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Use of a Biodegradable Annuloplasty Ring for Mitral Valve Repair in Children

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Mitral valve repair techniques have shown promising results with lower operative mortality, avoidance of anticoagulation, better preservation of left ventricular function, and the possibility of continued growth of the valve in young children. An annuloplasty ring has been used frequently for mitral valve repair since the late 1960s when the first human rigid mitral valve ring was introduced. The annuloplasty ring is sutured onto the native annulus to correct dilatation, consolidate the valve repair, improve leaflet coaptation during systole, and remodel the shape of the mitral valve. Since the initial rigid mitral rings, technical improvements have evolved flexible and semirigid rings. Traditional annuloplasty rings cover the needs of the adult population, but continue to produce suboptimal valve repair in pediatric patients. In addition, the classic annuloplasty ring used in the pediatric group has two major drawbacks directly related to the ring: exposed foreign material that poses a risk of fibrous tissue overgrowth, which may impact valve function; and restricted potential for native annular growth.

The concept of a biodegradable annuloplasty ring was presented in 1990 by Chachques and colleagues who demonstrated in an animal study that implantation of an absorbable prosthetic ring (despite the fact it was covered by synthetic material) preserved systolic and diastolic valve motion, and that the ring was absorbed and replaced by fibrous tissue. Continued research and technical development has led to the Kalangos biodegradable annuloplasty ring (Bioring SA, Lonay, Switzerland), now commercially available in sizes 16 to 36 mm. This biodegradable ring has a curved C-shaped segment of poly-1,4-dioxanone polymer colored with a blue dye, which makes it only a partial ring. The ring is attached at both ends with a needle-holding extension suture (2/0 monofilament polyvinyl). The ring is implanted into the posterior annulus using the suture extension, and fixed at the anterior and posterior trigones of the mitral valve. This way, the ring is completely imbedded inside the native annulus, with the fixation knots at the trigones as the only foreign material exposed, thus no postoperative anticoagulation therapy is required. The biodegradable ring contrasts with the traditional annuloplasty ring where the entire ring is exposed to blood. Prior to obtaining European certification and being commercially available in Europe and Asia, the Kalangos biodegradable annuloplasty ring was tested in an animal model of rapidly growing juvenile pigs. Histological examinations showed that the biodegradable ring was indeed absorbed and gradually replaced by fibrous tissue, with complete degeneration of the ring within 6 months. Macroscopic measurements of the valve orifice also confirmed that the fibrous tissue allowed for physiological growth of the native annulus.

Recently, we reported our experience with the biodegradable mitral ring in children undergoing mitral valve repair for rheumatic valve disease (44th annual meeting of the Society of Thoracic Surgeons, Fort Lauderdale, FL, USA, January 28–30, 2008). The functional impact of the biodegradable ring was compared to that of the classic Carpentier-Edwards annuloplasty ring. Due to the ease of implantation of the biodegradable ring, aortic crossclamp times as well as cardiopulmonary bypass times were significantly shorter than those required for the Carpentier-Edwards ring. Younger patients could be operated on due to the availability of smaller sizes of the biodegradable ring (15% had sizes <26 mm). During follow-up, none of the patients who received a biodegradable ring required reoperation, and there were no thromboembolic events in this group which was not treated with anticoagulants postoperatively. The biodegradable ring had a lower transmitral gradient over the first year of implantation, compared to the Carpentier-Edwards ring. In addition, it caused a smaller decrease in left ventricular fractional shortening compared to the
rigid ring. This might be due to the 3-dimensional flexible nature of the biodegradable ring, with consequently better preservation of native annulus contractility. On repeated postoperative echocardiography, the preoperative mobility of the posterior leaflet in the biodegradable ring group was found to be preserved, which may be explained by the absence of a spread of fibrous tissue induced by ring degradation over the insertion line on the posterior leaflet.4

Mitral valve repair should be the preferred strategy in children with mitral valve disease, whenever feasible. The use of a biodegradable annuloplasty ring, available in sizes down to 16 mm, allows surgical intervention at a younger age, contributes to early and midterm improvement of several valve-related parameters, and increases the durability of mitral valve repair in children, with diminishing risk of early reoperation and a potential for growth of the native annulus.

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