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REVIEW

Transcatheter pulmonary valvulation: Current indications and available devices

Revalvulation pulmonaire percutanée : indications et prothèses actuelles

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Summary Since the first transcatheter implantation of a pulmonary valve in 2000 in a twelve year-old boy with a dysfunctional right ventricle to pulmonary artery conduit by Philip Bonhoeffer and Younes Boudjemline, the Melody® valve has become worldwide used. It represents an efficient alternative to open-heart surgery. We aimed in this comprehensive review to describe

Abbreviations: CP, Cheatham-Platinum; LV, left ventricle/ventricular; PPVI, percutaneous pulmonary valve implantation; RV, right ventricle/ventricular; RVOT, right ventricular outflow tract; RV-PA, right ventricle to pulmonary artery; TOF, tetralogy of Fallot.

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Melody®
transcatheter
pulmonary valve;
Congenital heart
diseases;
Pulmonary valve;
Edwards SAPIEN®
pulmonic valve

the current indications of percutaneous pulmonary valve implantation, the devices currently used and the clinical results.

MOTS CLÉS
Remplacement
valvulaire pulmonaire
percutané ;
Melody® valve ;
Cardiopathies
congénitales ;
Valve pulmonaire ;
Edwards SAPIEN®
valve

Résumé Depuis la première implantation percutanée d'une valve pulmonaire en 2000 chez un garçon de 12 ans avec un conduit défaillant entre le ventricule droit et l'artère pulmonaire, par Philip Bonhoeffer et Younes Boudjemline, la valve Melody® est devenue d'utilisation courante dans de nombreux pays. C'est une alternative efficace à la chirurgie conventionnelle à cœur ouvert. L'objectif de cette revue non systématisée est de décrire les indications actuelles du remplacement pulmonaire percutané, les prothèses actuellement utilisées et les résultats cliniques.

Historical background

Percutaneous pulmonary valve implantation (PPVI) is a major advance in the interventional treatment of congenital heart diseases. Transcatheter relief of pulmonary valvar stenosis was first performed in 1953 by balloon angioplasty [1]. Since the development of open-heart surgery in the late 1950s [2], treatment of pulmonary valve or right ventricular to pulmonary artery conduit (RVPA) regurgitation was entirely surgical. Need for repeated surgeries in high-risk patients yield the need for a transcatheter solution. The first percutaneous transcatheter implanted valve was described by Davies et al., in 1965 to treat experimentally induced aortic regurgitation in dogs [3]. However, it is not until 1992 that Andersen et al., further reported the successful delivery of a catheter-mounted, balloon-expandable stent valve in the aortic position in pigs [4]. The same year, a prosthetic caged-ball aortic valve was also successfully deployed percutaneously in dogs by Pavcnik et al. [5]. The first transcatheter pulmonary valve was developed by Philipp Bonhoeffer and Younes Boudjemline in the late 1990s. A valved segment of a bovine jugular vein was sewed into a balloon-expandable vascular stent. Transcatheter pulmonary valve replacement was successful in animals [6]. Soon after, the first human transcatheter cardiac valve replacement was successfully reported in a twelve year-old boy with a dysfunctional RVPA conduit [7]. Medtronic inc. further conducted the in-vitro testing to complete the design process of the named Melody® transcatheter pulmonary valve. European certification was obtained in 2006 as well as Health Canada approval, making it the first commercially available transcatheter valve in the world. A Melody® valve was implanted in the 100th patient in 2005 and in the 1000th patient in 2009. The Melody® valve was approved for use in the United States of America in 2010. Since 2000, many clinical studies have reported early and mid-term outcome and more than 6000 valves have been implanted worldwide [8—19]. The Edwards® valve (Edwards SAPIEN® pulmonic transcatheter heart valve, Edwards Lifescience, Irvine, CA, USA) was initially used for transcatheter aortic valve replacement but then also for PPVI. It has reached CE certification for PPVI in 2010. First implantation was performed in 2006 in USA [20] and in 2010 in Europe [21]. Clinical results in the first implanted patients have subsequently been published [22—24].

Concept sustaining percutaneous pulmonary valve implantation for the management of congenital heart diseases

Incidence of congenital heart disease is approximately 8 out of 1000 babies. Around 20% of congenital heart diseases involve the right ventricle outflow tract (RVOT) and the pulmonary valve. Surgical palliation of many complex congenital heart diseases, including tetralogy of Fallot (TOF) with pulmonary atresia, truncus arteriosus, some forms of transposition of the great arteries, double-outlet right ventricle, Ross surgery for aortic valve disease and others, involves interposition of a conduit between the right ventricle and the pulmonary artery in the first months of life. Valved conduits are composed of synthetic material or non-viable homograft or xenograft tissue. Inability to follow the child growth, mechanical distortion and progressive degeneration lead to conduit stenosis over time. Regurgitation appears with degeneration of the leaflets. Other congenital