leakage.

Considering the main object of the study that would be a comparison of calcification in great vessels between two groups of patients with and without anastomotic leakage, the main limitation of this study would be a high variety of indications and types of anastomoses, so a uniform conclusion may not be drawn.

As a summary, our findings recommend that calci fication in the descending aorta and its major branches can be considered as a risk factor in the development of colorectal anastomotic leakage. Preoperative calcium score calculation in great arteries, along with the other underlying factors, can be helpful in predicting the outcome of anastomosis. Prospective studies with a larger number of patients should be performed and additional parameters should be studied to explore the full diagnostic potential of this method in preventing colorectal anastomotic dehiscence.

Conflict of interest

The authors declare that they have no conflict of interest.

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