Modified Konno Procedure for Left Ventricular Outflow Tract Obstruction

David P. Bichell, MD

The modified Konno procedure, or subaortic ventriculoplasty, first described by Cooley and Garrett in 1986, is employed to relieve tunnel or complex subaortic stenosis while preserving the aortic valve. Native tunnel subaortic stenosis is a far less common application for the modified Konno procedure than is the case of a previously operated patient who presents with complex left ventricular outflow obstruction from an intraventricular baffled ventricular septal defect (VSD) closure or other prior intracardiac repair. The subaortic interventricular septum is safely and extensively resected, creating a VSD where obstructive septum was previously located. The newly created VSD is then closed with supple material that can bulge away from the subaortic region, preserving an open left ventricular outflow tract. Creation of the VSD poses important risk of injury to the mitral valve, aortic valve, and conduction system, and these structures limit the boundaries of safe resection. The approach requires careful consideration of the septum from a combination of views through an aortotomy and right infundibulotomy. The resection is extended to the area immediately subjacent to the aortic valve annulus, and it is important to proceed with particular caution so as to avoid injury to the valve itself, while performing a complete resection of the subaortic obstruction.

An aortic cannulation site is placed on the distal ascending aorta, or proximal transverse arch, so that the cannula is sufficiently distal to provide an unobstructed view of the subaortic region through an aortotomy. Bicaval venous cannulation is advisable, as the right ventricle will be opened, and control of systemic venous blood in the field is in this way optimized.
Care is taken to delineate the course of the coronary arteries across the right ventricular infundibulum to choose a safe location for entry into the right ventricular cavity. A transverse right infundibulotomy is made and extended with direct visualization of the pulmonary valve annulus, so as to avoid injury to it. The infundibulotomy provides exposure of the pulmonary valve and the subpulmonary interventricular septum.

After the placement of an aortic cross-clamp and the administration of antegrade cardioplegia, a diagonal incision is made in the aorta, extended under direct visualization deep into the noncoronary cusp, such as will gain exposure of the aortic valve, and the subaortic interventricular septum. Asc. ao. = ascending aorta; MPA = main pulmonary artery; RA = right atrium; RCA = right coronary artery; RV = right ventricle; SVC = superior vena cava.

Figure 1  Care is taken to delineate the course of the coronary arteries across the right ventricular infundibulum to choose a safe location for entry into the right ventricular cavity. A transverse right infundibulotomy is made and extended with direct visualization of the pulmonary valve annulus, so as to avoid injury to it. The infundibulotomy provides exposure of the pulmonary valve and the subpulmonary interventricular septum.

After the placement of an aortic cross-clamp and the administration of antegrade cardioplegia, a diagonal incision is made in the aorta, extended under direct visualization deep into the noncoronary cusp, such as will gain exposure of the aortic valve, and the subaortic interventricular septum. Asc. ao. = ascending aorta; MPA = main pulmonary artery; RA = right atrium; RCA = right coronary artery; RV = right ventricle; SVC = superior vena cava.
Figure 2. The safely resectable region of the interventricular septum, mostly situated subjacent to the right-left commissure of the aortic valve, is visualized with gentle retraction of the coronary leaflets. Extensive resection can be made in the area delimited by the mitral valve (posteriorly), the nadir of the right coronary cusp of the aorta (anteriorly), and the aortic valve annulus (cephalad).

An accurate and expedient VSD creation requires exact knowledge of the location of the aortic valve annulus, even as resection is carried out from the right side of the heart. Septal resection that does not extend aggressively to the aortic valve annulus can result in residual subaortic stenosis, while only slightly overly aggressive resection injures the valve. Our approach has been to pass 2 sutures through the interventricular septum to delimit and therefore protect the aortic valve from injury as the septum is resected from the right ventricular view. A 4-0 polypropylene suture on an SH (large) needle is prepared by slightly straightening the needle. The needle is passed through the septum from the aortic side to the subpulmonary side, marking in 2 sites the location of the right cusp hinge points. This maneuver provides retraction and delimiting suture guides that protect the aortic valve from injury by errant myectomy. ant. = anterior; Ao = aorta; LV = left ventricle; MPA = main pulmonary artery; MV = mitral valve; PV = pulmonary valve; RV = right ventricle.
A VSD is created from the right-sided exposure, guided in its extent by the 4-0 polypropylene delimiting sutures. Care is taken to resect no tissue rightward of the nadir of the right coronary cusp, as the His bundle may reside in this membranous septal region. In cases where the subaortic obstruction is at the site of previous VSD repair, it is important to resect VSD patch redundancies that often constitute part or all of the obstruction, in addition to contributory septal muscle. It is also important to leave a rim of the previous VSD patch in place where it is in proximity to the His bundle, so that the new VSD closure material can be safely sutured to the free edge of previous patch material. Alternating examination of the VSD is made from transaortic and right ventricular views as the VSD is enlarged to relieve subaortic stenosis fully without injury to the aortic valve. The VSD is extended sufficiently apically so as to effect complete relief of midcavity or deeper levels of obstruction. VSD = ventricular septal defect.
Figure 4  Pledged VSD sutures are placed around the newly created VSD, assuring purchase of firm tissue. Cut muscle edges can be friable, and VSD closure sutures are placed accordingly deep from the edge.
Figure 5 A patch of thin, flexible material, ideally gluteraldehyde-treated autologous pericardium, is used for VSD closure. Rigid materials such as Dacron may be used also, but care must be exercised to fashion a nonredundant patch, as redundancy in a rigid patch can produce folds that produce recurrent subaortic stenosis. A common pitfall at this stage of repair is to fashion a VSD patch that is too broad in the apical-cephalad direction, resulting in a redundant patch fold and recurrent subaortic obstruction. It should be noted that patch fold redundancy from prior repair is commonly the etiology of the presenting obstruction, and occasionally the obstruction can be fully relieved by resecting the patch fold alone.

The VSD patch is lowered onto the defect and the sutures are tied to complete the septoplasty. Inspection and calibration are made through the aortic valve to assure full relief of subaortic obstruction, prior to closure of the aortotomy. The heart is then evacuated of air; the cross-clamp is removed, and rewarming is begun. LVOT = left ventricular outflow tract.
During rewarming, a patch is used to repair the right ventriculotomy; its configuration is tailored to assure that there is no right ventricular outflow tract restriction. Note that the patch from the septoplasty can bow anteriorly into the right ventricular outflow tract, and the right ventricular patch must be sufficiently large as to arc over this bulge, providing unrestricted eflux from the right ventricle. RV patch, right ventricular patch.
Conclusions

Primary tunnel left ventricular outflow obstruction in conjunction with aortic valve stenosis requires autograft or prosthetic aortic valve replacement in addition to ventriculoseptoplasty. Complex left ventricular outflow obstruction without aortic stenosis most commonly occurs in patients who have undergone prior intracardiac repairs such as that for double outlet right ventricle and rarely presents as a primary lesion. The modified Konno procedure, valve-sparing Konno procedure, or ventriculoseptoplasty can produce durable relief of complex left ventricular outflow obstruction with low morbidity. The effectiveness, safety, and expediency of the procedure require meticulous attention to the easily injured structures that delimit the margins of septal resection, while assuring the aggressive resection of all potentially obstructive material.

References