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Future Directions in the Management of Aortic Coarctation in Young Patients

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Introduction

Coarctation of the aorta (COA) is a congenital anomaly of the heart in which the descending aorta is obstructed. The narrowed aortic segment comprises of localized medial thickening along with infolding of the media and neointimal tissue [1-3]. The COA constitutes 5-8% of all babies born with congenital heart disease [4,5].

The management of COA was by surgical repair since its initial description by Crafoord and Nylin [6] and Gross [7] in mid 1940s. More recently, endovascular therapy either by balloon angioplasty [3,8-10] or intravascular stents [3,11-13] has to a large extent replaced surgery. Surgery in the neonates and young infants, balloon angioplasty in children and stents in adolescents and adults have become standard methods used in the management of COA [3,14-16]. However, recoarctation following both surgery [17-19] and balloon angioplasty [15,20,21] has been observed; the younger the child, the greater is the probability of recoarctation. Presumably because of this recurrence, some groups of cardiologists advocate use of stents even in infants and young children [11,22-28]. However, the stents, which are largely metallic, do not expand as the child grows; this is particularly true in the neonates, infants and young children, as has been articulated elsewhere [29-31] by us and others. While re-dilatation of the stents can be performed, such re-enlargement may not achieve adult size [32]. Therefore, alternative solutions [29,30,33,34] should be sought. Three types of solutions have been considered in the past and include biodegradable stents, growth stents and dilatable stents.

Biodegradable Stents

The concept for using biodegradable stent is that they open the coarcted aortic segment at implantation and dissolve over the next few months. They may be constructed with polycarbonates, polyesters, bacterial-derived polymers, or corrodible metals [35-37], mounted on balloons and trans-catheter implanted across the COA. The scaffolding left over by the dissolving stent may allow normal aortic tissue to grow and prevent significant recoarctation. Such a concept has been, though to a limited extent, tested in animal models [38,39]. Additional animal experimentation to examine issues such as mechanical stability including radial strength, body's inflammatory response and possible toxicity of the dissolving stent material should be undertaken followed by clinical trials to establish feasibility, safety and efficacy of such an approach. Report of utility of a bioabsorbable metal stent in a neonate with critical recoarctation [40] is a step in the right direction. However, clinical trials in large groups of infants and young children with COA are mandatory prior to adopting this mode of therapy. Furthermore, stent delivery systems should also be made small enough to be useful in neonates and young infants.

Growth Stents

To address the growth issue with the conventional stents, several investigators either cut open the stents longitudinally or construct two separate half stents and connected them with absorbable or thin Prolene suture material; such modifications have been described as open-ring [41] growth [42] or breakable [43] stents by the respective investigators. Implantation of these stents into blood vessels including the aorta of piglets and dilatation of these stents at follow-up was shown to be feasible by these investigators. Ewert and his colleagues [44] extended this concept to human subjects by implanting the growth stents in infants with aortic coarctation. The growth stents used by Ewert are made-up of two longitudinal halves of laser-cut 0.16 mm stainless steel connected to each other with absorbable, Polydioxanon suture material. The stents were mounted on 4 to 8 mm diameter angioplasty balloon catheters and were implanted via 5-French sheaths. Following implantation of the growth stents in 12 infants at a median age of 5 months, the mean gradient fell from 30 mmHg to 8 mmHg. At a median follow-up of 3 to 28 months, five patients required balloon re-dilatation of the initially placed growth stent. Six patients had larger stents implanted 19 to 34 months after initial stent placement. The authors conclude that growth stent is suitable for management of aortic coarctation in infants. However, the overall results may not be satisfactory since multiple interventions were required. Clinical trials in larger number of subjects may be necessary to demonstrate the usefulness of this concept and utility of this technique.

Dilatable Stents

If the stents implanted in neonates, infants and young children could later be dilated to 20 mm or more (adult size), such stents may have utility. Recent report by Shepherd and associates [45] of implantation of Valeo Biliary Pre-mounted Re-dilatable Stent (Edwards Life Sciences, California, USA) via a 7-French sheath in a 3-year-old child with COA is encouraging. Although not yet done, the authors state that this stent can be dilated up to 20 mm. Ready accessibility of such stents, particularly if they can be implanted via small sheaths may largely resolve growth issues related to stents in infants and your children.

Summary and Conclusions

Coarctations in neonates, infants and young children have high incidence of recurrence whether they are treated by surgery or by balloon angioplasty. Therefore, stents may help avert such a problem; unfortunately however, the stents do not grow as the child grows. Consequently, innovations such as bioabsorbable, growth and dilatable stents should be explored in the future.

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