EDITORIAL

STATIC BALLOON DILATION OF RESTRICTIVE ATRIAL SEPTAL DEFECTS

In this issue, Galal and Al-Fadley present an infant in whom they performed balloon dilatation of a restrictive interatrial communication which resulted in excellent palliation. This is a relatively new technique and has been used in the past only occasionally. Therefore, it is worthwhile reviewing the background information and the procedure as it stands at the present time.

Interatrial communication with shunting across it is highly beneficial in some congenital cardiac defects. Most important of these is transposition of the great arteries (TGA) with intact ventricular septum. In TGA, the aorta arises from the right ventricle and the pulmonary artery from the left ventricle so that the circulation is parallel instead of the normal circulation in series. The systemic venous blood does not become oxygenated, and the pulmonary venous blood does not reach the systemic circulation. Intracardiac mixing is essential for patient survival. These infants will present with severe cyanosis in the first few days of life and will not survive, unless treated promptly. Prior to 1966, the treatment of choice was surgical atrial septostomy, which, at that time, carried considerable mortality. In 1966, Rashkind and Miller2 described a technique of nonsurgical enlargement of the patent foramen ovale during cardiac catheterization. A deflated balloon catheter is advanced from the right atrium into the left atrium across the patent foramen ovale, the balloon is inflated with diluted radiopaque liquid and rapidly pulled back across the foramen ovale, rupturing the lower margin of the atrial wall below the patent foramen ovale. This procedure, Rashkind's balloon atrial septostomy, results in better mixing at the atrial level, increases the systemic arterial oxygen saturation, and decreases the mean pressure gradient across the interatrial septum. Once palliated with this procedure, these infants could later undergo total surgical correction.

There are other lesions in which an adequate interatrial opening may be of benefit. These include obstructive lesions of the ventricular inflow (or outflow) on the right (tricuspid atresia and pulmonary atresia with intact ventricular septum) or on the left (mitral atresia, aortic atresia, and hypoplastic left heart syndrome) side and total anomalous pulmonary venous connection. The usefulness of balloon atrial septostomy in the palliation of tricuspid atresia, pulmonary atresia with intact ventricular septum, mitral atresia, hypoplastic left heart syndrome, and total anomalous pulmonary venous connection has been demonstrated.

The original concept and subsequent success of balloon septostomy are based on the fact that the lower margin of the patent foramen ovale is very thin and membranous and can be torn by forcefully withdrawing a balloon (filled with diluted contrast material) from the left atrium to the right atrium. Beyond the neonatal period, the lower margin of the patent foramen ovale is thick and muscular and cannot be ruptured by balloon atrial septostomy; this has been the reason for failure of this procedure in older infants and children. To circumvent this problem, Park and his associates15,16 developed a catheter with a built-in, retractable blade (knife) to cut the lower margin of the foramen ovale (septum primum of the fossa ovales). The foramen ovale can then be further enlarged by balloon septostomy. Since Park's report on his clinical experience with this technique, reports of the collaborative study, ours, and others have been published. The success rate ranged between 70% to 90%. Although a larger experience with the technique and availability of different sizes of blade catheters and long introducer sheaths have improved the success rate, adequate septostomy has not been possible in patients with small and hypoplastic left atria.
Mitchell, Sideris, and their associates questioned why not static balloon dilation of atrial septum instead of dynamic balloon atrial septostomy; the basis of their argument was their success in producing large atrial septal defects in animal models by static balloon dilatation. To the best of my knowledge, the first human application of this technique was reported by Shrivastava and colleagues; they successfully performed balloon dilatation of atrial septum in an infant with complete transposition of the great arteries. In 1988, we performed balloon dilatation of the patent foramen ovale in an infant with transposition of the great arteries, large ventricular septal defect, and severe valvar and subvalvar pulmonic stenosis. The immediate results, with improvement of atrial shunting, are gratifying, but follow-up results could not be adequately assessed because of the associated pulmonic stenosis. Soon, other reports, including the report by Galal and Al-Fadley in this journal, appeared. In the report of Valvuloplasty and Angioplasty of Congenital Anomalies Registry, three infants with hypoplastic left heart syndrome were cited to have undergone static balloon dilatation of the patent foramen ovale; short-term results were successful. A young adult patient with primary pulmonary hypertension underwent balloon dilatation with a 12-mm balloon following Brackenbrough needle puncture of the atrial septum; this produced excellent palliation with relief of symptoms in this patient. More recently, Webber and associates reported producing adequate interatrial communication by balloon dilatation; the diagnoses in these patients, respectively, were pulmonary atresia with intact ventricul <r> septum, mitral atresia, and double-outlet right ventricle with subpulmonic ventricular septal defect.

As can be seen in this review, there is a limited but favorable experience with this technique. Experience in a larger number of patients with follow-up information may provide more definitive information on the safety and efficacy of this technique. Based on our own experience and this review, I would continue to recommend conventional Rashkind's balloon atrial septostomy for the newborn infants requiring adequate interatrial communication. In older infants and children, blade atrial septostomy and balloon (static) dilatation are choices. If the left atrium is large or normal in size, blade atrial septostomy should be considered. However, if the left atrium is small in size, balloon dilatation should be tried.

The procedure involves advancing a 5-French multi-A2 catheter (Cordis) or any other type of end-hole catheter from the right atrium into the left atrium and then into a left pulmonary vein. An exchange guidewire (I prefer extra stiff Amplatz wire) is positioned in the pulmonary vein through the catheter. The catheter is removed and exchanged with a balloon angioplasty catheter. The balloon is inflated to 3 to 5 atmospheres of pressure, taking care not to inadvertently dilate the pulmonary vein. The balloon inflation is repeated twice. The duration of inflation is recommended to be approximately 5 seconds with a five-minute interval in between dilatation. "Waisting" of the balloon during initial phases of balloon inflation, which disappears as the balloon is completely inflated, indicates that the foramen ovale is at least stretched beyond its initial size. Lack of "waisting" in the subsequent balloon inflations suggests that there was some enlargement of the foramen ovale. Recording of oxygen saturations, pressures across the atrial septum, and echographic, angiographic, and/or balloon-sizing prior to and immediately after static balloon dilatation are necessary to assess effectiveness of the procedure.

There are no data to indicate the most appropriate size of the balloon that should be used in this procedure; 8- to 20-mm diameter balloons have been used. Based on theoretical considerations with other lesions, a balloon that is three to four times the size of the patent foramen ovale (by echo) may be a good choice. The balloon, however, should not be larger than the estimated size of the atrium septum, measured on a precatheterization echocardiogram. It should be mentioned that the currently available balloon catheters are bulky and miniaturization of these catheters may make the technique easier.

In conclusion, blade atrial septostomy and static balloon dilatation of the patent foramen ovale are excellent adjuncts to Rashkind's balloon atrial septostomy technique in the transcatheter enlargement of interatrial communication. When the cardiologists are not familiar with blade septostomy technique or if the left atrium is small and hypoplastic, static balloon dilatation technique may be
useful in enlarging a restrictive interatrial communication. Further studies to document the safety and efficacy of this technique are essential prior to recommending it for general use.

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References
