Current Practice

Scope of catheter based interventions in paediatric cardiology

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(Key words: catheter based intervention, paediatric cardiology)

Interventional cardiology is a catheter based treatment modality for non surgical treatment of certain cardiac defects through venous and arterial access to restore normal or near normal haemodynamics.

Before 1980, lesions which required interventions were either surgically palliated or corrected. Although the first successful paediatric intervention, balloon atrial septostomy by Rashkind and Miller was performed in 1966[1], the era of paediatric intervention really began with pulmonary balloon valvuloplasty by Kan et al in 1982[2]. Since then there have been explosive developments in this field and it is now possible to deal with a multitude of paediatric cardiac lesions through transvenous approach. The goals of such interventions should be safety, effectiveness and wide applicability with clinically acceptable results.

More than half of all paediatric catheterisations are now related to interventional procedures and it has become a crucial aspect in the management of children with heart disease. Catheter techniques have become the accepted and preferred curative therapy for many acyanotic congenital heart defects. This tremendous development is mainly due to two reasons. First is the availability of better imaging modalities in the form of echocardiography (transthoracic, transoesophageal, intracardiac). Second is the innovation and refinement of hardware used in interventions such as catheters, guidewires, coils, devices, percutaneous valves and stents. In this respect the efforts made to achieve clinical excellence by clinicians and researchers have gone a long way in the development of the field.

Advantages of interventions over surgery are minimal anaesthetic complications, absence of sternotomy or thoracotomy related complications, no risks related to cardio pulmonary bypass, rare need of blood or blood product transfusions and minimal post procedural complications like haemorrhage, sepsis, and acid/base/electrolyte disturbances. Other advantages include little or no post procedural pain, short hospital stay, minimal psychological trauma and lesser procedural risk. Compared to surgery, interventional procedures can be repeated with negligible added risk and in a given time period more cases can be dealt with. The main disadvantage is the cost of the procedure.

Interventional approach can be attempted in congenital heart disease, acquired heart diseases (mitral stenosis) and arrhythmias (catheter ablations). Interventions are indicated in lesions which are hemodynamically significant and where there is a need for surgery or clinically significant tachyarrhythmias.

Interventions can be palliative or curative

Palliative

- Balloon septostomy
- Patent ductus arteriosus (PDA) stenting

Curative

- Coil embolisation (PDA, major aorto-pulmonary collateral arteries (MAPCAS), arteriovenous (AV) fistula)
- Device closure (atrial septal defect (ASD), PDA, ventricular septal defect (VSD))
- Valvuloplasty (pulmonary stenosis (PS), aortic stenosis (AS), mitral stenosis (MS))
- Angioplasty (coarctation of aorta (COA), branch PS)
- Stenting (COA, branch PS)
- Valve replacement (pulmonary, aortic)

Interventions in acyanotic heart diseases

Interventions in acyanotic congenital heart diseases are mostly curative and involve either closure of a shunt, abnormal connections, fistulae or relief of

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obstruction. In closure of shunts the commonest lesions that are corrected are PDAs and ASDs. In PDAs with suitable ductal anatomy, most of the lesions can be corrected either using coils or devices. Surgery is rarely required in the current era of management of PDA. In ASDs, only ostium secundum ASDs with adequate margins can be dealt with by interventions. Ostium primum ASDs and sinus venosus ASDs cannot be closed by transcatheter approach. Similarly, hemodynamically significant muscular VSDs can be closed using a device[3]. Clinically significant large VSDs with heart failure should be essentially closed surgically. In the recent past, grown up children or adults with perimembranous VSDs with significant shunts were closed with VSD devices with technical success but with the occurrence of the complicating atrioventricular (AV) conduction defect (complete heart block), the enthusiasm for device closure of perimembranous VSD[4] is certainly on the wane. It is also possible to deal with coronary AV fistulae, aortopulmonary windows and ruptured aneurysm of the sinus of Valsalva via the percutaneous approach.

The procedure of choice for significant aortic or pulmonary valve obstruction is balloon dilatation with excellent relief of obstruction[5]. The procedure can be repeated in the event of restenosis. In addition coarctation of aorta and branch pulmonary artery (PA) stenosis can be dilated and in certain cases stents can be used to maintain luminal patency.

Interventions in cyanotic heart diseases

Interventions in cyanotic lesions are almost palliative, never curative and mainly aimed at improving pulmonary blood flow. The first ever successful intervention, the balloon atrial septostomy, was in fact performed in a case of transposition of great arteries to promote mixing of blood at the atrial level and thus to improve oxygen saturation. The biggest impact of interventional cardiology in cyanotic congenital heart disease, is in the duct dependent pulmonary circulation especially in pulmonary atresia where the ductal patency is maintained by stenting[6], thereby avoiding a Blalock Taussig shunt. However this procedure needs a lot of skill and operator experience to achieve satisfactory results. In the case of pulmonary atresia it is also possible to perforate the atretic pulmonary valve with radiofrequency ablation or using a guidewire and establish antegrade flow across right ventricular outflow tract. In tetralogy of Fallot with cyanotic spells, it is possible to balloon dilate the stenotic pulmonary valve, improve pulmonary blood flow and prevent further episodes of cyanotic spells. Such establishment of increased flow will enhance the growth of pulmonary arteries and enable the surgeon to perform total correction later. Further, if needed, coil embolisation of multiple aortopulmonary collaterals can be performed prior to total correction of tetralogy of Fallot. In selected cases of pulmonary AV fistulae, coil embolisation can be curative.

Interventions for postoperative complications

Now it is possible to deal with postoperative complications of open heart surgery which may occur immediately or later, with catheter based interventions. Baffle leaks following atrial switch operation (Senning's) for transposition of great arteries (TGA)[7], closure of fenestration in the interatrial septum after completion of Fontan circulation and pulmonary AV collaterals after bidirectional Glenn Shunt are a few examples.

Role of surgeons in the interventional era

In spite of tremendous developments in the interventional field the surgeons still play a major role in the management of cyanotic and acyanotic heart diseases. However, in complex congenital heart diseases where multistage surgery is necessary, now there is a new trend where both the surgeon and the interventionist can use their skill and expertise to achieve optimal results. This hybrid approach where the surgeon and the cardiologist work under the same roof simultaneously, can reduce unnecessary dissection of tissues, shorten bypass time and minimise the risk of subsequent procedures due to less scarring of tissues. Sometimes it is also possible to correct the defect on a beating heart thus avoiding the complications of cardiopulmonary bypass.

In hybrid perventricular closure of muscular VSDs, after surgical sternotomy, the muscular VSD is approached by the paediatric interventionist on a beating heart, through perventricularly inserted delivery sheath and devices under transesophageal guidance. The advantage of this approach is the minimal ventricular incision and complete avoidance of cardiopulmonary bypass. Another classical example is placement of intraoperative stent in pulmonary arteries and perioperative interruption of Blalock Taussig shunt during total correction of tetralogy of Fallot. Such hybrid approaches can also be employed in management of pulmonary atresia with intact ventricular septum.

In conclusion, treatment of congenital heart disease has changed from being primarily surgical to a combination of transcatheter intervention and

surgery. The former has not only replaced surgery for treatment of a large number of defects but also provided an additional complimentary treatment for complex cardiac lesions and post operative residual lesions. Paediatric interventional cardiology continues to expand and new procedures such as percutaneous valve repair or replacement[8], percutaneous closure of patent foramen ovale (PFO) in patients following cryptogenic strokes and percutaneous closure of para valvar leaks are now being perfected.

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