

14 Valvular Stenosis

14-1. Valvular Stenosis

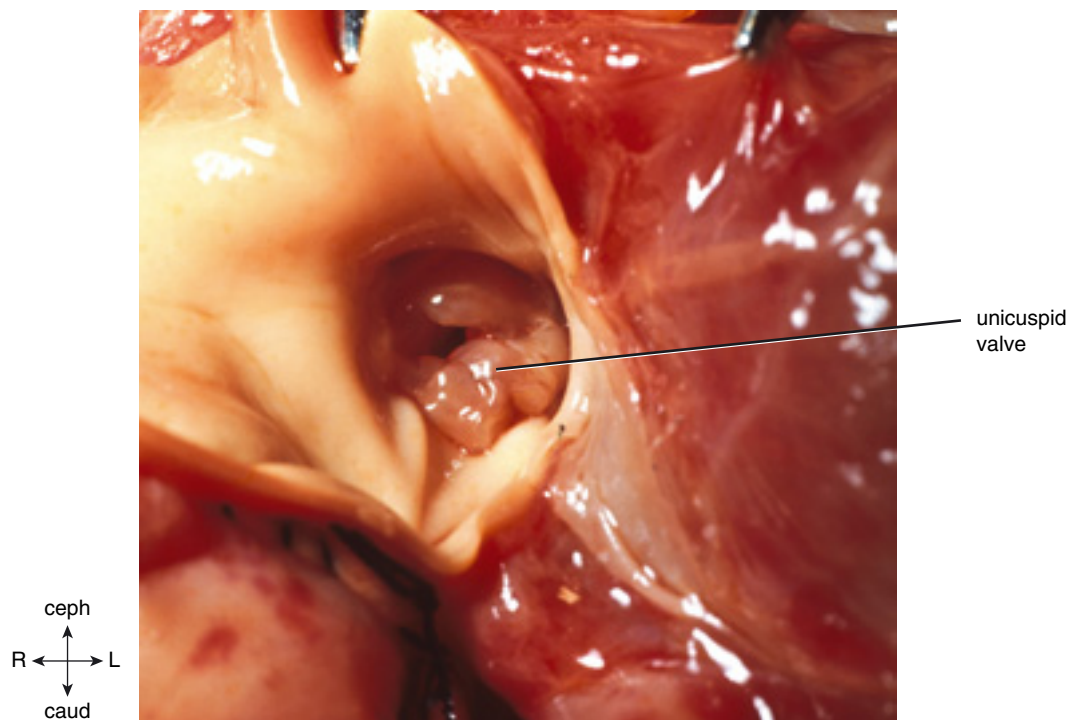


FIGURE 14-1. This photograph shows severe valvular stenosis as it occurs in a newborn. There is a unicuspid, horseshoe-shaped leaflet with a single posterior commissure. Leaflet tissue is thick, fibrous, and myxomatous. Successful valvotomy can be performed by creating a second commissure. Significant aortic regurgitation is rare due to the fibrous nature of the valve that prevents redundancy. Although typically there is residual stenosis after surgery, many infants will do surprisingly well for many years, even though the valve appears severely malformed and incompatible with life. This photograph was taken of a postmortem specimen in a child who died of other causes.

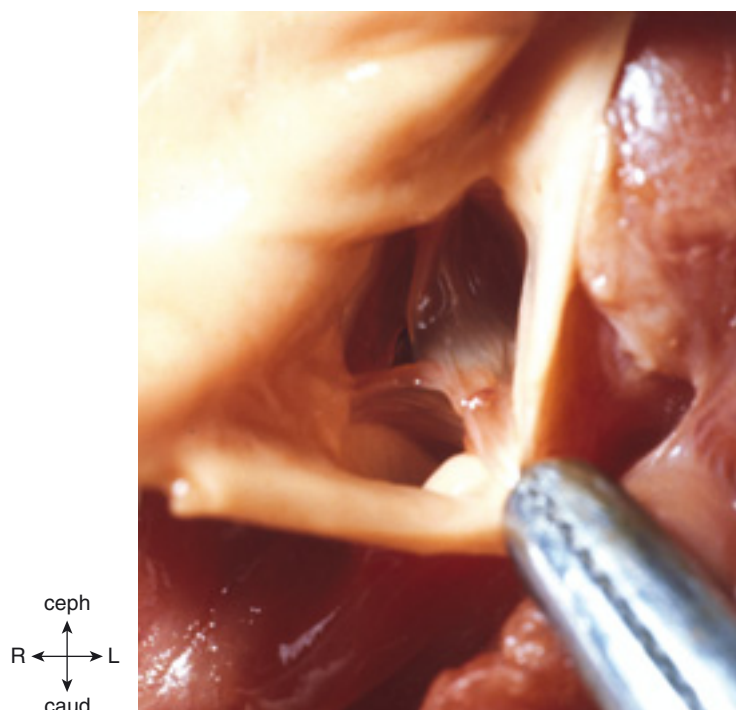


FIGURE 14-2. For comparison, this postmortem specimen shows a normal aortic valve in another newborn infant. There are three cusps and each is thin and pliable.

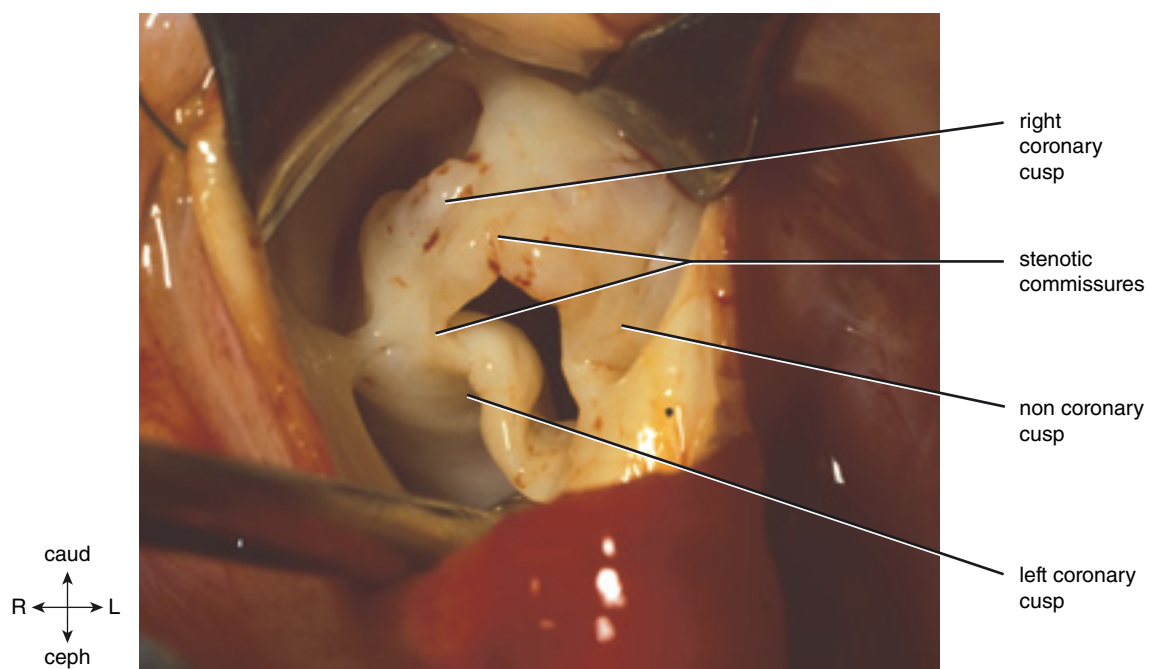


FIGURE 14-3. In this older child with valvular stenosis, the exposure is through a proximal ascending aortotomy, with cardiopulmonary bypass, aortic cross-clamping, and cardioplegia. There are three leaflets that are fibrous and thickened with stenosis primarily of two commissures.

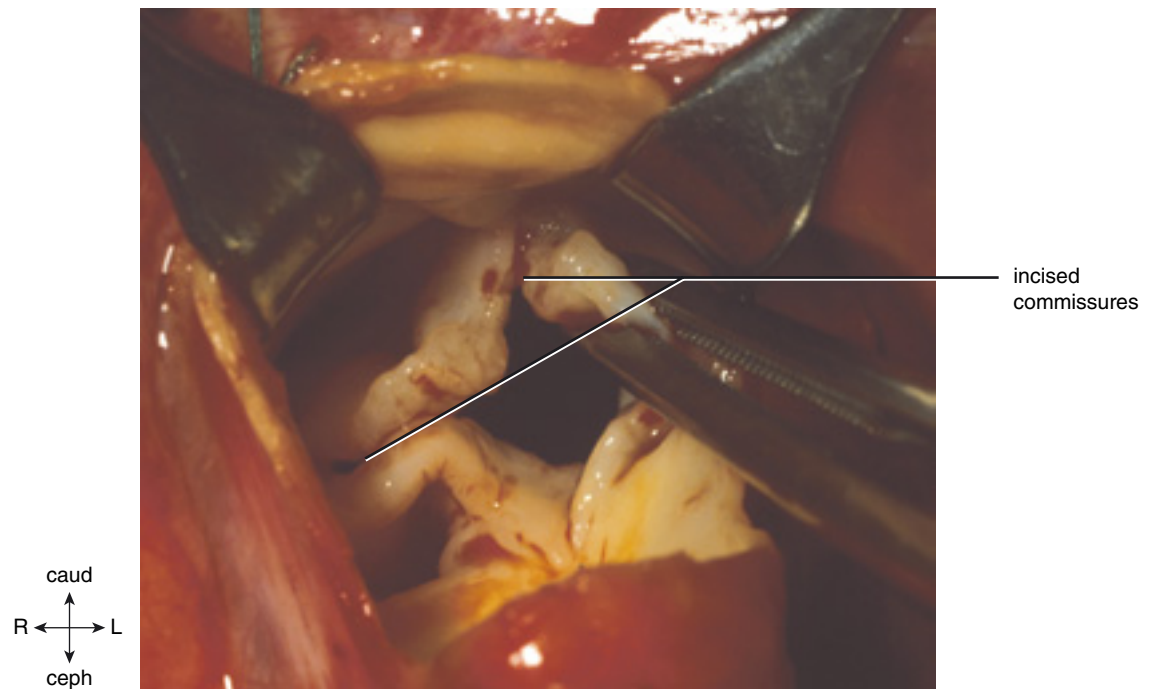


FIGURE 14-4. Valvotomy is performed by incising stenotic commissures. In some cases, the leaflets are thinned by resecting fibrous tissue.

14-2. Subaortic Stenosis: Fibromuscular Obstruction

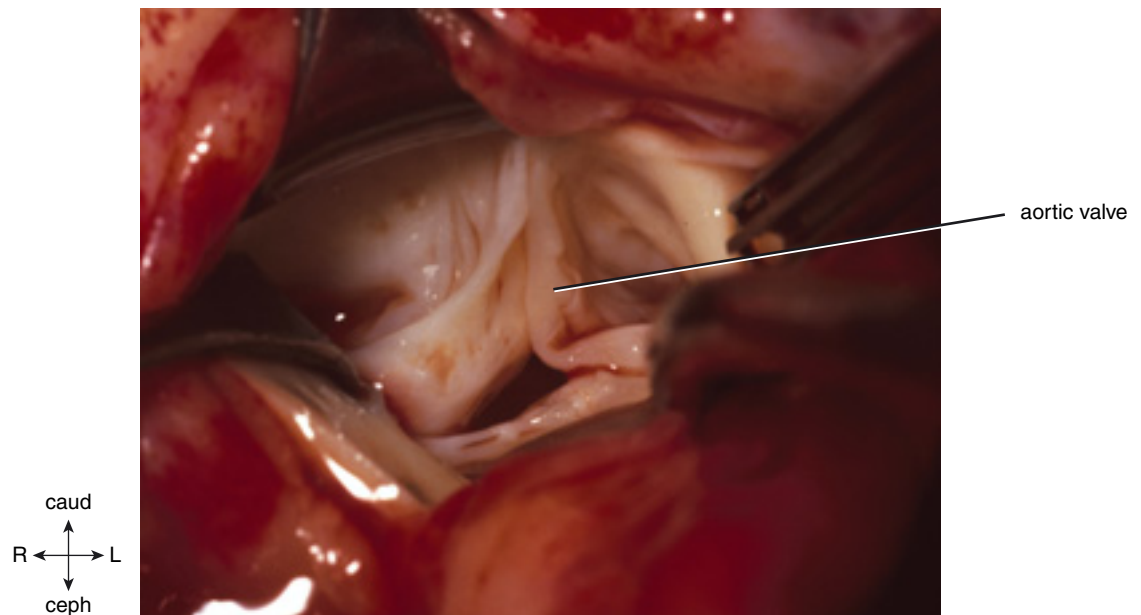


FIGURE 14-5. Repair of this anomaly is performed with cardiopulmonary bypass and aortic clamping, cardioplegia, and profound local cardiac cooling, working through a proximal ascending aortotomy. Typically, the aortic valve is normal as seen here. There are three leaflets without commissural stenosis.

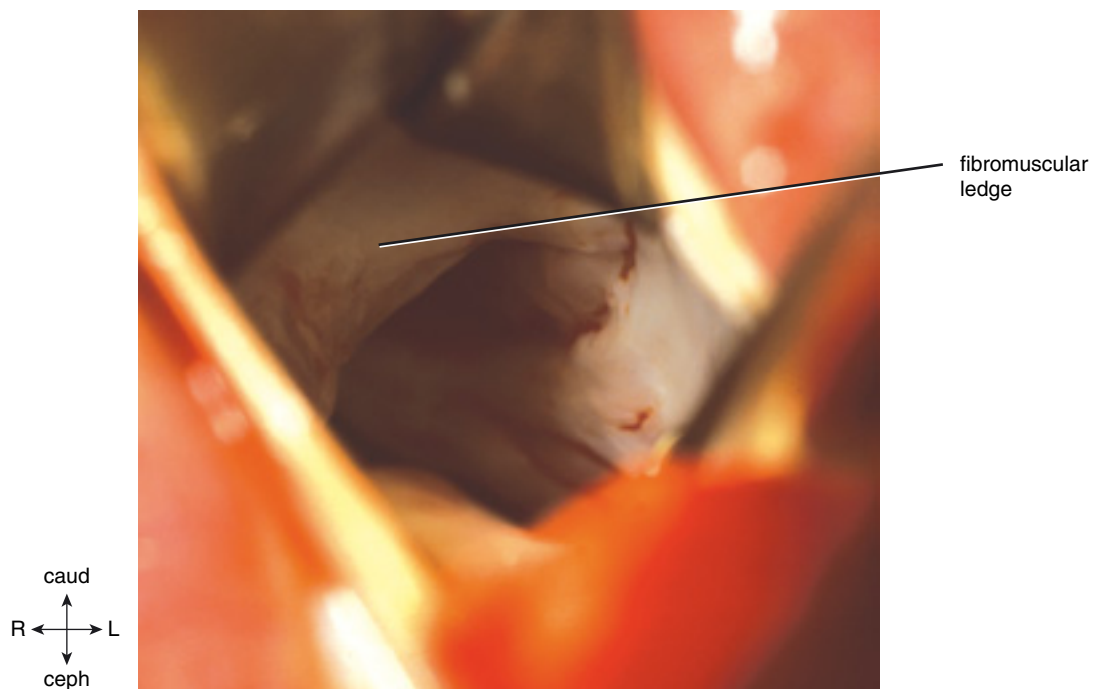


FIGURE 14-6. With retraction of the valve, a fibromuscular ledge is seen in the left lateral part of the outflow tract immediately below the valve annulus.

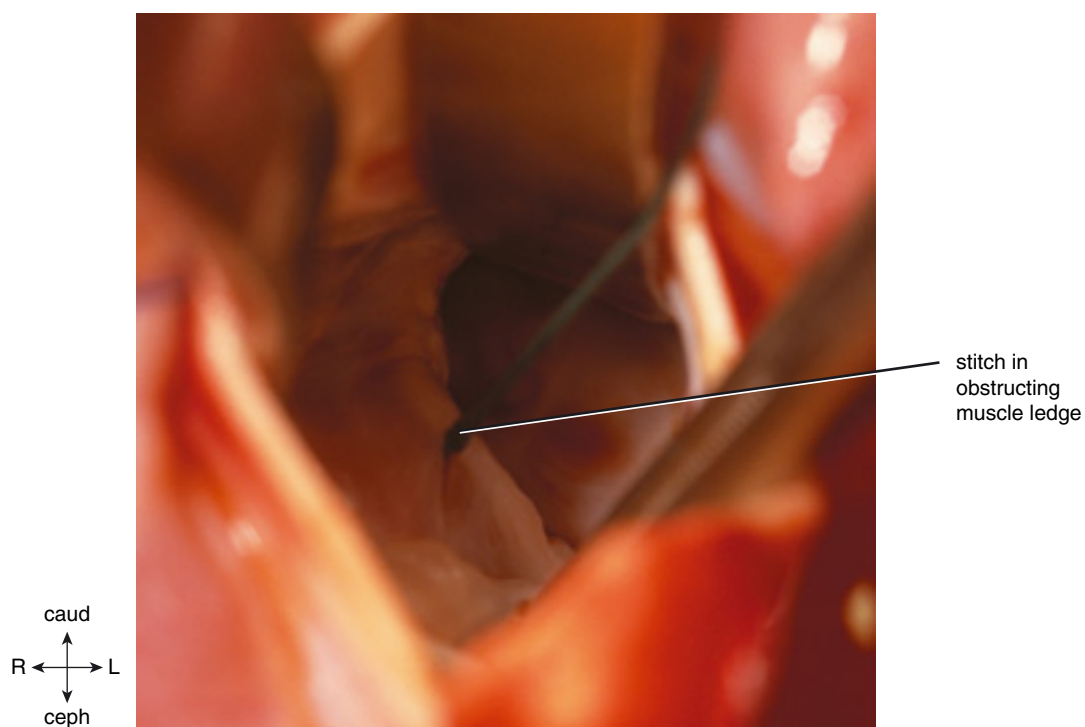


FIGURE 14-7. A stitch is placed in the middle of the ledge to facilitate grasping it while the resection is carried out.

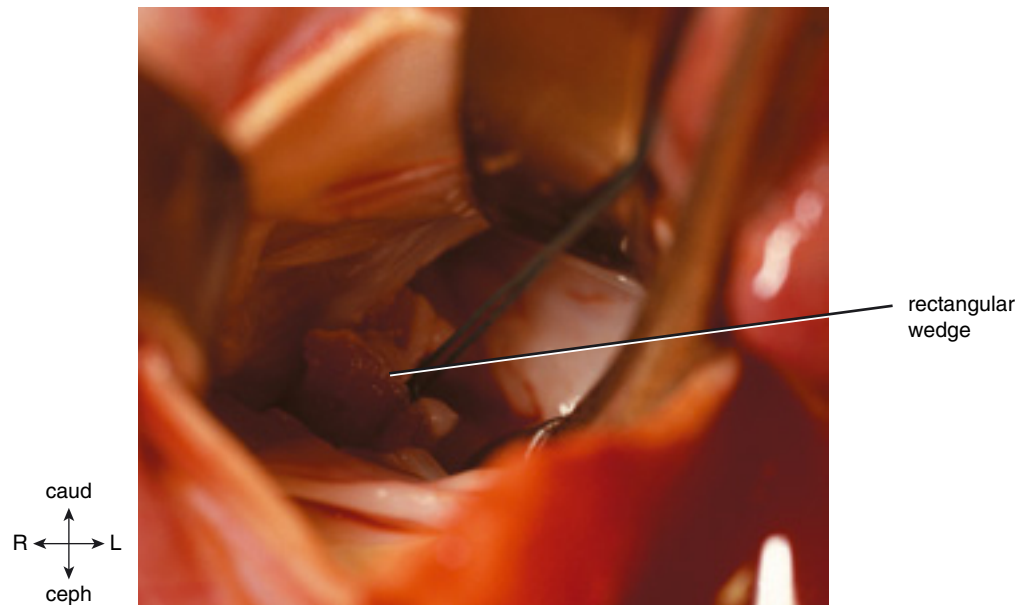


FIGURE 14-8. A rectangular wedge of fibromuscular tissue is resected. It is safe to resect tissue as far anterior as the region beneath the middle of the right coronary cusp. The bundle of His' pierces the ventricular septum beneath the noncoronary cusp, after which the bundle moves forward in the ventricular septum to the commissure between the non-coronary and right coronary cusps. Tissue is resected to the left and posteriorly as far as the base of the anterior mitral leaflet, which is located in the posterior wall of the left ventricular outflow tract.



FIGURE 14-9. The resected specimen is seen here.

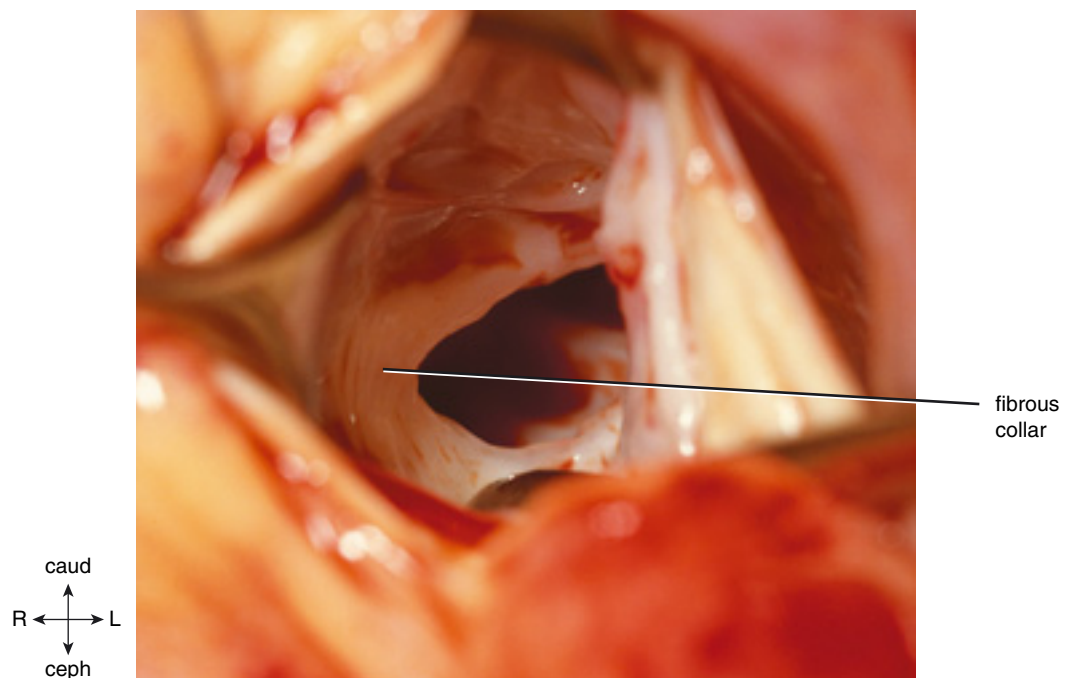


FIGURE 14-10. In another child, a typical fibrous collar is seen in the outflow tract immediately below the aortic valve annulus.

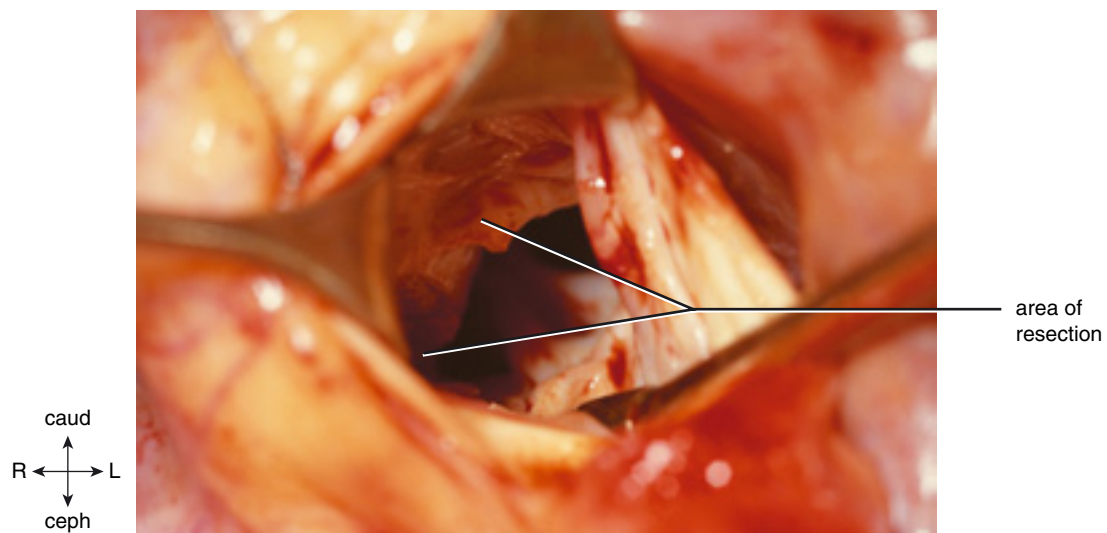


FIGURE 14-11. The fibrous collar has been resected along with a wedge of muscle.



FIGURE 14-12. In another patient, a normal aortic valve is seen.

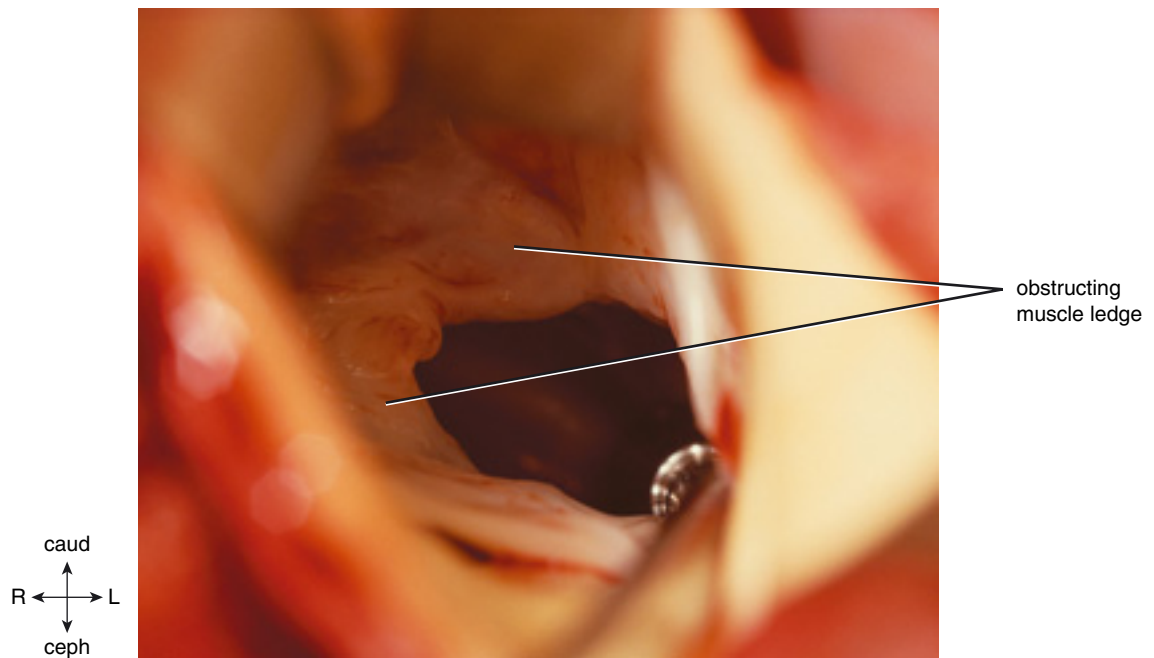


FIGURE 14-13. The valve cusps are retracted and a fibromuscular obstruction is seen immediately below the annulus.

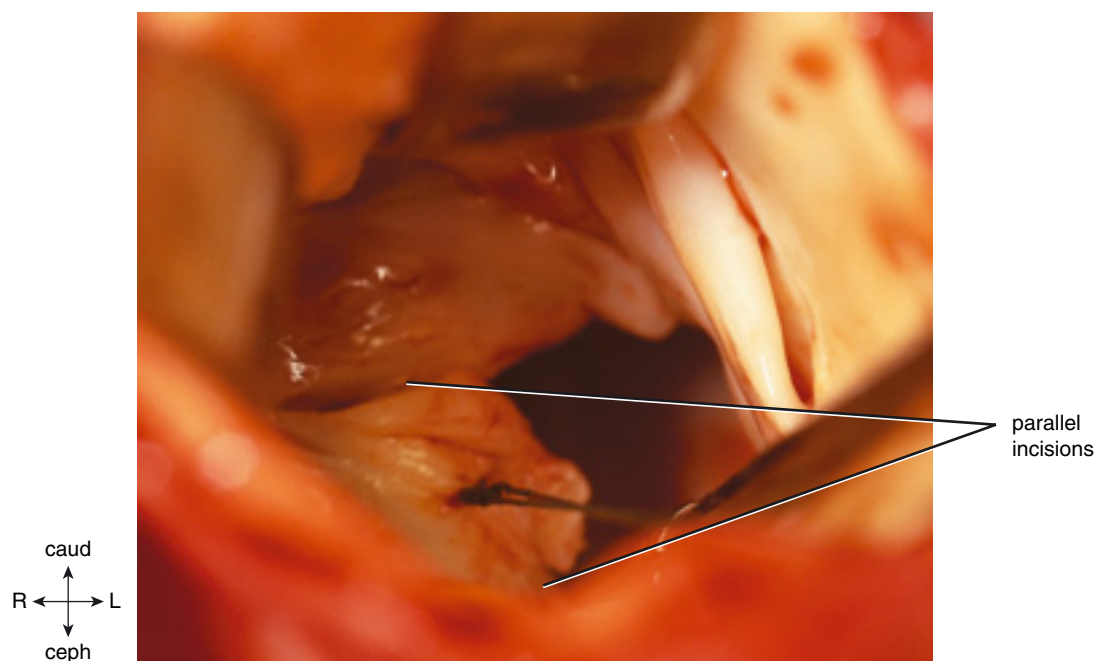


FIGURE 14-14. A stitch is placed in the mid part of the ledge for retraction, and parallel incisions are made in the obstructing tissue. The rightward one is below the mid part of the right coronary cusp.

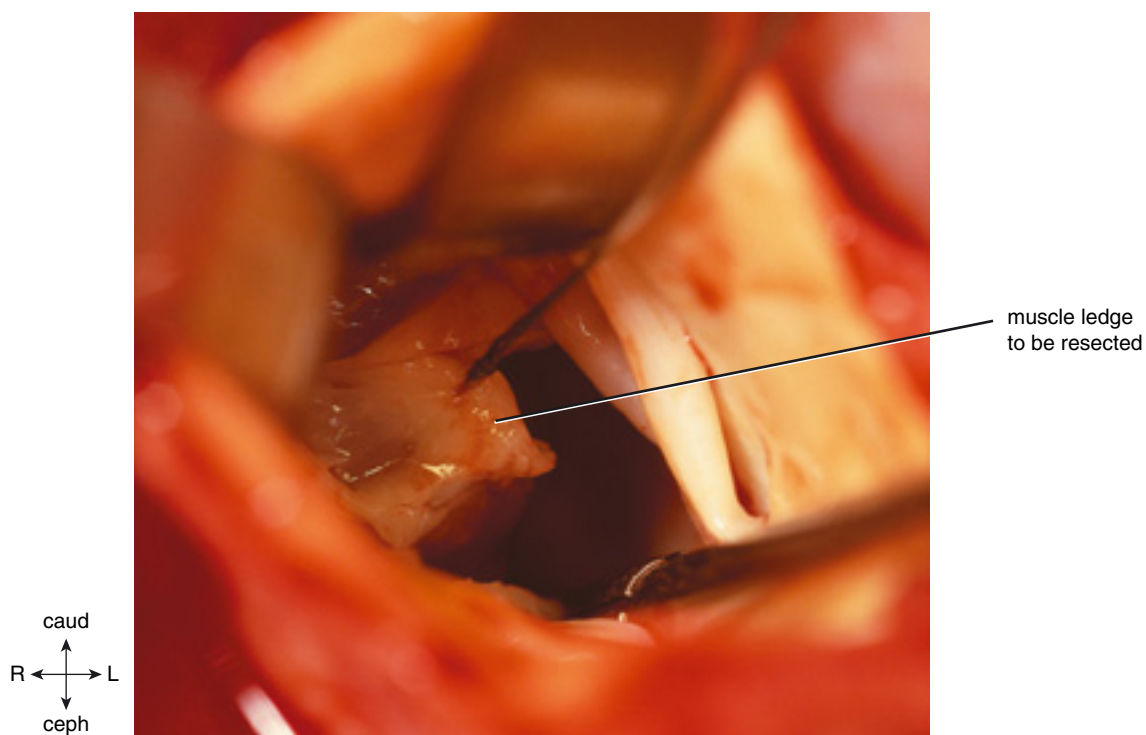


FIGURE 14-15. The obstructing muscle ledge is pulled into the field.

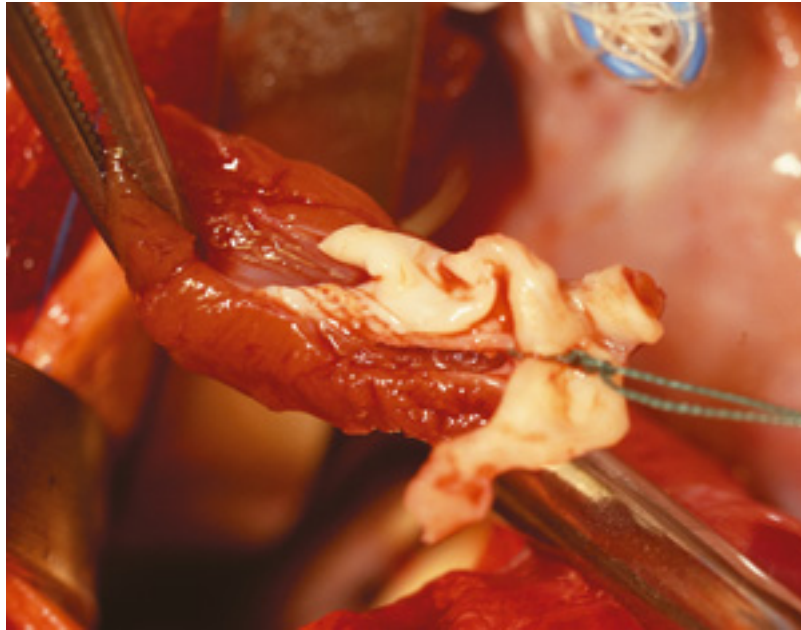


FIGURE 14-16. The resected specimen is shown. The obstruction extended deep into the sinus portion of the left ventricle, and the long resected specimen depicts the length of the obstructive process.

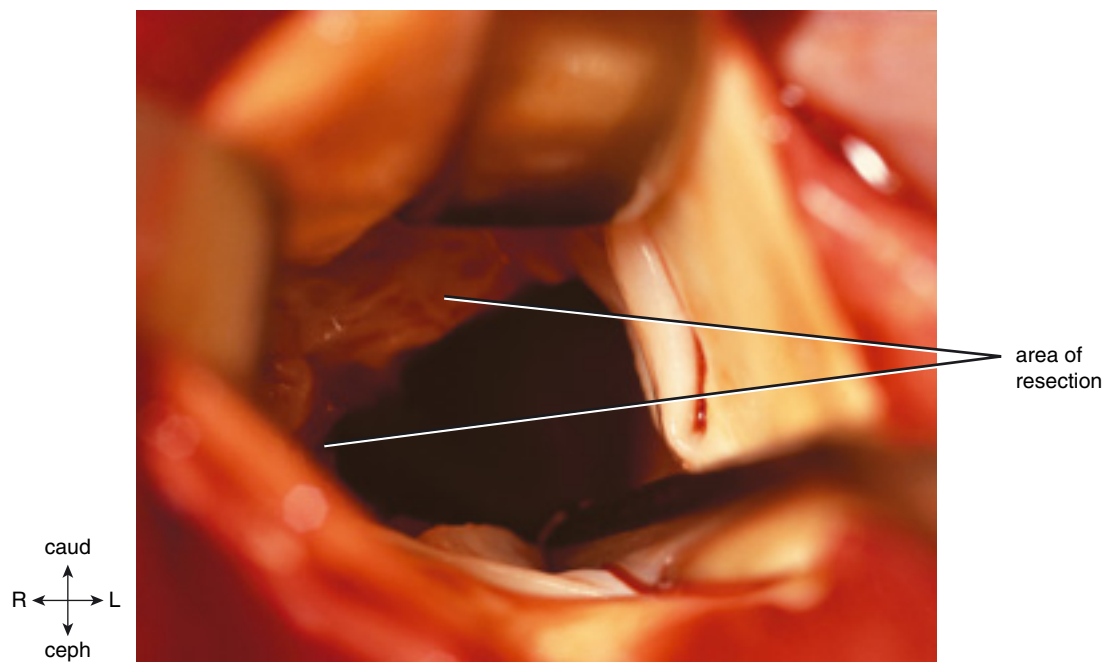


FIGURE 14-17. The area of resection is wide to ensure relief of the obstruction.

14-2-1. Anomalous Mitral Valve Papillary Muscle

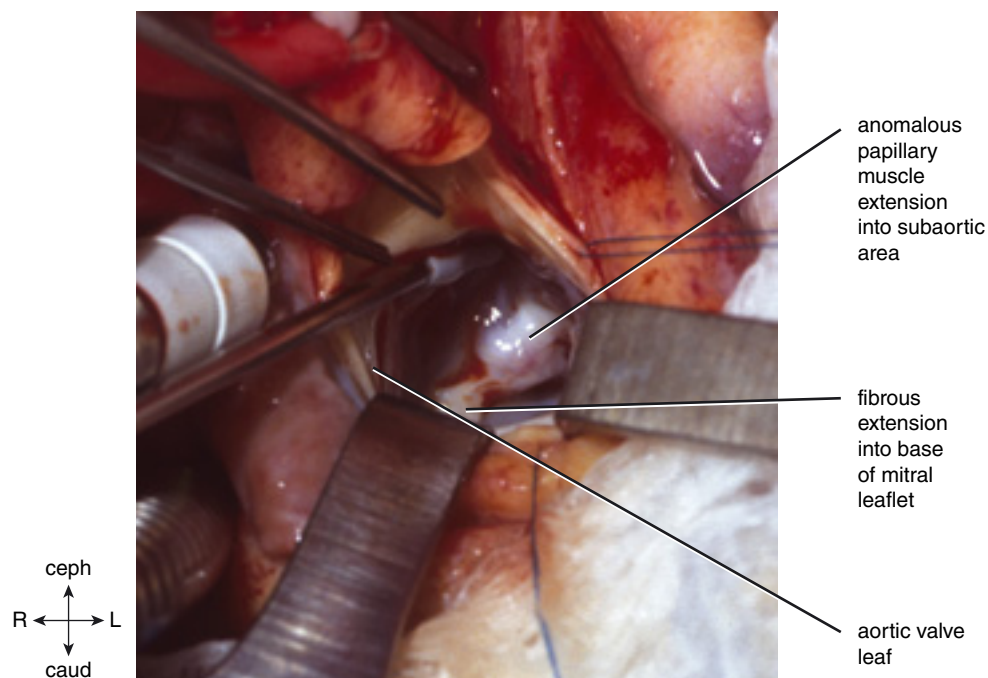


FIGURE 14-18. After placing another child on cardiopulmonary bypass, an opening is made in the proximal ascending aorta. A trileafed aortic valve is retracted, as is a narrow membrane located anteriorly. An obstructing muscle mass is exposed in the posterior left ventricular outflow tract. This is an anomalous extension of the mitral valve posterior medial papillary muscle with a fibrous tissue extension into the base of the anterior mitral leaflet.

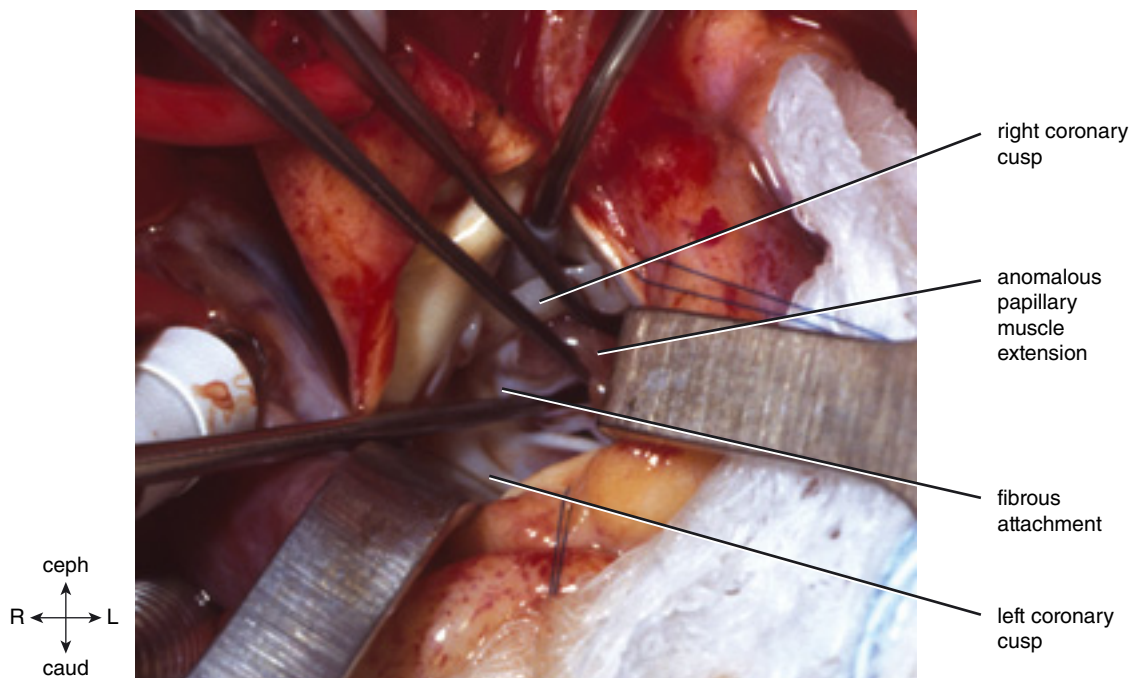


FIGURE 14-19. The fibrous membrane located beneath the right coronary cusp is excised and the anomalous muscle bundle is more easily seen.

FIGURE 14-20. The cephalad 25% of the posterior medial papillary muscle is excised. The lower portion of this papillary muscle is left intact and is attached to normal chords. The raw surface of the muscle excision is seen.

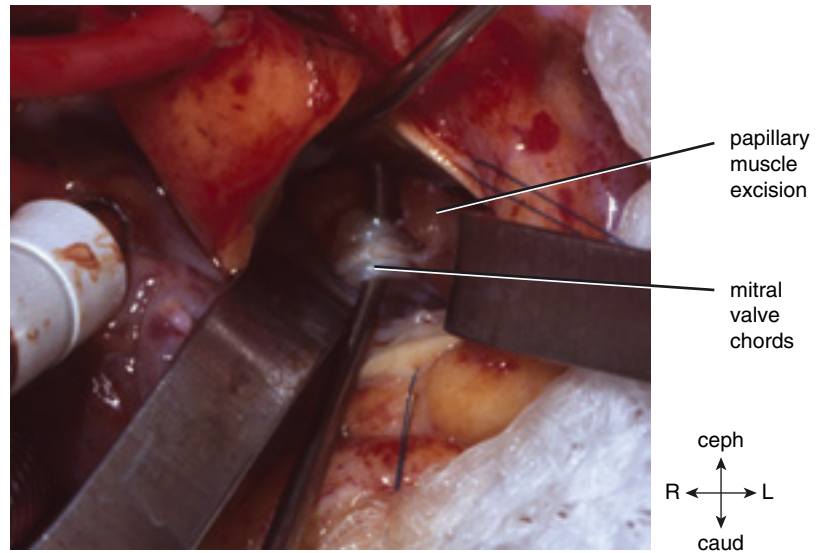
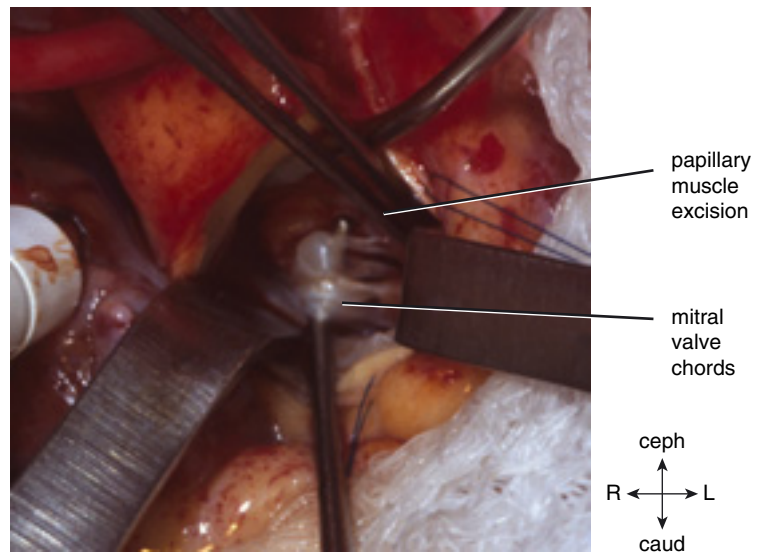


FIGURE 14-21. The raw surface of the excised muscle is again seen and normal mitral valve chords are identified. The lower 75% of the papillary muscle remains intact with these chords to provide mitral valve support. After closing the aorta and removing the child from bypass, there was no residual pressure gradient.



14-3. Modified Konno Procedure

In some patients, the left ventricular outflow tract is narrow and local tissue resection alone is inadequate to relieve the obstruction. A modified Konno procedure can be used in this diverse group of patients, which includes tunnel-like stenosis, stenosis in patients after total repair of complete atrio-ventricular (AV) canal, and some cases of hypertrophic cardiomyopathy. The geometry of the outflow tract is altered by full thickness resection of the ventricular septum working through a right ventriculotomy and an aortotomy. The left ventricular outflow tract is further augmented by ventricular septal defect (VSD) patch closure, placing the patch on the right ventricular surface of the septum. If that patch encroaches on the right ventricular outflow tract, an additional patch can be placed in the ventriculotomy. When the right ventricular outflow tract is not compromised by the intracardiac patch, the repair can be performed working through an aortotomy and an adjacent right atriotomy.

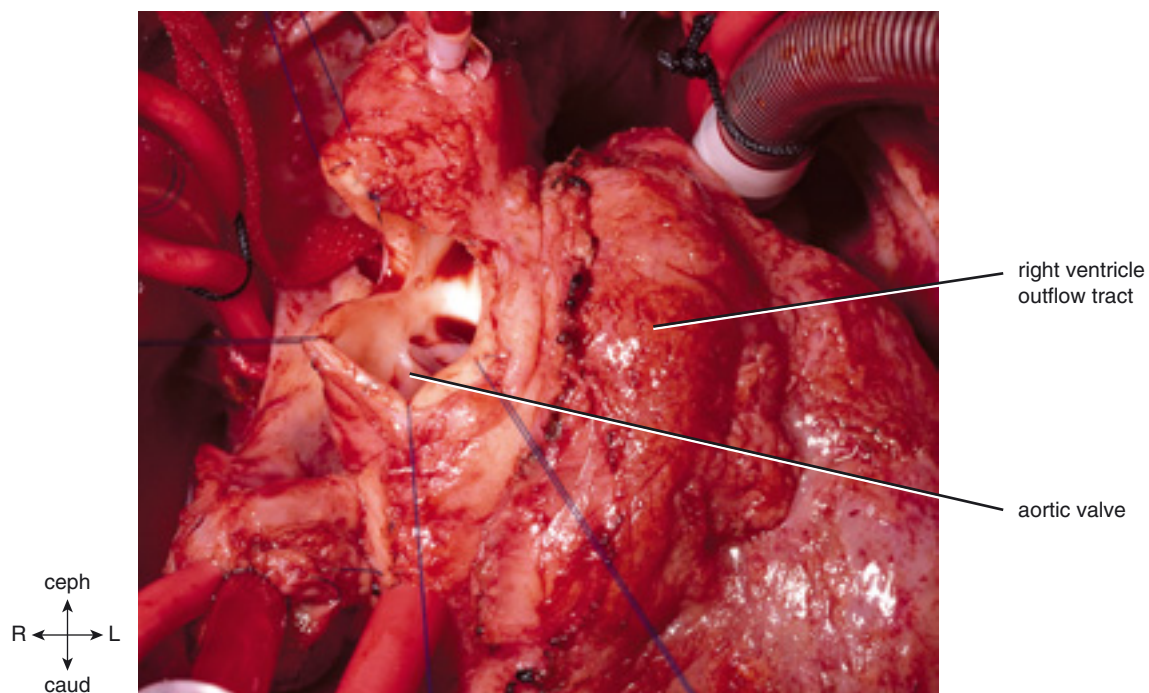


FIGURE 14-22. The child has been placed on cardiopulmonary bypass and the proximal ascending aorta opened. A normal aortic valve is identified and severe long segment subaortic stenosis seen.

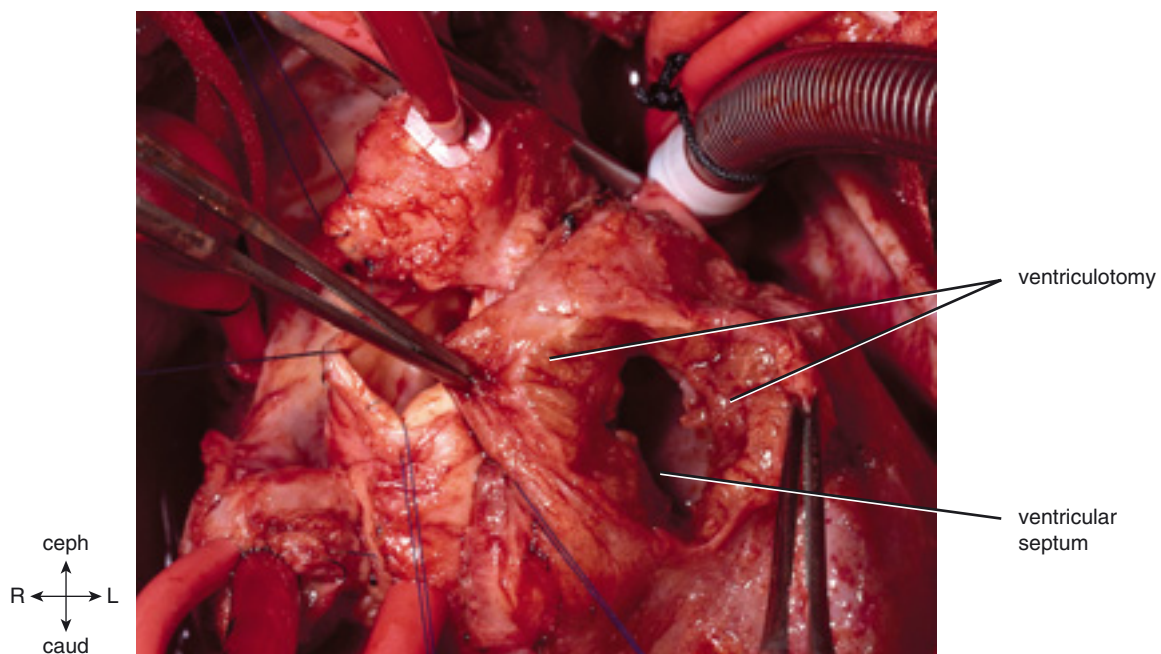


FIGURE 14-23. A ventriculotomy is made in the region of the right ventricular outflow tract.

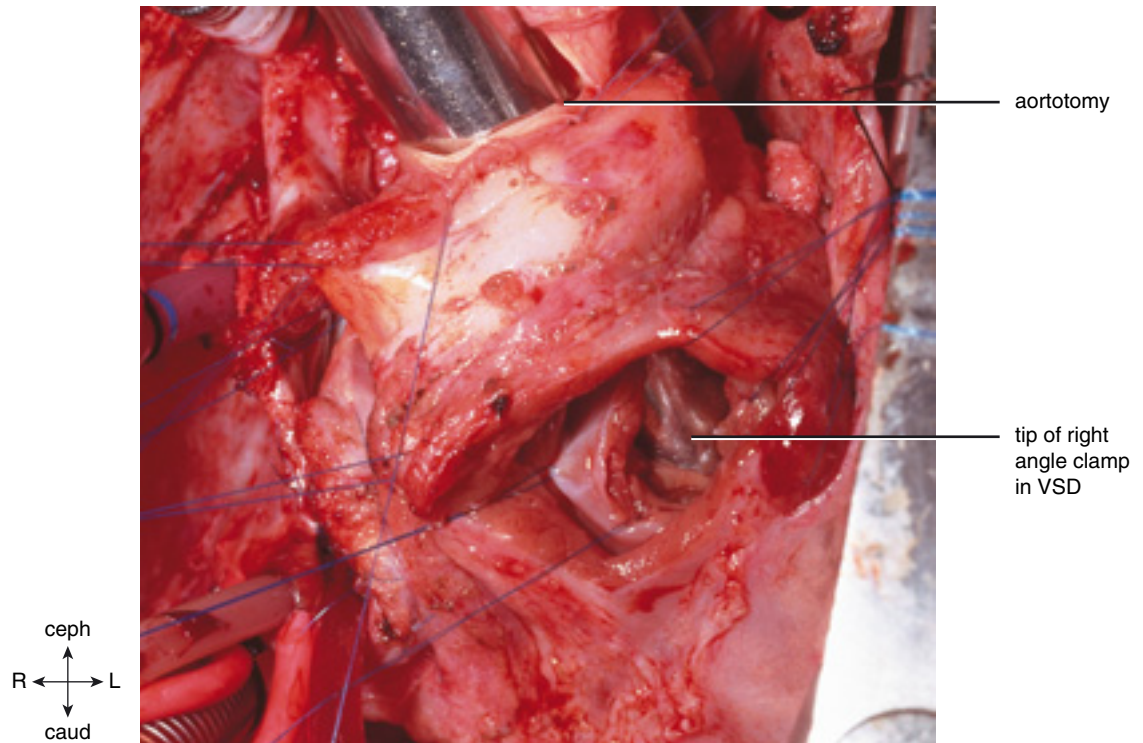


FIGURE 14-24. An oblique incision is made in the ventricular septum starting immediately below the aortic valve and extending caudad toward the patient's left side (starting at or to the left of corpora arantii of the right coronary cusp to avoid the His' bundle). To identify this region, a right-angle clamp is passed through the aortic valve to protrude in the region of the septum to be incised.

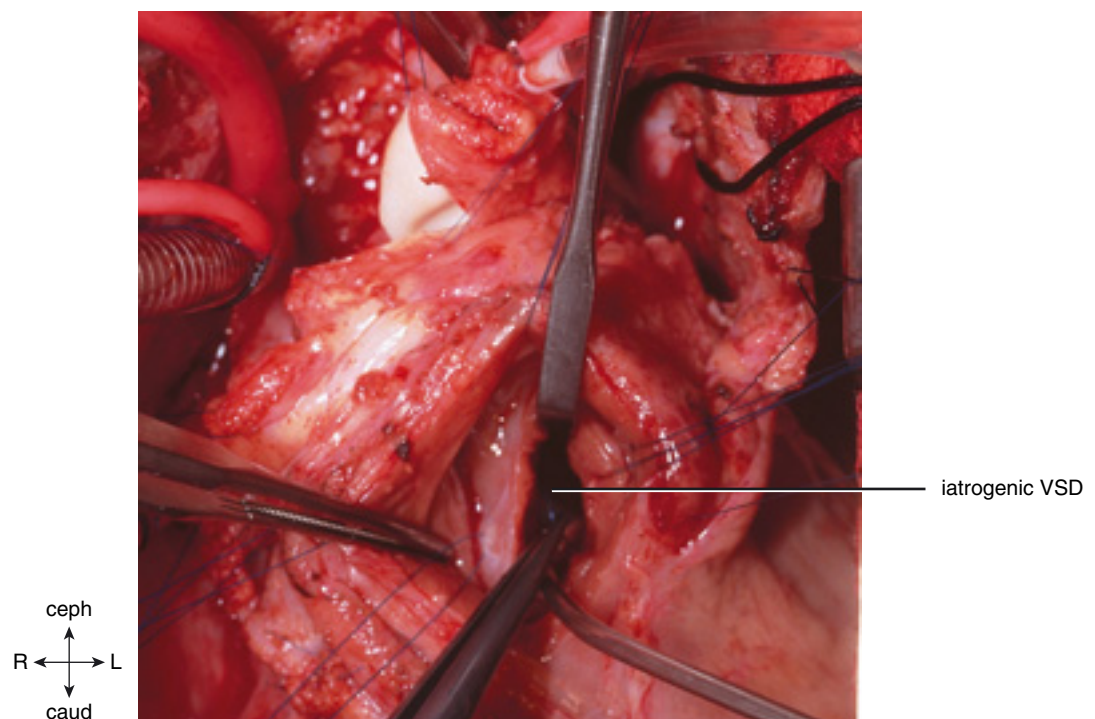


FIGURE 14-25. The large ventriculotomy is seen and through this region obstructing tissue in the left ventricle can be excised. If ventricular septal tissue is to be removed, this should be toward the patient's left in order to avoid the region of the bundle of His'.

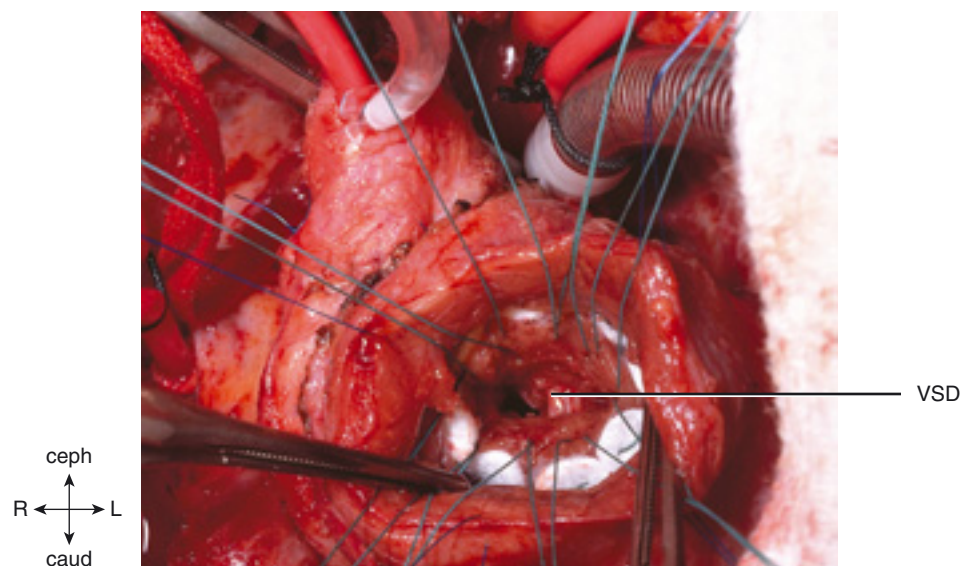


FIGURE 14-26. Multiple felted mattress sutures are placed around the right ventricular surface of the VSD.

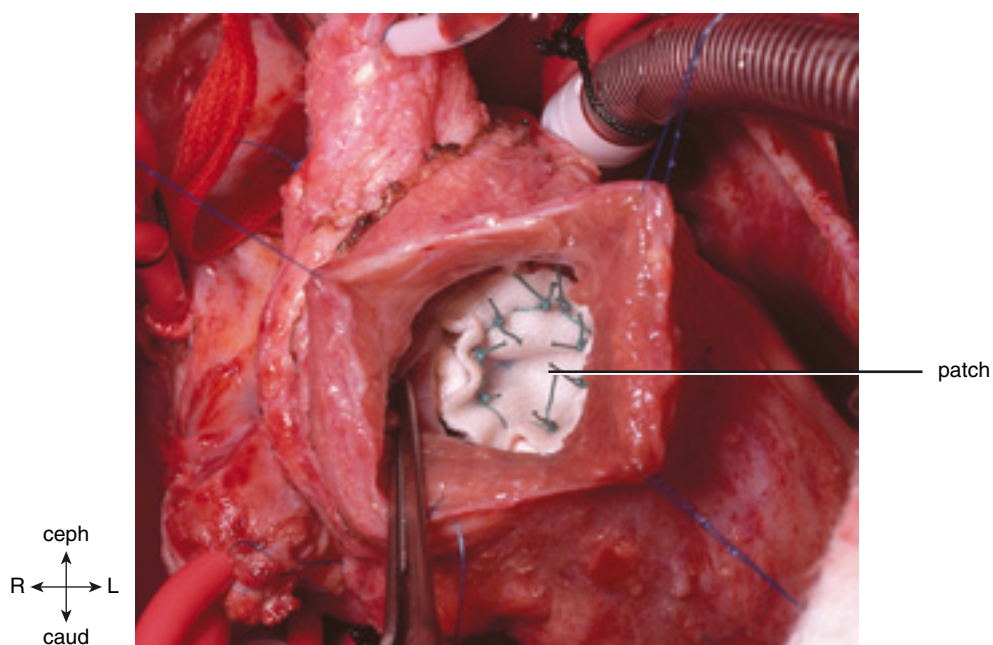
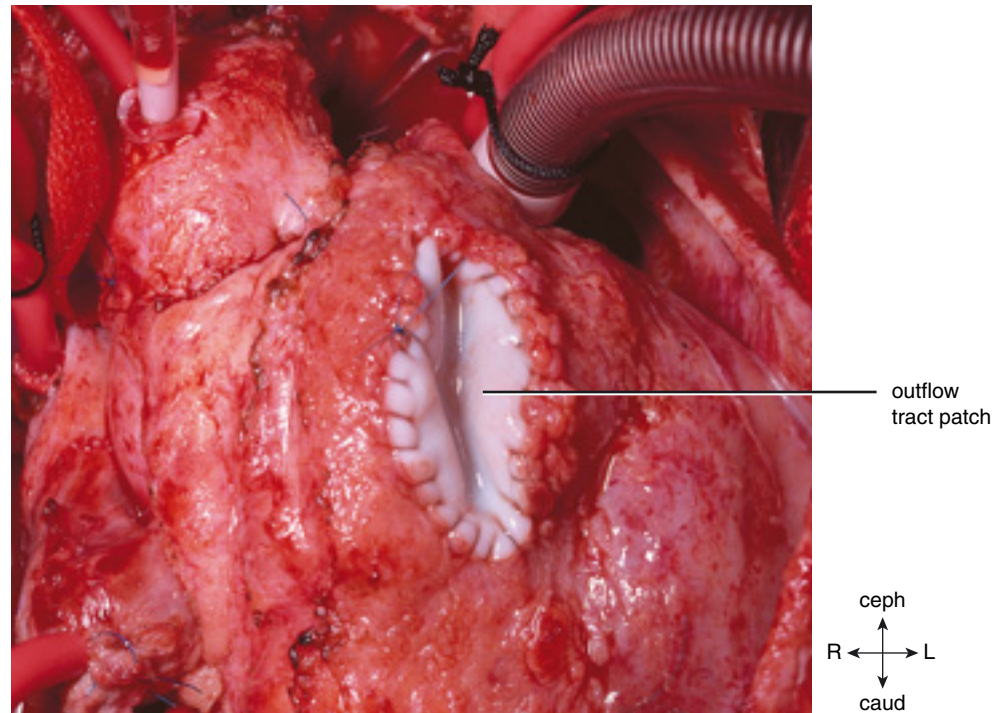


FIGURE 14-27. A Dacron® patch is used to close the VSD positioning the patch on the right ventricular surface of the septum.

FIGURE 14-28. The right ventriculotomy is closed with a tissue patch to enlarge the right ventricular tract; the aortotomy has been closed.



14-4. Supravalvar Stenosis

In the presence of this anomaly, there is usually a severe stenosing ring, at or immediately above the aortic valve commissures. A simple incision across the area of stenosis with patch angioplasty is often inadequate to relieve the obstruction. The stenosing ring must be incised into at least two sinuses of Valsalva. Three effective repair techniques are described.

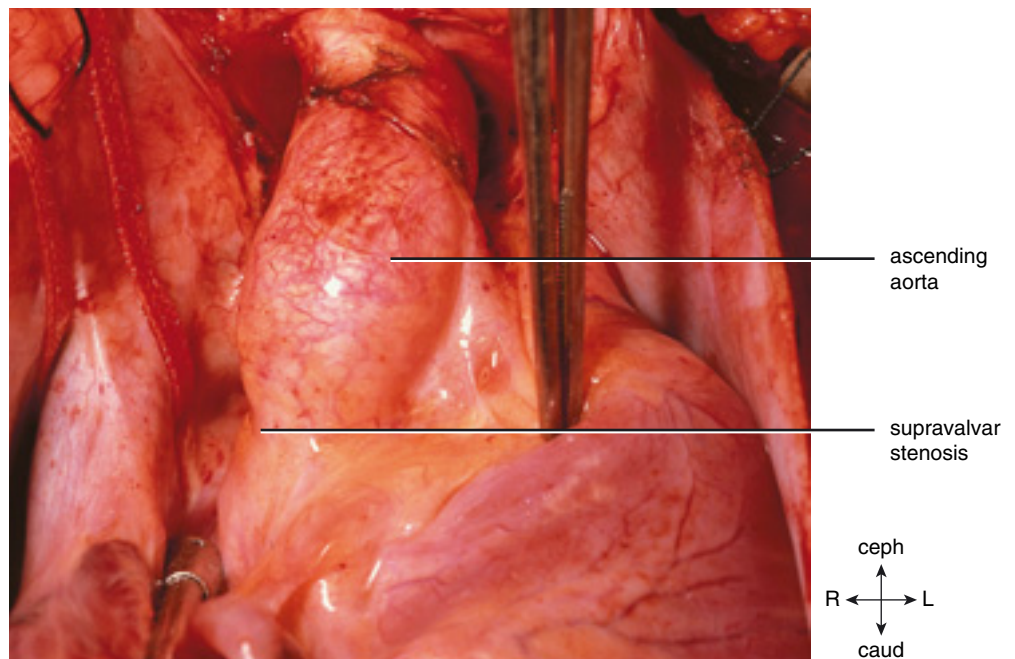


FIGURE 14-29. An external view of the heart shows the narrow proximal ascending aorta at the site of supravalvar stenosis.

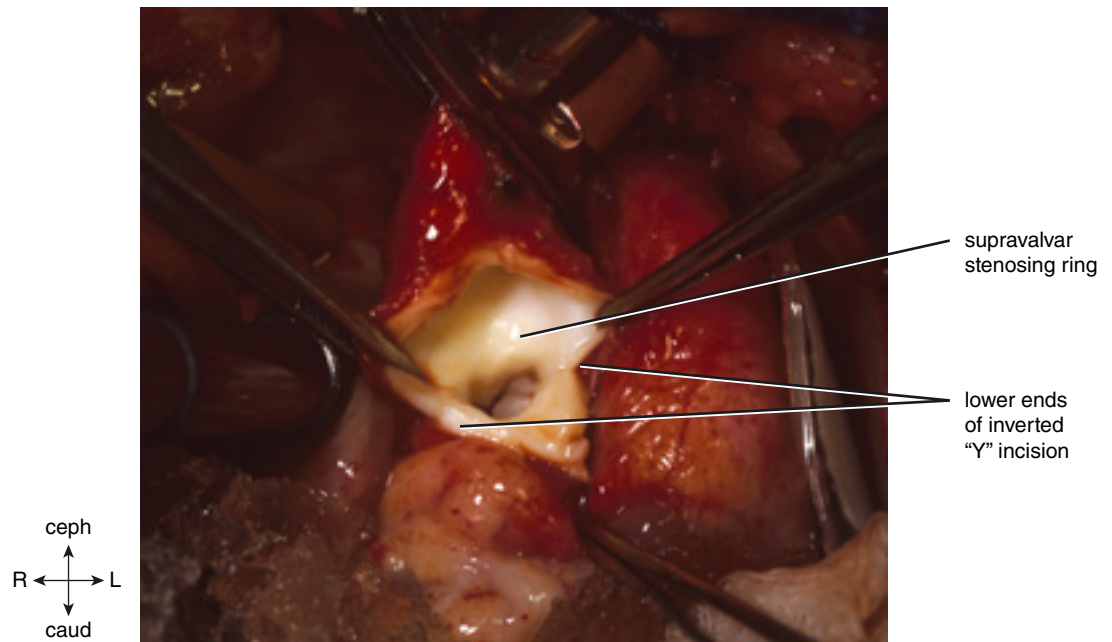


FIGURE 14-30. After the cardiopulmonary bypass is established, with moderate hypothermia, aortic cross-clamping, cardioplegic arrest, and profound local cooling, an inverted Y incision is made in the ascending aorta. The stenosing supravalar ring is seen.

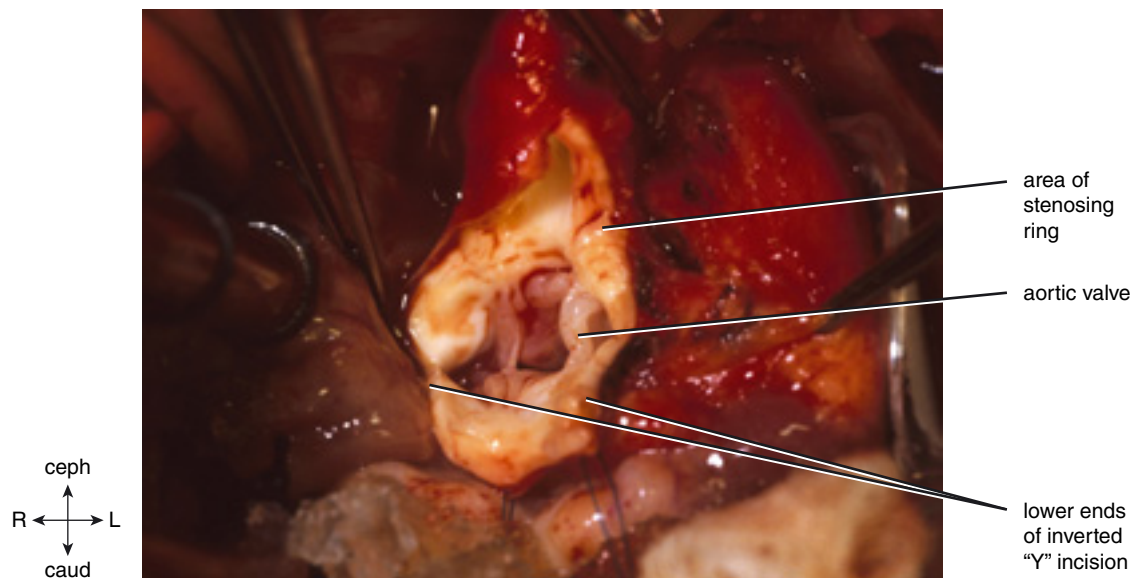


FIGURE 14-31. The lower ends of the inverted Y incision are extended into the sinuses of Valsalva of the noncoronary and right coronary cusps, respectively.

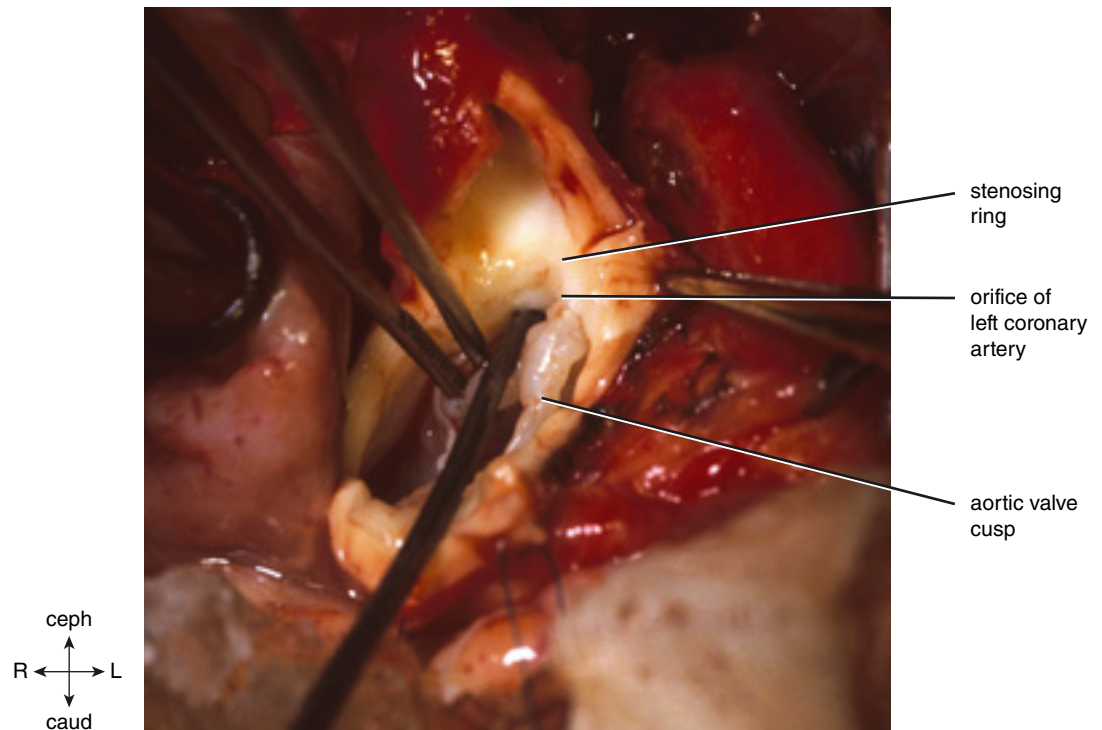


FIGURE 14-32. The root of the aorta is exposed after completing the inverted Y incision. The stenosing supra-aortic ring is immediately above the valve commissures. Normal valve leaflets are seen, and the orifice of the left coronary artery is located just beneath the ring. In some cases coronary stenosis occurs when fibrous tissue compromises the orifice.



FIGURE 14-33. A synthetic patch is tailored so that the lower points of the patch will fit in the opened sinuses of Valsalva.

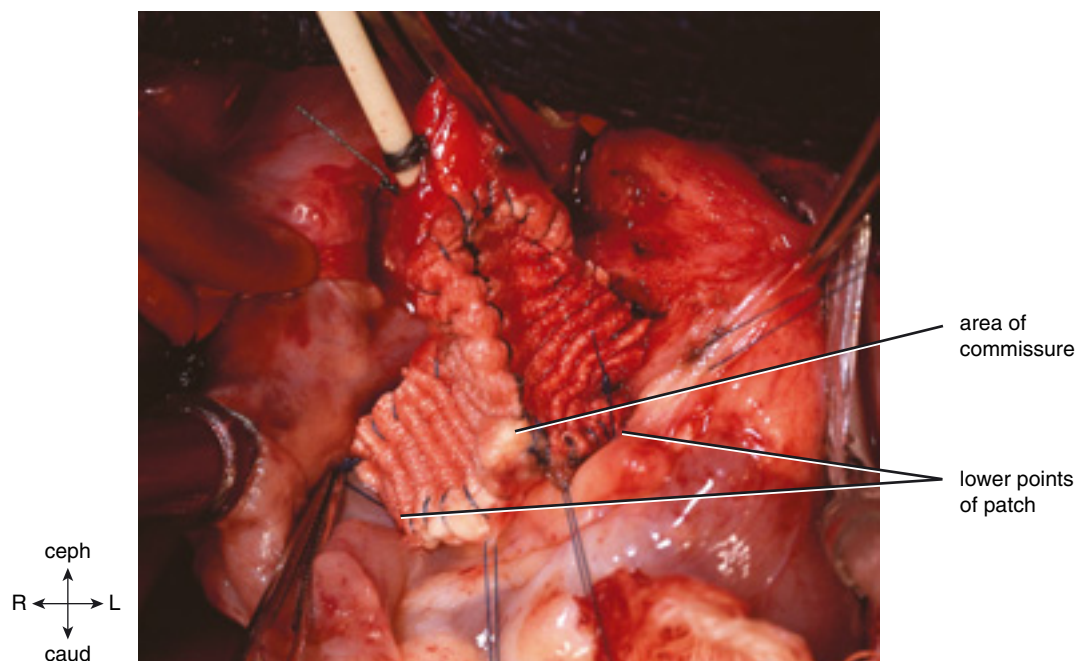


FIGURE 14-34. The completed repair is seen after the patch is stitched in place with a continuous suture.

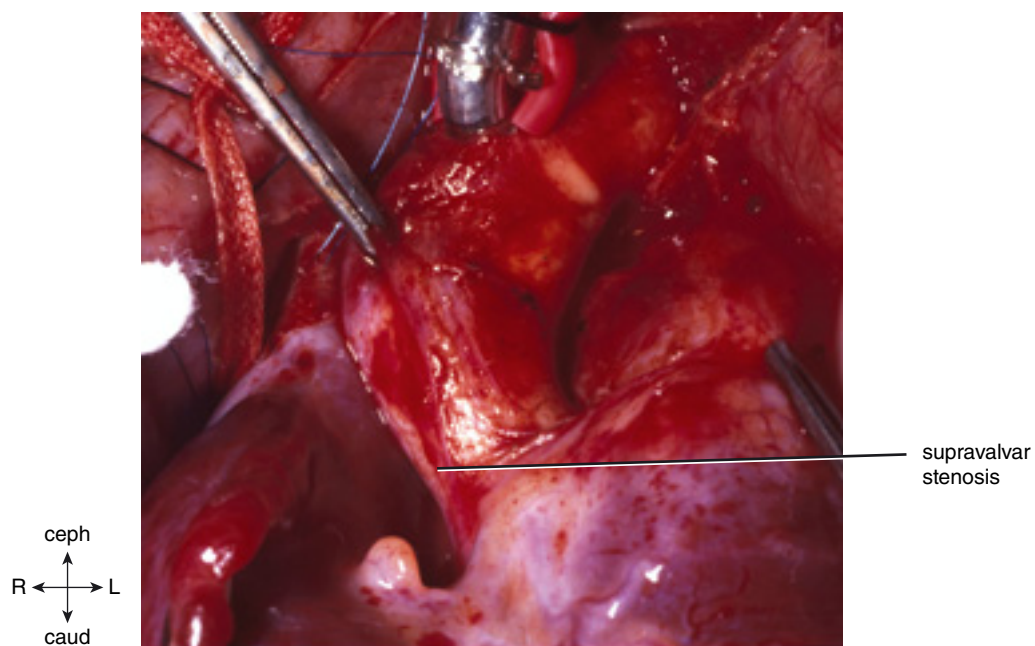


FIGURE 14-35. In another baby who has been placed on cardiopulmonary bypass, the area of supravulvar stenosis is in the typical position at the sino-tubular junction.

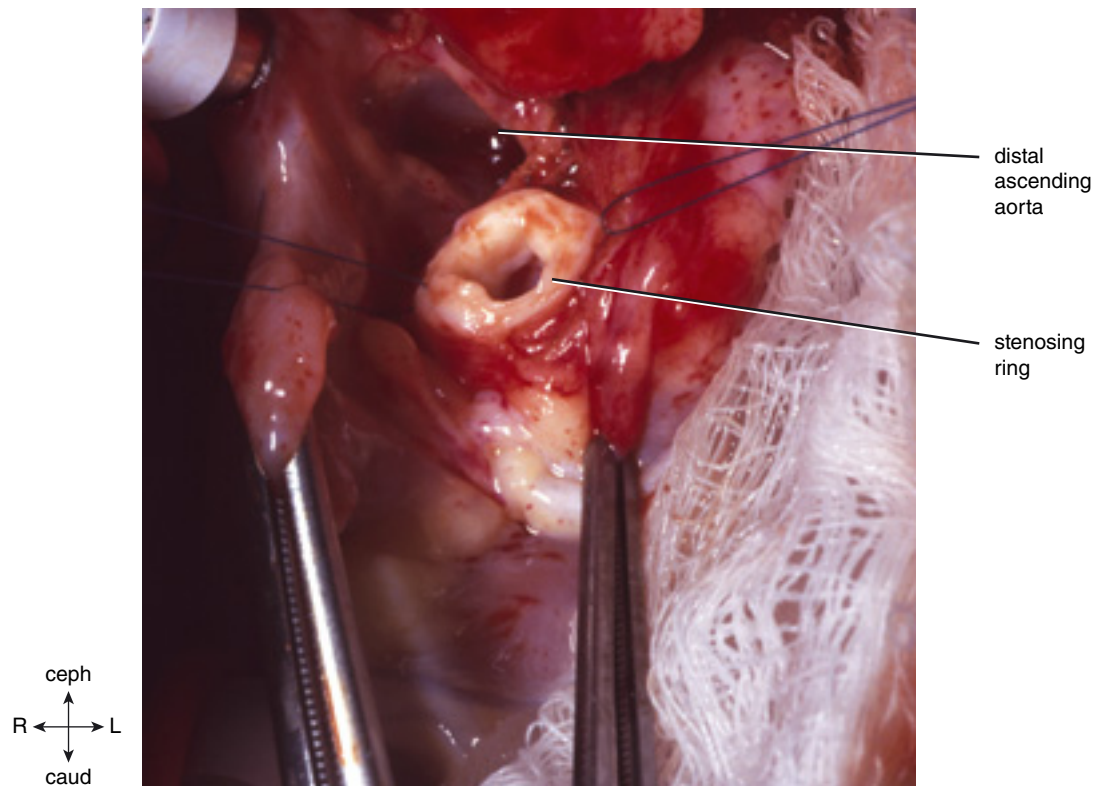


FIGURE 14-36. The ascending aorta is divided at/or immediately above the stenosing ring. Care must be taken to avoid injury to the coronary artery orifices, which are below the ring.

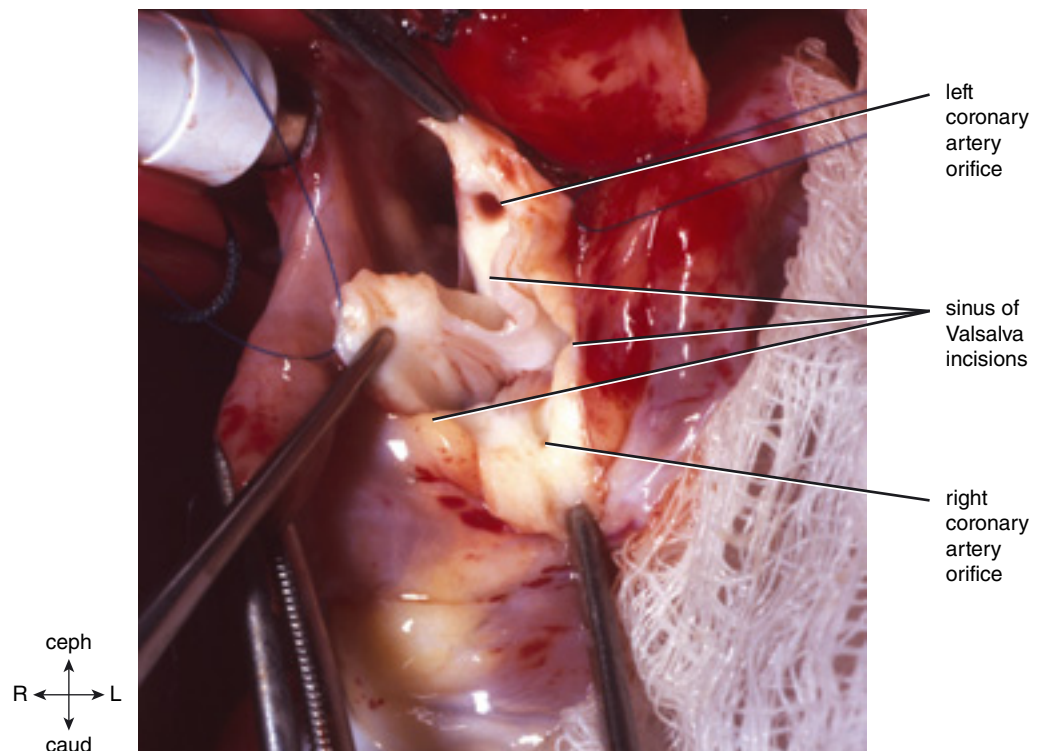


FIGURE 14-37. Incisions are made in each of the three sinuses of Valsalva from the ring to near the annulus. The proximity of the coronary artery orifices is seen.

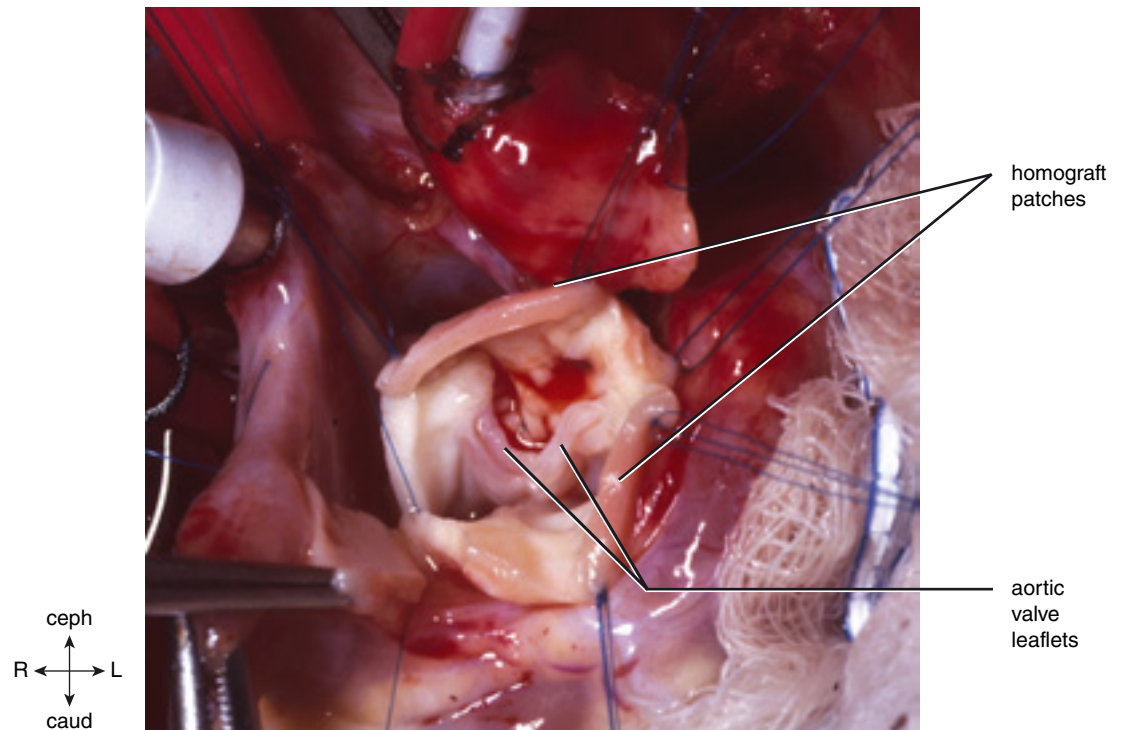


FIGURE 14-38. Triangular-shaped tissue patches of homograft pulmonary wall are stitched over incisions in the left and right coronary cusp sinuses. The noncoronary cusp sinus remains open and a patch will be placed here to complete this part of the repair.

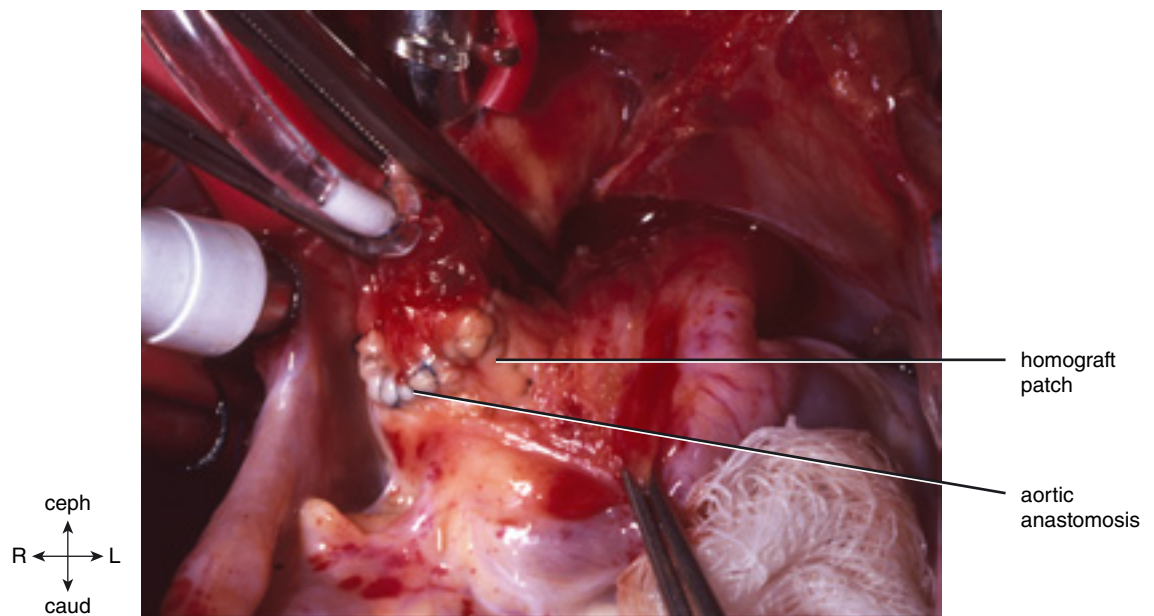


FIGURE 14-39. A direct end-to-end anastomosis is performed between the two aortic segments. Counter incisions in the upper aorta may be required due to the disparity in diameter of the two segments caused by adding the homograft patches.



FIGURE 14-40. In another infant, after establishing cardiopulmonary bypass with aortic clamping, cardioplegia, and profound local cooling, the supravalar stenosis is seen at the sinotubular junction.

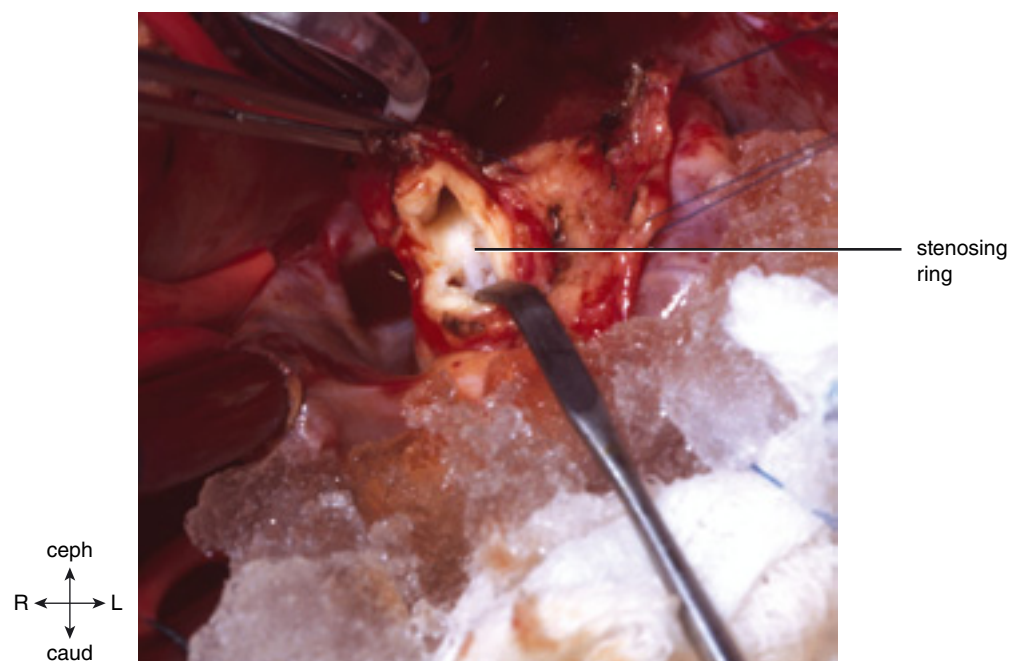


FIGURE 14-41. The ascending aorta has been widely dissected including the arch for mobility because the anastomosis will shorten the ascending aorta. Here, it is divided immediately above the stenotic ring. Care must be taken to avoid injury to the coronary arteries, which originate below the ring.

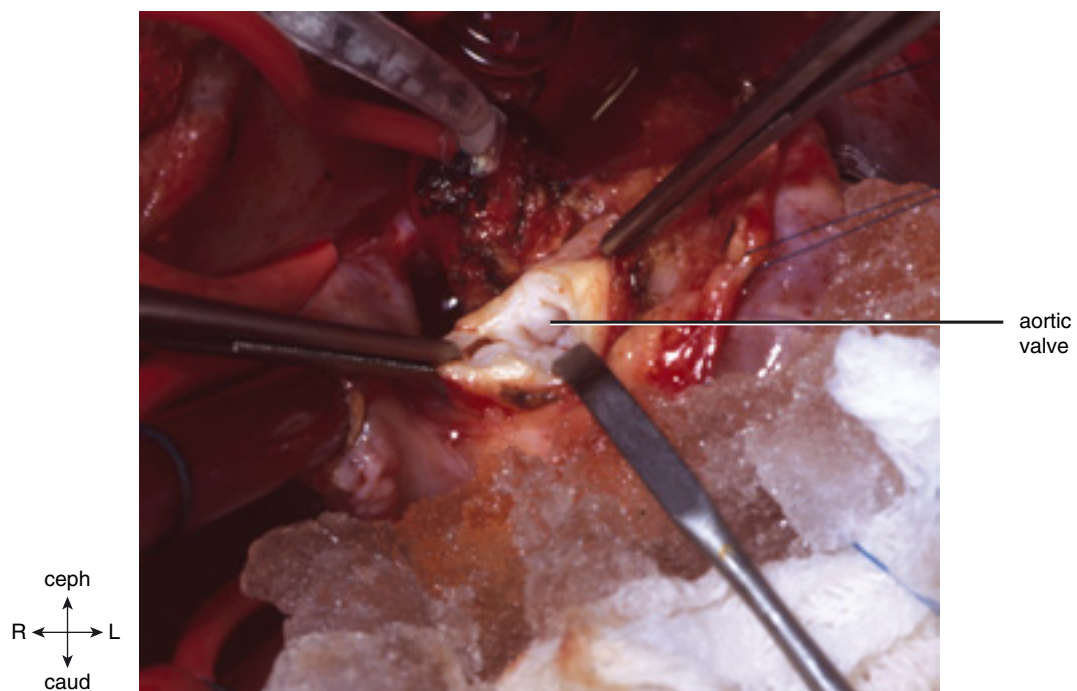


FIGURE 14-42. The ring is retracted to expose normal aortic valve leaflets and to view the coronary artery orifices.



FIGURE 14-43. Incisions are made from the ring into each sinus of Valsalva to near the aortic valve annulus.

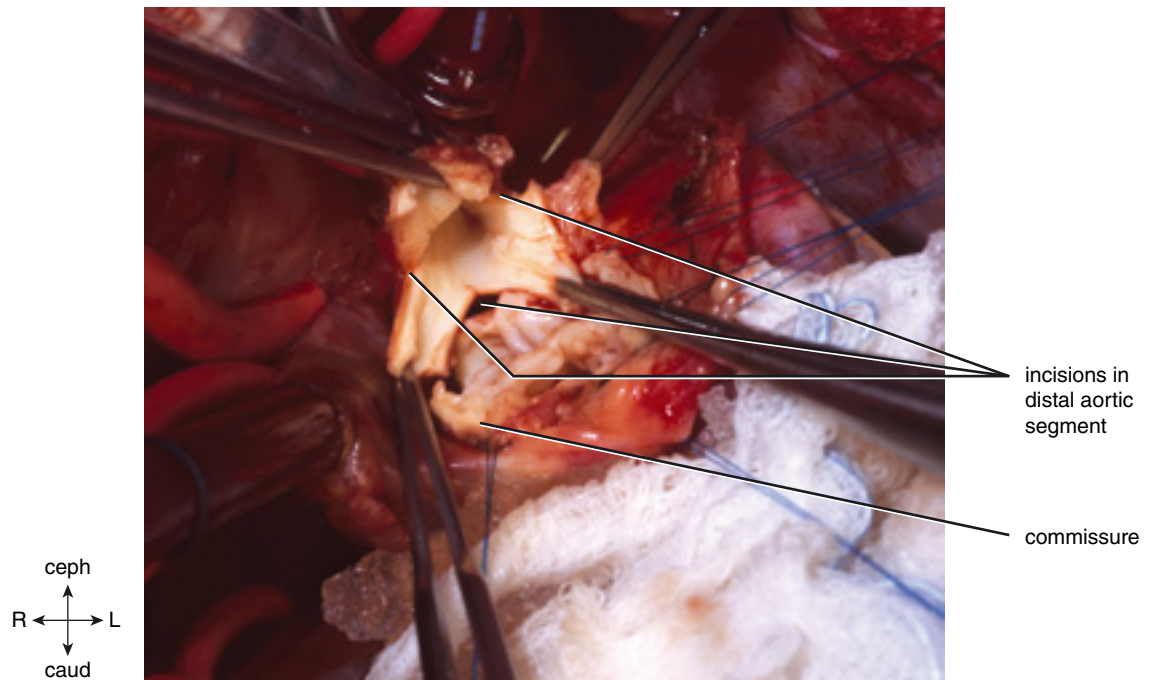


FIGURE 14-44. Longitudinal counter incisions are made in the upper aortic segment, each being opposite an aortic valve commissure.

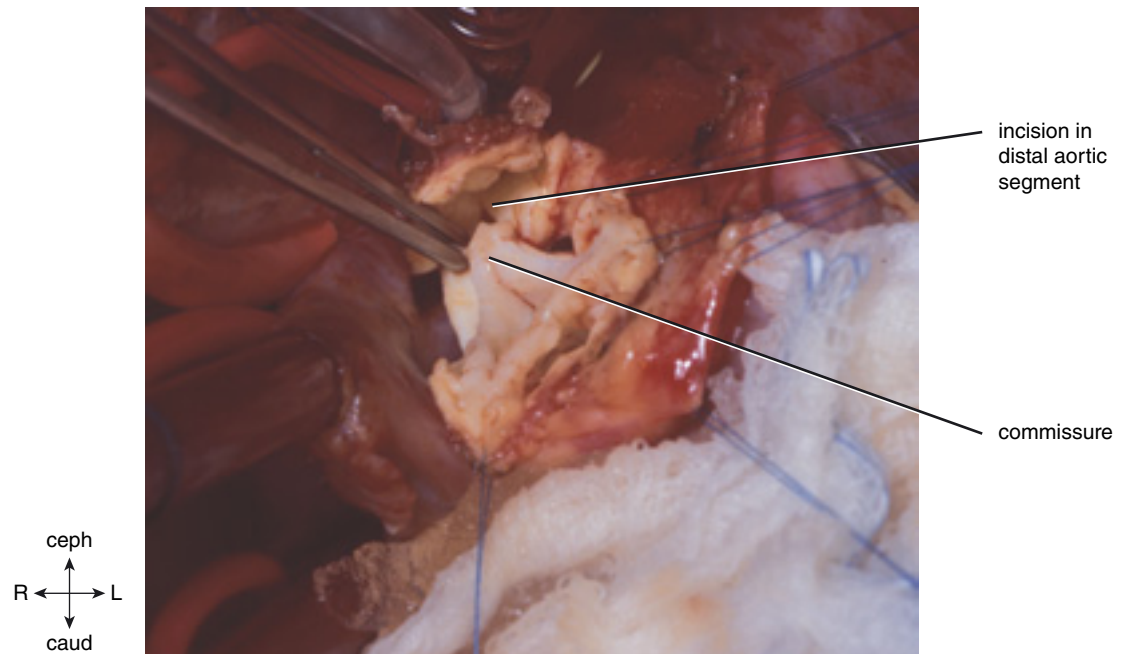


FIGURE 14-45. Each commissure will fit in an adjacent upper aortic longitudinal incision.

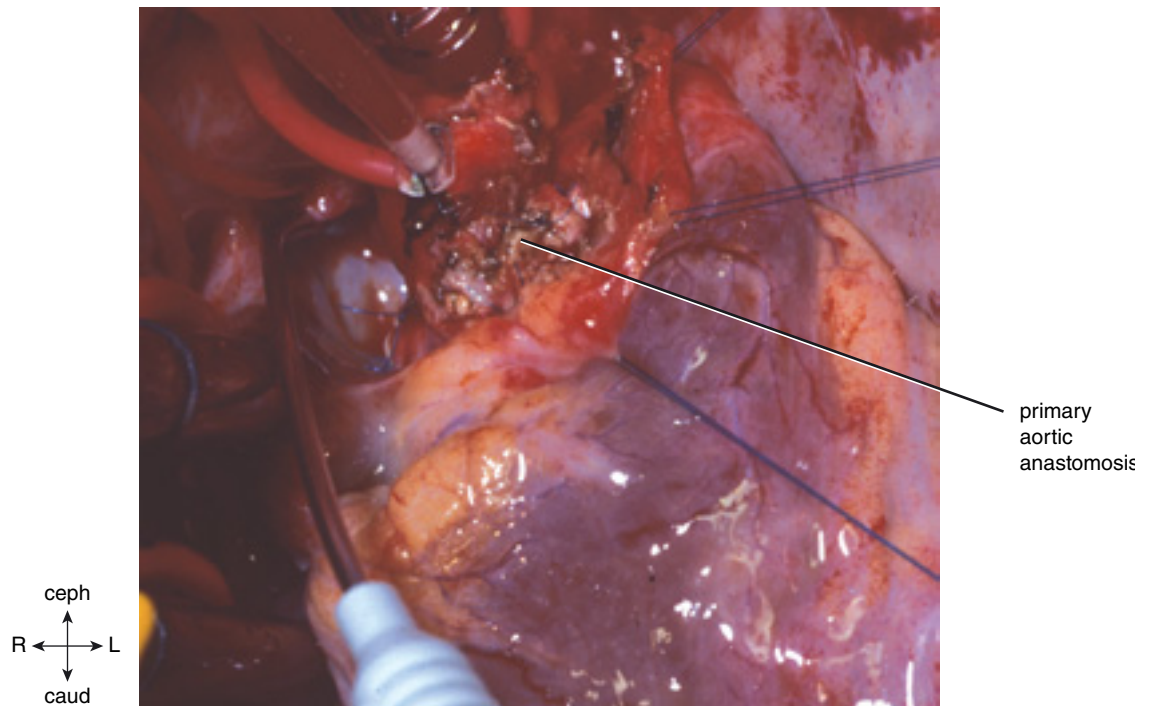


FIGURE 14-46. A direct end-to-end anastomosis is performed between the two aortic segments. With such, the area of previous stenosis has been opened widely by the incisions into each aortic segment.

14-5. Aortic Root Enlargement Procedures

14-5-1. Posterior Root Enlargement

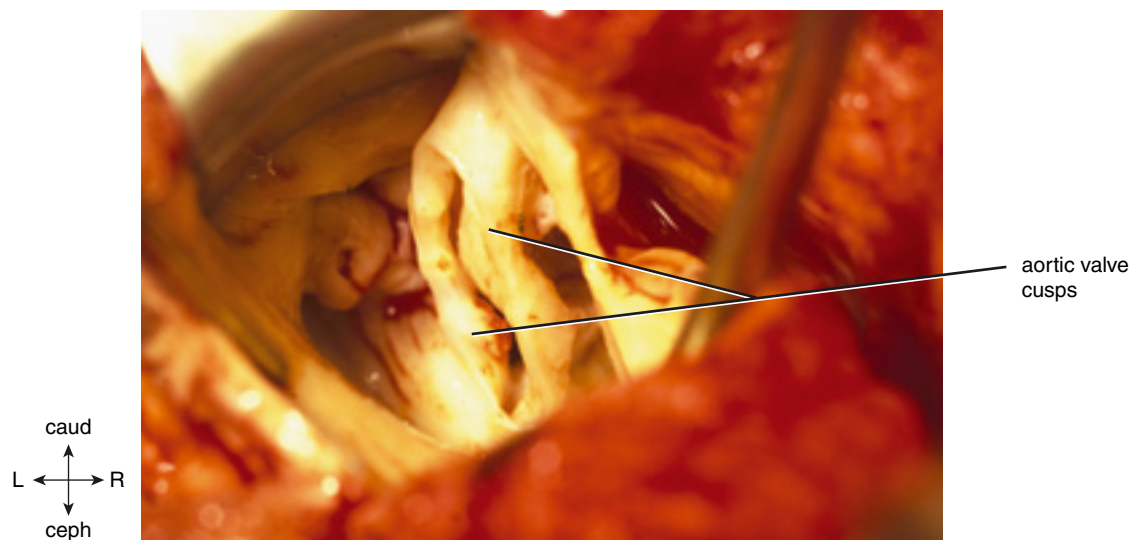


FIGURE 14-47. With cardiopulmonary bypass, aortic clamping, and cardioplegia with profound local cardiac cooling, a proximal ascending aortotomy is made. A bicuspid stenotic and dysplastic valve is seen. After it is determined that valvuloplasty is not possible, the valve leaflets are excised.

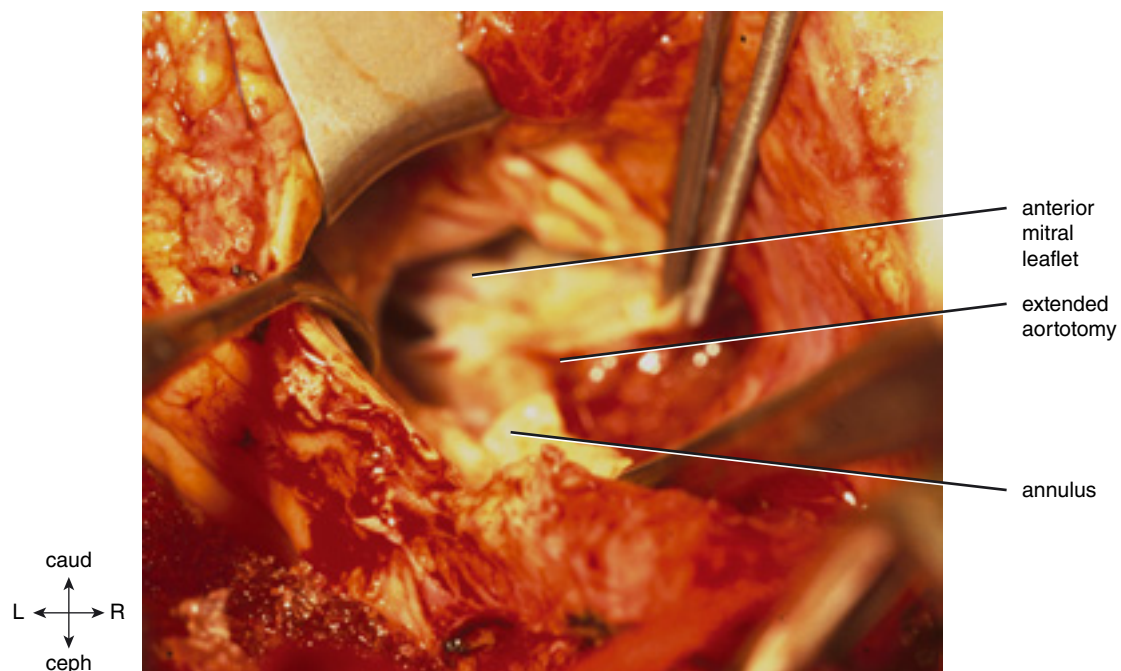


FIGURE 14-48. The aortotomy is extended caudad and posteriorly through the valve annulus to the base of the anterior mitral leaflet. With this technique, the annulus can be enlarged by up to 4 to 5 mm.

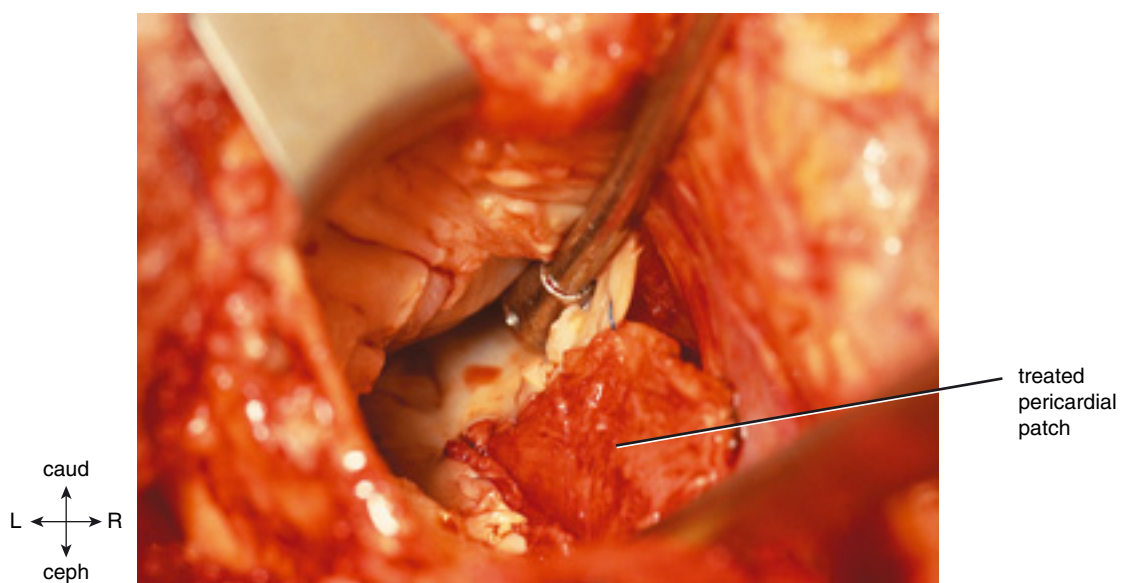


FIGURE 14-49. Glutaraldehyde-treated pericardium is stitched over the lower aortotomy extension.

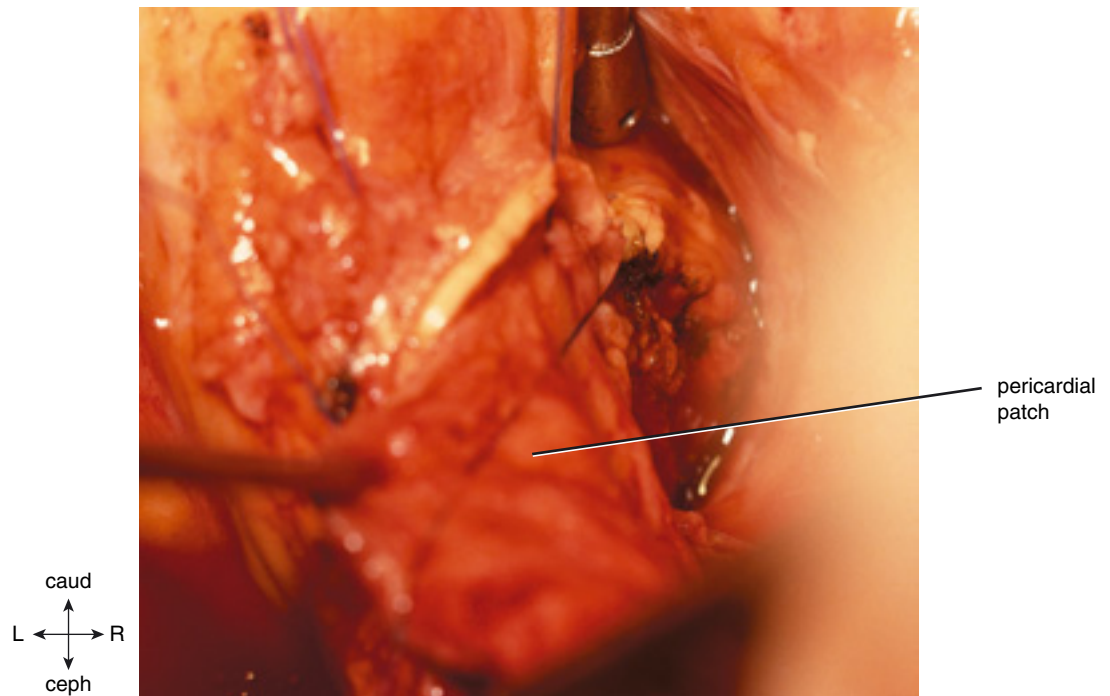


FIGURE 14-50. The pericardial patch is retracted anteriorly and seen from outside the aorta.

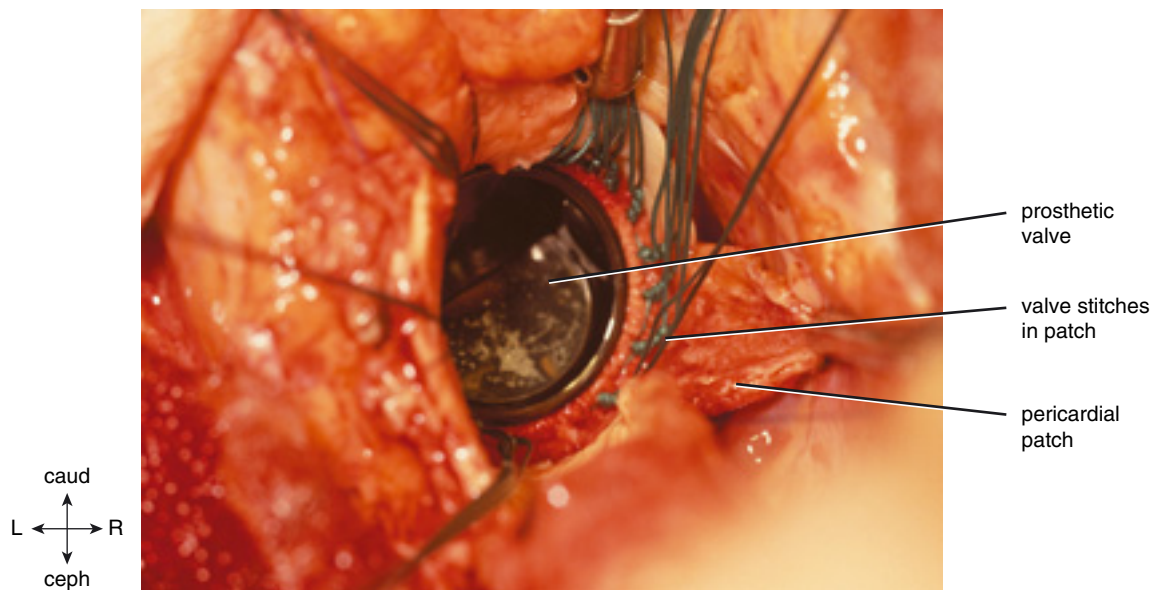


FIGURE 14-51. A prosthetic valve is implanted at the level of the native aortic valve annulus, and the pericardial patch now comprises part of that annulus. To complete the repair, the remaining pericardial patch is stitched over the aortotomy.

14-5-2. Konno Procedure with a Prosthetic Valve

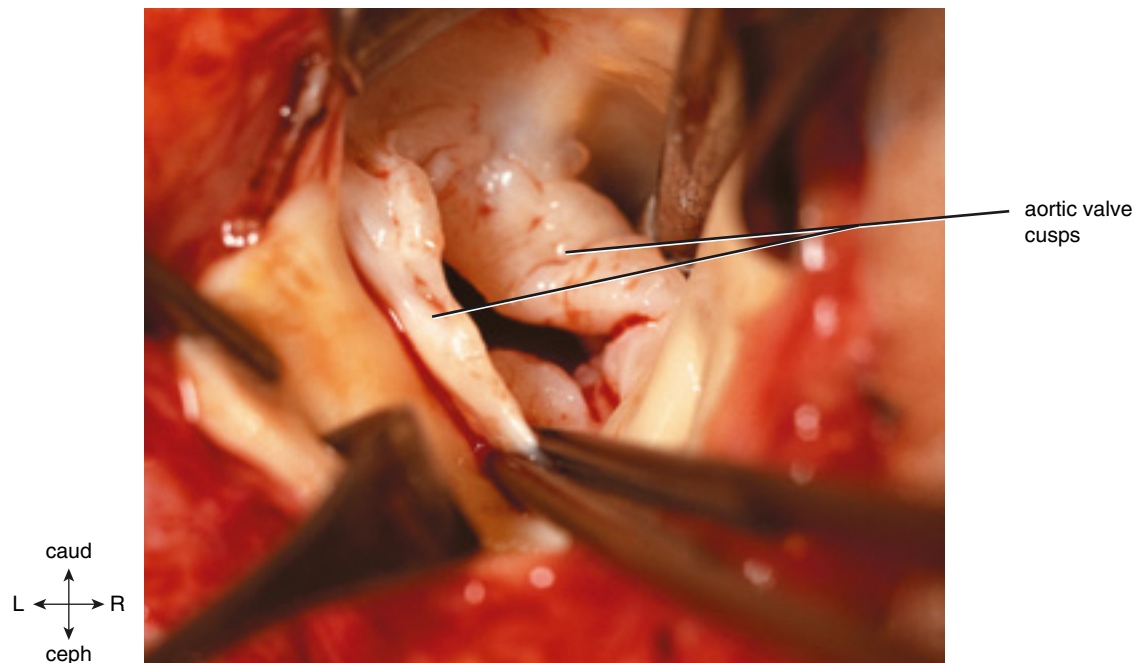


FIGURE 14-52. The aortotomy is made in a longitudinal direction and to the left of the right coronary artery orifice. The severely scarred valve cusps are beyond repair, and it is decided to proceed with valve replacement and anterior root enlargement.

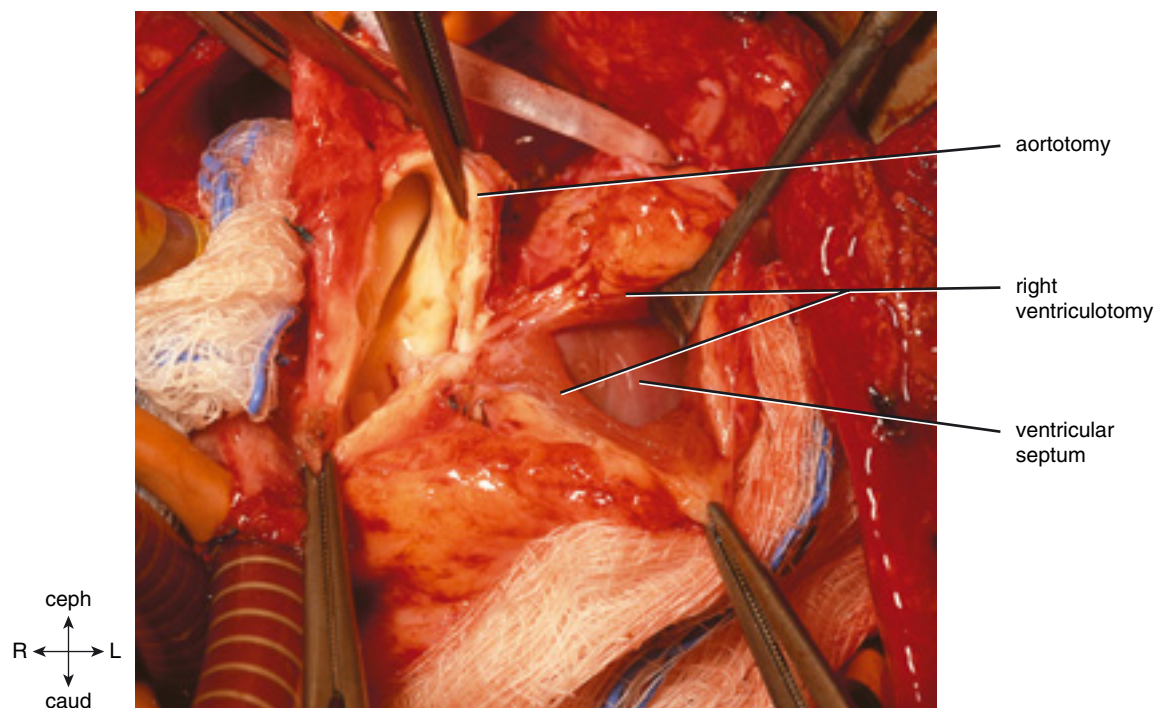


FIGURE 14-53. An adjacent incision is made in the anterior wall of the right ventricular outflow tract to expose the septum.

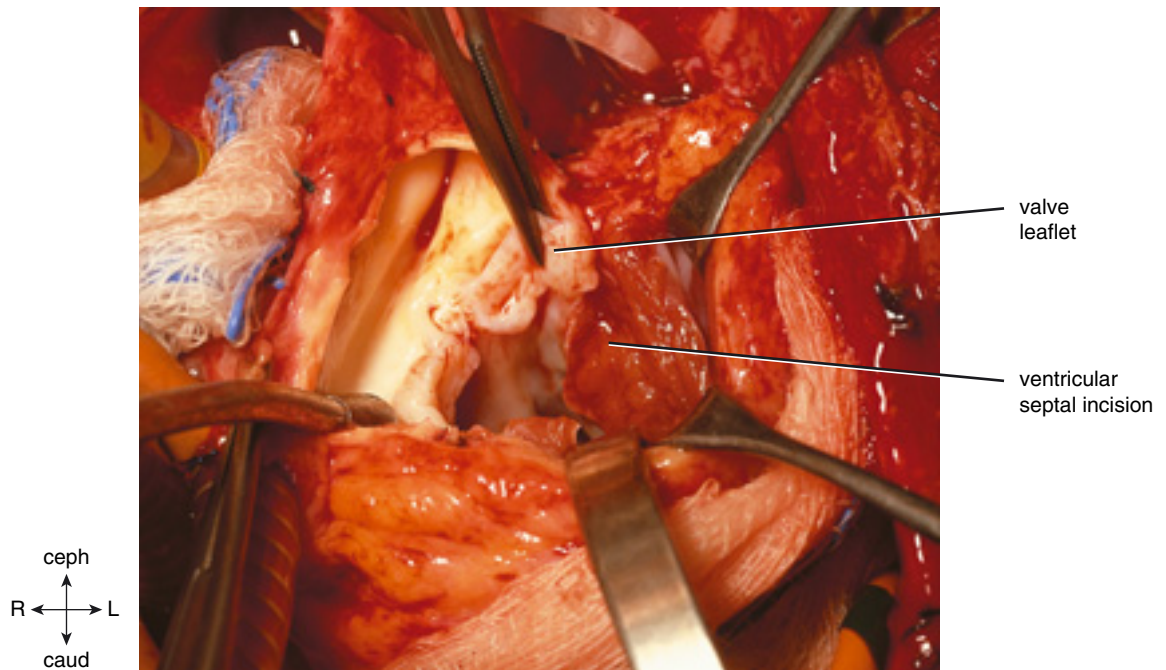


FIGURE 14-54. The aortic valve annulus is incised by working to the left of the right coronary orifice. The incision extends into the upper part of the ventricular septum cephalad to the His' bundle. Valve leaflets are excised in preparation for valve replacement.



FIGURE 14-55. A woven Dacron® patch is tailored to conform to the iatrogenic VSD and adjacent aortotomy. The lower part of the patch is placed over the VSD with interrupted felted mattress sutures, placing the patch on the left ventricular surface of the septum.

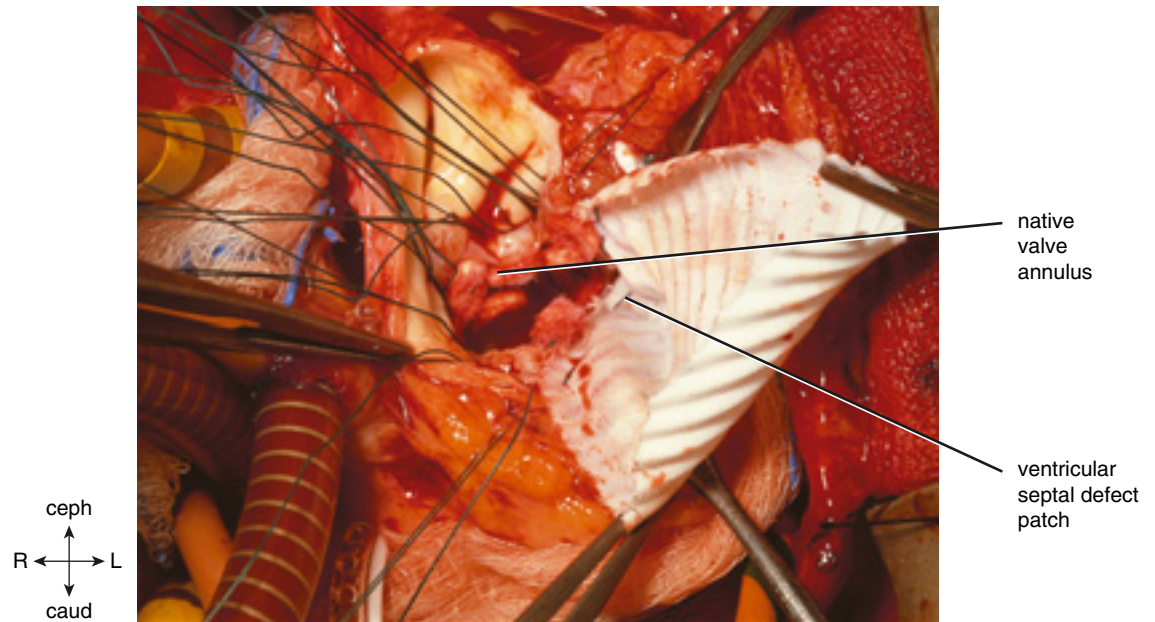


FIGURE 14-56. The patch is retracted anteriorly and interrupted valve sutures are placed in the native valve annulus. Additional anterior valve sutures pass through the patch.

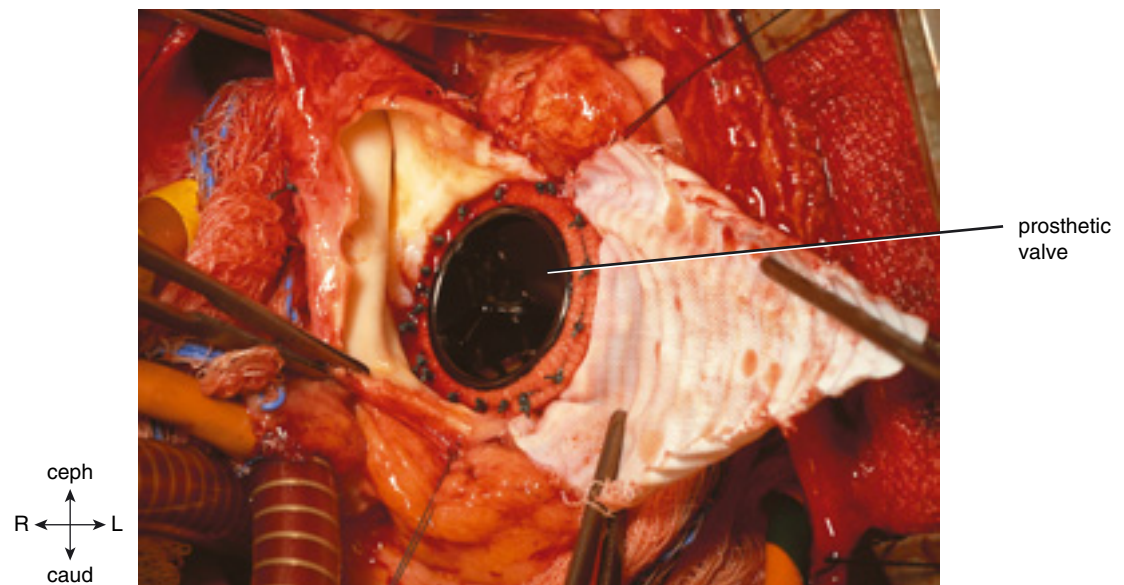


FIGURE 14-57. After the valve orifice is sized, an appropriate prosthetic valve is stitched in place in the subcoronary position. At least 60% of the valve annulus should be placed in the native annulus. Significant enlargement of the left ventricular outflow tract is accomplished, allowing for placement of a larger prosthesis.

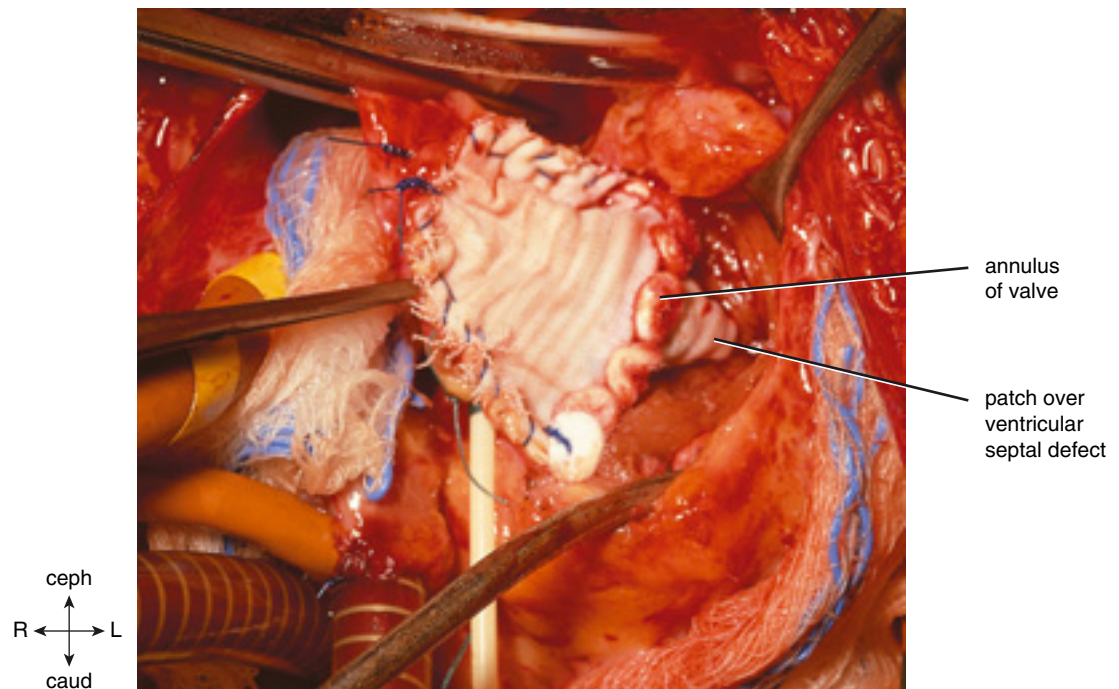


FIGURE 14-58. The upper segment of the Dacron® patch is stitched to the aortotomy with a continuous suture. Felt pledgets of valve sutures are seen and the repaired VSD is caudad to the valve annulus.

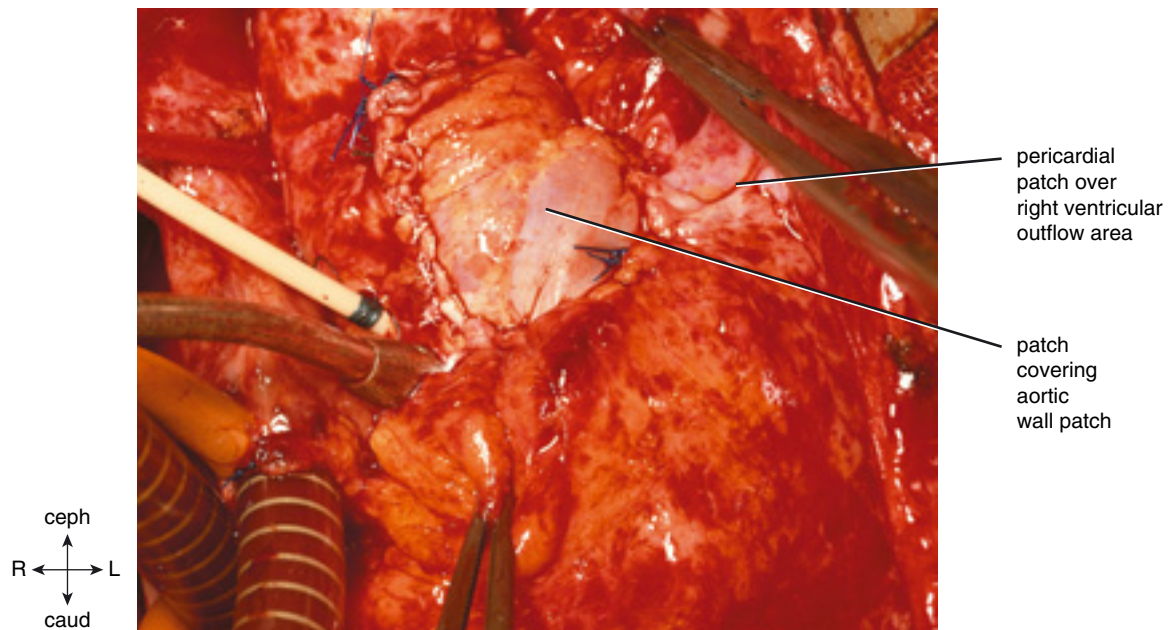


FIGURE 14-59. A pericardial patch is stitched over the right ventriculotomy and extends in continuity across the surface of the Dacron® patch. Blood that leaks from the Dacron® patch is collected beneath the pericardial patch and drains to the right ventricle.

14-5-3. Konno Procedure with a Homograft Valve

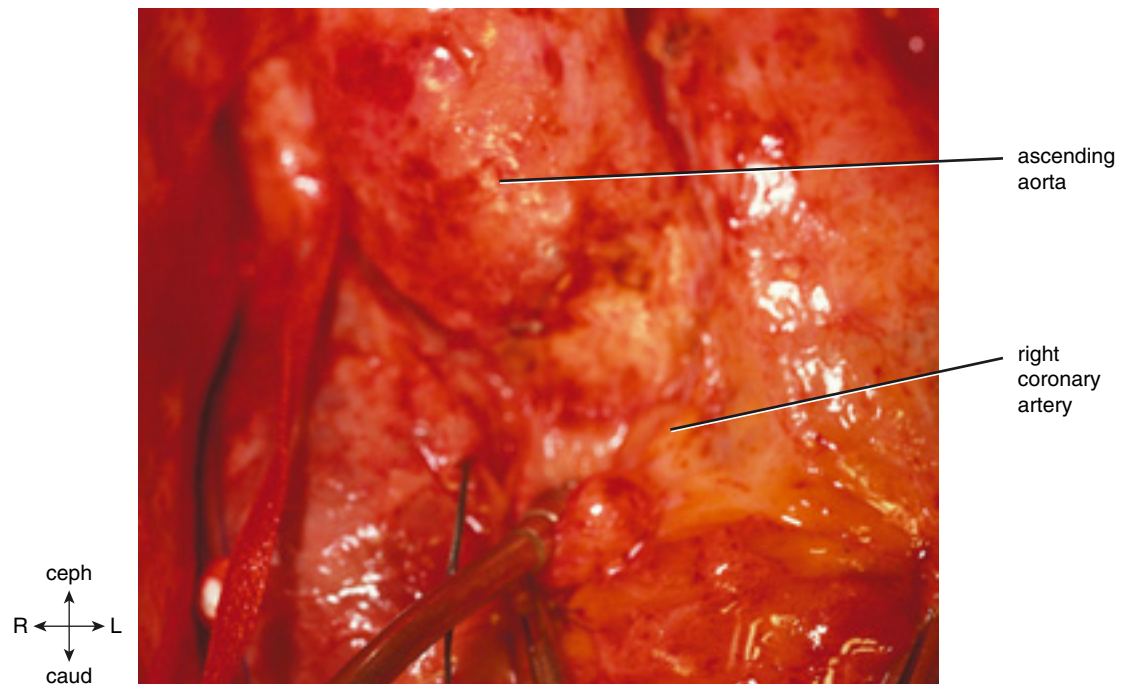


FIGURE 14-60. The right coronary artery is in the usual anterior aortic root location.

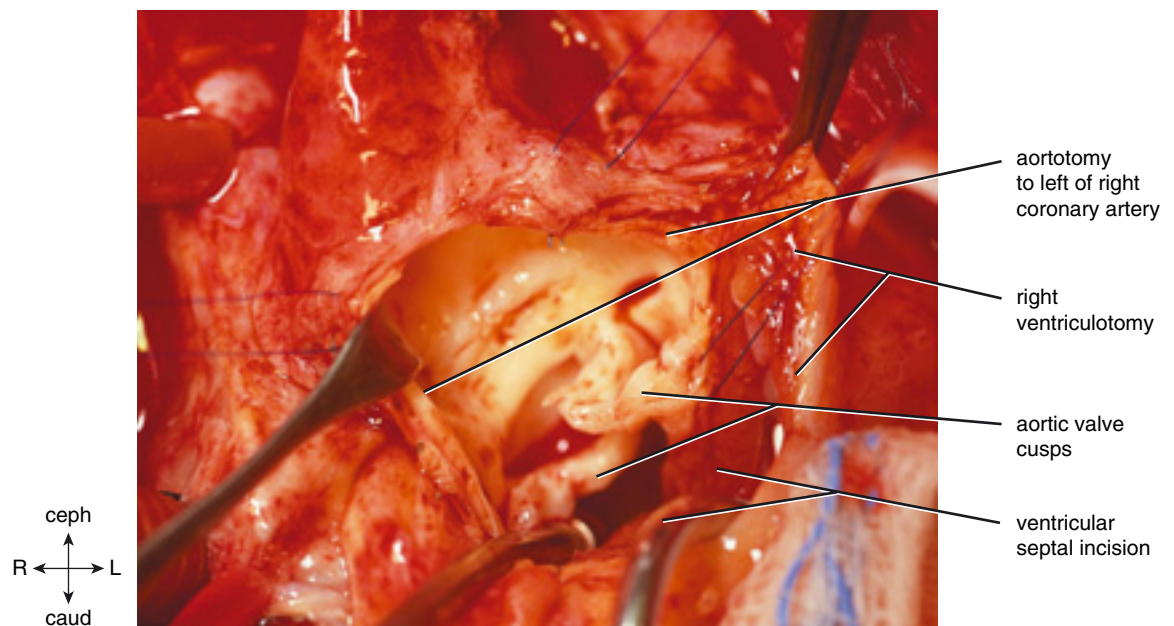


FIGURE 14-61. A longitudinal incision in the proximal aorta is directed to the left of the right coronary artery orifice. An adjacent right ventriculotomy is made, and the aortic valve annulus is incised, extending this incision into the ventricular septum.

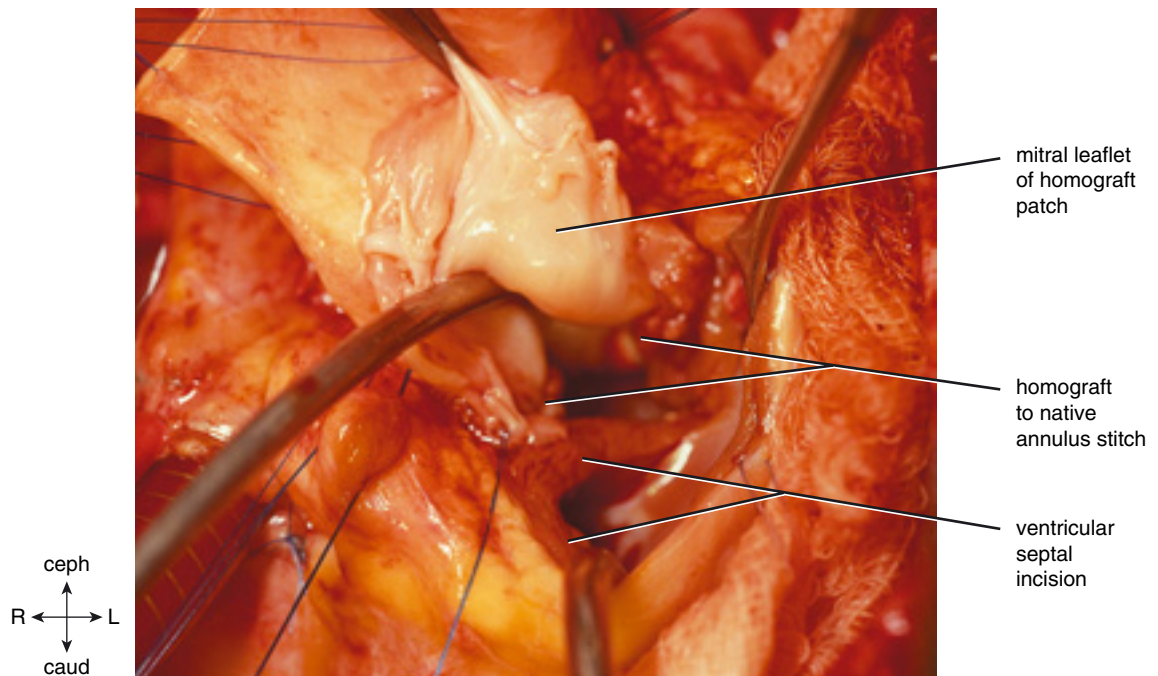


FIGURE 14-62. Native aortic valve cusps are excised. An aortic valve homograft is tailored, leaving a large patch of homograft wall anteriorly. The homograft is positioned so that its mitral leaflet is located anteriorly. The homograft is stitched to the native valve annulus with a continuous monofilament suture, placing this stitch immediately below the homograft valve annulus.

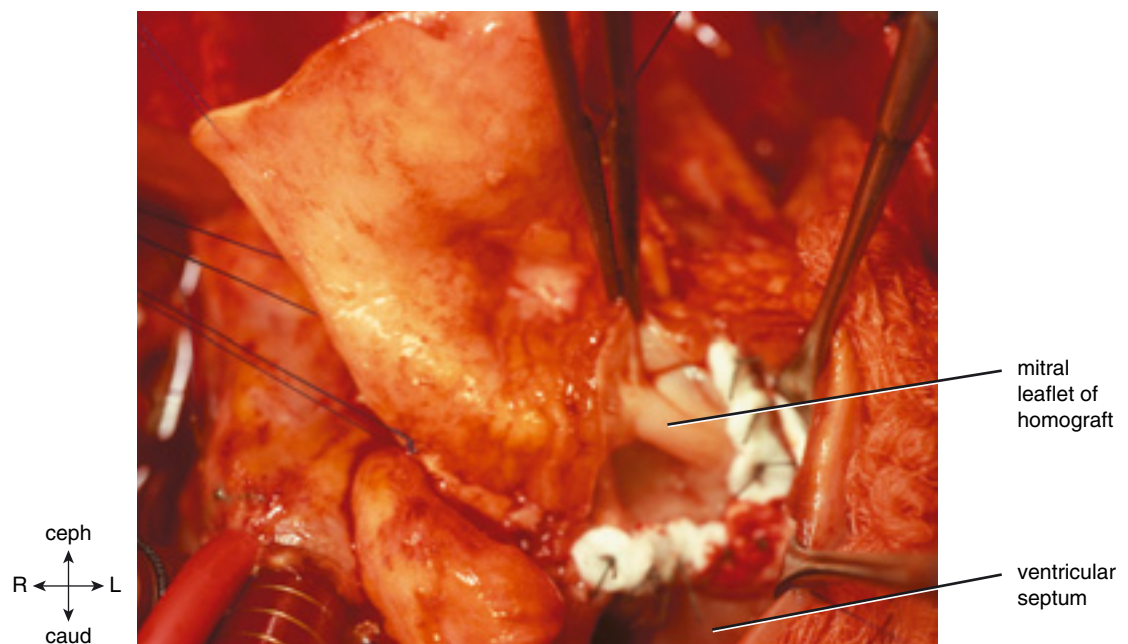


FIGURE 14-63. The homograft mitral leaflet is used to close the VSD with interrupted felted mattress sutures. These stitches are passed from the left ventricular surface of the septum and then through the adjacent homograft mitral leaflet. Pledgets are used on both surfaces of the septum.

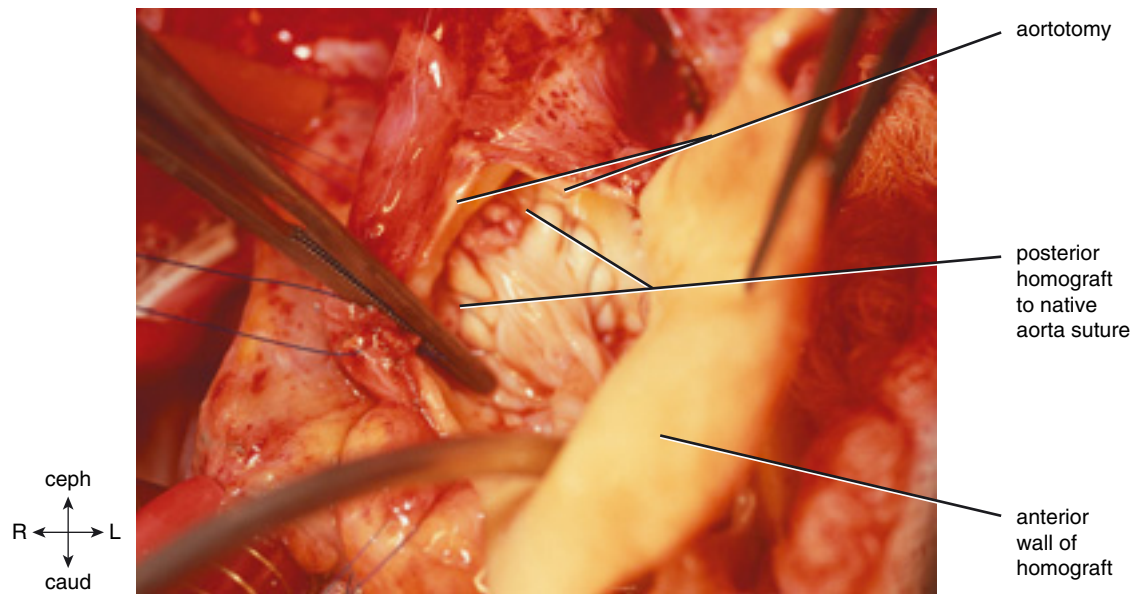


FIGURE 14-64. Homograft aortic wall is removed from two posterior sinuses of Valsalva of the graft. The central homograft commissure is in the midline, and the upper rim of the homograft is stitched to the posterior wall of the native ascending aorta.

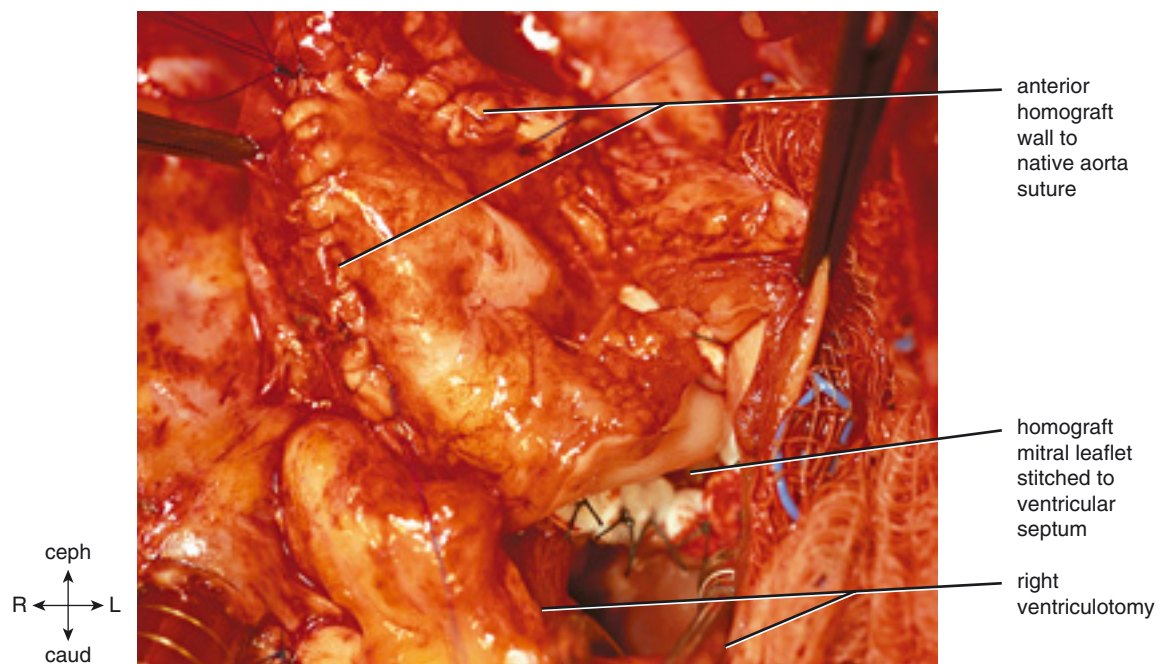


FIGURE 14-65. The anterior homograft aortic wall is stitched to the aortotomy of the native aorta.

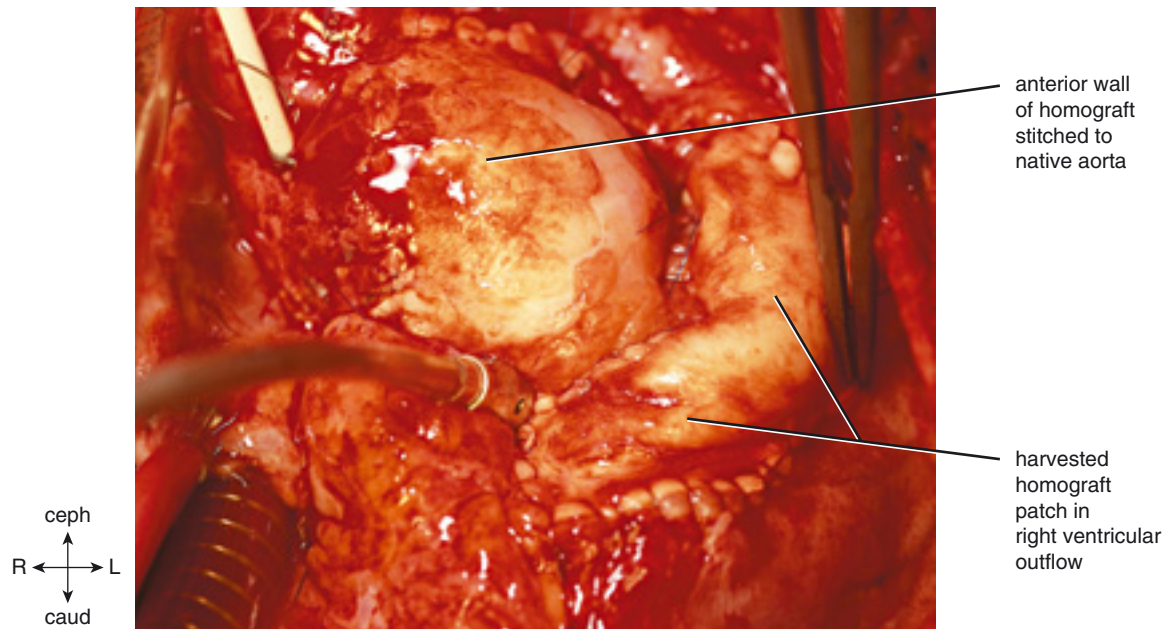


FIGURE 14-66. A homograft aortic wall patch that was harvested in the tailoring process is used to reconstruct the right ventricular outflow tract. The homograft aortic wall patch covers the ventriculotomy and is stitched to the anterior homograft valve annulus.

14-5-4. Ross–Konno Procedure

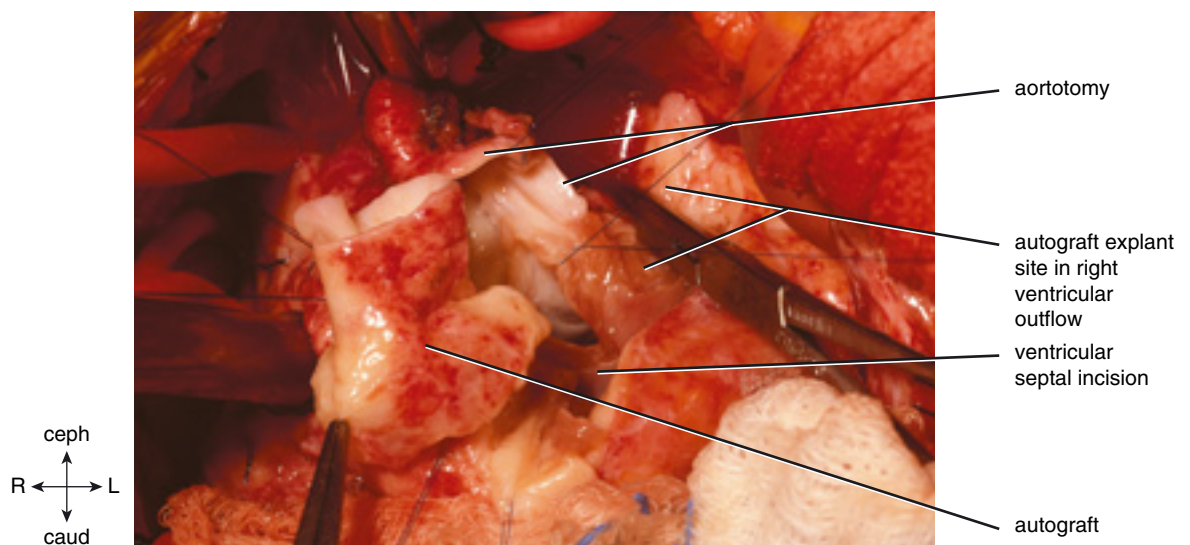


FIGURE 14-67. After establishing cardiopulmonary bypass with moderate hypothermia, aortic clamping, cardioplegic arrest, and profound local cooling, the pulmonary autograft is harvested. The main pulmonary artery has been divided proximal to the branches and the proximal vessel with the valve was harvested from the right ventricle. A circumferential 0.5-cm muscle bar was taken with the graft. Here, the ascending aorta has been opened in a longitudinal direction, extending this excision across the aortic valve annulus into the ventricular septum. This relieves the left ventricular outflow tract obstruction.

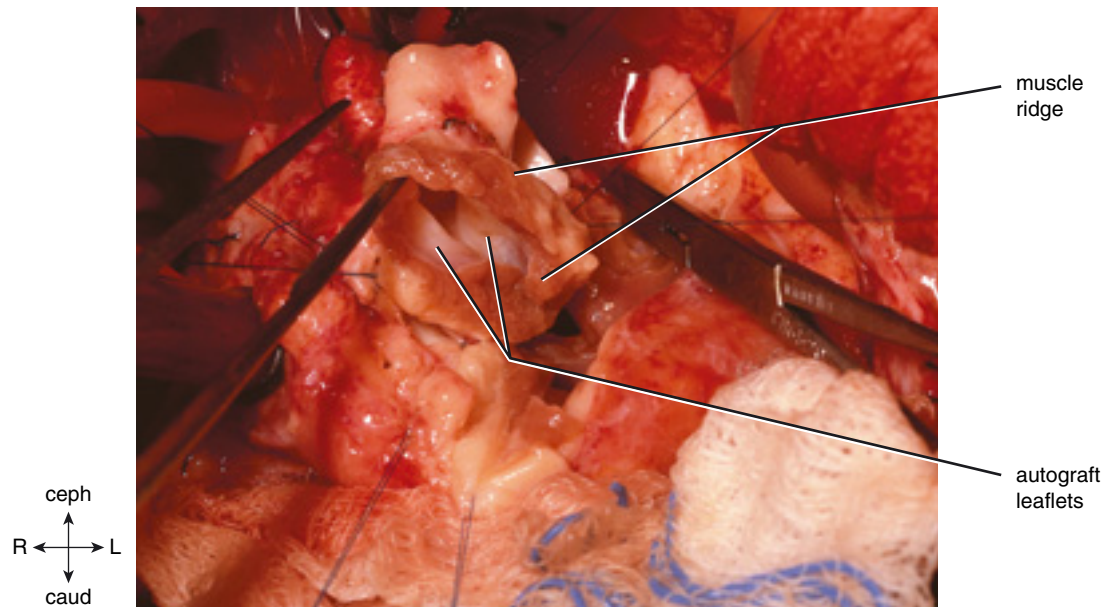


FIGURE 14-68. Prior to implantation, the autograft leaflets are inspected and found to be normal.

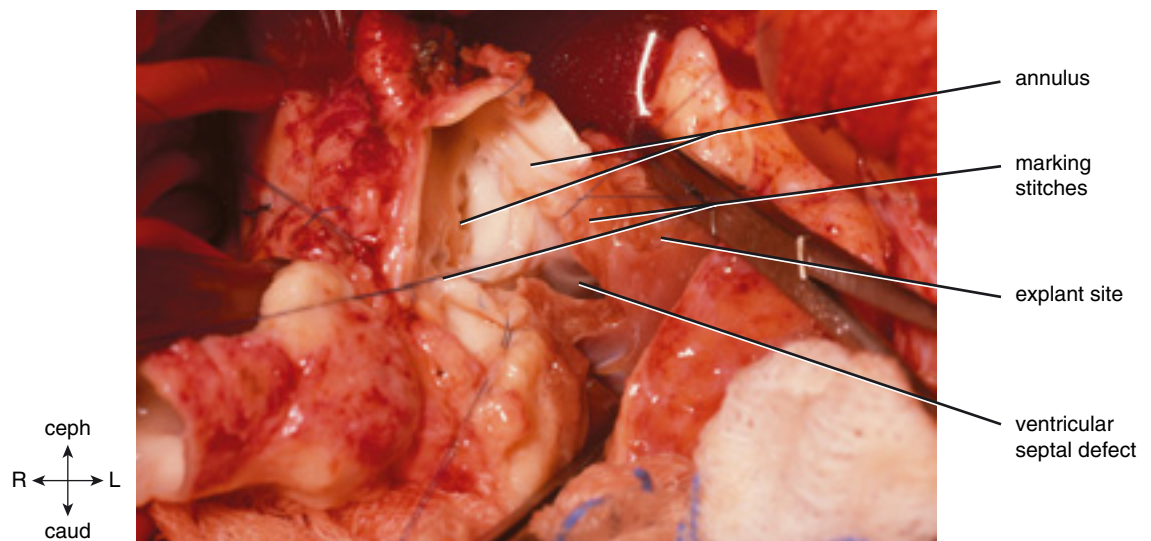


FIGURE 14-69. Aortic valve leaflets are excised, leaving a 1-mm segment of leaflet attached to the native annulus. The new left ventricular outflow tract opening is marked with three trifurcating stitches. These are placed opposite the native sinuses of Valsalva and will be inserted near the middle of each autograft sinus of Valsalva.

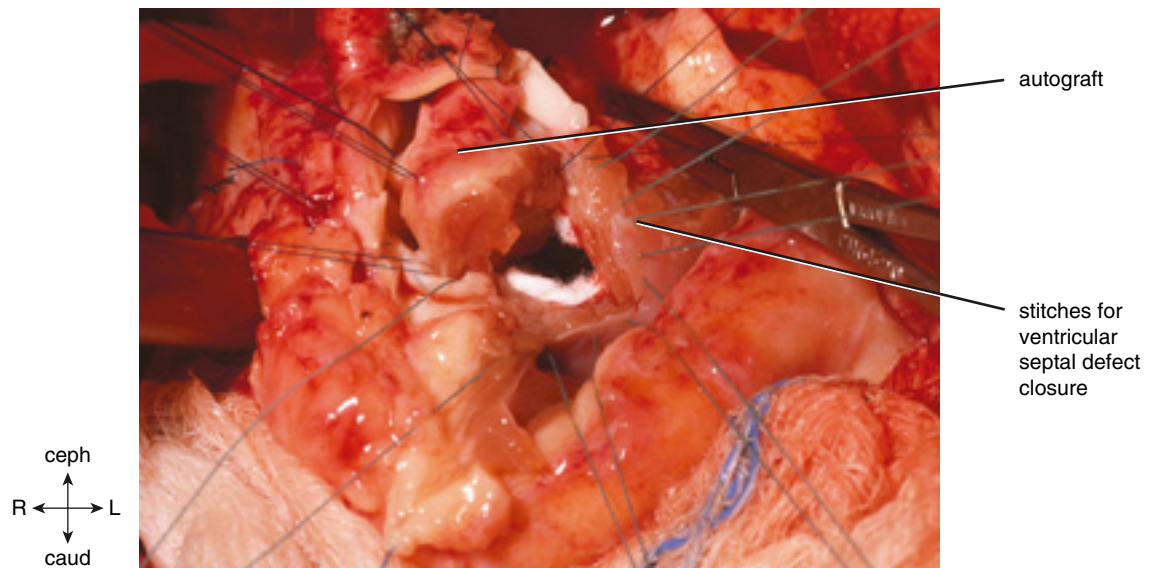


FIGURE 14-70. The trifurcating stitches are placed in the proximal autograft muscle bar, opposite the mid part of each autograft leaflet. Multiple interrupted felted stitches are passed through the ventricular septum from left ventricle into right ventricle in preparation for closing the VSD.

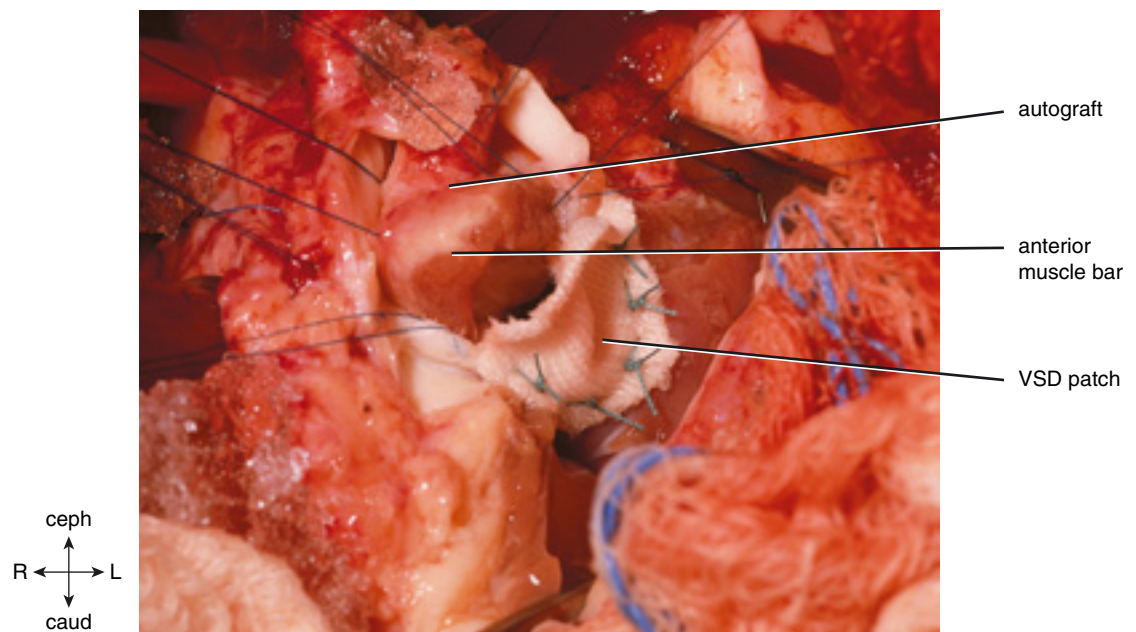


FIGURE 14-71. A Dacron® patch is placed over the VSD utilizing previously inserted stitches. The autograft will be attached to the native aortic valve annulus with multiple interrupted fine polypropylene sutures. In situ the graft fits well. The VSD patch will be attached to the anterior muscle bar with additional interrupted sutures.

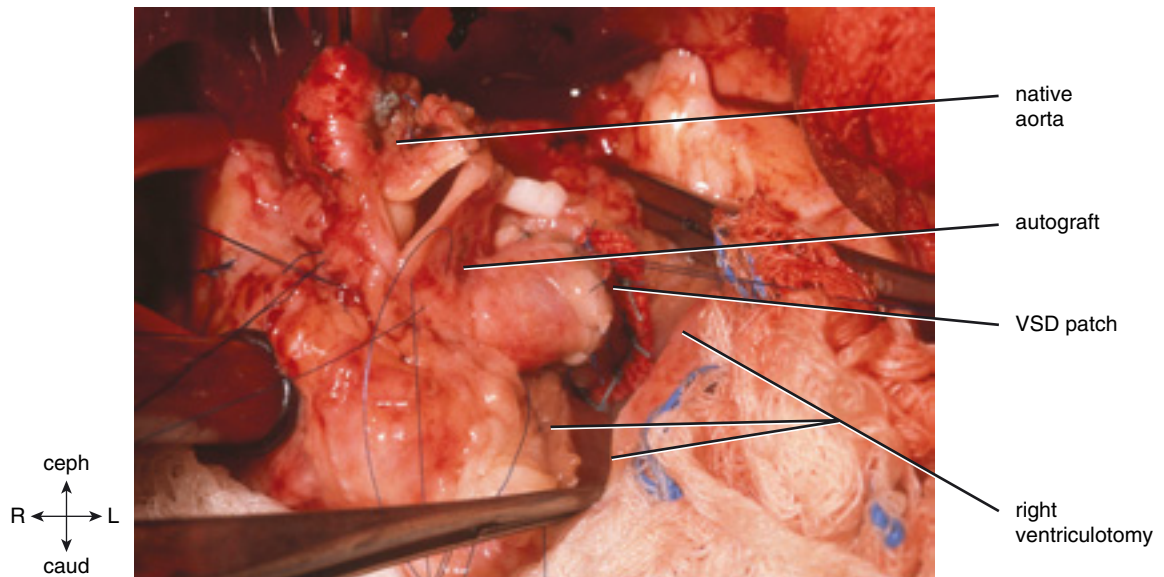


FIGURE 14-72. Working inside the native aorta, the posterior wall of the graft sinuses of Valsalva is tailored and then the graft is stitched to the posterior native aorta below and around the coronary orifices. The posterior graft commissure is also attached to the posterior native aorta. The anterior wall of the autograft is stitched to the opening in the native aorta.

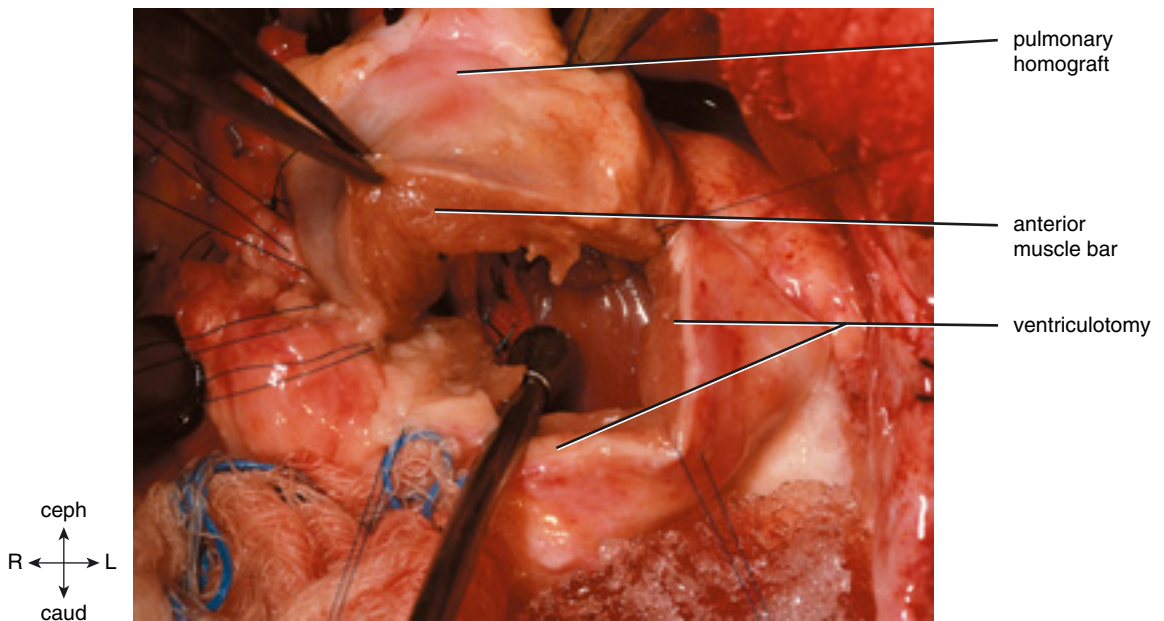


FIGURE 14-73. A pulmonary valve homograft with attached main pulmonary artery is used for reconstruction of the right ventricular outflow tract. Its muscle bar is stitched to the posterior right ventricle and the anterior graft muscle bar is stitched to the ventriculotomy.

14-6. Apical Left Ventricle to Ascending Aorta Conduit

In small infants, when an apical–aortic conduit is required, there may be inadequate space in which to work to attach the conduit to the descending aorta when working through a median sternotomy. Here the conduit is attached to the ascending aorta.

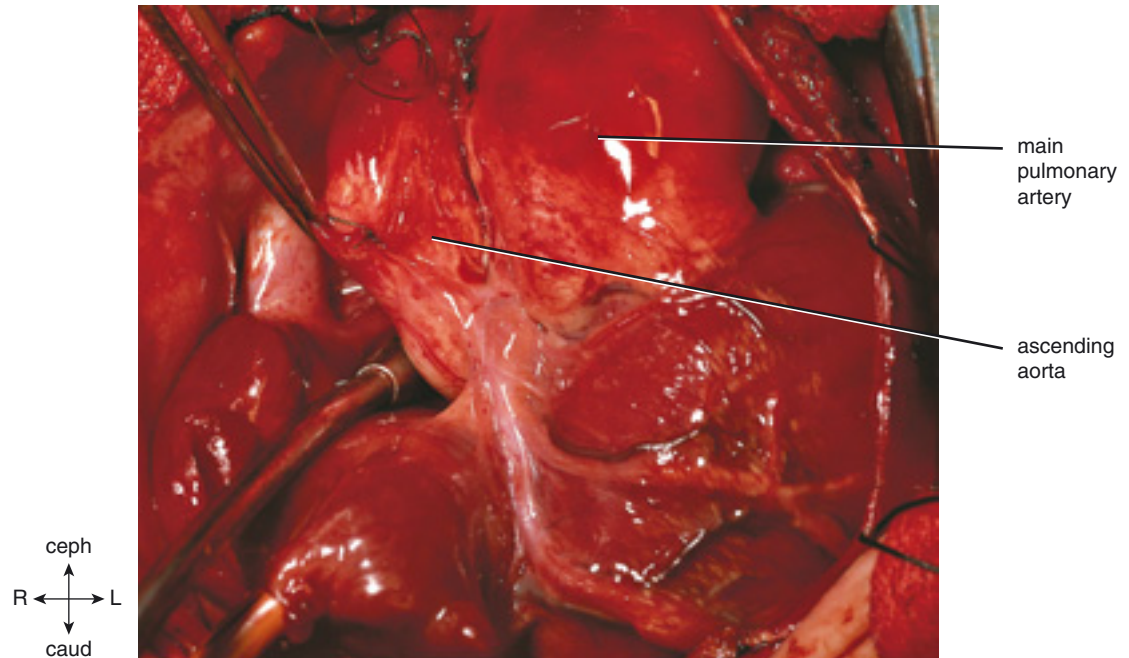


FIGURE 14-74. Through a median sternotomy, a small ascending aorta is seen. The procedure is performed with cardiopulmonary bypass, moderate hypothermia, aortic clamping, and cardioplegic arrest plus profound local cooling.

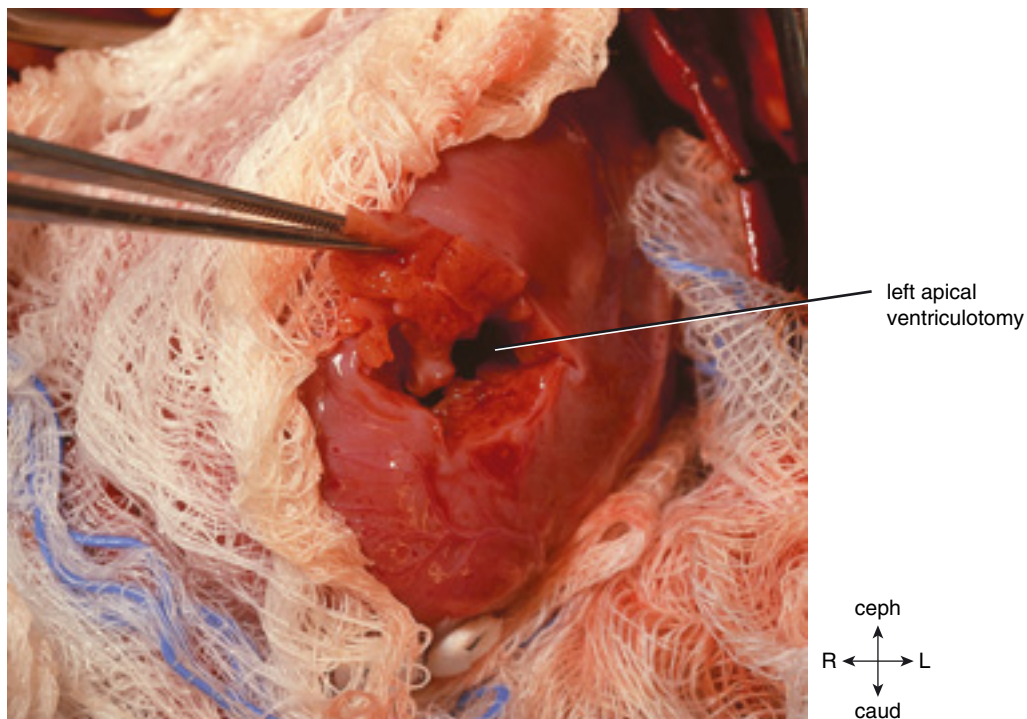


FIGURE 14-75. A left apical ventriculotomy is made, and a button of ventricular wall is removed.



FIGURE 14-76. A porcine-valved conduit (12mm in this case) is beveled and stitched to the ventriculotomy with a continuous monofilament suture. The conduit valve is placed near the ventriculotomy.

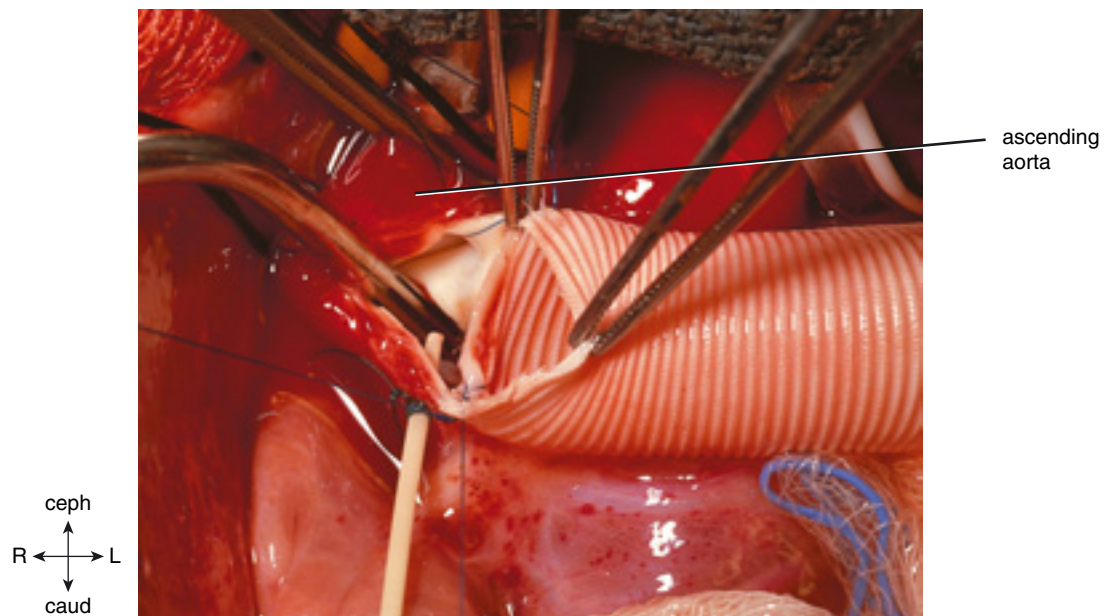


FIGURE 14-77. A longitudinal ascending aortotomy is made to accept the distal end of the conduit.

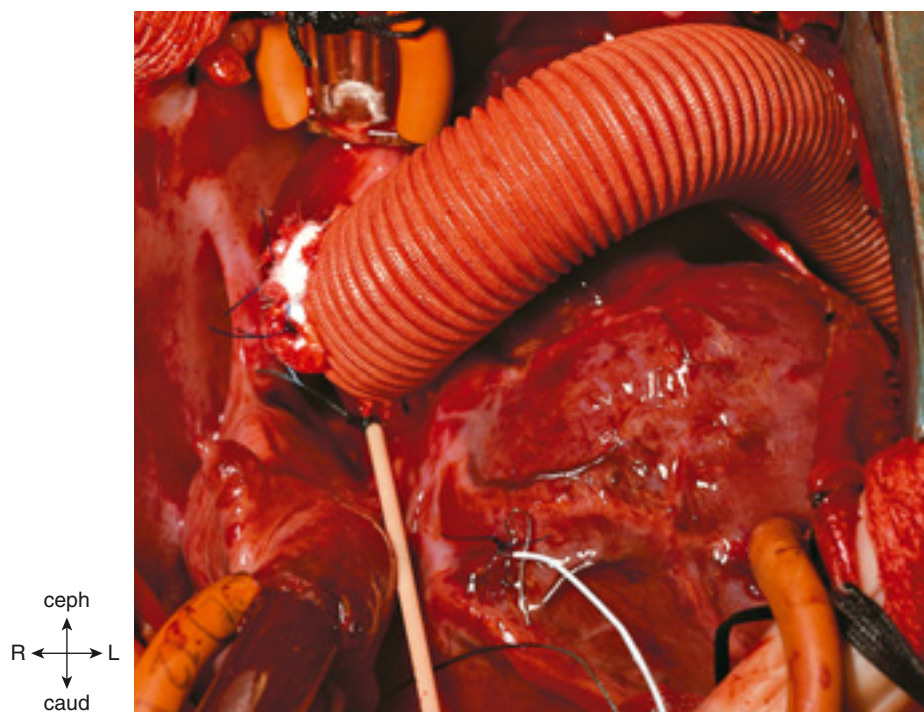


FIGURE 14-78. The completed aortic anastomosis is shown and the conduit lies along the left heart border.



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Color Atlas of Congenital Heart Surgery

Litwin, S.B.

2007, XVI, 479 p., Hardcover

ISBN: 978-0-387-35415-6