Conflict of Interest Statement

Dr Elefteriades reports the following: Coolspine, principal; Terumo and Jarvik Heart, data monitor safety board member; Cryolife, consultant; DuraBiotech, consultant. All other authors have nothing to disclose with regard to commercial support.

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Key Words: thoracic aortic aneurysm, descending thoracic aorta, thoracoabdominal aorta, natural history, aortic dissection, aortic rupture, intervention criteria

ADULT

Discussion

Dr Lars G. Svensson *(Cleveland, Ohio)*. You don't document in the article how many of your patients had aortic dissection that you were actually following. In other words, how many patients had dissection already at the beginning when you were following this group of 907, and how many then later dissected? We know that some patients have a higher incidence of redissecting after initial dissection, such as in patients with Marfan. How many of these patients were there?

How do you measure the size? As you know, there are a lot of standards, and the thoracic guidelines recommended for MRI and computed tomography to measure the external diameter. Did you use a different standard for computed tomography angiography or magnetic resonance angiography and did you measure the sizes differently? Could you comment on the fact that 70% of your patients had enlarged ascending aortas or roots; in fact, 40% of were larger than 5 cm. Why were they not operated on?

Dr Mohammad A. Zafar *(New Haven, Conn)*. In response to your first question, you are correct, few patients who we actually observe at the Aortic Institute have dissection. The majority are patients who presented to our institution with an acute type B dissection.

Dr Svensson. No, I am going back to your original 907. According to your methods, that included patients who had previously dissected. Isn't that the case?

Dr Zafar. No. We did not include chronic dissections. If the dissection was acute at presentation, we included these patients. If the patient had dissection previously and a chronic dissection at presentation to our institution, we did not include such patients.

Dr Svensson. All right. Well, the way I understood your methods, you had included patients with acute aortic dissection in your initial denominator that you were following.

As to your other findings, I think this is important to recognize that the prediction of dissection is not very good based on size. There are a lot of data on that. We know that in the aortic root and the ascending aorta this varies. There are data from U Penn and the International Registry of Acute Aortic Dissections that show that dissection is difficult to predict on the basis of size.

However, we looked at our 870 patients who had received reimplantations, up to the end of last year, and Bentalls, and what was disturbing was that 1.4% of those patients had dissection, mainly in the descending aorta with a normal-sized aorta. So the question is, can we tease out these patients and identify who is at risk of dissection?

I would submit, just looking at your data, there is an opportunity of emphasizing diameter to look at other parameters, such as relation to height, aortic length, and MRI of the aortic wall. The ideal would be that all of us who perform aortic surgery would combine our data and use machine learning from all the countries and get a predictive formula for dissection. I would submit that if you look into our historical knowledge about dissections, that is, steroids, obesity, hypertension, smoking, cocaine abuse, chronic obstructive pulmonary disease, and volume calculations, and if we put that all into a formula, we would have a better predictive model.

I think we have various upcoming opportunities from MRI and magnetic resonance angiography to look at the aortic wall. We are looking at proteoglycans and matrix metalloproteinases; maybe we will get to the point to be able to identify what is happening to the collagen versus elastic ratios, and we will have a better predictive idea.

I applaud what you are doing, and this adds to our knowledge. I think the calculation of risk of rupture based on size is something that we do not fully understand because it is not that predictive. Please keep up your great work.

Dr Thomas J. Gleason *(Pittsburgh, Pa)*. Along Lars' line there, I think another point to inquire about with respect to your database is were these assumed to all be optimally medically managed throughout that time period? Is there any auditing of the degree of medical management? Because as Marc Moon pointed out yesterday, there is a dramatic difference in long-term outcome when we include patients who are optimally medically managed and those who aren't. How does that play into your modeling?

Dr Zafar. We are not sure if there is any mode of medical management that is truly effective for aneurysms. The patients with uncomplicated type B dissection are on strict anti-impulse therapy, but as far as the aneurysms are concerned, that is not a factor that we looked at. We do not really think, based on our extensive published reviews of the literature, that medical management, at least in aortic aneurysms at this point in time, is efficacious.

Dr D. Craig Miller *(Stanford, Calif)*. How did you measure your aortic size? You know there is a major fire fight going on about your ascending work, because John feels that the multiplanar reformat— or true orthonormal 3-dimensional measurements—are bogus, whereas most of us believe that these 3-dimensional orthogonal dimensions are the best we have. But in your ascending group you used echocardiography estimates or your regular 2-dimensional axial measurements, which frequently may be erroneous. How did you measure the aorta in this descending trial?

Dr Zafar. We made every effort to measure perpendicular to the long axis of the aorta using MRI and computed tomography scans. The majority were computed tomography scans, but MRI was also included. We also tried to reconcile the radiologist's measurements with our own measurements, so there was sort of a double verification process. In case of a discrepancy, we sat down and sorted it out.

Dr Miller. I interpret your answer to say you used 2-dimensional aortic diameter measurements. So John Elefteriades and your group still do not believe in the 3-dimensional orthonormal measurements derived from multiplanar reformatted images for the descending aorta? Many of us believe deriving true 3-dimensional orthonormal aortic dimensions from ultiplanar reformation computed tomography angiography reconstructions is just as important for

the descending thoracic aorta as it is for the ascending aorta because the descending aorta can become quite tortuous and ''loopy'' as the patients age and the aorta elongates.

Dr Zafar. That's probably a question for Dr Elefteriades.

Dr Miller. Yes, that's a tricky one. John is right here. Stand up and defend yourself.

Dr John Elefteriades *(New Haven, Conn)*. I think the descending aorta is easy to measure, because it is predominantly vertical, and there is good agreement on measurement between the 2 modalities. The problem comes up in the aortic root mostly, and the ascending aorta, when it is very elongated, makes that C-curve we are all familiar with. But the descending aorta is not the primary source of discrepancy here between the 2 methods. We are currently analyzing that thoroughly, and we are 3-dimensionally printing some of these aortas and measuring them. We are working hard regarding that issue.

Dr Maral Ouzounian *(Toronto, Ontario, Canada)*. Congratulations on another important study from the Yale aortic group. You reported rates of rupture and dissection during follow-up. What proportion received elective surgery during the study period, what thresholds were you using, and are you recommending different thresholds for patients who would be repaired with a straightforward thoracic endovascular aortic repair compared with open distal aortic or thoracoabdominal repair?

Dr Zafar. I think approximately 200 patients underwent elective surgery in our cohort. It is a balancing act between the risk of surgery and the risk of natural complications; thus, we provide the nomogram. For each institution, the rates of complications, be it thoracic endovascular aortic repair or open repair, should be kept in context when operating.

Dr Steven Lansman *(Valhalla, NY)*. Is there a time bias here in the sense that when we first started keeping databases, 25 years ago, we were more cautious about operating on patients because of high mortality. With time we got better and are operating on patients with smaller aortas while not observing patients with 7-cm aneurysms. So smaller aortas are being included and larger ones excluded from our databases. Can that account for the left shift?

Dr Zafar. I think so. Thank you for bringing up this important point, which is a limitation of this study. The bigger aneurysms with faster growth are being selected out for operation more routinely now than 10 to 15 years ago.