type of AVR employed. The maximum follow-up in that series was only 21 months, however, and this may have limited the opportunity to observe important differences.

The primary limitation of this study is the heterogeneity of the patients and the greater complexity of the allograft group. The very need for the use of the allograft, in a practice in which the Ross procedure is preferred, is evidence of a more difficult to manage subgroup of patients. More rigidly controlled studies of autografts versus allografts are unlikely to be conducted. It is highly improbable that a randomized trial would be considered ethically justifiable in a pediatric population, given the considerable theoretical and proven advantages of the autograft. Other limitations of this study include the unavoidable problems of patient numbers and follow-up duration and completeness. Offsetting these limitations is the routine use of human valves in nearly all patients, with a less than 4% frequency of mechanical valve use over an extended period of time. Another value of this study is the series of detailed, sequential echocardiographic studies that permitted the detection of subtle changes in left ventricular physiology and morphology.

Whether the echocardiographic observations in this study are harbingers of future clinical events is unknown. It is generally accepted that reduction in left ventricular mass is a desirable goal. Resolution of ventricular hypertrophy is a slow and steady process that eventually produces improvement in objective measures of ventricular function and symptomatic status. Conversely, failure to resolve ventricular hypertrophy is associated with a lesser improvement in symptoms and functional measurements as well as an increased risk of death. It is logical to conclude that a more rapid and complete resolution of ventricular hypertrophy should be a factor in the type of aortic valve replacement device that a surgeon selects.

The existing literature combined with the favorable findings in this study thus should support the confident use of the autograft for pediatric patients when the autograft is not an option. At the same time, this study should encourage the use of the autograft AVR in children whenever possible both to achieve the maximum hemodynamic benefits for the myocardium and to favorably influence longer-term clinical events.

References


Discussion

Dr John A. Hawkins (Salt Lake City, Utah). Mark, first I commend you and your colleagues on excellent results obtained in this very difficult group of patients. Basically Dr Lupinetti and Dr Duncan and their colleagues have reported a large series of children undergoing AVR with both autografts and allografts, with only a 3% operative mortality and a single late death and an acceptable level of late morbidity. These are really admirable numbers for a complex group of patients dating from what I would assume is your first Ross procedure in 1994. From the outset I will have to say I am really a true believer in the Ross procedure and have no arguments with your approach. I would summarize your message this morning as basically, do a Ross procedure when you can and an allograft when you cannot. The significant findings you showed us today were that the left ventricular outflow tract Vmax basically increased in allografts and significantly decreased in the autograft group, while left ventricular posterior wall thickness decreased significantly in the autograft group and remained unchanged in the allograft group.

My first question has to do with the finding in your series of this significant increase in the Doppler-measured Vmax across the left ventricular outflow tract. What was the follow-up in both groups of patients? You stated that the follow-up was simply 1 to 80 months. What is the problem with the allografts developing this late gradient? Is it simply a time-related or growth phenomenon rather...
than a problem with the allograft per se? In other words, were the allograft patients simply observed longer and the finding was a result of lack of growth of the allograft itself rather than a problem with it alone?

Dr Lupinetti. The mean follow-up was 38 months for the Ross procedure patients and 40 for the allograft, no statistically significant difference. Also, the completeness of follow-up was exactly the same, 89% in each group, and each group had similar 12% to 13% incidence of being lost to follow-up. We could not attribute any differences in our echo observations to time-related phenomena.

Dr Hawkins. Do you think that 40 months is enough time in the allograft group for these patients to grow significantly, to perhaps produce the gradient because they are simply not growing?

Dr Lupinetti. That would be a difficult thing to determine given the heterogeneous patient age and size, but it does seem to be enough to evoke some change in allograft physiology that we think is the most likely explanation for this.

Dr Hawkins. My second question has to do with the use of posterior wall thickness as a measure of left ventricular hypertrophy. Why did you not use left ventricular mass, which is an indexed measurement and probably a more accurate measure of left ventricular hypertrophy, particularly over the wide range of patient ages and sizes that you examined? Your weights ranged from 3.6 kg all the way up to 130 kg and your ages ranged from as young as about 2 months all the way up to 22 years. Would this perhaps have been a better measurement of left ventricular hypertrophy rather than posterior wall thickness?

Dr Lupinetti. I agree. Left ventricular wall mass would have been a superior method of following the echoes. Unfortunately, although our clinical data were recorded prospectively and concurrently, our echo study was purely retrospective. Having to deal with a wide variety of echocardiographic techniques and a wide variety of echocardiographers and cardiologists over this time precluded the use of that. Instead, we had to go with the most consistent reproducible measurement that we had, which was posterior wall thickness.

Dr Hawkins. Last, inherent in any retrospective study is the inability to have truly comparative groups. Your autograft group tended to have mostly, if not solely, congenital aortic stenosis as their original disease as compared with the allograft group, which had a pretty diverse group of congenital defects such as truncus, Marfan syndrome, tetralogy, or some previous operation that destroyed the pulmonary valve. Do these differences in patient disease perhaps lead to the allograft patients having a worse hemodynamic result rather than the use of the allograft itself?

Dr Lupinetti. I think it almost certainly does. I think it is unquestioned that the quality of valve performance can be closely related to the condition of patient in whom the valve is implanted. I think what is remarkable about the allograft group is not that the hemodynamic performance was a little bit worse but that the clinical performance was perhaps as good as it was. I think there is no question that the allografts were biased against by the nature of the underlying disease.

Dr Edward Verrier (Seattle, Wash). My question concerns the deterioration of an allograft. In many adults receiving allografts for endocarditis, the valves deteriorate not only by calcification of the valve but the entire prosthetic root so that the reoperation is extraordinarily complex and potentially dangerous. We know that even in pulmonary allografts used in the right ventricular–pulmonary artery position, the primary mode of deterioration has to do with calcification, although it is a much easier replacement. Have you noticed an accelerated degeneration of the allografts with calcification and how did you have to reoperate on any of those that have been technically challenging in this younger group of patients?

Dr Lupinetti. You mean reoperating on the allograft in the Ross procedure?

Dr Verrier. No, not in the Ross procedure. It is the allograft in the aortic position that worries me the most. When allografts deteriorate and calcify and you reoperate, where you have coronary buttons in place, a root that is calcified, and an aortic valve that is calcified, that reoperation is very difficult. Having done this now recently this past year in 3 patients, all in their 20s, I found it extremely anxiety producing and a difficult challenge because I had to remove the entire root.

Dr Lupinetti. We did have to reoperate on 3 of the aortic allograft replacement patients. In 2 of those we were able to replace it with another allograft. In the third patient who had Marfan syndrome, the progressive dilatation of the root prohibited us from implanting another allograft; we used a composite mechanical valve and ascending aortic graft in that patient.

Dr Mark Metzdorf (Portland, Ore). I note 4% mortality in the Ross group and no mortality in the allograft group, which seems to be a more difficult set of patients to treat. Was the higher mortality significant and what were the reasons for the mortality?

Dr Lupinetti. Of the 3 patients who died, there was 1 patient who was initially treated with a balloon aortic valvotomy, with a rather hypoplastic left heart, and who returned at about a year of age with pulmonary hypertension due to restrictive left ventricular physiology. That patient underwent a Ross procedure but continued to have pulmonary hypertension and ultimately died of that. I do not think the nature of the valve replacement really had a material influence on how that patient would have done. The second patient died of hemorrhage, a simple technical problem that should not have been related to the type of valve replacement. The third patient had a diminutive aortic root that would have normally required a Kono procedure but the Kono could not be performed because of abnormal coronary anatomy. That patient was left with severe left ventricular outflow tract obstruction and ultimately died of left ventricular failure. It is hard to say that we could have made a material difference by our choice of valve, but as you say the allograft group was the higher risk, higher complexity group, and yet did quite well clinically.