Aortic surgery symposium 2010 discussions—Session VII: Descending/thoracoabdominal II and session VIII: Descending/thoracoabdominal III

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Discussion

Dr Randall B. Griepp (*New York, NY*). I have a few general comments. One thing that I would suggest to the community of aortic surgeons is that we considering using 1-year survival as the standard in reporting our results. In these extensive procedures that in many cases take a substantial toll on the patient, I think the patient who dies before 1 year has passed made a bad decision to have the operation, or perhaps the surgeon made a bad decision. I would suggest that 1-year survival is what we should look at rather than 30-day mortality.

The second suggestion is to present long-term mortality data either in comparison with an age-matched control or as standardized mortality ratios. For instance, in type A aortic dissections, we know that the standardized mortality rate is between 2 and 2½ times normal, or 2 to 2½. Even after successful type A repair, a patient is about 2 to 2½ times more likely to die each year than is a member of the normal population. This makes it easy to compare things from one series to the next. Since patients are of varying ages and sex distributions, it also makes it easier to go from one study to the next.

I have a couple of questions to start out with. Dr Kouchoukos and Dr Fehrenbacher—and maybe Dr Kulik would like to comment—what do you do about fluid retention after hypothermic circulatory arrest (HCA)? In my experience, most of these patients

come back from the operating room pretty heavy. How much fluid do they accumulate on the average? How much does it affect extubation time? When do you start diuresis?

Dr Nicholas T. Kouchoukos (*St Louis, Mo*). Fluid retention, I believe, is probably real. We do not systematically weigh the patients in the early postoperative period. They have a lot of monitoring devices and tubes that make it very difficult to do. In general, I think they do not come back overloaded, at least in terms of their intravascular volume. We generally initiate gentle to moderate diuresis in the operating room and continue it in the early postoperative period. I think your point about fluid retention having some influence on pulmonary function is probably also real.

Dr Griepp. What is your regimen for managing the coagulation system at the end of an operation done with HCA? Do you use thromboelastography? What do you give routinely, and what do you give when things are bad?

Dr Kouchoukos. We do not give blood component therapy routinely. In fact, a percentage of these patients, perhaps 10%, and particularly those with aneurysms involving only the thoracic aorta, received no blood products. We have used this technique in a few Jehovah's Witnesses and have been successful. We use the thromboelastogram currently to guide our blood component administration. Most of our patients, at least those with Crawford type II or III aneurysms—the extensive ones—will receive one round of fresh frozen plasma, as well as platelets and cryoprecipitate on occasion. But we have no other specific regimen. We have not used aprotinin since our early experience because it was so disastrous.

Dr John Fehrenbacher (*Indianapolis, Ind*). We have similar results. With regard to fluid retention, other surgeons who have used HCA have asked that question because of their concern that the patients were so swollen. Our patients are cold and we are running low flow: 1 L to 1500 L. We do not worry about running calculated flows on the heart–lung machine when we are doing the distal work. As long as I have a radial artery pressure of 40 mm Hg, I am happy, even as the patient starts to warm. We use the typical diuresis that would be used with any pump: it is not excessive. The patients are swollen, but, as I mentioned, the prolonged extubation rate was only 11%. Frankly, a lot of the reasons for prolonged extubation are neurologic rather than lung problems.

From a coagulation standpoint, we give 10 g of alpha-aminocaproic acid before turning the pump on; we give another 5

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Abbreviations and Acronyms

CSF = cerebrospinal fluid

CT = computed tomography

HCA = hypothermic circulatory arrest

g every 3 hours—which indicates how long the pump runs are—and we are not routinely give clotting factors. Our mean blood utilization—not intraoperatively, but for total hospital stay—was 4.7 units of blood. In general, we are frequently giving a platelet pheresis pack, cryoprecipitate, or a fibrinogen concentrate, but not always. My guess is that we are using those about half the time.

Dr Joseph S. Coselli (*Houston, Tex*). We do pretty much the same thing. We do the minority of cases under HCA. If we put them on pump, we are putting them on pump to cool them down, and generally it is a selected group of patients: it is not across the board.

Although he blew past it, Dr Fehrenbacher pointed out something that I think is critical from a neurologic standpoint in these patients. When I am working on the proximal anastomosis in and around the arch, I have a clamp on the descending thoracic aorta, and the pump flow is about 2 L/min. I think that the filling of blood in the arch that is emanating back toward you that you have to suck away is extremely important in keeping out air, and you float out some debris. I think I saw that in his film. I think it is important.

The only thing that I would add with the bleeding issue is to keep in mind the use of factor VII from time to time if you get into a really serious coagulopathy.

Dr Grieppe. Thank you. I will add my two cents. I think the biggest problem with postoperative fluid retention is if diuresis is conducted too quickly while the capillaries are still leaking and the patient becomes hypovolemic, even though he is 10 kg overweight. I believe the coagulation defect of hypothermia is platelet function; I think having a couple packs of platelets ready is a good idea. I actually think fresh frozen plasma is probably harmful, but I will leave it at that.

Dr Fehrenbacher. What we have noticed (and it is very interesting; we have a series now), is that when the patient is hypothermic, the platelet count drops dramatically. As the patient warms, the count comes right back up. For a long time we were ordering platelets and even transfusing on pump. But once I started using BioGlue adhesive (CryoLife, Inc, Atlanta, Ga) to seal the needle holes, I got a little more bold about not ordering platelets, and platelet counts that were 30,000 at 15°C were 85,000 at 37°C. So we are a little less aggressive with platelets.

Dr Grieppe. One of the issues with extensive stenting is the left subclavian artery. Perhaps Mr Chesire and Dr Kuratani would like to comment. How many of your patients had coverage of the left subclavian artery? These were all more distal aneurysms, is that not correct?

Mr Nicholas J. W. Chesire (*London, United Kingdom*). I was reasonably gentle in the way I framed our experience. Early on in this series, we had a malignant combination, I think, of ignorance about the need to keep the left subclavian in circuit and a kind of overblown confidence in this new operation. We did all of our first 45 cases just blindly covering the left subclavian if we needed to.

We never revascularized it. All our thoughts and concentration were on arm ischemia. I remember talking at several meetings and saying that, in our thoracic endovascular aneurysm repair (TEVAR) and thoracoabdominal program, we had to go back and revascularize only 2 patients, both young men with old transections who were fit and active and had arm claudication. Actually, I think a combination of taking on the wrong patients and not revascularizing the left subclavian gave rise to the uptick in spinal cord injury that we had. We really had to readdress our whole program. As I said, the only patients in whom we do not revascularize the left subclavian now are those with acute dissection in whom there is a great deal of backwash. We are only doing the thoracic portion, where the figures suggest that there is a relatively low incidence of spinal cord injury. Everyone else gets a left subclavian in circuit now.

Dr Toru Kuratani (*Osaka, Japan*). Usually we use much longer stent grafts for thoracoabdominal aortic aneurysms. The collateral circulation is very important, and the left subclavian artery is very important for the collateral circulation. Any time we obstruct the left subclavian artery, we need to assure the patency of left subclavian artery flow. The hypogastric artery is also very important to prevent paraplegia or paraparesis. We check flow in the hypogastric artery and left subclavian artery preoperatively.

Dr Grieppe. I have 1 final question for the hybrid surgeons. Do you ever do these procedures in 2 stages? I know there are access problems in many cases, but is there a situation in which you do your debranching and then say that is enough for today; let's come back in a week or so?

Mr Chesire. We have a kind of division of views in our unit. I am quite keen to split the procedure in two. It has often been a very long day and the patient is coagulopathic. Paradoxically, if it has been long and the patient is cold, I suppose it is actually slightly better for the spinal cord. We have had interval ruptures in 2 cases, and in our European paper we described 3 interval ruptures in that short period of time. It happens if the patients are sick after a large abdominal operation and there is a delay in getting the stent graft in.

Dr Grieppe. What percentage of yours in this series are 2-stage procedures?

Mr Chesire. I cannot remember exactly in that series. It is 18 of 110 in the European series, or 18.9%.

Dr Kuratani. Usually we use a 2-stage operation, because with a debranching operation added to an accessory operation, sometimes there is too much blood loss. At such a time, blood pressure is unstable, and the stent graft operation has a risk of paraplegia. We do the bypass operation on the first day, and the next day we try the stent graft surgery. In the presentation, perhaps 95% of the patients had a 2-stage operation.

Dr M. Schepens (*Brugge, Belgium*). I have 2 short questions, 1 for Dr Coselli and 1 for Dr Kouchoukos or Dr Fehrenbacher, who use deep hypothermia. The first question concerns the technique of giving intravenous dye after reperfusion of the kidneys. Joe, are you comfortable with that? Do you think it is useful to give intravenous dye and to check the time that it appears in the urine as a marker of postoperative renal function?

The second question is in regard to the use of cerebrospinal fluid (CSF) drainage and full heparinization. Have you seen any complications related to that?

Dr Coselli. With regard to the intravenous dye, except under rare circumstances, we use it for urine clearance routinely and really have not seen a downside to that.

Dr Schepens. Exactly. We use it all the time. We found that when the dye appeared in the urine within 30 minutes after reperfusion, there was a very low chance that renal failure would develop afterward.

Dr Coselli. I find it most useful when I have an atrophic or absent left kidney, I have reattached the right kidney, and I am concerned about the circulation, as it is otherwise hard to manage.

Dr Griep. Joe, what dye are you talking about? Is it methylene blue?

Dr Coselli. He is not talking about intravenous contrast for arteriography. He is talking about dye for urine clearance.

Dr Schepens. Indigo carmine blue.

Dr Kouchoukos. We have not used any contrast, and since we have gone to using the branch grafts for the renal and visceral arteries, we measure flow in these arteries before we leave the operating room. We have had a similar experience to Dr Coselli with one kidney, but generally we are certain that there is adequate flow in the renal arteries at the conclusion of the procedure.

With regard to CSF drainage and full heparinization, this is a real concern. We procrastinated a bit before implementing the use of CSF for that reason. Since we have been using it, however, our complication rate has not been different from what you heard presented. A subdural hematoma, which required surgical drainage, developed in 1 of the 53 patients in whom CSF drainage was used, but she survived. Obviously one has to be careful about use of CSF drainage with full heparinization. If we get a bloody tap or encounter any other difficulty with insertion of the catheter, we abandon its use.

Dr Fehrenbacher. I do not use dye, but what I expect to see once we are off-pump and have pulsatile flow is at least 100 to 200 mL of urine every half hour. If I see 20 or 30 mL, then I know I probably have a technical problem with the bypass.

With regard to CSF drainage, our beliefs are the same as those that have been outlined. We use motor evoked potentials. If the patient is warm and has pulsatile flow, and the motor evoked potentials do not come back immediately to baseline, then we put a drain in before we leave the operating room. Otherwise, we do not drain CSF routinely, except when there is evidence of delayed spinal cord injury.

Dr J. Bavaria (Philadelphia, Pa). Martin, this is an excellent series with a mean follow-up of almost 5 years—very good long-term data. Have the endoleak rates improved over time as the grafts have improved? The short grafts were disastrous for endoleaks. I would like to know whether your 1-month or 30-day endoleak rate has changed over the past 10 or 12 years that you have been doing this.

Dr Martin Czerny (Berne, Switzerland). The endoleak rate has definitely decreased over time. From the very beginning, we followed a very extensive policy of long landing zones. However, when we reflect on the past 12 years of implementing this therapy, I think the conclusion is that the longer the landing zone and the lower the number of prostheses, the higher the probability of success both early and long term. It is clearly the case that the rate of type III endoleakage has been dramatically reduced over time.

Dr Bavaria. I have a second follow-up question that is similar. I am interested in your type II subclavian endoleaks, which we never have because we always take care of the subclavian artery and never over-stent it without either ligating it or coiling it or

something. What is your policy now toward the subclavian artery with regard to the proximal landing zone?

Dr Czerny. In the elective setting, we use transposition in every case. The cases I showed were all emergency settings in which we did not have any time to revascularize in advance, and we got a feel for that in the midterm.

Dr M. P. Siegenthaler (Bethesda, Md). I have a question for Martin Czerny. What was the incidence of late endoleaks in stent grafts with a perfect result initially? I assume a lot of the problems you observed were difficult cases in which you had problems from the beginning. However, how many have you seen that were perfect initially, with no type I or type III endoleak, that on late follow-up had endoleaks?

Dr Czerny. That is a very good question. The answer is none of them, just two type V endoleaks. These were the ones, of course, that were not predictable. As we know, the first-generation stent grafts had a plasma leakage problem. The grafts that were ideal at the beginning remained stable over the years.

Dr Siegenthaler. You made the point that long-term follow-up is important, so couldn't you make the point that if it is perfect early, it is very likely that it will stay that way?

Dr Czerny. That is a very good question. There are 2 points. Aortic disease will develop in 10% of our patients in other segments over the years. I think the surveillance of other segments is probably more important than the surveillance of a primary perfect result. Furthermore, we have detected 15 or 16 newly diagnosed asymptomatic malignancies in these patients, primarily bronchial carcinoma but also colon carcinoma, which we were able to detect at a very early stage because we monitored them for aortic disease. Therefore, I think that routine follow-up computed tomographic (CT) scans have their merits for all these reasons.

Mr Chesire. It is a good question, though. It reflects some of the thinking and some evidence in the abdominal aorta. If there is a good infrarenal neck and long engagement of the iliacs, then the incidence of stent graft problems with the modern systems is very low. However, where I would take issue with you is in assuming in any of these cases that the graft sits perfectly. When you have to go around that evil-shaped arch and there are large numbers of stent grafts overlapping each other over a very long segment, then you can never feel perfectly comfortable that this is okay. I agree with Martin. These patients need follow-up all the time.

Dr Coselli. This is a group of patients receiving long-term follow-up. They do pretty well. What we have suggested to many of them is that if we are going to follow up the rest of the aorta with a CT scan and we do not have an early endoleak that we are observing, we not give them intravenous contrast in those follow-up studies and reduce that additional impact.

Dr H. Ogino (Suita City, Japan). My concern is about the reconstruction of the visceral arteries, including the intercostal artery. My question is to Dr Kouchoukos and Dr Coselli. How often did you encounter aneurysms after the island technique? And Dr Coselli, how often do you use your Vascutek branched graft (Terumo Corporation, Tokyo, Japan)? I like a branched graft. Could you please answer?

Dr Kouchoukos. We have seen intercostal patch aneurysms develop late postoperatively. One of the reasons, I think, is that, particularly for patients with chronic dissections, we have been very liberal about implanting large numbers of intercostals because most of

them are patent. Most of the patch aneurysms can now be repaired with endovascular grafting techniques, and we have had very good success in treating them in this manner, assuming that there is a suitable landing zone on either side. We have used branched grafts in the hope of eliminating patch aneurysms of the visceral patch, and we have not had any problems with this approach.

Dr Grieppe. I could point out that if you do not use the intercostal arteries in the first place, you will not have that problem.

Dr Kouchoukos. I still have a little anxiety about ligating all of the intercostal arteries, particularly when operating on a 30- or 35-year-old patient with Marfan syndrome. I just do not have the courage to do that.

Dr Coselli. I do not know what the exact incidence is of patch aneurysms. From following Dr Crawford's patients and our own, I guess we probably have operated on 40 or so visceral patches. It is related to time and also to the disease process, as well as to hypertension. Connective tissue disorder, dissection, and hypertension are the things that we worry about. With intercostal patch aneurysms in recent years, we have had the exact same experience: we put stent grafts across these, and at least to date, we really have not had any neurologic sequelae from that. How often do I use the branch graft? Unlike Dr Kouchoukos, I use it selectively in the patients that I described. Also, any time we redo a patch aneurysm, if we are going to do it open, we will virtually always use a branch graft. In our overall experience, it is a little less than 10%.

Dr Kouchoukos. Dr Kulik may want to comment on this because he did all of the groundwork for our publication on this subject. If you look at the literature, there is very little written about the prevalence of patch aneurysms. There are scattered series and scattered case reports, particularly regarding visceral patch aneurysms. One of the problems, of course, is that these probably go undetected in a substantial number of patients unless they are scanned on a routine basis. Therefore, the actual prevalence may be higher than has been reported.

Mr Chesire. One thing that has not been raised is the use of branch or fenestration technology for patch aneurysms, particularly on the visceral segment, because they are straight and they get good Dacron landing zones top and bottom. We have not done any yet, but we are looking out for them.

Dr Alexander Kulik. I would like to follow up on Dr Kouchoukos's point about the incidence of patch aneurysms. Having reviewed the literature to evaluate the incidence of visceral patch aneurysms, I found that it is anywhere between 4% and 8%. There was a series from Italy that estimated the incidence at 4% and a series from Johns Hopkins that reported a visceral patch aneurysm incidence of 7.5%. With regard to intercostal patch aneurysms, in a review of Dr Kouchoukos's experience, we noted that 7.1% of patients treated with intercostal artery reimplantation at the time of the initial aortic surgery had intercostal patch aneurysms develop over long-term follow-up. A number of these patients were treated very successfully with stent graft techniques.

Dr Grieppe. We have used Dr Spielvogel's graft for branch grafting, and it is very useful if you want to plan for possible later stent-graft implantation. It gives you a lot of freedom, either bringing it from below or bringing it from above, and leaving a large part of the main graft available for a landing zone.

Dr J. Bachet (*Abu Dhabi, United Arab Emirates*). I have a small technical question for Dr Kouchoukos and Dr Fehrenbacher. In the

few patients in whom I have used deep hypothermia during replacement of the thoracoabdominal aorta, I have noted that it was difficult, at least for me, to deair the arch. I remember 1 patient who most probably had an air embolus when we resumed proximal bypass. What are your techniques to safely deair the arch in deep hypothermia before resuming cardiopulmonary bypass?

Dr Kouchoukos. I can remember when we first started doing this, and I also remember seeing Dr Crawford do a case. I was absolutely terrified about the probability of entrapping air. Dr Fehrenbacher has a little different technique from ours, but what we do is initiate the venous perfusion retrogradely through the venous cannula as we are completing the proximal aortic anastomosis. If this is done for several minutes, the whole arch will fill with blood. As I mentioned in my presentation, if you have a vent in the left heart, you have to be sure that vent is not operating while you are filling the proximal aorta, so that you do not suck air into the heart. These maneuvers, in our experience, are satisfactory. Dr Fehrenbacher continues perfusion from below, which accomplishes the same thing.

Dr Bachet. Are you saying that you have a systematic shunt between your arterial line and your superior vena cava line in your bypass system?

Dr Kouchoukos. That is correct, and if you have the head in a dependent position, you can generally fill the arch and the graft without difficulty.

Dr P. Aranda (*Malaga, Spain*). Dr Coselli, do you think there is a minimum number of cases a hospital should be doing to do a thoracoabdominal operation or should these patients be referred? What do you think is the minimum number of patients per year to start one of these programs? The second question is to Dr Chesire regarding hybrid revascularization of the visceral arteries. I would like to know your opinion about using the ascending aorta as the inflow for your viscerales as proclaimed by Dr Exposito in Italy, among others.

Dr Coselli. I am not absolutely certain how to answer. I think it is more than just a surgeon's skill level. You have to build a team around some of these complex aortic cases to do a wide variety of things that we have talked about over the last couple of days: the technicians, the anesthesiologists, the perfusion team, and the post-operative care management personnel. It takes a really focused effort to have really good results. There are actually some data with regard to the mortality rates of thoracoabdominal aneurysms from some articles that have been written on Medicare data. In my recollection, if you are not doing at least 25 a year, your mortality rate begins to rise in a statistically significant fashion. I am not absolutely certain of that 25% figure, but I think that is fairly close. I personally think the number actually may be a little bit higher than that.

Mr Chesire. I agree very much with Joe's point. There is a good evidence base in infrarenal aneurysm repair, which is infinitely easier, with a cutoff point beginning with a minimum of 35 cases. So one would have thought the thoracoabdominal repair, needing a team and everything else, is going to require even an even greater number of cases to be sure of getting good results.

Dr Aranda. Can you comment on the ascending aorta as an inflow for the visceral vessels?

Mr Chesire. We have done 2 of those, and it is very successful. It is a nicer looking procedure than this rather ugly retrograde graft. It is just very invasive, and you cannot help thinking should you

have just fixed the whole thing as an open operation by the time you have done that much surgery.

Dr Grieppe. Let me ask a question for the surgeons and hybrid personnel here. What about preoperative workup? What do you require in your patients before you take them to the operating room to do one of these big procedures? Should they be catheterized? Should they have a stress test? What else? Do they need a pulmonary function test or a walking test?

Dr Kouchoukos. For patients with thoracoabdominal or extensive descending thoracic aneurysms, and for any patient over the age of 40 to 45 years, we perform coronary angiography as the principal screening study. We do not rely on stress testing or thallium testing. Instead of wasting considerable time and money doing noninvasive testing, it is much quicker and possibly cheaper to do a cardiac catheterization. As Dr Fehrenbacher indicated in his presentation, a not insignificant number of patients will require coronary artery bypass grafting or stenting before aneurysm repair, and this has been our experience as well. In addition, if more than mild aortic regurgitation is present preoperatively, aortic valve replacement will be necessary before proceeding with the aneurysm repair.

With regard to pulmonary function, as Dr Fehrenbacher indicated, we have operated on patients who are oxygen-dependent. We do not rely heavily on pulmonary function tests. Somebody who has a massive aneurysm impinging on the left lung may do surprisingly better than you expect once you remove the aneurysm and the lung expands.

Dr Grieppe. Should you be able to walk up a flight of stairs?

Dr Kouchoukos. No. As I indicated, some of these patients are oxygen-dependent. They are not walking anywhere.

Dr Fehrenbacher. My beliefs are exactly the same. Especially with cold circulatory arrest, we are fibrillating all these hearts. Early on, I was doing stress tests, until I had the first patient go back to the unit after a 6- or 7-hour operation and have fibrillation. I could not resuscitate the patient, and at autopsy he had a very proximal left anterior descending lesion, but had had normal stress test results. That is unusual, but now they all get catheterized. I also think that some of the reasons that we have a 53% 10-year survival in this group of patients is probably because a lot of people die postoperatively from coronary artery disease. We are fixing that as we go: left-sided lesions, left anterior descending arteries, circumflex arteries. When you are doing a descending Crawford I, or even a Crawford II, it is painful, but we bypass the coronary arteries with veins and hook the veins to the Dacron graft in the distal arch or proximal descending aorta.

Dr Coselli. What we do is fairly similar. I even try to evaluate the younger patients with a perfusion scan or a stress test. I figure that if I am evaluating them for an aneurysm, they already have a major risk factor, so I want to be careful. We are fairly aggressive about catheterizing our older patients. Even putting in some coronary stents and then doing a thoracoabdominal aneurysm procedure a short time afterward is worrisome. I worry about those stents somewhat; even that is not a fail-safe situation. We do not do an arteriogram on patients undergoing thoracoabdominal aneurysm surgery anymore. We rely almost exclusively on the CT scan, with the exception of patients having a hybrid approach. I like to get an arteriogram on those patients before we subject them to that particular procedure. I am not a huge enthusiast of the hybrid approach, but we have done a number of them.

Mr Chesire. We still use dobutamine stress echocardiography as a screening test and catheterization as needed. Our coronary mortality is not our biggest problem. Amazingly, despite almost starting this program to avoid multiple organ dysfunction and systemic inflammatory response, we still see it in these patients, and that is the commonest cause of death that we have, unless there is some other catastrophe. We focus quite a bit on the kidneys as well, and we still do nuclear split function scanning, because we are very keen on making sure we revascularize, particularly if they have more than one renal artery. That is a really big issue for the hybrid approach. The final point echoes what Joe said: we really get such good images on the CT now that we have just about given up doing preoperative angiography on any of the patients.

Dr Kulik. I recently had a patient who had a coronary angiogram the day before descending thoracic aortic stent graft repair, and there was a high-grade focal lesion in the circumflex coronary artery. The question was, what do you do with it? If you are going to treat it with a coronary stent, the cardiologist is going to request treatment with clopidogrel (Plavix) for a few months. However, the anesthesiologists would not be willing to place a CSF drain at time of stent graft surgery with clopidogrel on board. Is the best treatment coronary stenting and delaying aortic stent graft repair? Or should we forgo the CSF drain? Or should we leave the circumflex artery lesion alone? This is a complicated decision that requires many factors to be considered.

Dr Bavaria. I would like to revisit the type II indication situation, and maybe Marc can comment. We have today Dr Grieppe's group with a 15% to 20% mortality rate for type II. If you look at all the data from the presentations today, you are looking at a 20% to 30% combined paraplegia, stroke, and death rate for type II thoracoabdominal aortic aneurysms. Maybe Joe's data are a little better, but everybody else's are not. What I am wondering is whether we should be using 5.5 or 6 cm for these type II aneurysms, or whether it should be 7 cm if you look at the Yale data regarding rupture risk versus complication rates and the natural history of a 7-cm aneurysm in a patient with a body surface area of 2. What is everybody using for type II thoracoabdominal aneurysms as an indication for surgery?

Dr Czerny. I think we actually have quite reliable data on the natural history, especially from the Yale group. For us, 6 cm is the cutoff based on the balance of the remaining risk of the operation and the threat of the natural course of the disease.

Dr Grieppe. Let me ask also your comment on whether there is a difference between dissection and degenerative or atherosclerotic aneurysms?

Dr Czerny. It is 6 cm for both.

Dr Coselli. We basically use 6 cm also, but we also try to look at the rate of growth. We look at a family history of problems. It is as though we are walking up a flight of stairs. I try to index the aneurysm somewhat to the size of the patient. I think age must be included as a factor. We are more aggressive in patients with dissection and connective tissue disorders of all kinds.

Dr Kouchoukos. I mentioned this yesterday, Randy, but I think you do have some data indicating that the natural history of the patients with dissection in the descending thoracic or thoracoabdominal aorta is not as good as it is for the degenerative disease in terms of the risk of rupture. We tend to be a little bit more aggressive with younger patients with Marfan syndrome or other connective tissue

disorders and would consider even 5 or 5.5 cm as an indication for operation in that situation. For the degenerative aneurysm, I think we would wait until 6 cm in most patients. One of the dilemmas is the older patient, 72 or 73 years old, who has an aneurysm that is growing slowly. Do you wait 3 or 4 or 5 more years until renal insufficiency or more pulmonary insufficiency or cardiac problems develop, or is it better to go ahead when everything is optimal? I do not have a specific answer to that question, but I think it is a dilemma that we face not infrequently. Sometimes we are tempted to ignore the diameter threshold and operate earlier.

Mr Chesire. We use 6 cm as a minimum point. I believe the data indicate that the rupture risk for that given size is higher for women, but the outcomes are poorer for women in our series, so they kind of balance each other out and we carry on using the same thing. I would agree with what was said already about dissection and connective tissue disease.

Dr Fehrenbacher. As I mentioned, we are probably more aggressive: our threshold is 5.5 cm in general. We take into consideration age, comorbidities, and family history. Clearly, dissection in our experience has a worse prognosis than atherosclerosis, so we are more aggressive with dissection than with atherosclerosis. However, in general, I see the hinge point and I see the numbers. There was a great review 2 years ago in a supplement to *The Annals of Thoracic Surgery* that reviewed all this as it has been reviewed here today, and that hinge point is around 6 cm. Where I grew up in southern Indiana, you always try to get the punch in before somebody punches you. So if the punch comes at about 6 cm, we go for 5.5 cm.

Dr Kuratani. Usually we use 66 mm in the nondissected aneurysm. In the dissection, the rupture risk is likely very high, so we

use 55 mm or so. In Marfan syndrome, our indication for surgery is 50 mm or even lower.

Dr Kulik. Just to clarify, if memory serves me well, the hinge point for descending thoracic aortic aneurysms is 7 cm. That is the basis for justifying aortic surgery at 6 cm, before getting to that hinge point. In the ascending aorta, the hinge point is 6 cm, justifying treatment at 5 or 5.5 cm (Coady MA, Rizzo JA, Hammond GL, Kopf GS, Elefteriades JA. Surgical intervention criteria for thoracic aortic aneurysms: a study of growth rates and complications. *Ann Thorac Surg.* 1999;67:1922-6).

Dr Grieppe. I think we also have to keep in mind that these data are pretty old now and that the natural history of some of these diseases may be changing with beta-blockade, more careful surveillance, and treatment of blood pressure. That has to be kept in mind.

There is one dilemma. You see the thoracic aorta getting longer and longer, and you see this big ugly aneurysm curling, and you say: "Call the thoracic endovascular aneurysm repair (TEVAR) guys; this looks like a mess." And they say: "We can't do that: it's too tortuous; the landing zones are twisted." So you are going to have to operate anyway. Sometimes you can wait too long, I suppose. But I think the issue of size is important.

One other situation that I am sure you all know about concerns the patient a few months after an acute type B dissection which was treated very successfully medically, with an aorta by the time he left the hospital of about 4 cm. When you see him a few months later, it is 4.7 or 5 cm. In those high-risk patients, 5 cm is a very conservative number. If it is within a year or 2 of an acute type B dissection and the diameter is more than 5 cm, I think these patients definitely should be operated on. I think we have some data from the Far East that will support that.