Distal thoracic aorta as inflow for the treatment of chronic mesenteric ischemia

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Purpose: **Mesenteric revascularization for chronic mesenteric ischemia (CMI) traditionally involves antegrade or retrograde bypass graft originating from the supraceliac or infrarenal aorta. The distal thoracic aorta (DTA) may provide a better inflow source than the abdominal aorta. The purpose of this study was to evaluate the results with the DTA used as inflow for the surgical treatment of CMI.**

Methods: **All patients undergoing mesenteric revascularization for CMI with grafts originating from the DTA were identified from 1990 to 1999. A ninth interspace thoracoretroperitoneal incision was used for exposure, and distal aortic flow was maintained by use of a partial occlusion clamp.**

Results: **Eighteen consecutive patients with CMI underwent mesenteric bypass grafting with the DTA used as inflow. All patients were admitted with chronic abdominal pain or weight loss, with two (12%) requiring urgent revascularization because of acute exacerbation of chronic symptoms. Fourteen (78%) patients had both celiac and superior mesenteric artery bypass grafts placed, and three (17%) patients had superior mesenteric artery grafts alone. There was one (6%) perioperative death and three (17%) major complications. There was no kidney failure, mesenteric infarction, or spinal cord ischemia. The life-table survival rate was 89%, 89%, and 76% at 1, 3, and 5 years, respectively. All 18 patients remained symptom free and required no additional procedures to assist patency. There was no evidence of graft stenosis or occlusion (100% patency) for those grafts evaluated objectively during the mean follow-up of 34.8 months (range, 1-97 months).**

Conclusions: **Antegrade mesenteric revascularization with the DTA used as inflow is associated with low morbidity and mortality rates. Furthermore, it provides excellent midterm patency and survival results and should be considered as a primary approach for reconstruction of patients with CMI. (J Vasc Surg 2001;33:281-8.)**

During the past two decades numerous publications have reported the merits of various methods of revascularization for chronic mesenteric ischemia (CMI).[1-5] Controversy centers primarily around two issues: the merits of antegrade versus retrograde bypass grafting in providing optimal revascularization and the need for complete revascularization to reduce the risk of recurrence. In 1981 Hollier et al[3] popularized the concept of complete revascularization, proposing that, by reestablishing blood flow to all diseased vessels, the risk of recurrent symptoms and associated complication related to graft thrombosis or stenosis was reduced. In distinct contrast Gentile et al[6] believe that isolated retrograde bypass grafts to the superior mesenteric artery (SMA) provide comparable results and long-term prevention of recurrence. Antegrade bypass grafts theoretically provide the best flow characteristics and may minimize the risk of kinking that has been proposed as a mechanism of perioperative thrombosis. To date, no method has been proved to be superior because most studies have a limited cohort size as a result of the low prevalence of this disease. Furthermore, several reports lack objective follow-up data and have based their life-table patency solely on clinical observations, which may underestimate the incidence of graft thrombosis and stenosis.[2,3,5]

Revascularization traditionally involves antegrade or retrograde bypass grafts originating from the supraceliac or infrarenal aorta with a transabdominal approach. In cases where abdominal disease or prior surgery would render a difficult transperitoneal exposure, the distal thoracic aorta (DTA), which is relatively free of atherosclerosis, may provide a better inflow source. The purpose of this report is to evaluate the results with the DTA used as inflow for the surgical treatment of CMI.

PATIENTS AND METHODS

From 1990 to 1999 all patients undergoing mesenteric revascularization for CMI with grafts originating from the DTA were identified from the Vascular Surgery Operative Database at the University of North Carolina. Patient demographics and procedural characteristics were obtained from hospital records. Angiography was performed and available for review in all patients. Mesenteric vessels were characterized as being stenotic if > 50% stenosis existed. The status of the internal iliac arteries was documented when angiographic evaluation was available.

Patients were positioned in the right lateral decubitus orientation after intubation with a double lumen endotracheal tube (Fig 1). If access to the iliac or femoral vessels

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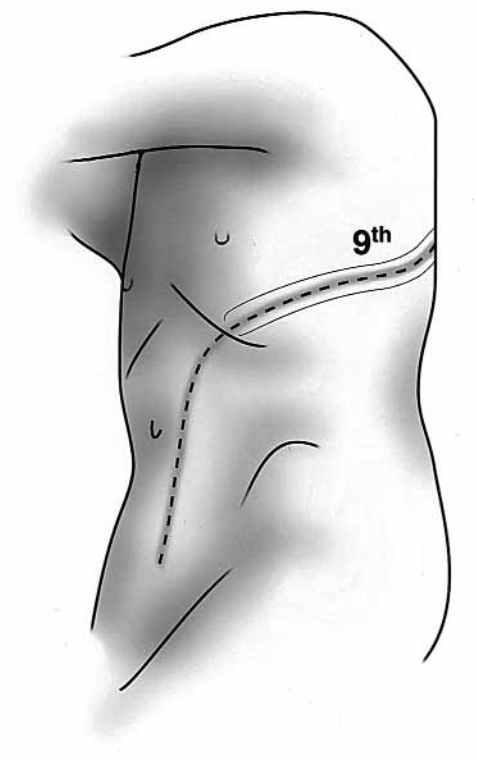

Fig 1. Patient positioned in right lateral decubitus position before undergoing thoracomesenteric bypass grafting. *Dashed line* shows intended location of incision.

was required, then the pelvis was rotated at approximately 60 degrees. A bean bag and axillary roll were routinely required to aid in positioning. A ninth interspace thoracoretroperitoneal incision was used to expose the thoracic and upper abdominal aorta. Mobilization of the peritoneum and its contents from the undersurface of the diaphragm was performed bluntly. The diaphragm was incised in a curvilinear fashion 2 cm from its costal edge to preserve innervation and with marking stitches to improve reapproximation. The inferior pulmonary ligament was divided, as well as the crus of the diaphragm. The celiac and superior mesenteric vessels were exposed until a suitable bypass graft site was obtained (Fig 2). If required, 8 to 10 cm of vessel can be exposed. The left kidney was left undisturbed in its native position to facilitate distal exposure of the SMA. A partial occlusion clamp technique was used to maintain distal aortic flow to the kidneys and spinal cord (Fig 3). The proximal anastomoses were performed with a single clamp application to minimize repeated trauma to the thoracic aorta. Prosthetic bypass graft conduits were used and routed through the diaphragmatic hiatus to their respective vessels in an end-to-side fashion to establish antegrade flow (Fig 4).

Patients revascularized after January 1996 were monitored prospectively and underwent objective documentation of patency before discharge with computed tomography, magnetic resonance angiography (MRA), or duplex scan evaluation. Duplex ultrasound scanning was initiated at the 4-month follow-up visit and performed every 6 months to 1 year thereafter to detect graft stenosis. Most studies were obtained on patients in a fasting state. If a technically inadequate or nondiagnostic study result was obtained, an MRA was performed to assess graft patency along with the degree of stenosis. Patients undergoing revascularization before 1996 underwent follow-up with sequential duplex ultrasound scanning over the past 3 years. Stenosis criteria were based on elevated diastolic velocities greater than 45 cm/s for the SMA and 55 cm/s for the celiac artery (CA) bypass grafts.[7] Additional follow-up information was obtained with subsequent office visits. Complete revascularization was defined as establishment of antegrade flow in all diseased vessels.

Statistical analysis was performed with Kaplan-Meier life-table analysis, with significance established at an overall level of P less than .05. Values are expressed as a mean ± SE.

RESULTS

Eighteen consecutive patients with CMI underwent mesenteric bypass grafting with the DTA used as inflow and represent the entire institution's experience. The average age at operation for this cohort was 64.4 years (range, 36-79 years), with all but one (94%) patient being a woman. All patients were white and were admitted with abdominal pain or weight loss (Table I). The pathophysiology involved atherosclerotic occlusive disease in 16 (89%) patients and Takayasu's arteritis in two (11%). Two patients required urgent revascularization because of acute exacerbation of chronic symptoms. The average time for diagnosis was 10.3 months (range, 2-24 months), and in the 15 patients reporting weight loss, the average was 18.3 kg (range, 9-45 kg) during this period. Significant risk factors are listed in Table II and are notable in that 83% had significant tobacco use, and none of the patients had diabetes. Five prior vascular procedures had been performed in four patients and included carotid endarterectomy (n = 3), aortobifemoral bypass graft (n = 1), and femorofemoral bypass grafting (n = 1). All but three patients (83%) had prior abdominal surgery, which involved cholecystectomy in 44% of the patients and intestinal resections for nonischemic indications in three patients (17%).

One-, two-, and three-vessel involvement occurred in 6%, 50%, and 44%, respectively, and is depicted in Table III. None of the patients had isolated involvement of the CA or inferior mesenteric artery (IMA). Twelve of 18 patients had angiographic evaluation of their internal iliac arteries. Unilateral disease was present in six patients (50%), and bilateral internal iliac occlusive disease was present in five (42%). Twenty-two percent of the patients had both IMA stenosis and bilateral internal iliac stenosis.

Thirty-three vessels were reconstructed and included CA and SMA reconstruction in 15 patients (83%) and isolated SMA revascularization in three (17%) (Table III).

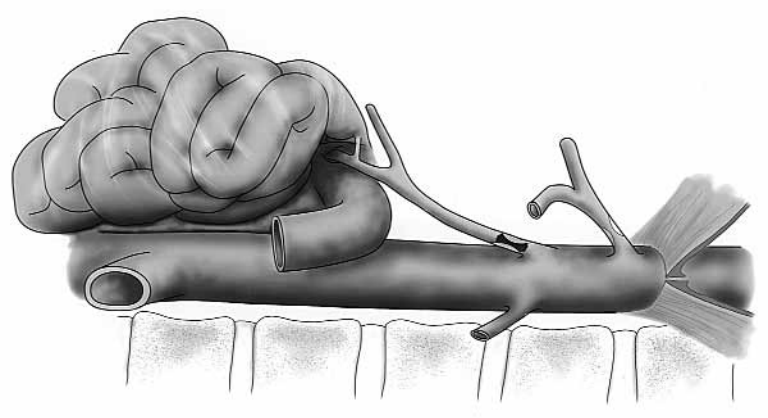

Fig 2. Exposure of DTA and upper abdominal aorta through thoracoretroperitoneal incision.

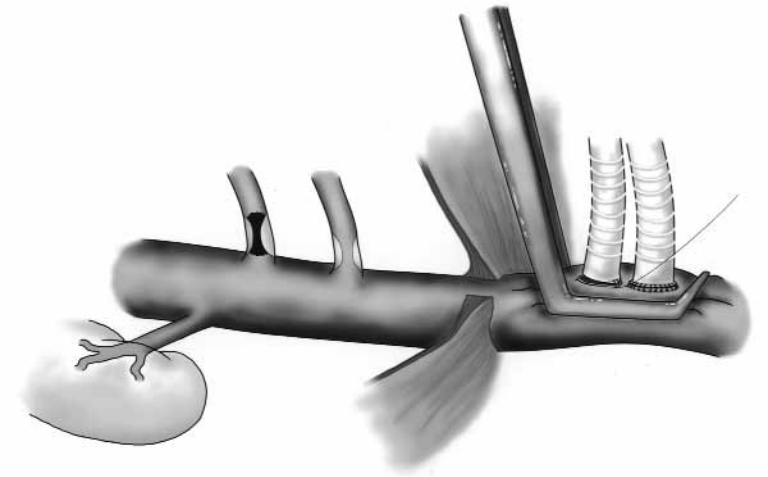

Fig 3. Partial occlusion clamp placed on DTA. Proximal graft anastomoses of individual grafts depicted.

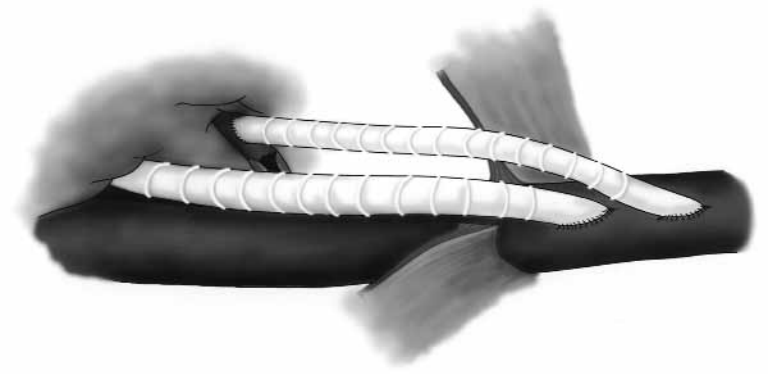

Fig 4. Graft orientation through diaphragmatic hiatus to CA and SMA.

Table I. Presenting symptoms for 18 patients undergoing thoracomesenteric bypass grafting

Presenting symptom	*No. of patients (n = 18)*
Abdominal pain	14 (78%)
Weight loss	15 (83%)
Pain or weight loss	18 (100%)
Pain and weight loss	11 (61%)

Table II. Risk factors for 18 patients undergoing thoracomesenteric bypass grafting

Risk factors	*No. of patients (n = 18)*
Smoking	15 (83%)
Diabetes	0
CAD	8 (44%)
Angina	2 (11%)
MI	4 (22%)
CHF	3 (17%)
PTCA	1 (6%)
CABG	3 (17%)
Stroke	1 (6%)
Hypertension	15 (83%)
Hyperlipidemia	5 (28%)
Renal insufficiency	3 (17%)
COPD	6 (33%)
Hypercoagulable	0
Prior vascular surgery	4 (22%)

CAD, Coronary artery disease; *MI,* myocardial infarction; *CHF,* congestive heart failure; *PTCA,* percutaneous transluminal coronary angioplasty; *CABG,* coronary artery bypass grafting; *COPD,* chronic obstructive pulmonary disease.

Table III. Distribution of involved vessels for 18 patients undergoing thoracomesenteric bypass grafting

Vessel involved	*No. of patients (n = 18)*
Celiac	16 (89%)
SMA	18 (100%)
IMA	9 (50%)
Right hypogastric	2 (11%)
Left hypogastric	4 (22%)
Both hypogastric vessels	5 (28%)
Celiac, SMA, and IMA	8 (44%)
Celiac and SMA	8 (44%)
Celiac and IMA	0
SMA and IMA	1 (6%)
SMA only	1 (6%)
IMA and bilateral hypogastric	2 (22%)

None of the patients had revascularization of their IMA. An adequate distal end point could not be obtained in one patient with an occluded CA and was not revascularized; however, the IMA was patent without evidence of disease. Complete revascularization was performed in 44% of the patients. Bifurcated graft configurations were used in three patients with parallel straight grafts used for the remainder of the patients requiring multiple vessel revascularization (Fig 4). Bifurcated grafts were used in our early experience; however, this has been abandoned for a parallel straight graft configuration, which allows for better graft orientation and routing through the diaphragmatic hiatus. Ringed polytetrafluoroethylene was the conduit chosen in 32 (94%) of the grafts, and polyester fiber (Dacron) in one. On the basis of distal vessel caliber, graft size was 8 mm and 6 mm in 11 (33%) and 22 (67%) of the bypass grafts, respectively. Proximal thoracic aortic endarterectomy was never necessary. Both proximal and distal reconstruction used end-to-side anastomosis, and only two patients required distal endarterectomy to achieve an adequate revascularization. Concomitant vascular procedures were undertaken in five patients. In three patients with coexisting severe claudication, thoracobifemoral bypass grafting was performed, and two patients underwent left renal artery bypass grafting for severe left renal artery stenosis and malignant hypertension.

Operative time averaged 343 minutes, and partial clamp time was 27 minutes, with an average blood loss of 625 mL. Ten of the 18 patients were extubated at the completion of the procedure, whereas the remaining eight remained intubated for an average of 3.3 days (range, 1-8 days). There was one perioperative death (6%) resulting from multisystem organ failure (MSOF). In this patient, both bypass grafts were patent on postoperative computed tomography imaging. Major complications developed in three additional patients (17%) and included two myocardial infarctions and one respiratory failure requiring short-term reintubation. Six minor complications occurred: arrhythmias (n = 2), uncomplicated pancreatitis (n = 1), *Clostridium difficile* colitis (n = 2), and upper extremity rest pain caused by subclavian stenosis (n = 1). Of note, there was no kidney failure or spinal cord ischemia. Excluding the patient with a prolonged hospital course caused by MSOF, the mean length of stay was 11.5 days and was increased to 13.3 days when all patients were included.

All patients remained clinically symptom free and required no additional procedures to assist patency during the mean follow-up of 34.8 months (range, 1-97 months). The life-table survival rate was 89%, 89%, and 76%, at 1, 3, and 5 years, respectively (Fig 5). Three patients died of unrelated causes and included lung cancer (n = 2) and myocardial infarction (n = 1). One of the patients died at 3 months before undergoing any objective follow-up. Objective data were obtained in 13 of the 16 patients surviving longer than 4 months. Two of the three remaining patients died of the aforementioned causes before obtaining objective documentation at 42 and 61 months after operation. The third patient has declined objective evaluation but remains clinically symptom free at 65 months. Of those patients undergoing objective evaluation, duplex scanning was diagnostic in 12 patients (92%), and MRA was diagnostic in the 13th. There were no focal elevations in diastolic graft velocities, and all bypass grafts (100%) evaluated objectively remain patent.

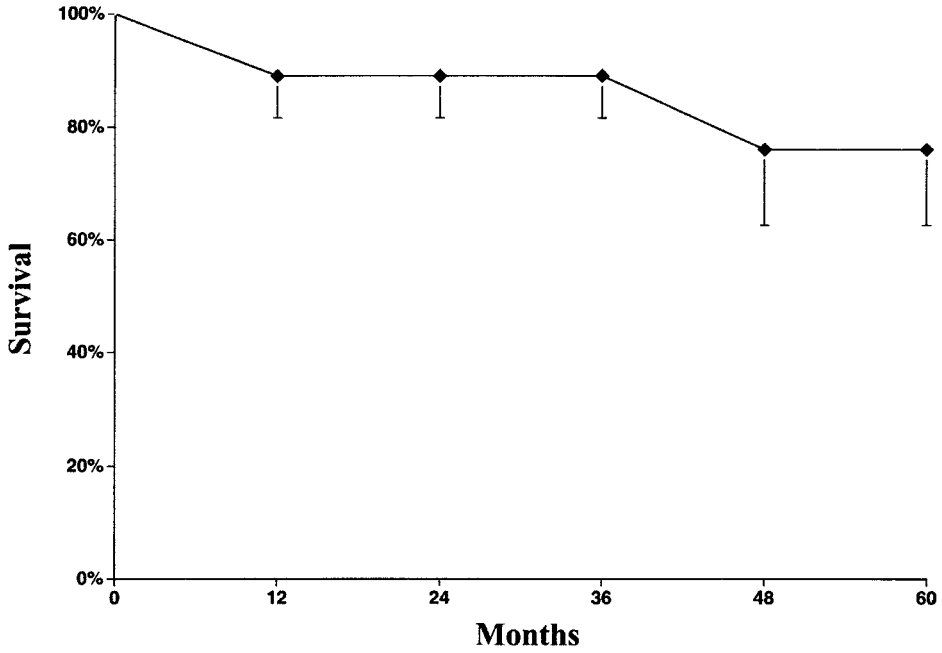

Fig 5. Life-table survival of 18 patients undergoing thoracomesenteric bypass grafting.

DISCUSSION

Even though the prevalence of atherosclerosis in the visceral vessels ranges from 6% to 24% in autopsy reports,[8,9] CMI is an infrequently encountered clinical occurrence. It has been postulated that the clinical syndrome rarely exists because of an excellent intestinal collateral circulation.[10-12] In spite of this, patients with single-vessel occlusive disease may be admitted with CMI, which typically involves the SMA.[13,14]

For surgical correction of CMI, nearly all exposures use a transperitoneal midline incision. Stoney et al[4] advocate transaortic endarterectomy or antegrade bypass grafting from the supraceliac aorta with medial visceral rotation. With these techniques he and his colleagues have achieved 97% 1-year and 86% 5-year patency rates, with complication rates being higher for the transaortic endarterectomy group (17% vs 0%, $P = .03$).[4,15,16] Taylor et al[13] prefer retrograde bypass graft from the infrarenal aorta because of its familiar exposure and reduced risks with clamping and dissection. They have avoided kinking by careful attention to graft configuration and have achieved a 5-year patency rate of 96% with an operative mortality rate of 7%.[13] Johnston et al[17] treated 34 patients with antegrade or retrograde bypass grafts and noted 1- and 5-year survival rates of 100% and 86%, respectively. Of note, 19% of these procedures were performed through a thoracoabdominal incision; however, no specific details or analysis was given. More recently a transabdominal thoracoabdominal approach was reported as being well tolerated, although no critical evaluation of results was reported.[18]

Hollier et al[3] have stressed the importance of performing complete revascularization, so that single-graft thrombosis does not result in bowel infarction. The recurrence rate was reduced from 50% to 17% by use of this technique. The mortality rate and long-term results of the procedure can be improved by limiting the complications associated with mesenteric revascularization.

We have a significant experience with the descending thoracic aorta for lower extremity revascularization and have found it to be relatively free of atherosclerotic disease.[19,20] In addition, the incision is well tolerated without significant pulmonary or other complications. As a result, we have expanded its use as an inflow source for mesenteric revascularization. In our group of 18 patients, as in other published series, there was a propensity toward female patients without diabetes and with a history of smoking.[17,18,21-23] However, our white race distribution (100%) is an unusual finding and has not been observed previously in the literature. Furthermore, nearly half of this population (44%) had undergone cholecystectomy before visceral revascularization. It is unclear whether this was truly the result of gallbladder ischemia or simply due to the increased incidence of cholecystectomy for gallbladder disease since the advent of laparoscopy.

Thoracoretroperitoneal revascularization provides several technical advantages. A thoracoabdominal incision allows for easy exposure of the thoracic and abdominal aorta, and, when necessary, concomitant procedures can be performed for renal and lower extremity revascularization. It is, however, more difficult in patients who have undergone prior left chest surgery. Because the DTA is rarely diseased, partial occlusion is possible, thereby reduc-

ing the potential for renal and spinal cord ischemia associated with supraceliac clamping. Even in debilitated patients, the incision is well tolerated, allowing discharge at an average of 13.3 days, which compares favorably with other studies.[18,23] Potential criticism for this approach could include the inability to adequately expose a distal patent vessel for revascularization. This occurred in one patient who could not have the CA revascularized. This patient has done well with SMA revascularization alone, suggesting that adequate collateral vessels exist between the SMA and CA in many cases, allowing for successful single-vessel reconstruction. If necessary, the splenic artery can easily be dissected from within the peritoneum and antegrade revascularization performed.

In spite of widespread distribution of atherosclerosis in the visceral vessels, only 17% of our patients had previous and 28% concomitant vascular procedures performed. The SMA was involved in all patients and the CA in 89%. Although complete revascularization has received much attention in the literature,[3,22,24,25] our approach has been to reestablish blood flow only to diseased SMA and CA vessels (> 50%) and not base operative strategies on the status of the IMA. With this strategy complete revascularization was performed in 44% of the cases. In spite of the presence of combined IMA and bilateral internal iliac artery stenosis in 22% of the patients, recurrent symptoms did not develop, even though the IMA was never revascularized.

Our operative mortality rate (6%) correlated well with that reported by most previous studies[17,23,26] and was associated with MSOF as others have reported.[22,26,27] Given the malnourished nature and comorbid conditions present in this population, further reduction of this rate may be difficult. Of note, several studies have emphasized the grave prognosis and high mortality rate associated with perioperative graft thrombosis,[3,23,24,26,28] which did not occur in our study.

During our mean follow-up of 34.6 months, no patient had development of recurrent symptoms or stenosis on the basis of objective follow-up. When the DTA is used as inflow, our midterm results suggest that patient survival, not graft patency, is the limiting factor. Because only antegrade bypass grafts were performed, comparison with retrograde bypass grafts must be based on historical data, which have been published early and include late failure rates in the range of 0% to 15%.[17,23,24,26] By providing antegrade bypass grafts from the DTA, we think that the tendency for graft kinking is reduced and the propensity for thrombosis caused by progression of atherosclerotic inflow disease is minimized. Also, the short nature of these antegrade bypass grafts may allow for partial or complete endothelialization of the grafts decreasing the propensity toward thrombosis.

In conclusion, antegrade mesenteric revascularization with the DTA used as inflow was associated with an acceptable mortality and morbidity rate in this debilitated group of patients. Furthermore, it provides excellent midterm patency and survival results that were not associated with either early or late thrombotic complications. The results were not influenced by the completeness of revascularization, and life expectancy was limited by other comorbid conditions. We think that this technique should be considered as a primary approach for reconstruction of patients with CMI.

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DISCUSSION

Dr K. Wayne Johnston (Toronto, Ontario). Dr Porter, members, and guests.

This paper presents data that support my personal view that complete mesenteric revascularization using grafts that run in a straight line from the thoracic aorta or perhaps supraceliac segment is the optimal approach. However, it is crucial, as the authors fairly point out, to note that other reports have had equally satisfactory results, including single grafts from the abdominal aorta, balloon angioplasty, and transaortic endarterectomy.

This is the first large reported series of thoracomesenteric grafts. The authors report excellent results: one death in 18 patients, 75% 5-year survival, and no late deaths from mesenteric ischemia. That's commendable. These excellent results are, however, similar to the other techniques that I mentioned.

The average operative time was 5.5 hours. The following technical comments may be worth considering. First, a double lumen endotracheal tube is actually not necessary, since the exposure of the distal thoracic aorta is all that's required. Our anesthetists take extra time inserting a double lumen tube.

The diaphragm does not need to be divided as extensively as suggested by the authors. Just divide enough to allow the ribs to be separated and the thoracic aorta in the lower segment to be exposed. This simpler approach might have prevented the prolonged intubation that was required in eight of the 18 patients in this study.

In performing the proximal aortic anastomosis, a partial occluding clamp presumably allows distal flow; however, in my experience, a partial occluding clamp usually compromises distal flow and makes what is otherwise a simple anastomosis more difficult. It's often easier to simply cross clamp the aorta and expeditiously perform the proximal anastomosis. If two grafts are performed as noted in the figure, the authors anastomose both of them to the aorta rather than simply taking the second graft off the side of the primary graft.

This excellent series and the other reported series in the literature are all very small. Consequently, no definite conclusions can be reached on the optimum method of mesenteric repair, and no data can support one's bias. I suspect that personal preference and experience with one technique may be the most important deciding factor in what technique you use.

Thank you.

Dr Mark A. Farber. Dr Johnston commented on the fact that double lumen endotracheal intubation is not necessary in all patients. That is exactly correct. However, it does give you more latitude if you have it in. If it's not needed, you do not have to clamp that left lung.

He also commented that, in his opinion, it may have affected our average intubation. Ten of the 18 patients were extubated at the completion of the procedure. The remaining eight patients had an average intubation of 3.3 days, and that includes the patient who was intubated with multisystem organ failure for long duration. So I don't think that it affects it significantly.

What we have done is exactly what you mentioned. I did show a slide in which the diaphragm is left intact. If you don't want to take the diaphragm all the way down in curvilinear fashion, you can do that. It does require more mobilization of the peritoneum on the posterior side of the diaphragm and does subject a patient to an increased risk, theoretically, of a splenic injury. We have not seen that, but theoretically, it is possible.

You mentioned the single graft configurations that we used in a parallel fashion. You can take them off as a branch point, as you saw, for renal artery bypass. We find it slightly easier and have more latitude in how the grafts lie if we do two single grafts. The aortic side-biting clamp that we use you can easily fit two 8-mm grafts if need be. We typically use an 8- and a 6-mm graft. By checking with a handheld continuous wave Doppler, we do ensure that you have prograde flow. Theoretically, that should minimize your risk of having spinal cord ischemia from placing a thoracic clamp on the aorta but would technically never be zero, but I'd try to limit that as much as possible because it would be a devastating complication to have.

Dr G. Patrick Clagett (Dallas, Tex). We've utilized this approach, but mainly when the supraceliac aorta was unavailable for use for other reasons, such as previous operations or extensive disease. And my question is, why not use the supraceliac aorta? It's, I think, a much simpler operation. It's readily available, and you avoid the thoracotomy and a lot of the problems that you mentioned. How many of these patients would have been amenable to a supraceliac aortomesenteric bypass?

Dr Farber. Not having participated in all the patients, I can't tell you. From their angiographic evaluation, I would say a small number, probably 15% to 20% of them, would not have been suitable for a supraceliac clamp in that region. Theoretically, as you know, that would submit the patient to some risk of spinal cord ischemia.

There is some theoretical advantage to using thoracic aorta. We all know that supraceliac disease exists. Maybe the reason why some grafts fail with supraceliac or infrarenal bypass grafting is that progression of inflow disease. The thoracic aorta is less prone to atherosclerosis, and maybe by providing inflow for your grafts from this area, we don't have those early or late thrombotic complications. The patients appear to expire of other comorbid problems, not from thrombotic or ischemic bowel complications that occur.

Dr Porter. Certainly all of our clinical experience, I think, is the same. The supraceliac aorta is occasionally involved in devastating atherosclerosis that we almost never see in the thoracic aorta. I have to interject that.

Dr Kenneth Ouriel (Cleveland, Ohio). I agree wholeheartedly with the findings of the UNC group. I think an antegrade bypass is better than a retrograde bypass. And I also agree that the descending thoracic aorta is a good inflow site. But a thoracotomy through the ninth inner space is certainly not the only way and not my preference for exposing that segment of aorta. With a mechanical retractor, resection of the 11th rib, and division of the crura of the diaphragm, there is no reason that one couldn't approach the segment of aorta that we saw in your pictures through a purely retroperitoneal procedure. I wonder if you've considered using that approach instead of a thoracotomy in these sometimes frail and medically compromised patients.

Dr Farber. We have not considered a purely retroperitoneal approach. We will do thoracic exposures for our neurosurgical and our orthopedic colleagues quite frequently. I don't know that

resecting a rib is that much better than the thoracotomy. As I mentioned, 10 of the 18 patients were intubated immediately after the procedure, and we've not had any significant pulmonary complications, but we will consider that. Thank you.

Dr Hugh G. Beebe (Toledo, Ohio). I thought Dr Clagett was going to enumerate the advantages of the supraceliac approach in a more detailed way, and I just wanted to offer the advantages as an alternative. You can go a surprising distance up the thoracic aorta from a small upper midline laparotomy by opening the aortic hiatus of the diaphragm. So it's an antegrade thoracic bypass graft with no thoracotomy, which is pretty morbid, with no incision taking down the diaphragm, which can be morbid, and with only two anastomoses both the celiac and superior mesenteric arteries can be reconstructed with a single bypass graft, as we have previously reported with similar outcomes in a similar size series. So I just wanted to offer that as an alternative and ask whether in your institution you have any consideration of that approach?

Dr Farber. The times that we have used that approach have been in patients who have not presented with classic mesenteric ischemia symptoms but with median arcuate ligament syndrome. That's where we utilize that approach. We've used it that way and via a thoracoabdominal approach, so that we can resect all that associated tissue.

I personally don't have any personal experience doing a supraceliac bypass. I find that's working in a smaller area. The exposure here is wide open, and there is no problem with how the grafts lie, putting clamps, or any other problems. You don't have any problem with potential disease of the supraceliac aorta. So we have not chosen that approach; maybe that's due to our familiarity and extensive use of the thoracic aortic for mesenteric bypasses and for thoracobifemoral bypasses. Thank you.

Dr John E. Connolly (Irvine, Calif). I'd like to congratulate the authors on their excellent results.

Dr Stoney, I believe, was the first to show that the distal thoracic aorta can be reached through an abdominal midline approach, and I would like the authors to comment on that as opposed to their approach.

Also, your approach described today is not dissimilar to that required for the trapdoor endarterectomy of the origins of mesenteric vessels; perhaps yours is even a little greater in magnitude.

The criticism of that operation has been that the retroperitoneal approached is too complicated and secondly, that you have to temporarily clamp the aorta above the kidneys. We find that the endarterectomy is very similar to a carotid endarterectomy. It doesn't take any longer. And if you put a little ice in the abdomen, you have at least 60 minutes of safe renal artery ischemia.

The advantage of this operation is that all of the occlusive disease is removed without the need for any bypasses, which can subsequently occlude. Since the operative approach is no more extensive than that described today, we favor the trapdoor endarterectomy procedure for mesenteric ischemia and wonder if the authors have tried it or have an opinion of it.

Dr Farber. We don't use that particular approach. I think that you can use it if you are very facile with endarterectomy. I think one adjuvant that has not been talked about that the group from Bowman Gray utilizes is duplex scanning after you complete an endarterectomy. They use it mainly for renal revascularization, but I think if you're going to do that, I would make sure that some intraoperative evaluation of the distal end points be done. This may be one way to avoid some problems. We have not used that particular approach, however.

Dr Sateesh C. Babu (Valhalla, NY). I would like to just express the opposite point of view. We have used iliac artery exclusively as the inflow because these patients, at least in our institution, are very old and nutritionally depleted. They are also having COPD and don't tolerate thoracotomy very well. And about 2 or 3 years ago we presented our experience, and we haven't had any chance to repent it or regret it. The iliac artery, provided the aortoiliac system is patent, works very well as the inflow, and the blood flow in retrograde to the superior mesenteric artery hasn't had any problem in our experience, at least. The operation is simple and can be done very quickly.

Dr Farber. I'll take your comments in two parts. One part is the debilitated thoracotomy perception. I think when you use a thoracic epidural along with the advancements in anesthesia, especially in the last 10 years, I think one sees significantly less complications associated with a thoracotomy. A low thoracotomy is not anywhere near as morbid as an upper thoracotomy, and it's extremely well tolerated using these adjuvants.

In terms of the iliac vessel–based bypasses or retrograde bypasses, you do have progression of disease, as we all know. Many of these patients, as you saw in our paper, had previous abdominal surgery, which can add to potential complications. The kinking issue that Dr Porter's group has described and avoided by using a general curve is difficult to perform, in my opinion. But then again I don't have the experience that Dr Porter does. So I would just prefer to use our approach. In our practice we have a significant experience with the thoracic aorta, which facilitates this surgical approach.