Transcatheter Tricuspid Valve Replacement of NaviGate Bioprosthesis in A Preclinical Model

Appendix 1: Surgical Procedure

All animals were quarantined by the Biological Resources Unit (BRU) of the Gateway Institute for at least 2 weeks before use in the chronic studies. Animal selection was based on physical exam and body weight (85 to 105kg).

Anesthesia was induced by an intramuscular injection of ketamine (20 mg/kg) followed by general anesthesia maintained with isoflurane inhalation 1.0 - 2.5% via endotracheal intubation. A continuous infusion of lidocaine (1 mg/kg/hr) was administered to control potential ventricular arrhythmias, and peripheral lines were placed. Animals in both types of intervention received the same anesthesia protocol.

Delivery system

The delivery system evokes the configuration of a mitral commissurotomy device of decades past. The curved shape and angulation of the shaft leads the distal end into a central alignment position in the Tricuspid valve. The distal section is flexible, as that includes the 30F stent-enclosing capsule and a mechanism that allows steering in four directions, and depth control by forward or reverse motion of the distal capsule when in the immediate vicinity of the tricuspid annulus plane. Retraction of the capsule causes exposure of the distal aspect of the valved stent deploying the ventricular winglets or graspers that capture the leaflets above the mitral chordae tendinae (Fig. 2)

Set up for Implantation Procedure:

The animal is placed on the surgical table on the left lateral position. A left groin access is used for femoral arterial pressure monitoring line, and jugular and femoral veins for a venous infusion

line and for placement of Intra Cardiac Echocardiogram (ICE) probe catheter. The ICE and or transesophageal echocardiography (TEE) were used for baseline evaluation before, during, and after the surgical procedures. Tricuspid annulus dimensions, both from the anterior-posterior (AP) and from the commissure-commissure (CC) directions, as well as RA dimensions were obtained with ICE. A right 4th or 5th intercostal thoracotomy is performed. Upon opening the pericardium, the infusion rate of lidocaine was increased (to 2 mg/kg/hr.) to prevent arrhythmias during manipulations of the heart. Systemic anticoagulation was achieved through an initial bolus of 300 IU/kg heparin before access the heart and the activated clotting time was maintained greater than 450 seconds throughout the experimental study. A double 4-0 Prolene with pledgets purse-string sutures are placed at the RA appendage.

The RA wall is opened and the new NCSI delivery catheter (Fig. 4 C) is placed, which is de-aired, and flushed. The prosthetic valve mounted delivery system is then introduced and advanced into the RA chamber toward to the tricuspid annulus. Using echocardiographic and fluoroscopic guidance (right anterior oblique 27° and cranial 4° plane), the valve mounted delivery system is moved in small iterations until it is centered over the tricuspid valve orifice, the stented valve is positioned with equal valve height above and below the tricuspid annulus (TA). The NaviGate tricuspid valved stent does not require rapid ventricular pacing for valve deployment. After that, the delivery system is safely withdrawn, the RA puncture access site is closed using 4-0 Prolene purse string sutures, and then the right thoracotomy is also closed as usual fashion in sequential layers.

After the valves were implanted, the prosthetic valve function is evaluated by echocardiography, right heart angiography, in order to confirm the proper placement of the valve, and (PVL), as well as measure hemodynamic pressure gradients across the valve, and to identify any damage to the TA or adjacent structures produced by the procedure.

Echocardiographic, hemodynamic evaluations, and valve function data are repeated after a 20 minutes period to stabilize the hemodynamics.

Appendix 2: Post-Deployment Measurements and Management

Right ventricular angiography was performed to confirm proper placement of the valve and to rule out RVOT obstruction and/or TR (central - paravalvular), coronary artery angiogram was performed to rule out coronary arteries obstruction or compression. Both TEE and ICE were used to confirm both placement and proper valve function. Echocardiographic, hemodynamic interrogations, and valve function assessment were repeated after 20 minutes when hemodynamic stability was achieved. When hemostasis was ensured, chest, neck, and femoral incisions were closed in layers in the usual fashion. The animals were allowed to recover in the acute care unit after the procedure. Standard postoperative care was given including pain control and perioperative antibiotics. Anticoagulation management used heparin 2,000 unit's x every 12 hours, administered subcutaneously for the first 3 days only, after which the animals received neither anticoagulation nor anti-platelet therapy. The venous line and chest tubes were removed on the first postoperative day or when clinically indicated. The animal was then returned to regular housing. During the recovery period, the animals were carefully examined once a day by the laboratory veterinarian. When animals were considered to have reached the desired study term, they were electively euthanized according to the protocol and the SOP for euthanasia at Gateway Laboratories. Any gross pathology findings were photographed and documented.