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REVIEW

Novel materials and devices in the transcatheter management of congenital heart diseases—the future comes slowly (part 3)

Matériaux et dispositifs novateurs dans le traitement par cathétérisme interventionel des malformations cardiaques congénitales — l'avenir arrive lentement (partie 3)

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Summary Correction of malformations affecting the right ventricular outflow tract often results in residual abnormalities that require valve implantation at a later stage to prevent right ventricular deterioration. In the paediatric population, the pathology of congenital valve stenosis or insufficiency is often complex, options for surgical repair are limited, and valve replacement remains the only—albeit unattractive—alternative. Prosthetic heart valve implantation can be performed either surgically or, nowadays, percutaneously. Current transcatheter devices allow less invasive percutaneous valve implantation in selected patients after surgical repair, but are suitable for only a small portion of paediatric patients. In addition, there is a large heterogeneous group of patients who undergo surgical constriction of the pulmonary trunk, either to reduce pulmonary blood flow or to retrain or support the left ventricle. In the third part of this review series, we focus on new biomaterials, devices and technologies that

Abbreviations: PA, pulmonary artery; RVOT, right ventricular outflow tract.

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have the potential to extend transcatheter valve implantation to a broader spectrum of congenital cardiovascular lesions, with safe and durable results in children, and on transcatheter options for the creation of a partial obstruction within the pulmonary trunk (pulmonary artery banding).

MOTS CLÉS
Malformations cardiaques congénitales ;
Bioingénierie ;
Maladie valvulaire congénitale ;
Implantation de valve par voie percutanée ;
Cerclage pulmonaire

Résumé La correction des malformations de la voie d'éjection droite se traduit souvent par des anomalies résiduelles, qui nécessitent l'implantation de valves pour empêcher la détérioration du ventricule droit. Dans la population pédiatrique, la pathologie congénitale des valves cardiaques est souvent complexe. Les options de réparation chirurgicale sont limitées et le remplacement de la valve reste la technique la plus utilisée. Les dispositifs percutanés permettent l'implantation moins invasive de valves chez une petite partie de patients soigneusement sélectionnés. De plus, il y a un groupe hétérogène et important de patients nécessitant un cerclage de l'artère pulmonaire, soit pour réduire le débit sanguin pulmonaire et le risque d'artériolite pulmonaire ou pour ré-entrainer un ventricule gauche sous-pulmonaire. Dans la troisième partie, nous nous concentrons sur les nouveaux biomatériaux, dispositifs et technologies, qui ont le potentiel d'élargir les indications du remplacement valvulaire percutané, et sur les options percutanées de création d'un cerclage endovasculaire de l'artère pulmonaire.

Background

There is an ever-growing population of patients who survive surgical correction of congenital heart defects. Often, these patients have residual abnormalities that require reinterventions at a later stage. In particular, correction of right ventricular outflow tract (RVOT) obstruction mostly results on long-term in either regurgitant pulmonary valve or stenotic valved conduit. To prevent right ventricular deterioration, valve implantation is needed, which can be performed surgically or percutaneously. In the paediatric population, the pathology of congenital valve stenosis or insufficiency is often complex, options for surgical repair are limited, and valve replacement remains the most performed—albeit unattractive—strategy. Transcatheter pulmonary valve insertion is nowadays performed widely. The transcatheter devices currently available, however, are suitable for only a small portion of children. The majority of prosthetic valve implantations in children are performed surgically.

In addition, there is a large heterogeneous group of patients who undergo surgical constriction of the pulmonary artery (PA), either to reduce pulmonary blood flow or to ''retrain'' or support a left ventricle. Surgery is currently the only option to achieve pulmonary banding.

In the third part of this review series, we focus on transcatheter options to create a partial PA obstruction and revalvulate the wide regurgitant RVOT, and on advances in the development of a durable transcatheter prosthetic heart valve for growing patients.

Transcatheter creation of partial pulmonary trunk obstruction

Small patients with large left-to-right shunt and at high surgical risk, infants with univentricular heart lesions and an unprotected pulmonary vascular bed, and patients with ventricular septal defects not suitable for primary closure, currently undergo the PA banding procedure. PA banding is also used to ''retrain'' the subpulmonary left ventricle, before or not before anatomical repair, in patients with late-diagnosed transposition of the great arteries, with systemic right ventricular dysfunction after atrial switch procedures, and with the congenitally corrected transposition [1]. Furthermore, clinical interest has recently emerged in PA banding as an alternative option to support the left ventricle in small children with severe dilated cardiomyopathy [2]. During the PA banding procedure, a small tape is fixed around the pulmonary trunk, which may result on long-term in arterial wall fibrosis, which often needs surgical reconstruction after debanding. To reduce the risk of PA deformation, an alternative technique was proposed, consisting of partial obstruction of the pulmonary trunk by an intraluminal membrane [3] (Fig. 1A). Although surgical PA banding is a technically simple operation, it may be