Comparison between the transabdominal and retroperitoneal approaches for aortic reconstruction in patients at high risk

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Purpose: **The purpose of this study was to compare the transabdominal approach with the retroperitoneal approach for elective aortic reconstruction in the patient who is at high risk.**
Methods: **From January 1992 through January 1997, 148 patients underwent aortic operations: 92 of the patients were classified as American Society of Anesthesia (ASA) class IV. Forty-four operations on the patients of ASA class IV were performed with the transabdominal approach (25 for abdominal aortic aneurysms and 19 for aortoiliac occlusive disease), and 48 operations were performed with the retroperitoneal approach (27 for abdominal aortic aneurysms and 21 for aortoiliac occlusive disease). There were no significant differences between the groups for comorbid risk factors or perioperative care.**
Results: **Among the patients of ASA class IV, eight (8.7%) died after operation (retroperitoneal, 3 [6.26%]; transabdominal, 5 [11.3%]; *P* = .5). There was no difference between groups in the number of pulmonary complications (retroperitoneal, 23 [47.9%]; transabdominal, 19 [43.2%]; *P* = .7) or in the development of incisional hernias (retroperitoneal, 6 [12.5%]; transabdominal, 5 [11.3%]; *P* = .5). The retroperitoneal approach was associated with a significant reduction in cardiac complications (retroperitoneal, 6 [12.5%]; transabdominal, 10 [22.7%]; *P* = .004) and in gastrointestinal complications (retroperitoneal, 5 [8.3%]; transabdominal, 15 [34.1%]). Operative time was significantly longer in the retroperitoneal group (retroperitoneal, 3.35 hours; transabdominal, 2.98 hours; *P* = .006), as was blood loss (retroperitoneal, 803 mL; transabdominal, 647 mL; *P* = .012). The patients in the retroperitoneal group required less intravenous narcotics (retroperitoneal, 36.6 ± 21 mg; transabdominal, 49.5 ± 28.5 mg; *P* = .004) and less epidural analgesics (retroperitoneal, 39.5 ± 6.4 mg; transabdominal, 56.6 ± 9.5 mg; *P* = .004). Hospital length of stay (retroperitoneal, 7.2 ± 1.6 days; transabdominal, 12.8 ± 2.3 days; *P* = .024) and hospital charges (retroperitoneal, $35,587 ± $980; transabdominal, $54,832 ± $1105; *P* = .04) were significantly lower in the retroperitoneal group. The survival rates at the 40-month follow-up period were similar between the groups (retroperitoneal, 81.3%; transabdominal, 78.7%; *P* = .53).**
Conclusion: **In this subset of patients who were at high risk for aortic reconstruction, the postoperative complications were common. However, the number of complications was significantly lower in the retroperitoneal group. Aortic reconstruction in patients of ASA class IV appears to be more safely and economically performed with the retroperitoneal approach. (J Vasc Surg 1999;30:400-6.)**

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Presented at the Twenty-third Annual Meeting of The Southern Association for Vascular Surgery, Naples, Fla, Jan 27–30, 1999.
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0741-5214/99/$8.00 + 0 **24/6/100054**

The most appropriate operative approach for aortoiliac reconstruction remains controversial. Most vascular surgeons are trained in the classic transabdominal approach to the infrarenal aorta. However, all surgeons would agree that the retroperitoneal approach is advantageous with a patient who has a hostile abdomen or in the presence of renal anomalies. In addition, there may be possible physiologic advantages to avoiding the peritoneal cavity. Nevertheless,

the retroperitoneal approach to the aorta has failed to gain widespread acceptance, largely because it is technically a more difficult and time-consuming operation. Several reports have advocated the retroperitoneal approach[1-3] for elective aortic operations in healthy patients, but these reports are offset by equally excellent studies that advocate the transabdominal approach.[4,5] The purpose of this study was to evaluate the retroperitoneal versus the transabdominal approach for infrarenal aortic reconstruction in patients who are at high risk.

PATIENTS AND METHODS

One hundred forty-eight patients who underwent elective aortic operations for either aortoiliac occlusive disease (AIOD) or abdominal aortic aneurysms (AAAs) between January 1992 and January 1997 were evaluated retrospectively. Of the 148 patients, 92 were classified as American Society of Anesthesia (ASA) class IV.[6] The patients of ASA class IV have severe systemic disorders that are already life threatening and may not be correctable with operation. Examples of these disorders include congestive heart failure, unstable angina, and advanced degrees of pulmonary or hepatic insufficiency.[6] Patients with emergency operations, patients with suprarenal aneurysms, and patients in whom renal artery reconstruction was necessary were excluded from the study. Between January 1992 and July 1994, 44 consecutive operations were performed with the transabdominal approach—25 for AAAs and 19 for AIOD. During this time, several patients who were not classified with ASA class IV underwent aortic reconstruction with the retroperitoneal approach. We noted that these patients fared better than did the patients for the transabdominal approach, and we began using the retroperitoneal approach exclusively in August 1994. Between August 1994 and January 1997, 48 operations were performed with the retroperitoneal approach—27 for AAAs and 21 for AIOD. There were no statistically significant differences between the operative groups for the comorbid risk factors of age, tobacco use, congestive heart failure, chronic obstructive pulmonary disease, diabetes mellitus, previous myocardial infarction, or coronary artery heart disease (Table I). The preoperative cardiac workup was made on the basis of a complete history and physical examination and on an electrocardiogram to screen for the risk factor criteria of Eagle et al[7] (Q wave, history of ventricular arrhythmia, diabetes mellitus, age > 70 years, and angina). Patients with one or two risk factors were considered to be at intermediate risk and underwent dipyridamole-thallium stress testing (DTS). If the DTS results showed no defect, the patient underwent operation; if the DTS results showed reperfusion defect, the patient underwent cardiac catheterization; and if the DTS results showed fixed defect, the patient underwent echocardiography to assess left ventricular ejection fraction (LVEF). The patient underwent cardiac catheterization if the LVEF was less than 35%, and the patient underwent operation if it was greater then 35%. Patients with left main coronary artery disease or its three vessel equivalent underwent cardiac revascularization (balloon angioplasty/stenting or coronary artery bypass grafting). Perioperative anesthetic and postoperative pain management methods were the same between groups.

Table I. Comorbid risk factors for patients who underwent aortoiliac reconstruction

	Retroperitoneal approach (n = 48)	*Transabdominal approach (n = 44)*
Age (years)	70.5 (± 8.3)	69.2 (± 7.8)
Tobacco use	35 (73%)	33 (75%)
Congestive heart failure	35 (73%)	32 (72%)
Chronic obstructive pulmonary disease	34 (71%)	32 (72%)
Diabetes mellitus	34 (71%)	33 (75%)
Previous myocardial infarction	22 (46%)	21 (46%)
Coronary artery heart disease	31 (65%)	30 (65%)

Anesthesia and operative technique. Before the induction of general anesthesia, radial artery, pulmonary artery, and epidural catheters were placed in all the patients. Epidural catheters were placed at T8-L2, and a mixture of fentanyl citrate (15 ug/mL) and bupivacaine hydrochloride (0.25%) was used to control pain after surgery in all patients. The positioning of the patient for the retroperitoneal approach was critical and is well described, but it does merit review.[1] The patient was placed with the hips almost parallel to the table, and the left shoulder and trunk were elevated 45 degrees with the aid of an air-evacuating Styrofoam "bean bag" (Fig 1). The incision was extended from the level of the umbilicus laterally to the tip of the eleventh or twelfth rib. The rectus, internal and external oblique, and transversus abdominus muscles were divided with electrocautery. As the retroperitoneum was entered, the ureter and kidney were left in their anatomic, posterior position (Fig 2). The peritoneum was mobilized medially to gain exposure to the distal aorta and iliac arteries, and the infrarenal aorta was exposed to the level of the left renal vein. Proximal anastomoses that were performed for aortoiliac occlusive disease were per-

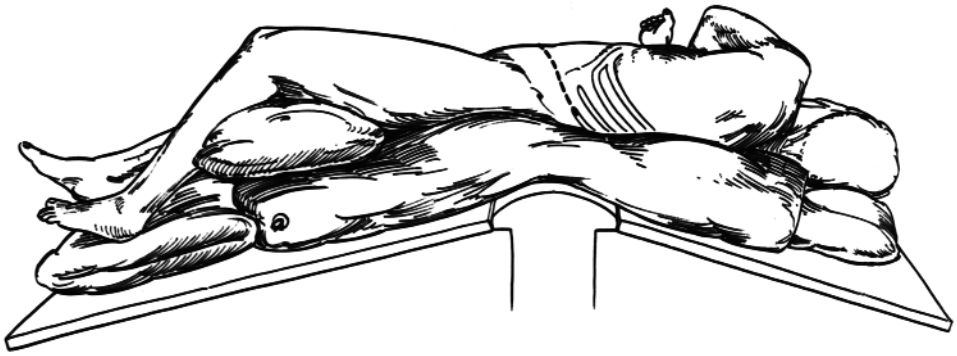

Fig 1. Positioning for retroperitoneal approach. Patient is positioned in lateral decubitus position, with chest at 45 degrees and pelvis almost level. Operating table is retroflexed to open space between costal margin and pelvic brim.[8]

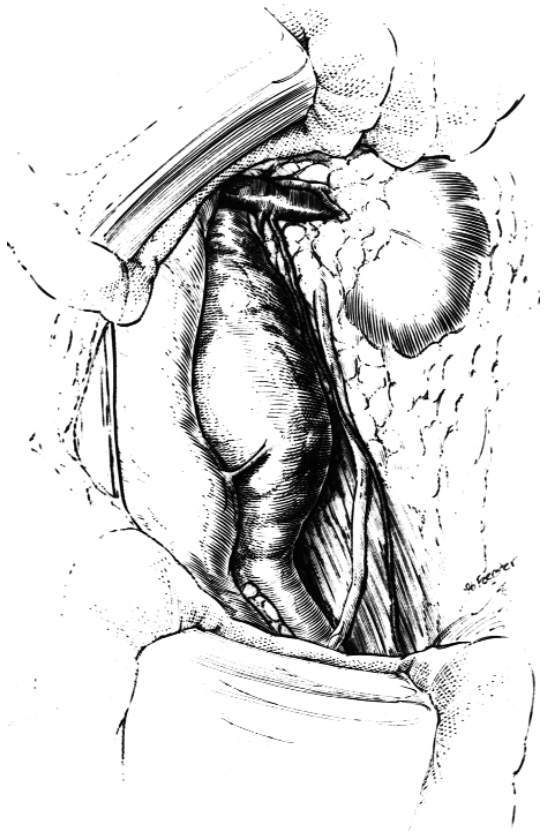

Fig 2. Exposure of infrarenal aorta via retroperitoneal approach. Left kidney and ureter are left in situ, and peritoneal sac is rotated medially.[15]

formed in an end-to-side fashion. The operative approach (retroperitoneal versus transabdominal) was not influenced by the indication for the operation or by the anastomotic configuration.

Each patient was followed longitudinally, and data concerning complications, cost, and hospital length of stay (LOS) were recorded. The postoperative complications included *ileus*, which was defined as prolonged nasogastric intubation (>72 hours) because of a delay in bowel function as documented with diffuse bowel dilatation without evidence of obstruction. Cardiac complications included congestive heart failure, arrhythmia that necessitated intravenous pharmacologic treatment, and ischemia as evidenced with anginal pain and documented with electrocardiographic changes or elevation of the CKMB (cardiac creatine kinase) fraction in patients who were symptomatic. Pulmonary complications included pneumonia that was documented with chest radiograph and sputum cultures, prolonged intubation (>72 hours), and adult respiratory distress syndrome, as defined by increased arterioalveolar gradient, non-cardiogenic pulmonary edema, and severe hypoxia as the result of intrapulmonary shunting with characteristic chest radiograph findings. The late complication of incisional hernia was evaluated for all the patients.

Statistical analyses were performed for preoperative risk factors, intraoperative and postoperative complications, hospital LOS, and cost data with Student *t* test. The long-term survival data were calculated with the lifetest procedure (life-table survival estimates).

RESULTS

Operative mortality. During the 30-day perioperative period, death occurred in three patients in the retroperitoneal group (6.26%) and in five patients in the transabdominal group (11.3%). This difference did not reach statistical significance ($P = .5$; Table II). The operative mortality rate for the 56 other patients who were non ASA class IV was 3.5% (two of 56).

Postoperative complications. Pulmonary complications occurred in 23 patients (47.9%) in the retroperitoneal group versus 19 patients (43.2%) in the transabdominal group. This difference did not reach statistical significance ($P = .07$). Cardiac complications occurred in six patients (12.5%) in the retroperitoneal group as compared with 10 patients (22.7%) in the transabdominal group. This difference was statistically significant ($P = .004$). Gastrointestinal complications occurred in five patients (8.3%) in the retroperitoneal group as compared with 15 patients (34.1%) in the transabdominal group. This difference was statistically significant ($P = .002$). Incisional hernias developed in six patients (12.5%) in the retroperitoneal group versus five patients (11.3%) in the transabdominal group. This difference was not statistically significant ($P = .5$; Table II).

Operative time. The mean retroperitoneal operative time (3.35 hours; range, 3.17 to 3.53 hours) was approximately 37 minutes longer than the mean transabdominal operative time (2.98 hours; range, 2.79 to 3.17 hours). This difference was statistically significant ($P = .006$; Table II).

Blood loss. The blood loss was approximately 250 mL greater in the retroperitoneal group (mean, 803 mL; range, 723.8 to 882.2 mL) than in the transabdominal group (mean, 647 mL; range, 557.8 to 736.2 mL). This difference was statistically significant ($P = .012$; Table II).

Analgesics. The use of intravenous narcotics (morphine) in the retroperitoneal group (mean, 36.6 ± 21 mg) was less than in the transabdominal group (49.5 ± 28.5 mg), as was the duration of epidural analgesics (retroperitoneal, 39.5 ± 6.4 hours; transabdominal, 56.6 ± 9.5 hours). These differences were both statistically significant ($P = .004$; (Table II).

Length of hospital stay. The mean hospital LOS for the patients who underwent the retroperitoneal approach was 7.2 ± 1.6 days (range, 5.6 to 8.8 days) versus the mean LOS for the transabdominal group, which was 12.8 ± 2.3 days (range, 10.5 to 15.1 days). This difference was statistically significant ($P = .024$; Table II). The patients in the retroperitoneal group were discharged from the hospital on average 5.6 days earlier than were the patients in the transabdominal group.

Hospital charges. The mean hospital charge for patients in the retroperitoneal group was $35,587 ± $980 per patient versus $54,832 ± $1105 for the patients in the transabdominal group, which represents a savings of $19,245 per patient for the retroperitoneal approach. This difference was statistically significant ($P = .04$; Table II).

Table II. Comparison of outcomes for patients who underwent aortoiliac reconstruction with the retroperitoneal approach versus the transabdominal approach

	Retroperitoneal approach (n = 48)	*Transabdominal approach (n = 44)*	*P value*
Operative mortality rate	6.26% (3)	11.3% (5)	.5
Pulmonary complications	47.9% (23)	43.2% (19)	.7
Cardiac complications	12.5% (6)	22.7% (10)	.004
Gastrointestinal complications	8.3% (5)	34.1% (15)	.002
Incisional hernia	12.5% (6)	11.3% (5)	.5
Operative time (hours)	3.35 (± 0.18)	2.98 (± 0.19)	.006
Blood loss (mL)	803 (± 79.2)	647 (± 89.2)	.012
Analgesics (intravenous mg)	36.6 (± 21)	49.5 (± 28.5)	.004
Analgesics (epidural mg)	39.5 (± 6.4)	56.6 (± 9.5)	.004
Hospital length of stay (days)	7.2 (± 1.6)	12.8 (± 2.3)	.024
(US dollars)			
Hospital charges	35,587 (± 980)	4,832 (± 1105)	.040
Survival rate at 40 months	81.3% (± 4.03)	78.7 (± 5.46)	.53

P values of ≤ .05 were considered to be statistically significant.

Survival. There was no statistically significant difference at the 40-month follow-up examination in the survival rates between the retroperitoneal (81.3%) and the transabdominal (78.7%) groups with life-table analysis ($P = .53$; Table II).

DISCUSSION

Since the first successful retroperitoneal aortic reconstruction was reported by Oudot[8] in 1950, controversy has surrounded its use in elective abdominal aortic operations. The technical advantages of the retroperitoneal approach include: the avoidance of adhesions from prior abdominal operations, the easier exposure in patients who are obese, the improved exposure of the aortic "neck" in large aneurysms, the easier juxtarenal and suprarenal aortic control, the safer repair of inflammatory aneurysms, and the greater safety in patients with certain renal vascular anomalies.[1-3,9-11] The cited physiologic advantages of the retroperitoneal approach include: decreased postoperative ileus, decreased third space fluid loss, reduced hypothermia, fewer hemodynamic stresses, decreased pulmonary compromise, faster recovery, and fewer overall complications.[1,3,9-11] These potential physiologic benefits are thought to result from the fact that the peritoneal cavity is not violated and that its

contents not manipulated, which thereby results in diminished heat and evaporative losses, less third space fluid losses, decreased postoperative pain, and reduced compromise of pulmonary and gastrointestinal function.[1,3,10-12] The potential disadvantages of the retroperitoneal approach include poor access to the right renal artery and inability to visualize the left colon after revascularization.[1-3] Several authors have stated that the exposure to the right iliac bifurcation or the need for IMA implantation are contraindications to the retroperitoneal approach.[1,9,13] We have found, however, that simply dividing the posterior rectus fascia allows excellent exposure to the right iliac bifurcation and the IMA. Consequently, the number of bifurcated versus tube grafts placed with the retroperitoneal approach was not significantly different.

Three prospective, randomized reports have compared the retroperitoneal approach with the transabdominal approach for abdominal aortic operations.[2,4,5] Cambria et al[4] found that the only benefit of the retroperitoneal approach was the earlier resumption of oral intake and, therefore, concluded there was no major advantage in the use of the retroperitoneal versus the transabdominal approach. This finding was corroborated by the report of Sieunarine et al.[5] However, the 1995 study results of Sicard et al[2] showed significant reductions in the length of intensive care unit stay, hospital LOS, cost of care, and overall incidence of postoperative complications in patients when aortic operation was performed with the retroperitoneal approach.

In the 1989 nonrandomized comparison study of the retroperitoneal and transabdominal approaches from Sicard et al,[1] 21 of the patients had severe chronic obstructive pulmonary disease or recent myocardial infarction and were considered to be at too high of a risk to undergo aortic operation with the transabdominal approach. These patients selectively underwent operation with the retroperitoneal approach. The morbidity (38%) and mortality (0%) rates for these patients at high risk were excellent, and Sicard et al[1] concluded that the retroperitoneal approach should be the preferred approach for elective aortic operations in patients at high risk.

The ASA categorizes patients for surgery into classes according to cormorbid risk factors.[6] The patients of ASA class IV are those with severe systemic disorders, which may include cardiac insufficiency, persistent angina, active myocarditis, and advanced degrees of pulmonary, hepatic, renal, or endocrine insufficiency.[6] These patients at high risk with multiple comorbid medical problems have high morbidity (38%, in the 1989 report of Sicard et al[1]) and mortality (8% to 30%) rates that are associated with aortic operations, despite advances in perioperative management.[13] Analysis results of the patients at high risk in this study showed a significant decrease in morbidity when the retroperitoneal approach was used instead of the transabdominal approach (Table II).

The retroperitoneal approach avoids the midline incision and the associated bowel dilation and rectus spasm that may cause severe discomfort that can hinder patient mobilization, pulmonary toilet, and resumption of gastrointestinal tract function. In this series, the retroperitoneal approach was less painful, as evidenced by the significant reduction in intravenous narcotics and epidural analgesics, which in turn helped reduce the hospital LOS and hospital charges. Cardiac and gastrointestinal complications associated with the retroperitoneal approach have been reported to be markedly reduced,[1,3,4] and our data support these findings. The increase in cardiac complications that is seen in the patients for the transabdominal approach was thought to be a result of the postoperative fluid shifts and the resulting hemodynamic stress associated with violating the peritoneal cavity. There was no difference in the incidence of pulmonary complications or incisional hernias between the groups. Operative time in this series, however, was significantly longer with the retroperitoneal approach. The additional time was the result of the opening and closing of the flank wound. The opening for the retroperitoneal approach necessitates a far more meticulous dissection than does the transabdominal approach because the correct plane between the transversus abdominus and the peritoneum must be carefully dissected to avoid entering the peritoneal cavity. Similarly, the closing of the flank wound is performed in multiple layers as opposed to the customary single layer closure of a midline wound. Blood loss was also greater in the retroperitoneal group and may be attributed to the more extensive dissection that is necessary to transect the musculature of the lateral abdominal wall and its associated postoperative oozing into tissue planes. Despite this, blood transfusion requirements with the retroperitoneal approach were not significantly increased. The 8.7% mortality rate, although higher than that reported by Sicard et al[1] for patients of ASA class IV (0%), was within the reported range (8% to 30%) for patients at high risk who underwent aortic operations.[13]

With health care reform focusing on cost containment and with its concomitant financial constraints on today's surgical patient, a shorter hospital LOS with its inherent health care savings is another benefit

of the retroperitoneal approach. As the population ages, the number of patients of ASA class IV who require aortic operations will increase and this will become an even greater issue. Indeed, the 1996 data from the Health Care Finance Administration on 31,625 patients who had undergone routine elective AAA operations show that the mean hospital LOS was 9.5 days, which resulted in a $15,000 diagnosis-related group loss per patient to the hospital.[14] In this study, the mean LOS and hospital charges were significantly reduced when the retroperitoneal approach was used (Table II). Thus, a healthcare savings was realized. This is encouraging to note because the transabdominal approach was used earlier (1992 to 1994) in the study than was the retroperitoneal approach (1994 to 1996) when the healthcare costs were rising annually.

CONCLUSION

Although a number of studies have suggested that patients at high risk who undergo abdominal aortic operations fare better with the retroperitoneal approach, no trial has specifically addressed this question. Patients of ASA class IV who underwent aortic reconstruction with the retroperitoneal approach had a significant reduction in postoperative pain and in gastrointestinal and cardiac complications, which resulted in a shortened hospital LOS and health care cost savings. Although operative time and blood loss were greater with the retroperitoneal approach, there was no difference in the incidence of pulmonary complications or incisional hernias. There was no difference between the retroperitoneal and transabdominal groups in the perioperative mortality or survival rates at 40 months. In patients of ASA class IV, abdominal aortic operations can be more safely and economically performed with the retroperitoneal approach.

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Submitted Feb 1, 1999; accepted May 12, 1999.

DISCUSSION

Dr Scott L. Stevens (Knoxville, Tenn). Most vascular surgeons agree that a retroperitoneal approach can be helpful in select, pressing aortic reconstructions—in particular, in patients who are morbidly obese, in patients who have redo aortic surgery, in patients with inflammatory aneurysms, and in patients with a hostile abdomen. Much more controversial, however, is the role for a retroperitoneal incision for a straightforward, uncomplicated aortic repair.

Proponents of the retroperitoneal approach cite physiologic advantages. They note decreased physiologic trespass by not traversing the peritoneal cavity. Theoretically,

this accounts for decreased pulmonary and decreased cardiac complications. It also may account for a quicker return of bowel function. Critics of this incision note that it prevents the exploration of the abdominal contents, that it limits the exposure to the right renal artery, and that it can impede the control of right iliac artery disease.

Certainly, the retroperitoneal incision necessitates a more meticulous dissection and the layered closure is more time-consuming. I have noted patients with retroperitoneal incisions to have chronic incisional pain, and often they are troubled by the flank bulge that develops in the area of denervated muscles.

In the series presented by Dr Kirby and colleagues, the utility of a retroperitoneal incision in high-risk, ASA class IV aortic reconstructions is addressed. They demonstrate decreased cardiac complications, quicker return of bowel function, shorter length of stay, and less hospital charges. They also demonstrated no difference in pulmonary complications, longer operative times, and increased blood loss. Their conclusion is that the retroperitoneal incision is safer and more economical as compared with the transabdominal incision in ASA IV aortic reconstructions.

In summary, this paper presents a wealth of data addressing an important surgical challenge—that is, improving the results of high-risk aortic reconstructions.

I commend Dr Kirby on an excellent presentation and the authors on fine clinical results. I take issue, however, with their conclusion that it provides a more safe and more economical approach. I do not think the data exist to establish one incision as superior to the other.

I have three questions for Dr Kirby. First, considering the trend for shorter lengths of stay, decreased cardiac complications, and early removal of nasogastric and endotracheal tubes, do you think that, with historical controls for the transabdominal incision category, the results of your study may have been biased in favor of the retroperitoneal group?

Second, did you evaluate long-term sequela specific to incisional approach, such as chronic incisional pain, small bowel obstruction, aortoenteric fistula, incisional hernias, or flank bulges?

Third, your study shows advantages for retroperitoneal exposure in high-risk patients, yet many aortic reconstructions are straightforward and uncomplicated. What is your algorithm for uncomplicated aortic reconstructions, and do you think the advantages of a retroperitoneal approach transfer to these patients as well?

Dr Lemuel B. Kirby. Thank you, Dr Stevens, for your insightful discussion and excellent questions. The first question addresses our use of historic controls for the transabdominal group and whether this biased our results because of improvements that have occurred in perioperative care with time. This is a valid point. I would respond by saying that all of our patients underwent treatment identically. They all received epidural catheters, pulmonary artery catheters, and arterial lines and were all cared for in the same intensive care unit, often by the same nursing staff. Also, to my knowledge, there have been no changes in the reported morbidity or mortality rates for aortic procedures because of improvements in perioperative care since 1992, which is when our study began.

The second question addresses the long-term sequela related to the flank incision, such as chronic pain, small bowel obstruction, aortoenteric fistula, and incisional hernias or flank bulges. Our study focused primarily on the perioperative period, so we did not specifically record data on many of these sequela. Regarding incisional hernias or bulges, as you are aware, a number of published reports have cited an increase in these complications with the retroperitoneal approach. In some of these reports, the authors used a "mass" closure, whereas we have used a multilayered closure of all three musculofascial layers. In fact, we found no increase in the incidence of incision hernias with the retroperitoneal approach. These data appear in our manuscript.

In your third question, you asked whether our improved results in high-risk patients who underwent the retroperitoneal approach could be expected in the "routine" patient. The reductions in gastrointestinal complications and postoperative pain should be appreciated by all patients, regardless of their preoperative medical condition.

The reduction in cardiac complications may be specific to the high-risk patient, but it is doubtful that the ultimate improvements of shorter hospital stay and cost savings are purely the result of cardiac complications. Therefore, I think I would agree with Dr Sicard and believe that the retroperitoneal approach can deliver equal results in these patients and may ultimately lead to a shorter hospital stay and cost savings in all patients.