Update in Interventional Treatment and Rehabilitation

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The progress of cardiology intervention has been rapid and spectacular in the past twenty to thirty years. The term 'intervention' is aimed to describe an invasive treatment modality as separated from non-invasive treatment method, which usually means drug treatment. Initially, invasive treatment means surgery, which involves making open wounds to work out a treatment. Nowadays, this term is singled out to describe invasive treatment that involves no or very small surgical wounds. Common examples are making access to central vascular structures such as the heart through the use of peripheral arteries or veins. A better term for this approach is 'endovascular intervention'. Intervention can now be broadened to include treatment modules that can facilitate rehabilitation. A good example is the use of cardiac re-synchronization therapy to treat and to rehabilitate patients with certain types of congestive heart failure.

The most popular endovascular intervention nowadays is coronary revascularization, which means repairing a diseased (usually narrowed) coronary artery. It was first named percutaneous transluminal balloon angioplasty (PTCA), by using an inflatable (and deflatable) balloon device to expand the coronary lumen. The first human case was performed in 1977. After 3 decades, in the year 2007, we have seen exponential increase in the worldwide use of percutaneous coronary intervention (PCI), a broader term that includes all kinds of endovascular devices that can be used to modify the lumen size of coronary artery. It is estimated that just in the USA, 1,000,000 PCI procedures were performed annually.

Steady improvements in the equipment used for PCI have been and will certainly be on-going. Reductions in device profile, improvements in catheter flexibility and introduction of stents have extended the scope and breadth of clinical practice. The type of lesions amenable to PCI has become progressively more complex, and the outcomes have progressively improved. Special attention has to be drawn to the use of drug-eluting stents (DES) which had developed in the early 2000s. Randomized trials and registries have demonstrated the benefit of DES in patients with focal de-novo lesions as well as in patients with long and small vessels, chronic total occlusions, bypass graft diseases, in-stent restenosis, and in patients with STEMI. Other currently available devices are rotational atherectomy, thrombectomy and aspiration devices, and embolic protection devices. Technical improvements worth mentioning comprise the use of intra-vascular ultrasound (enable operators to visualize directly the artery lumen and artery wall characteristics), the access through radial artery (smaller wound and better haemostasis as compared to femoral approach), and the designs of vascular closure devices for femoral approach. Finally, the adjunctive drug therapies have added values in the outcome of PCI. Examples are dual oral anti-platelet therapies (aspirin plus clopidogrel) and intravenous glycoprotein 2b3a inhibitors.

Endovascular interventions have already been successfully applied in other fields of cardiology. Percutaneous mitral valvuloplasty was first performed in 1984 as an alternative to surgical mitral valve commissurotomy in patients with rheumatic mitral stenosis. The most commonly used approach now is to

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perform a transseptal puncture to gain assess to the left atrium, followed by a pressure-distensible dumbbell-shaped balloon dilatation of the stenotic mitral valve. Other valvular interventions include percutaneous mitral valve repair, aortic valvuloplasty, and percutaneous aortc valve replacement.

Another kind of endovascular interventions is aimed for non-coronary obstructive vascular disease. This category consists of atherosclerotic disease of the abdominal aorta and the arteries below (renal, mesenteric, aortoiliac and femoropopliteal), or disease of the supraaortic extracranial arteries (subclavian, vertebral, common carotid and internal carotid), or even the disease of intracranial arteries (e.g. proximal mid cerebral). The most common technology involved is still endovascular ballooning and stenting. Newer techniques have been used in some particular areas, such as cryo-balloon for femoropopliteal disease. Sometimes atherosclerotic disease of the abdominal aorta will present in the form of aneurysm rather than obstruction, then endovascular deployment of aortic stent graft can be considered.

Endovascular interventions have also been practiced in certain kinds of congenital heart diseases and congenital vascular diseases. The procedures can be performed in neonatal, childhood, adolescent or adult stage, depending on the symptom manifestation and urgency of intervention. An example of intervention in adulthood is alcohol ablation in the treatment of hypertrophic obstructive cardiomyopathy (HOCM), in which the septal branches of coronary artery that supply the hypertrophic septal muscles are ablated with alcohol (to make a confined myocardial infarction of the septal muscles). Another example is the closing of atrial septal defect or patent ductus arteriosus with endovascular occlusive devices. Embolization of cerebral artery aneurysm by embolization coils is a method to prevent or to treat rupture aneurysm.

The practice of non-drug therapy for cardiac arrhythmias has created a different category of intervention, another name for it being electrotherapy. It involves a totally different concept by aiming to stop the generation and propagation of abnormal electrical impulse in the heart, or to trigger an impulse when necessary. It can be subdivided into 2 parts, catheter ablation therapy and implantable device therapy.

The purpose of catheter ablation is to destroy myocardial tissue by delivering electrical energy through electrodes on a catheter placed next to an area of the myocardium integrally related to the onset or maintenance of the arrhythmia. The first catheter ablation procedures were performed using direct-current shocks, but this energy source has been supplanted by radiofrequency (RF) energy, hence the term radiofrequency ablation (RFA). Usually the target tissue has been identified by a preceding procedure called electro-physiology stimulation (EPS), which involves the placement of several diagnostic electrode catheters in strategic positions inside the heart (such as right atrium, right ventricle, next to His bundle, and coronary sinus) and programmed stimulation of the heart through different electrodes to trigger the suspected arrhythmia. The target tissue can usually be the slow pathway in AV node, an accessory pathway or the right ventricular outflow tract. The ablation is claimed successful when the initially triggered arrhythmia is not reproduced by subsequent programmed stimulation. Advances in this field include the use of newer energy source such as cryothermal energy, specially designed ablation catheters, and new mapping techniques such as electroanatomical mapping. The ablation therapy for atrial fibrillation is gaining popularity as well.

The advances in implantable devices are rapidly growing. The first kind of implantable device is permanent pacemaker, designed to treat brady-arrhythmia, such as AV block or sick sinus syndrome. It consists of an impulse generator box usually inserted subcutaneously in the infra-clavicular region. One or 2 pacing leads (single or dual chamber type) are placed transvenously into the right ventricle apex and/or right atrial appendage, and then connected to the generator. Impulse is generated whenever a delay in atrial and/or ventricular rhythm is detected. Advances in pacemaker technology have been tremendous. The leads, the generator, the pacing mode, the pacing algorithm and the site of pacing

have all been modified according to the need, the safety and the comfort of patients. The most important advance, however, is the incorporation of anti-tachycardia and defibrillation function in the implantable device, hence the name implantable cardioverter-defibrillator (ICD). ICD is now indicated in patients with ventricular tachycardia and ventricular fibrillation, or to prevent sudden cardiac death in severe heart disease cases.

The ever growing complexity of implantable devices has allowed more disease entities to be treated. The concept of cardiac resynchronization therapy (CRT) is another product. It is designed to treat patients with refractory heart failure as a result of severe structural heart disease that is not amenable to other modes of treatment. It is especially suitable for patients with dys-synchronized left and right heart contraction, reflected by the presence of left or right bundle branch block. Usually a third pacing lead is inserted via the coronary sinus into a cardiac vein in order to trigger the left ventricle. Thus, synchronized atrio-ventricular and ventriculo-ventricular contraction can be maintained. Better designs in leads and anchoring methods are now available, and new indications are forthcoming. The combination of CRT and ICD has created the device known as CRT-D.

New advance in intervention techniques and creation of new concepts is a non-stop process. The yield of today is the effort of the past, not to mention the compulsory elimination of those outdated. Be it cardiac or non-cardiac, catheter-based or device-based, new toys are bound to come and replace the old. It is our role to keep abreast of the updated knowledge in order to make our patients benefit.