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EDITORIAL COMMENT

Overcoming Complexity

Stenting for Aortic Coarctation Comes of Age*

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Considering surgical repair of coarctation of the aorta (CoA) has just celebrated its 70th birthday (1), evolving through a number of operative modifications, it is impressive to consider that endovascular therapies for CoA, relatively youthful in their existence, have evolved rapidly to become the treatment of choice in most older children and adults. In particular, stenting for CoA, yet to reach 25 years since its original description (2), has been shown to provide excellent short- and long-term outcomes (3–5). Indeed, in a contemporary multicenter, nonrandomized evaluation of 350 patients weighing more than 10 kg undergoing either surgical or transcatheter management (stenting or ballooning) of CoA, stenting was associated with gradient reduction equivalent to that of surgery; however, with a shorter hospital stay and fewer complications (6). Stented patients were more likely to require a planned reintervention, which may reflect the lack of an available balloon-expandable covered stent in the United States, leading to a relatively conservative dilation strategy. Either way, this reflects a very precocious development from a relatively youthful procedure. There are those who may argue that surgery still remains a better option, providing a more comprehensive treatment for the entire spectrum of complex disease seen within the "syndrome" of CoA (7), including complex stenoses and aneurysm formation. However, reports of transverse arch stenting (8) and aneurysm exclusion (9) have evolved rapidly, indicating endovascular therapies can compete with surgery in providing a full range of therapeutic options for CoA and its complications.

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In this issue of *JACC: Cardiovascular Interventions*, Suárez de Lezo et al. (10) add to the data base by confirming the potential for treatment with stenting of a broad range of complex anatomic substrates seen in patients with CoA over a 21-year period. Sixty patients with a mean age of 24 years were retrospectively divided into 4 main groups on the basis of anatomic features: presence of complete interruption, associated aneurysm formation, complex stenosis, or reintervention for somatic outgrowth of early stent implantation diameter. A variety of approaches were used on the basis of the dominant underlying pathology with one-third of the cohort having more than 1 complex feature, highlighting the broad anatomic variability that exists with CoA. Stent deployment was successful in all cases, with surprisingly no stent migration, an issue seen not infrequently in early series describing this approach. The reduction in pressure gradient in those with dominant stenosis was impressive; however, there was a death in a 52-year-old male patient who had bare metal stenting of a diffuse long-segment recoarctation. One wonders whether a covered stent, had it been available at the time, might have avoided the post-procedural demise as recent reports have suggested that older age and longer segment stenosis may be associated with higher risks of aortic wall injury (3). One other patient experienced a stroke, with minor vascular access site injury seen in 4 other patients and 2 patients requiring blood transfusion for blood loss, representing a periprocedural complication rate of 13%, likely reflecting the complexity of pathologies encountered. It is unclear whether the timing of these complications related to earlier experience, as has been seen with other series (3). Over a mean follow-up period of 10 years, the impact

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of stenting on blood pressure normalization was impressive, with almost 80% of the cohort not requiring medication for blood pressure control. Five patients required aortic valve surgery, and there was late mortality in 3 patients thought to be largely unrelated to stenting, with a 15-year actuarial survival estimate of 92%, reminding us of the associated longer term challenges that exist with the diffuse upper-limb vasculopathy represented by CoA.

So what does this study add to what is already known about stenting for complex CoA? If each of the subcohorts were evaluated independently, then perhaps very little, as stenting for each of these pathologies has been previously described. However, taken as a whole, this report reminds us of the complex and diffuse nature of the disease that we are treating and that a full barrage of equipment, occasionally including covered stents, is required if as interventionalists we are to tackle this syndrome safely and effectively. It also reminds us of how far we have come in a short space of time with stenting, treating the most complex of aortic arch pathologies, supported by rapidly evolving imaging modalities and a multidisciplinary collaborative approach to ensure optimal outcomes for our patients. It is unclear what the next 25 years of coarctation stenting will bring us as the procedure matures. One can hope that a greater understanding of not only the anatomic consequences of our interventions but also the physiological impact of rigid stents on fluid mechanics within the aorta will come to light. Perhaps we can hope by the time that stenting for CoA is celebrating its 50th birthday the suggested upcoming revolution of bioresorbable scaffolds will be available to these patients also and continue the goal of reestablishment of normal vascular function in the aortas of these unfortunate few. It is likely, therefore, that the most complex challenges with this disease are yet to come.

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