Implantation of Palmaz Stents in Branch Pulmonary Arteries Using Olbert Balloons

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Twenty-three patients, ranging in weight between 4.9 and 74 kg, underwent stent implantation in branch pulmonary arteries. At first, high-pressure balloons were used for stent implantation but, because of stents slipping off the balloons, subsequently in eight patients, aged 2–18 years and weighing 11–72 kg, Olbert balloons were used.

Fifteen stents were implanted in 11 vessels in these 8 patients. No instance of stent slippage occurred during introduction through the sheath or when the stent was passed around the curves of the right heart. In one patient, the fully expanded stent slipped over the wire into the main pulmonary artery. This occurred because of undersizing of the stent. The stent was readvanced into position and expanded using a larger balloon. No significant complications occurred with these balloons.

The use of Olbert balloons for stent implantation in branch pulmonary arteries is recommended.

Key words: interventional pediatric cardiology, pulmonary arteries, Olbert balloons

INTRODUCTION

Over the past few years, stents have been used with increasing frequency in congenital heart defects. The major indication for their use is postsurgical branch pulmonary artery stenosis, but they are also used in children with naturally occurring branch pulmonary artery stenoses (such as in Alagille’s syndrome). The main reason for their increasing use is the lack of sustained success following conventional balloon dilation.

The most frequently used stent is the Palmaz balloon-expandable stent (Johnson & Johnson Interventional Systems, Warren, NJ). At some centers, including ours, the stents are mounted on balloons with high rupture pressure (e.g., Blue Max, Meditech, Watertown, MA) and are introduced through an 11 Fr sheath in order to place them across the stenotic lesion. At other centers, conventional balloons were used for stent deployment, with a high-pressure balloon used only if there was a residual stenosis in the stent. However, when the stents mounted on these balloons are maneuvered across the various curves of the right heart, they frequently slip off the balloon, necessitating removal of the whole unit and further crimping of the stent onto the balloon. Furthermore, even when the stents have been deployed across the stenosis, the deflated balloon profile consists of wings on the balloon and this makes removal of the balloon from the expanded stent hazardous, with the possibility of stent dislodgment.

We have evaluated the use of Olbert balloons for stent implantation, because of the favorable balloon characteristics. These include moderately high rupture pressures and the nylon weave and coaxial design of the balloon, which do not allow the stent to slip off, and which prevent wing formation when the balloon is deflated, thus reducing the likelihood of the stent being dislodged.

POPULATION AND METHODS

Between December 1991 and December 1994, 23 patients have undergone stent implantation in our institution. Their ages ranged between 5 months and 36 years and weights between 4.9 kg and 74 kg.

Stents have been implanted in branch pulmonary arteries in 19 patients. Of these, 10 were postsurgical and 9 naturally occurring stenoses. In other patients, the other sites of stent implantation included inferior vena cava in one patient (in this patient, the procedure was combined with stent implantation in a pulmonary artery branch), descending aorta for aortic recoarctation in two patients, infundibulum for acquired infundibular atresia in one patient, and main pulmonary artery in one patient.

Of these patients, eight had their stents implanted using Olbert balloon catheters (Meadox Surgimed, Denmark). Their ages ranged between 2 and 18 years, mean 10.4 years, and weights between 11 and 72 kg, mean 42 kg. Informed consent for the procedure was obtained from the patients or their parents. The technique of stent implantation has been well described in detail in the literature [1]. After hemodynamic and angiographic assessment, the position of the stenosis and the landmarks are identified. A heavy-duty superstiff Amplatz 0.035-inch exchange guidewire is placed in the distal lower lobe pulmonary artery. A 11 Fr Mullins transseptal sheath and dilator are then passed over the guidewire, until the sheath is distal to the stenosis. The dilator is removed,
leaving the guidewire in place, and the sheath is flushed with heparinised saline. Preliminary balloon angioplasty of the stenosed pulmonary artery is not performed prior to stent implantation.

The Olbert balloon is constructed of a nylon weave. It differs in construction design from other conventional balloons [2,3]. It has a coaxial design, so that during inflation, the outer catheter slides forward over the inner with retraction of the catheter tip (Fig. 1). On deflation, the balloon returns to its original low profile. It is available in diameters of 6–14 mm and varying lengths. The manufacturer’s recommended inflation pressures are higher than conventional angioplasty balloons. The Palmaz stent is mounted in the middle between the two markers at either end of the balloon. It is then crimped onto the balloon by steadily increasing finger pressure all around the stent.

The balloon-mounted stent unit is passed over the exchange guidewire inside the transseptal sheath until it is across the stenosis. The sheath is withdrawn until it is clear of the proximal end of the balloon. At this point, an angiogram is performed through the sheath, to check the position of the stent. The balloon is then inflated to a pressure of 8–12 atm, in order to deploy the stent. The balloon is deflated and gradually eased out of the expanded stent back into the sheath without rotation and withdrawn. A final angiogram is performed.

RESULTS

Fifteen stents have been implanted in 11 vessels in 8 patients. No instance of stent slippage occurred during its introduction through the sheath or when being manoeuvred past the sharp curves of the right heart or bends at the origins of the branch pulmonary arteries. No instances of balloon rupture were encountered. In one pa-
Fig. 3.  

a: Cine frame of a patient, in whom a stent is about to be placed in the right pulmonary artery. The stent has been mounted on a Blue Max balloon. Because it kept slipping off the balloon when being passed round the curves in the right heart, the stent was mounted nearer to the distal marker (arrow).  
b: The balloon inflation has begun to inflate the proximal part of the stent.  
c: On near complete inflation of the balloon, the stent has slipped off the balloon and moved distally.  
d: The stent has been deployed and expanded in a conical shape. A smaller diameter balloon has been passed through the stent to inflate the distal part of the stent.

tient, the fully dilated stent slipped from the left pulmonary artery over the wire back to the main pulmonary artery. This occurred after the Olbert balloon had been withdrawn probably because the size of the left pulmonary artery had been underestimated. Using a larger diameter balloon, the stent was easily readvanced into a satisfactory position and further expanded.

In three vessels, overlapping stents were deployed using the same Olbert balloon, without any complications. On some occasions, the 11 Fr sheath could only be placed in the desired artery and past the stenosis with extreme difficulty and with the aid of a loop in the right atrium. This resulted in several tight curves within the heart but, despite these, a stent mounted on an Olbert balloon was maneuvered through the sheath without slipping off the balloon (Fig. 2).

**DISCUSSION**

Until recently, the method of implanting Palmaz stents in branch pulmonary arteries consisted of mounting the stents on a wrapped balloon. At some centers, conventional balloons were used, while in others, because of rigidity of the stenoses, balloons of high rupture pressure, such as the Blue Max, were used. The stent is mounted on these balloons using a combination of finger crimping and a special crimper supplied with the stent. The mounted stent is then passed through a long transseptal sheath over a guidewire. Once the stent is deployed, the balloon is deflated and rotated to ensure that it is free from the stent and removed. Using this method, we frequently encountered the stent slipping off the balloon when the stent—balloon unit was being passed through tight curves in the right side of the heart. These curves included those from right atrium to right ventricle or, more frequently, at the curve from the inlet part of the right ventricle to the main pulmonary artery, or occasionally when passing from the main pulmonary artery into the sharp bends formed by the origins of either of the branch pulmonary arteries. Slippage of the stents necessitated the removal of the whole stent-balloon unit and
Olbert Balloons for Stent Implantation

More importantly, inflation of the balloon to deploy the stent occasionally resulted in slippage of the stent off the balloon proximal or distal to the site of the stenosis (Fig. 3). In this situation, and especially when the stent has slipped distal to the balloon, the stent cannot be retrieved for repositioning on the balloon and deployment is irreversible. Smaller balloons usually have to be inserted within the partially expanded stent, in order to expand it fully. Another stent overlapping the first stent may have to be implanted. Rarely, the slipped stent cannot be deployed at or near the intended site and may have to be implanted at a different site in the cardiovascular system or removed surgically [4].

The Olbert balloon has several important advantages over the other balloons. The woven nylon material of the balloon does not allow the stent to slip off it easily. In fact, on one occasion, before implantation of a Palmaz stent, we attempted to remove a stent hand-crimped onto an Olbert balloon but were unable to do so without cutting the balloon longitudinally inside the stent. Another advantage is that once the balloon deflates, it assumes the same profile as before inflation, without any ridges or wings. This eliminates any possibility of the balloon catching on the stent and dislodging it. Furthermore, this property also allows the balloon to be used to important more than one stent, if that is needed. A potential disadvantage of this balloon concerns its characteristic of shortening of the tip and distal shaft on inflation. However, this has not been a major area of concern in our practice. It has not slipped the stent off the balloon or dislodged it.

We recommend the use of Olbert balloons for stent implantation particularly when the route to the site of implantation is tortuous. This has reduced the complications associated with stent delivery and has made the procedure safer and quicker. However, despite this lack of stent slippage off the balloons, stents should not be maneuvered through the heart without the cover of a transseptal sheath.

REFERENCES