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Current Status of the Use of Retroperitoneal Approach for Reconstructions of the Aorta and Its Branches

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Objective

The objective of this article is to determine whether retroperitoneal approach for aortic surgery has certain physiologic, technical advantages.

Summary Background Data

The retroperitoneal approach for abdominal aortic reconstruction classically had been reserved for select patients with either high-risk comorbid disease or specific anatomic problems that preclude the transabdominal approach. With increasing appreciation of the physiologic, anatomic, and technical advantages of the extended posterolateral retroperitoneal approach, the authors have expanded its use for repair of all types of aortic visceral and renal artery disease as well as ruptured abdominal aortic aneurysm and infected aortic grafts.

Methods

From January 1981 to September 1995, 2340 retroperitoneal aortoiliac reconstructions were performed in 2243 patients. Aortic reconstructions accounted for 1756 cases: 1109 for elective abdominal aortic aneurysms, 210 for ruptured and symptomatic aortic aneurysms, 399 for occlusive disease, 18 for infected aortic grafts, and 20 for other indications. Iliofemoral disease was the indication for 584 procedures. As experience was gained, this approach also was used for 417 renal and 50 celiac and superior mesenteric artery reconstructions.

Results

The mean age was 67 years with 1590 men and 653 women. Overall mortality was 5.2% for all aortic cases: 2.4% for elective, 12.6% for symptomatic, and 29.0% for ruptured aortic aneurysms. Major complications occurred in 12.5% of the elective procedures and in 38.3% of emergency procedures. Over the past 5 years, the average length of hospital stay for uncomplicated elective abdominal aortic aneurysms was 6.1 days, intensive care unit stay was 0.7 day, and diet was resumed by postoperative day 1. Five-year graft patency was 99% for aneurysms and 95% for occlusive disease.

Conclusions

The retroperitoneal approach offers certain physiologic advantages associated with minimal disturbance of gastrointestinal and respiratory function, thereby reducing the length of intensive care unit and hospital stay. In addition, its technical advantages and flexibility facilitates visceral and juxtarenal aortic reconstructions without the need for thoracotomy.

The retroperitoneal approach consists of a family of exposures and incisions that allows access to the abdominal aorta and its branches. Charles Rob[1] was the first to report a large clinical series of more than 500 procedures through an anterolateral retroperitoneal approach. He concluded that this exposure had several physiologic advantages such as decreased pain, ileus, hospital stay, and earlier resumption of diet. The technical limitations of the anterolateral approach made it applicable to only 25% of his patient population with aortic disease. However, he concluded that this approach should be used whenever possible. Later, Williams et al.[2] reported on the extended left posterolateral retroperitoneal approach that further facilitated the exposure of the proximal aorta and its branches. Despite these and other reports, the retroperitoneal approach for abdominal aortic reconstruction commonly has been reserved for select patients with either high-risk comorbid disease or specific anatomic problems that preclude the traditional transabdominal approach. With recent reports showing an increasing appreciation of the physiologic, anatomic, and technical advantages of the retroperitoneal approach, we have expanded its use for repair of all types of aortoiliac, visceral, and renal artery disease as well as of ruptured abdominal aortic aneurysms and infected aortic grafts.[3–6] Herein, we report our long-term results, technique, and postoperative outcome in more than 2300 such reconstructions.

MATERIALS AND METHODS

From January 1981 to September 1995, 2340 retroperitoneal aortoiliac-based reconstructions were performed in 2243 patients. Aortic reconstructions accounted for 1756 procedures: 1109 for elective abdominal aortic aneurysms, 210 for ruptured and symptomatic abdominal aortic aneurysms, 399 for aortoiliac occlusive disease, 18 for infected aortic grafts, and 20 for other indications.

Of the 1756 aortic cases, 1657 were performed through the left retroperitoneal approach and 99 through the right. Seven hundred sixty-one were performed using an open endoaneurysmorrhaphy technique and 995 used the exclusion and bypass technique. Four hundred seventeen renal artery reconstructions were performed in 351 patients and 50 visceral reconstructions were performed using the left retroperitoneal approach since 1986.

Indications for surgery are listed in Table 1. Overall demographics show 71% of our patients were men, 15% were diabetics, and 40% were smokers. The average age was 67 (range, 1–95) in the aortic group and 65 (range, 1–91) in the iliac group.

All elective patients underwent biplane aortography, and those with suspected aneurysmal disease also underwent computed tomography. Patients with a history of renal insufficiency with a salvageable kidney, presumed renovascular hypertension, significant (> 80%) renal artery stenosis, and/or renal artery anatomy that necessitated reconstruction were evaluated by selective angiography. Indications for renal revascularization are listed in Table 2. Patients with thoracoabdominal aneurysms were excluded from this study. Visceral reconstructions were performed for mesenteric ischemia.

Preoperative cardiologic evaluation was performed before all elective cases. This consisted of a comprehensive history and physical assessment of risk factors and electrocardiography. Thallium-persantine stress test and cardiac catheterization were performed as indicated. All patients underwent general anesthesia with full invasive monitoring. Twenty-five grams of mannitol were given intravenously before incision to promote vigorous diuresis. Subsequently, 5 g/hour were administered intravenously throughout the early postoperative period. Heparin (30 U/kg) was given intravenously before aortic cross clamping. The left retroperitoneal approach using the extended posterolateral incision was used preferentially; however, patients with disease primarily on the right side were approached through a right retroperitoneal approach.

Patients were followed up in the office every 3 months for the first year and every 6 months thereafter with clinical examination, pulse volume recordings, and duplex or renal flow scans or both as indicated in patients with renal revascularization. Duplex examinations were used for visceral reconstructions. Patients with recurrent symptoms or changes in their noninvasive laboratory test received further investigation or angiography or both. Patients who had operations for aortic graft infec-

Table 1. INDICATIONS FOR RETROPERITONEAL RECONSTRUCTIONS

Elective AAA	1109
Symptomatic AAA	103
Ruptured AAA	107
A-I occlusive disease	399
Iliofemoral disease	584
Infected aortic graft	18
Other	20

AAA = abdominal aortic aneurysm; A-I = aortoiliac.

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Table 2. OPERATIVE MORTALITY

Elective AAA	2.4%
Symptomatic AAA	12.6%
Ruptured AAA	29.0%
A-I occlusive disease	4.5%
Renal	5.7%
Visceral (SMA/celiac)	10.9%

AAA = abdominal aortic aneurysm; A-I = aortoiliac; SMA = superior mesenteric artery.

tions were followed up with serial indium-labeled leukocyte scans every 6 months and then yearly as well as clinical examinations. Follow up was complete in 92% of patients.

Estimated blood loss, operative mortality, cardiorespiratory, renal, and wound complications were prospectively entered in our computerized vascular registry. Also, short- and long-term patency was recorded.

Postoperative complications were considered to be major if the patient's hospital discharge was delayed, a major therapeutic intervention was needed, or if complications compromised the patient's postoperative recovery. The posterolateral approach was used preferentially as reported previously.[3-9]

RESULTS

The 30-day mortality was 5.2% for all aortic reconstructions, elective and emergent (Table 2). For elective abdominal aortic aneurysms, the mortality was 27 (2.4%) of 1109. Eleven of these 1109 patients (1%) died of cardiac complications. There were 28 (2.6%) nonfatal cardiac complications; 23 (2.1%) of 1082 patients had pulmonary complications, 23 (2.1%) had worsening renal dysfunction, and 8 (0.7%) of 1082 patients had colon ischemia. There were two immediate occlusions treated by thrombectomy with long-term patency, and there were seven late occlusions; four treated by thrombectomy and three treated by a redo bypass. Estimated blood loss for this entire group was 810 ml (range, 50–9000), and standard deviation was 800 ml. Three hundred thirteen (28%) had tube grafts and 796 (72%) had bifurcation grafts.

Retroperitoneal exclusion bypasses were performed on a total of 995 patients: 941 (95%) were performed for aneurysmal disease, and the remaining 54 were for other indications. Operative mortality was 2.4%. Estimated blood loss in these cases was 661 + 718. Eighteen (1.8%) showed expansion of their excluded aneurysm in the late postoperative period; 14 were treated by surgery, 2 were treated by embolization of the inflow source to the excluded aneurysm, and the remaining 2 are being observed. Major complications are listed in Table 3.

One hundred seven ruptured aneurysms were repaired through the retroperitoneal approach; 83% were men, 4% were diabetic, and 25% were smokers. The average age was 72 (range, 52–95). Thirty-eight (36%) aneurysms were repaired using tube grafts and 69 (64%) were repaired using bifurcated grafts. Operative mortality was 31 (29%) of 107, and 16 (52%) of 31 deaths were for multisystem organ failure. There were seven nonfatal pulmonary complications, two cardiac, and two stroke complications. Four patients had worsening of renal insufficiency, three patients had colon ischemia, and one patient had paralysis. There was one immediate occlusion that was treated by thrombectomy and no late occlusions. Estimated blood loss for this group was 2962 ml (range, 200–9800), and standard deviation was 1928 ml.

One hundred three symptomatic aneurysms were repaired; 71% were men, 8% were diabetics, and 29% were smokers. The average age was 72 (range, 52–88). Thirty-

Table 3. NONFATAL COMPLICATIONS*

	Retroperitoneal AAAs			Other Indications	
	Elective (N = 1109)	Symptomatic (N = 103)	Ruptured (N = 107)	Occlusive (N = 399)	Renal (N = 417)
Cardiac	2.6%	6.7%	2.6%	1.3%	1.2%
Pulmonary	2.1%	7.8%	9.2%	2.6%	0.6%
Renal	2.1%	2.2%	5.3%	0.8%	2.1%
Bleeding	1.4%	3.3%	0.0%	1.3%	0.3%
Stroke	0.6%	0.0%	2.6%	0.3%	0.3%
Colon ischemia	0.7%	0.0%	3.9%	0.5%	0.0%

AAA = abdominal aortic aneurysms.
* No major nonfatal complications in visceral group.

one percent required tube grafts and 69% required bifurcation grafts. The operative mortality was 13 (12.6%) of 103: 4 (31%) of 13 died from cardiac complications, 3 (23%) of 13 had colon ischemia, 2 patients had a stroke, and the remaining 4 had other complications. There were 13 cardiopulmonary complications that were nonfatal. Total major complications for the symptomatic group was 14% compared to a complication rate of 29% (22 of 79) in the ruptured group.

Three hundred ninety-nine patients were operated on for aortoiliac occlusive disease: 61% were men, 22% were diabetics, and 52% were smokers. The average age was 64 (range, 31–94). Operative mortality was 18 (4.5%) of 399. The primary cause of death was cardiac: 7 (39%) of 18. There were 15 nonfatal cardiopulmonary complications, 9 immediate occlusions (7 treated by thrombectomy and 2 by rebypass), and 20 late occlusions (9 treated by thrombectomy, 10 by new bypass, and 1 is being observed). Estimated blood loss averaged 558 ml (range, 50–6000) with standard deviation of 569 ml. Five-year patency rates for aneurysmal and occlusive disease were 99% and 95%, respectively.

There were 417 renal artery reconstructions performed in 351 patients: 255 were performed with abdominal aortic aneurysms, 84 were primary procedures for renovascular hypertension, and 78 were performed with other aortic reconstructions. There were 60 bilateral procedures performed. Three hundred ten bypasses were performed with 6 mm polytetrafluoroethylene grafts; 71 transaortic endarterectomies were performed and 30 were repaired by direct reimplantation. Operative mortality was 20 (5.7%) of 351. The majority of deaths were secondary to cardiopulmonary problems (25%). There were four nonfatal myocardial infarctions and seven patients with worsening of renal dysfunction. Only one patient ended up on long-term dialysis. There were five early occlusions, four of which were revised successfully. Two patients had late occlusions. Blood pressure was improved in 27%, stabilized in 70%, and worsened in 3%.

Of the iliac procedures, there were 584 procedures performed. Operative mortality was 1.9%. There were 6.2% major complications, including nine cardiac nonfatal events, two strokes, and two patients with colon ischemia.

Of the 50 visceral reconstructions, 29 were performed to the superior mesenteric artery, 17 to the celiac artery, and 2 each to the splenic artery and inferior mesenteric artery. Operative mortality was 5 (10.9%) of 46, and there were 2 late occlusions. One had a rebypass at 19 months and the other presented with ischemic bowel and died at 24 months.

Over the past 5 years, the average intensive care stay for elective uncomplicated aneurysms was 0.7 day, resumption of diet occurred on the first postoperative day in more than 87% of patients, and 84% of patients could be discharged by postoperative day 6.

Eighteen patients had new "in-line" aortic reconstructions for infected aortic graft without cross contamination through the retroperitoneal approach and removal of the infected prosthesis transabdominally. As documented by Indium-labeled leukocyte scans and clinical examinations, there have been no recurrent graft infections or sepsis in these patients from 4 months to 9 years. There was one death from myocardial infarction at 2 months (5.6%). Three (17%) of 18 had major complications (1 bleed, 1 myocardial infarction, 1 thrombosis of a graft limb). There was no difference in survival between men and women.

DISCUSSION

Exposure of the aorta through a retroperitoneal incision has been performed since the inception of modern vascular surgery. As mentioned previously, Rob[1] in his earlier report noted that this approach could be used with minimal physiologic disturbance of the patient. The entire postoperative course was made considerably easier, complications were less frequent, and recovery was "smoother and faster." However, the perceived technical limitations of an anterolateral approach made most surgeons reluctant to use this incision, opting instead for a transperitoneal approach for reconstruction of the aorta. Furthermore, excellent results from transperitoneal aortic reconstructions have been reported through the years.[10–14]

However, there have been numerous comparison studies from Sicard, Johnson, Gregory, and our group that have outlined technical and physiologic improvements in perioperative outcome in patients who had undergone retroperitoneal aortic procedures.[15–22] These studies re-emphasized that the retroperitoneal approach was associated with decreased perioperative fluid requirement, decreased perioperative pulmonary complications, less ileus, earlier resumption of diet, and decreased length of stay in the intensive care unit and in the hospital. In the only study to dispute these data, Cambria[23] showed no improvement in perioperative hospital course in patients undergoing aortic procedures by the retroperitoneal compared to the transperitoneal approach. Because the anterolateral approach was used in all patients undergoing retroperitoneal exposure in Cambria's study, this may have been one of the reasons why no difference was seen. In addition, this approach is limited by the lack of proximal exposure of the aorta, especially with disease that extended to and above the renal arteries. However, more proximal aortic exposure can be obtained by using an extended posterolateral approach as outlined by Williams et al.[2] This latter approach is

comparable to a thoracoabdominal incision without entering the chest and parallels medial visceral rotation as pioneered by Stoney for visceral and renal aortic reconstruction.[24,25] This exposure obviates any of the limitations seen with the anterolateral approach and facilitates the technical conduct of the operation.

We have elaborated on our experience with the retroperitoneal exposure during the past 15 years in a quest for performing aortic reconstructions that cause the least amount of physiologic disturbance to the patient. The exclusion and bypass of aortic aneurysms were developed to minimize operative blood loss and make the operation less physiologically stressful for the patient. This involves ligation of the aortic aneurysm sac proximally and distally and excluding it from direct arterial circulation. In 977 of 995 patients, the excluded sac thrombosed; however, there were 18 patients (1.8%) who had persistent flow in the sac despite exclusion. Fourteen patients required reoperation. This technique appears to be acceptable and safe and is similar to the technique that some are now using for intraluminal stenting of abdominal aortic aneurysms.[26] In addition, the left retroperitoneal approach allows for easy access to the series of lumbar arteries feeding the abdominal aortic aneurysm. These lumbar vessels can be clipped or ligated before opening the sac if an open endoaneurysmorrhaphy is performed, thus reducing blood loss. Technically, this would be very difficult to accomplish transabdominally, as access to the lumbar vessels is more troublesome from an anterior approach.

As experience was obtained with suprarenal dissection, it soon became more apparent that with division of the left crus of the diaphragm and elevation of the kidney, the suprarenal and visceral aorta could be exposed readily. Indications were expanded to include symptomatic aneurysms, and it was noted that expeditious supraceliac control could be obtained during these urgent operations.

As soon as experience was obtained with these exposures, we started performing ruptured abdominal aortic aneurysm repairs through the left retroperitoneal approach. Quick access to the supraceliac aorta can be obtained by taking a route cephalad to the upper pole of the kidney, avoiding the hematoma, dissecting the crus of the diaphragm off the supraceliac aorta, and exposing this portion of the aorta for cross-clamping.[4] No patient has been lost because of uncontrolled hemorrhage or inability to control the proximal aorta. Although many surgeons regard a ruptured aneurysm as a contraindication to the use of a retroperitoneal approach, its use in these situations is now standard in our practice. Only those patients actively undergoing cardiopulmonary resuscitation are repaired transabdominally.

Transabdominal exposure of the suprarenal and visceral aorta is hindered by anatomic structures such as the left renal vein and pancreas. From the lateral approach, once the lumbar branch of the left renal vein is ligated and the crus of the diaphragm divided, the left renal vein, pancreas, and visceral structures can be retracted anteriorly, medially, and cephalad, giving superior exposure of the visceral aorta. The left kidney may be mobilized posteriorly for distal exposure of the superior mesenteric artery. At this point, aortic cross clamping can be performed above, below, or between any visceral or renal vessel. Since 1987, 50 visceral reconstructions have been performed through the extended left posterolateral approach.[3,6] None of these have necessitated conversion to a transperitoneal exposure for technical reasons. One advantage of this approach is that when combined with bowel resection, the bypass can be performed through the clean retroperitoneal incision, the incision can be closed, the patient can be placed supine, and the bowel resection can be done transabdominally.

Finally, as we became experienced in this approach, we extended its indications to deal with the difficult patient population who presents with aortic graft infections.[5] As most abdominal aortic surgery is performed transabdominally, the pararenal aorta may be exposed and controlled retroperitoneally through clean planes. To obviate the potentially lethal complication of aortic stump blowout, an in-line aortic reconstruction is performed through these clean planes; the infected graft then is removed transabdominally. We have performed this in 18 cases without cross infection of the new in-line aortic graft. These patients have been followed up with indium-labeled tagged leukocyte scans and have had no late infections thus far. Although this technique can not be used in all cases, we have found this to be a preferred technique because it gives the most direct blood flow to the lower extremities and removes the possibility of aortic stump blowout from aortic ligation.

The average patient undergoing an uncomplicated retroperitoneal aortic reconstruction is extubated, eats, and ambulates on the first postoperative day. Over the past 5 years, more than 85% of our patients have been able to be discharged on or before postoperative day 6 without problems.

In conclusion, the extended posterolateral approach to the aorta and its branches appears to be a viable option for reconstruction of the abdominal aorta. Also, visceral and bilateral renal artery revascularization can be performed through this approach. In addition, symptomatic and ruptured aneurysms as well as selected infected aortic grafts can be repaired without an increase in mortality and morbidity and with optimal results. It is difficult to improve on the landmark article by Rob,[1] where he states that "most of the advantages of the extraperitoneal approach relate to the fact that the patient's entire post-

operative course is made considerably easier and not only are complications must less frequent, but recovery is smoother and faster." This approach not only offers the physiologic advantages of the retroperitoneal approach, but also the flexibility that many think the transabdominal approach offers.

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Discussion

DR. CALVIN B. ERNST (Detroit, Michigan): There are several aspects of this report that merit comment. But because of time limitations, I would like to focus on those patients who underwent renal artery reconstructive procedures.

It should be noted at the outset that what we have just heard is a review of the largest series of retroperitoneal aortic reconstructions, and clearly these authors are enthusiasts. At the Henry Ford Hospital, we have used the extended left retroperitoneal exposure for approximately 25% of our last 1000 elective infrarenal aortic aneurysm repairs and 70% of the last 100 perirenal aortic aneurysm repairs.

However, with a cautionary note, we are somewhat reluctant to use such an approach when right renal artery beyond the ostium requires reconstruction. I think as a generalization that if one has not used this approach very often as the authors have, one has to be concerned about right renal arterial reconstruction. The essayists have recorded 417 renal artery reconstructions. Yet in the manuscript, the indications were not detailed as to the side of repair, the type and extent of the lesion, and the results.

Right renal revascularization through the left flank entails the risk of early or late occlusion, particularly if the lesion extends beyond the first 1 or 2 cm from the artery's origin. Because it is technically challenging to perform a precise anastomosis to the distal right renal artery, and if endarterectomy is chosen, correction of the uncommon but not rare occurring distal intimal flap is equally difficult.

My only question is this, Dr. Darling: How many right renal revascularizations were performed and how many of these were documented to be patent postoperatively by objective studies such as arteriography? Because asymptomatic renal artery oc-