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REVIEW

Stents in paediatric and adult congenital interventional cardiac catheterization

Apport des stents pour le cathétérisme interventionnel des cardiopathies congénitales de l'enfant et de l'adulte

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Abbreviations: BIB, Balloon-In-Balloon catheter; CHD, congenital heart disease; CP, Cheatham-Platinum; PA, pulmonary artery; RV, right ventricle; RVOT, right ventricular outflow tract.

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Bioresorbable stent

Summary A 'stent' is a tubular meshed endoprosthesis that has contributed to the development of interventional catheterization over the past 30 years. In congenital heart diseases, stents have offered new solutions to the treatment of congenital vessel stenosis or postsurgical lesions, to maintain or close shunt patency, and to allow transcatheter valve replacement. First, stents were made of bare metal. Then, stent frameworks evolved to achieve a better compromise between radial strength and flexibility. However, almost all stents used currently in children have not been approved for vascular lesions in children and are therefore used 'off-label'. Furthermore, the inability of stents to follow natural vessel growth still limits their use in low-weight children and infants. Recently, bioresorbable stents have been manufactured and may overcome this issue; they are made from materials that may dissolve or be absorbed in the body. In this review, we aim to describe the history of stent development, the technical characteristics of stents used currently, the clinical applications and results, and the latest technological developments and perspectives in paediatric and adult congenital cardiac catheterization.

MOTS CLÉS
Stent ;
Cardiologie congénitale ;
Cardiologie pédiatrique ;
Cardiologie interventionnelle ;
Stent biorésorbable

Résumé Un stent est une endoprothèse maillée tubulaire qui a contribué à l'essor du cathétérisme interventionnel sur les trente dernières années. En cardiologie pédiatrique et congénitale, les stents ont offert de nouvelles solutions pour traiter des sténoses congénitales des vaisseaux ou des lésions postopératoires, pour maintenir ou occlure la perméabilité d'un shunt et pour permettre le remplacement valvulaire par voie percutanée. À l'origine, les stents étaient formés d'une structure métallique « nue ». Puis plusieurs structures de stents ont été dessinées pour un meilleur compromis entre force radiaire et flexibilité. Néanmoins, la plupart des stents actuellement utilisés n'ont pas été développés pour les lésions congénitales de l'enfant et sont utilisés « off-label ». De plus, l'incapacité des stents à suivre la croissance naturelle des vaisseaux limite leur usage chez les enfants de faible poids et chez les nourrissons. Des stents biorésorbables ont récemment été développés avec la capacité d'être dégradés par l'organisme. Dans cette revue générale, nous avons souhaité décrire l'historique de développement des stents, les caractéristiques techniques des stents actuellement utilisés, les applications cliniques et les résultats, les dernières évolutions technologiques et les perspectives dans le domaine des cardiopathies congénitales.

Background

Since the first report of transcatheter balloon dilation of pulmonary stenosis in 1953 [1], balloon angioplasty has been widely used for many valvular and vascular congenital lesions [2—5]. However, ineffective relief of obstruction and vessel damage have been observed [3—5]. A 'stent' is a tubular meshed endoprosthesis that has contributed to overcoming these issues [4,6—8]. In this general review, we will first describe the pioneering reports of stents development. Next, we will investigate the technical aspects of the available stents. Concepts sustaining the use of stents in congenital heart disease (CHD) catheterization, as well as clinical applications and complications, will be underlined. Finally, future directions will be discussed.

Historical background

The origins of the word 'stent' remain controversial; it may be an old English word derived from the verb 'stenten'. The Latin root is 'extendere', meaning to stretch out. Conversely, the word may have been first used in 1916 by Jan F. Esser, a Dutch plastic surgeon, to describe a medical prosthesis created by an English dentist, Charles Stent (1807—1885) [9]. In 1964, Charles Dotter suggested that an implantable prosthetic device might be used to maintain the luminal integrity of diseased vessels. A precursor stent was successfully positioned in femoral dog arteries, but with secondary dislocations and narrowing [10]. Therefore, it was not until the early 1980s that stents regained interest, with a self-expandable stent with a memory-of-shape property [11]. The first human intracoronary stent (Wallstent™; Boston Scientific, Natick, MA, USA), made of a self-expandable stainless-steel mesh, was successfully deployed in coronary arteries by Jacques Puel in 1986 in CHU Toulouse [12].

Stents rapidly increased interest in the interventional treatment of CHD. In the mid-1980s, Julio C. Palmaz developed a balloon-expandable stent that was successfully implanted in various locations in 1991 [8]. Later, in the early 2000s, Philipp Bonhoeffer and Younes Boudjemline used a stent as a support to anchor a valve in a right