Surgical Technique

A Suggested Technique for "Orthotopic" Heart Transplantation

in a Patient with Situs Inversus

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We describe a technique for "orthotopic" heart transplantation in a patient with situs inversus. The left atrial, aortic, and pulmonary artery anastomoses were performed directly, in the usual manner. The recipient's right atrium was converted into a tunnel, and the donor's right atrium was left intact. Anastomoses were therefore required between the 2 inferior venae cavae (by direct end-to-end anastomosis) and the 2 superior venae cavae (necessitating the insertion of a Dacron graft). We suggest that even simpler techniques, perhaps not requiring the use of an artificial vascular prosthesis, are possible. ***(Texas Heart Institute Journal 1993;20:281-4)***

Heart transplantation for cardiomyopathy in a patient with situs inversus using a donor heart of normal anatomy would appear to have been performed only once previously, by the Utah group in 1987.[1] In 1990, we performed such a procedure in a 36-year-old woman with situs inversus who had undergone previous complete repair of tetralogy of Fallot at the age of 11 years.

Although the cardiac transplant surgeon will be faced very rarely with the need to perform heart transplantation in a patient with situs inversus, we believe that the surgical aspects of such a procedure are worthy of brief report. The primary technical problem that requires consideration is the mode of reconstruction of the right-sided venous (superior [SVC] and inferior [IVC] vena caval) anastomoses. Secondary, less important, questions include the choice of sites of venous cannulation and the matter of whether it is necessary to open the pericardium on the left side to more readily house the apex of the donor left ventricle.

The left atrial, aortic, and pulmonary artery anastomoses can be performed without difficulty, in the usual manner. The recipient's right atrium, however, is situated to the left of the recipient's left atrium (Fig. 1A), while the donor right atrium lies in the usual anatomic position, to the right of the recipient's left atrium. The Utah group brought about a connection of these 2 chambers by performing 2 innovative but relatively complex procedures: 1) the 2 IVCs were connected by fashioning a tunnel consisting of the pericardium posteriorly and of the recipient's mobilized right atrium anteriorly; and 2) a right-sided SVC was created by translocating the recipient's SVC to the right and by forming a 2nd pericardio-venous tunnel.[1]

Our own approach, described below, appeared to us to be more straightforward, anatomically more "natural," and technically less complex. Furthermore, in our own patient, previous cardiac surgery prevented us from following the Utah technique.

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Operative Technique

Excision of the Donor's Heart. The donor's heart was excised by the standard procedure,[2] except that the full length of the SVC was retained with the heart. The posterior wall of the left atrium was prepared in the usual way by incising the tissue between the orifices of the 4 pulmonary veins.[2] The right atrium, however, was not incised as usual, but was left intact because it would not require anastomosis directly to any other structure.

Recipient's Operation. The left femoral artery and vein were cannulated and connected to a 5%-dextrose-primed Cobe membrane heart-lung machine (Cobe

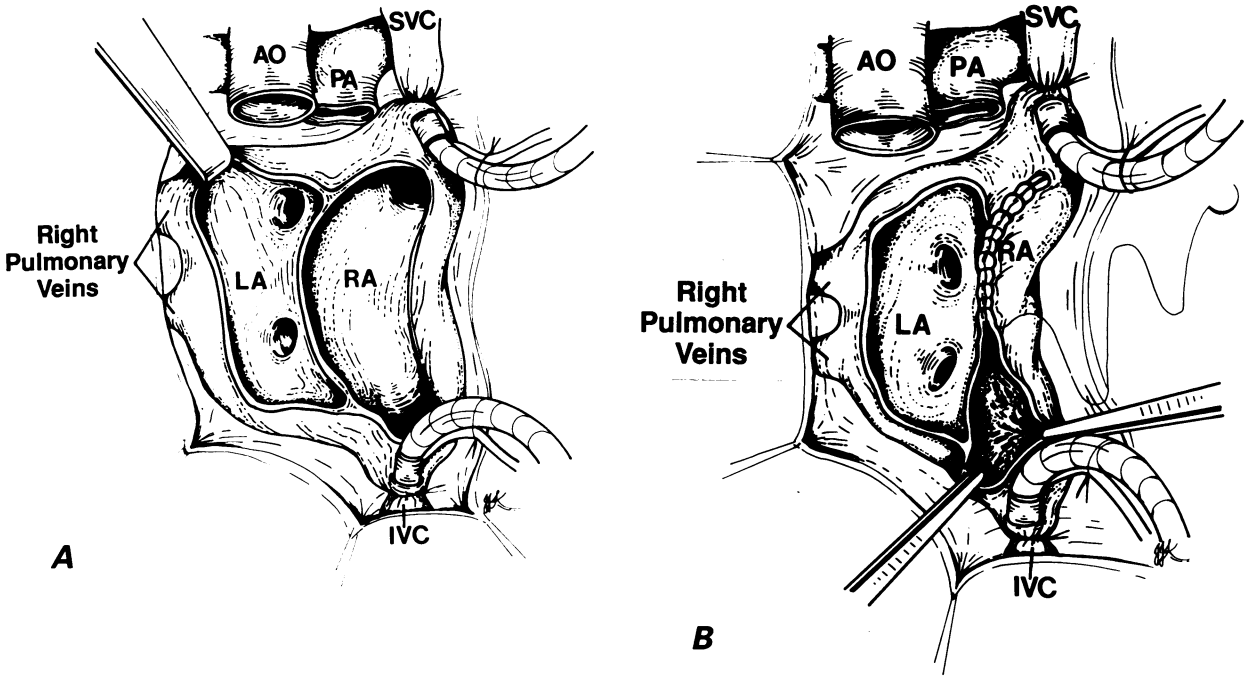


Fig. 1 ***A****) Structures remaining after cardiectomy in a patient with situs inversus. The right and left atria are transposed and the relationship between the aorta and pulmonary artery is slightly anomalous.* ***B****) The recipient's right atrium is closed in the form of a tunnel by suturing the free wall to the right atrial portion of the atrial septum. Subsequently, the junction of the IVC with the right atrium will be divided and the cardiac remnant oversewn.* ***C****) When the donor left atrium is anastomosed to the recipient's*

AO = aorta; IVC = inferior vena cava; LA = left atrium; LV = left ventricle; PA = pulmonary artery; RA = right atrium; RV = right ventricle; SVC = superior vena cava

Laboratories, Inc.; Denver, Colorado, USA). This is our frequent practice in patients who have undergone previous surgery within the pericardium, so that pump-oxygenator support can be initiated immediately should cardiopulmonary hemodynamics become unstable during the mediastinal dissection. A midline sternotomy was then performed, and tight adhesions between the heart, sternum, and pericardium were divided. The SVC and IVC were cannulated directly, using straight venous cannulae (SVC 32 mm, IVC 36 mm) (Research Medical; Midvale, Utah, USA) (Fig. 1A).

When the donor's heart (which was of normal anatomy) was available, the recipient's aorta was cross-clamped and the recipient's ventricles were excised. The aorta and pulmonary artery were divided above their respective valves, and the left and right atria were divided superior to the atrioventricular groove. The structures that remained in the patient's chest are shown in Figure 1A.

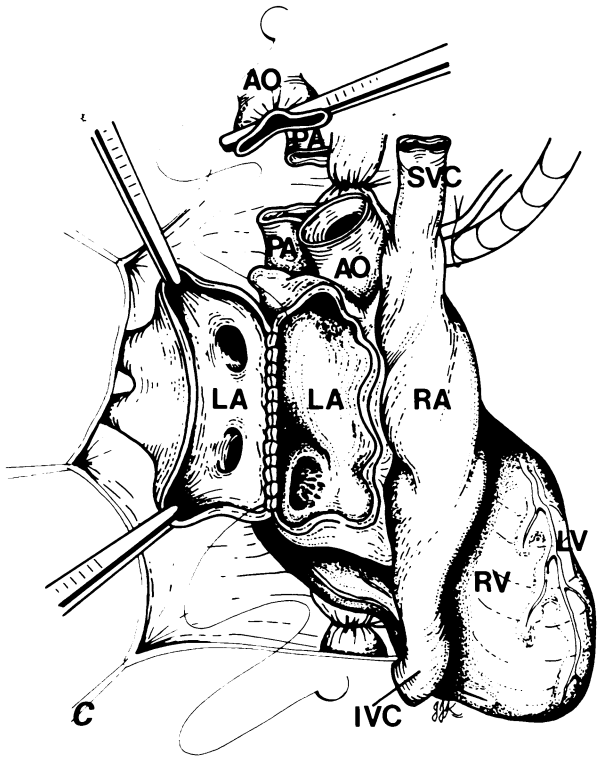
The recipient's right atrium was then converted into a tunnel by suturing the free wall of the right atrium to the atrial septum (Fig. 1B). The IVC was divided at its junction with the right atrium, and the cardiac side was oversewn, thus creating a blind sac at the caudal end of the right atrium. Blood from the native right atrium could therefore drain only into the SVC. The donor's and recipient's left atria were then anastomosed, initially by suturing the free wall of the donor's left atrium to the recipient's atrial septum and then the atrial septal component of the donor's left atrium to the free wall of the recipient's left atrium (Fig. 1C).

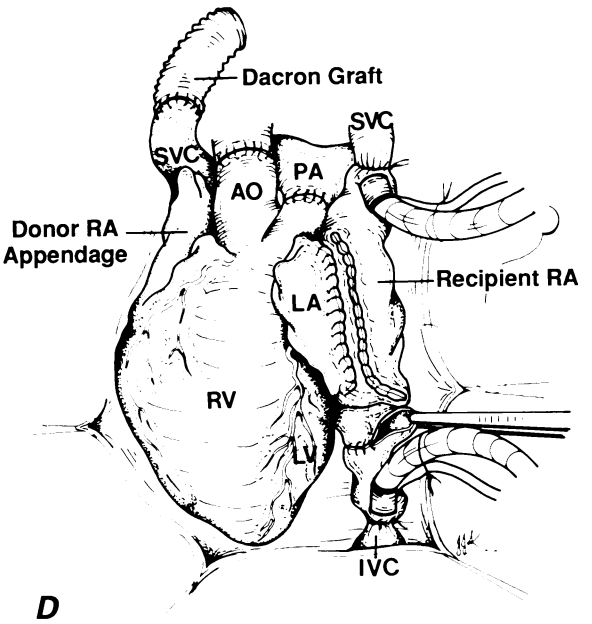
The aortas of donor and recipient were anastomosed end-to-end, as were the pulmonary arteries (Fig. 1D). Although there was some malalignment of the recipient's native aorta in relation to her native pulmonary artery, these anastomoses were not difficult.

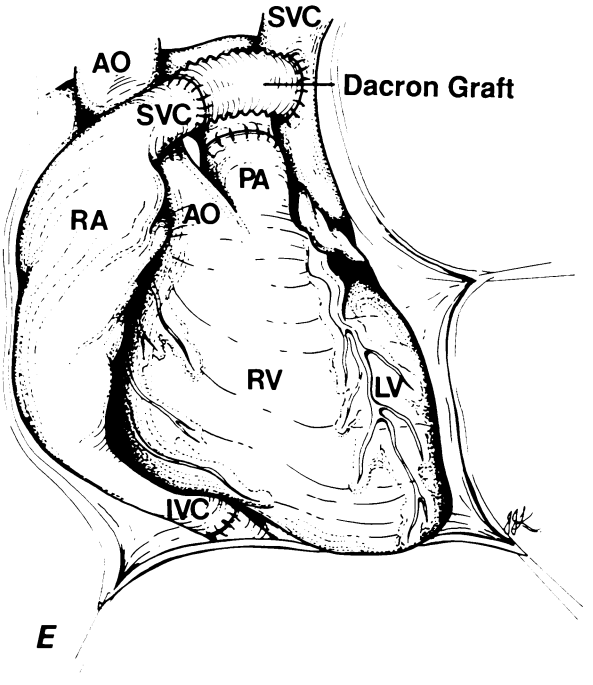
The donor IVC was anastomosed end-to-end to the caudal remnant of the recipient's IVC (Fig. 1D). This anastomosis was also achieved easily, without placing undue tension on these structures.

Finally, a 6-cm Dacron graft was anastomosed end-to-end to the donor's SVC (Fig. 1D), and then end-to-side to the recipient's SVC, completing the operation (Fig. 1E). At the conclusion of this procedure, we conjectured that the Dacron graft might not have been required, for a direct anastomosis between the donor's SVC and the supero-medial aspect of the recipient's right atrium might have been possible.

The donor's heart was easily contained in the pericardial cavity, without distortion or compression and







*left atrium, the initial suture line joins the free wall of the donor left atrium with the left atrial portion of the recipient's atrial septum. Subsequently, the left atrial portion of the donor's atrial septum is anastomosed to the free wall of the recipient's left atrium. The donor's right atrium is not directly involved in an anastomosis to any recipient structure. **D**) The left atrial anastomosis has been completed and the donor heart has been rotated toward the right side of the pericardial cavity. The suture line converting the recipient's right atrium into a tunnel can be seen. The aortic and pulmonary artery anastomoses have been completed, and a Dacron graft has been anastomosed end-to-end to the donor SVC. The recipient's IVC has been divided at its confluence with the recipient's right atrium, and the cranial (right atrial) remnant has been oversewn (although this cannot be seen in the drawing). The caudal part of the recipient's IVC is in process of being anastomosed end-to-end to the donor IVC. **E**) The Dacron SVC graft has been anastomosed end-to-side to the recipient's SVC, thus completing the operative procedure. The heart lies normally, in the left side of the pericardial cavity.*

without the need to incise the left wall of the pericardium.

Circulation through the Donor Heart. Blood returning from the upper part of the recipient's body into the SVC drained through the Dacron graft into the donor's SVC and right atrium. Any blood collecting in the remnant of the recipient's right atrium was also returned to the donor heart via the SVC. Blood returning from the lower part of the recipient's body drained through the direct IVC anastomosis into the donor right atrium. Subsequent circulation of blood through the donor right ventricle, the recipient's lungs, the donor left ventricle, and into the recipient's aorta was as usual after orthotopic heart transplantation.

Discussion

This surgical procedure, although complicated both by the recipient's anomalous anatomy and by her previous cardiac surgery, was accomplished without undue technical difficulty. Cardiac function was immediately good and remained so throughout the patient's life after transplantation. Despite a technically uneventful surgical procedure, the patient died of liver failure in the 2nd month after transplantation.

Venography confirmed that circulation of blood from the recipient's venae cavae through the donor heart was unimpaired and did not appear to be a factor in the development of liver failure, the cause of which remains uncertain.

Recommendations

Our experience with this operation has led us to believe that the simplest and best technique in these circumstances is to begin by converting the recipient's right atrium into a tunnel, and then to perform the left atrial anastomosis, followed by the aortic and pulmonary artery anastomoses, all of which are straightforward. At this stage, the best approach to the right-sided anastomoses can be determined. This might vary from patient to patient, depending on variations in the anatomy. An end-to-side connection between the 2 IVCs (rather than end-to-end, as used in our patient) would probably be the better choice. A vascular graft may be required for the SVC anastomosis, but at times the surgeon may be able to avoid its use.

Acknowledgment

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