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Key Words: Eisenmenger syndrome, lung transplant, Potts shunt, pulmonary hypertension

Discussion

Presenter: Dr Timothy S. Lancaster

Dr Emre Belli *(Paris, France)*. To transform the idiopathic primary pulmonary hypertension to a ductus arteriosus-related Eisenmenger syndrome type is one of the rare contributions in the new era to our surgical armamentarium, and it is marginal, too, because the patients are rare and managed far from our surgical environment. I have a few quick questions—first of all, technical ones.

You had the 3 patients under ECMO before surgery where you have judged that it can be considered a contraindication for this procedure. However, 4 other patients underwent the Potts procedure with cardiopulmonary support. What was the reason or rationale for this support?

Dr Timothy S. Lancaster *(St Louis, Mo)*. You're right. Three of the patients who underwent the Potts on mechanical circulatory support were the 3 who were on preoperative ECMO. There were 4 others, 2 patients with ECMO. Those were the first 2 patients in the series, in whom ECMO was used for additional support because of the unfamiliarity with the procedure, and those patients tolerated that well.

CPB was used in the 2 remaining patients. One was an older teenager with an extremely dilated PA (~4 cm), which we thought could not be clamped safely without decompression of the right side, so that patient was cannulated femoral vein to descending aorta for partial support. The last one was done on full CPB; that was a patient postarterial switch who had pulmonary hypertension, but also severe pulmonary insufficiency, and we wanted to do pulmonary valve replacement at the same time as the Potts shunt. That was done through a redo sternotomy approach—pulmonary valve replacement and a Potts shunt.

Dr Belli. So 7 patients had no direct anastomosis, but with interposition of a conduit. The spirit of this procedure in particular when you do a through thoracotomy without support is to crossclamp both vessels simultaneously, allowing to adjust right to left pressure ratio. How did you manage this situation? Because if you crossclamp first the PA to the aorta, you can be in trouble to diminish cardiac output. How did you manage technically?

Dr Lancaster. In all the patients, we certainly perform a test clamp of the PA before initiating the anastomosis. We use side-biting clamps for partial occlusion in almost all scenarios. In the patients in whom we use a conduit, we do clamp just 1 vessel at a time and with the combination of test clamping and an experienced anesthesia team, now accustomed to taking care of these patients with supersystemic PA pressures, our patients have done okay with that.

Dr Belli. Moving on to the spirit and philosophy of this procedure: More than one-third of your patients had prior congenital heart surgery. I didn't see the details on the slides. What etiologic type of pulmonary hypertension did you consider?

Dr Lancaster. Three or 4 of them had received repairs of atrial septal defects and ventricular septal defects. There was the 1 patient I alluded to who had a previous arterial switch operation and 1 patient who had an AV canal repair. In all scenarios, the patients did not have residual congenital heart defects that we thought explained their pulmonary hypertension, as in Eisenmenger syndrome. It was believed to

be idiopathic PAH coincidental with preexisting congenital heart disease.

Dr Belli. I wasn't expecting to have a Shone-like hypoplastic—

Dr Lancaster. Yes, there was 1 patient (the first patient) who had a Shone complex.

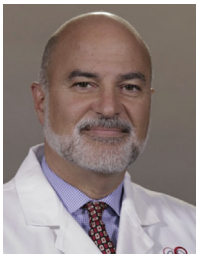
Dr Belli. There is 1 other issue: The pulmonary vascular resistance in some patients as we observe is not stable. That means there is a pulmonary reactivity, and we observed in a couple of patients that the shunt is working or not according to the patient's status. Would you comment on this? Can we have an additional technique to do this type of procedure—avoiding left-to-right but allowing a right-to-left shunt?

Dr Lancaster. Certainly. I know that you've written on that topic. I would say that in the follow-up we've obtained on our patients so far, we haven't seen the problem that you allude to, which would be pulmonary overcirculation due to left-to-right shunting through the Potts shunt. But a concept that has been used in a small number of patients is to use a 1-way valved conduit as the Potts shunt to allow right-to-left shunting and prevent future left-to-right shunting in the case that the PA pressures do become sub-systemic, as you said. I know that you've done that in animals and in a couple humans. We also have used valved conduit in 2 patients so far. The most recent was the postarterial switch patient who had pulmonary valve replacement at the same time that we used a valved conduit for the Potts shunt. In that scenario, we used a bovine jugular vein valved conduit inside a polytetrafluoroethylene graft (essentially a supported Contegra graft) as the conduit. That patient is only a few months out, but he's done very well so far.

Dr Belli. Of course, there is a debate going on—Potts versus transplantation. And nowadays, according to your experience, which type of patient you schedule is more likely for Potts procedure: pathology status, age, and so forth? What are the indications where primarily you would go on Potts rather than listing for a transplant?

Dr Lancaster. At this point, we are often getting referred patients who already have an interest in Potts shunt. So that's definitely 1 factor—the family's preference for or against Potts shunt, or for or against lung transplant. I'd say that in patients who seem to be appropriate candidates (who, as evident from the data that we shared, would be patients with supersystemic pulmonary hypertension, but preserved RV function), I think we would recommend Potts and certainly offer Potts shunt if that's what the family prefers. To better gauge RV function, we are starting to do more cardiac MRI preoperatively to get a better objective assessment of RV ejection fraction and function.

Dr Belli. Thank you.



Dr Emile A. Bacha *(New York, NY).* As you probably know, we published our experience in the *Journal* in 2019 with a valved unidirectional shunt placed via sternotomy on bypass in every single case. We do that because we want to stay away from the pleural spaces for the time when the lung transplant will occur. We think that the valve provides a lot of benefits, as you just discussed. We do those all on CPB and use perioperative ECMO. We've done 6 or 7 cases (5 were described in the article, and in the meantime we've done 2 more). I've been impressed after the initial rocky postoperative course (which is difficult) how well these patients become from a symptomatic standpoint. I mean, they really start to be able to go to school, walk around, and so forth. It is impressive how their RV function improves almost immediately. It goes from very bad RV function on the preoperative TEE to much better function on the intraoperative postoperative TEE. I'm a big fan of this procedure, but I would strongly recommend using the valved conduits.

Dr Lancaster. After our most recent experience with the valved conduit, I think we will likely transition to that being the primary approach, probably through the front on bypass, like you said. We have performed 2 lung transplants after Potts shunt. One was a patient of our own in the series, and another had a Potts shunt completed at an outside facility, and the adhesions in the left chest and the potential hazard of taking down the shunt should not be underestimated. So I think that staying out of pleural spaces is important for future lung transplant.