Surgical Relief of Aortic Insufficiency by Direct Operation on the Aortic Valve

By William H. Muller, Jr., M.D., W. Dean Warren, M.D., J. Francis Dammann, Jr., M.D., Julian R. Beckwith, M.D., and J. Edwin Wood, Jr., M.D.

The treatment of aortic insufficiency has presented a serious problem to both the physician and surgeon. Medical treatment generally has been unsatisfactory and, because of the mechanical nature of the defect, a surgical approach appears to offer the most promise. For this reason, extensive investigation of various methods has been undertaken. The development of the Hufnagle valve \(^1\) was a significant advance in the evolution of methods for treatment and, in many instances, has been life-saving. It has not been entirely satisfactory, however, because the blood in the upper part of the body still remains insufficient because of the position of the valve in the descending aorta. A more direct method which obviates this difficulty is one which allows the surgeon by using the pump oxygenator to repair the deformed aortic valve or partially or totally to replace it with a prosthesis. In devising procedures to treat aortic insufficiency, it seems to us that the multiplicity of morphologic forms demands individualization of the operative procedure applicable to the specific type encountered. Moreover, cardiopulmonary bypass is considered a prerequisite. This report concerns the surgical treatment of this lesion at the University of Virginia Hospital.

In order to have a clear concept of the surgical problem, it is necessary to understand the etiology and pathogenesis of aortic insufficiency. Men are predominantly affected with this lesion in a ratio of approximately 3 to 1. Rheumatic fever is the most common cause, and syphilis is reported as second but was not a causative factor in our series of patients.

Subacute bacterial endocarditis accounts for a significant number, and 2 of our patients had free aortic regurgitation as a result of this lesion. Two also had aortic insufficiency as a result of dissecting aneurysms of the aorta. Aortic insufficiency may be congenital. It may also be associated with Marfan’s syndrome and accompanied by aneurysmal dilatation of the ascending aorta and of the aortic annulus. In addition, blunt or penetrating trauma has been reported as an etiologic agent.

Segal et al.\(^2\) outlined the natural history of the disease in a clinical study of 100 cases and found that most patients had rheumatic fever at the age of about 13. Seven symptom-free years usually passed before hemodynamically significant aortic insufficiency occurred. Another interval followed without symptoms for about 10 years, when dyspnea, angina pectoris, and congestive failure appeared and slowly progressed for about 6½ years until death resulted suddenly from ventricular fibrillation, congestive failure, bacterial endocarditis, or coronary insufficiency. This course, though average, may be altered in many ways. All of the patients in Segal’s study who followed this pattern had severe aortic insufficiency. Many patients with mild to moderate insufficiency, however, may be asymptomatic for a much longer period and may not develop significant symptoms until late in life.

Aortic insufficiency increases tremendously the work load of the left ventricle, which becomes thickened and dilated. This hypertrophy compounds the problem of inadequate blood supply to the coronary arteries because diastolic filling of these arteries is already diminished, and increased size of the left ven-
tricular mass causes relative coronary insufficiency. This insufficiency probably accounts for the angina associated with advanced aortic insufficiency and enhances the development of cardiac failure or sudden acute ventricular fibrillation, which so often results in death.

The death of so many patients in the fourth or fifth decades makes the development of satisfactory corrective procedures of utmost importance. As mentioned previously, the most widely used surgical method of treating aortic insufficiency has been the insertion of the Hufnagel ball-valve. This method is thought by its originator to control approximately 75 per cent of the reflux and thus greatly relieves the work load on the heart. The valve can be inserted rapidly into the descending aorta, but efforts in the experimental laboratory to insert it more proximally were met with complex problems. It has been pointed out that, after insertion of the Hufnagel valve, the fall of diastolic pressure in the upper extremities may result in increased angina. Moreover, the degree of clinical success has been limited in the hands of many surgeons.

Bailey utilized a heavy ligature about the base of the aorta proximal to the coronary arteries to narrow the annulus and thus reduce the insufficiency, but this method proved unsatisfactory and was not employed extensively. More recently Taylor and associates reported a similar procedure in 11 patients in whom there were 4 operative deaths and 2 late deaths. The other 5 patients were improved at the time of the report. In 1958 Lillehei et al. reported their experience with 3 patients, 2 of whom had aortic insufficiency. The third patient developed considerable aortic insufficiency after aortic valvulotomy for stenosis. In the first 2 patients, one commissure was closed with mattress sutures to form a bicuspid valve; 1 patient survived and showed improvement. In the patient who developed insufficiency after valvulotomy one commissure was sutured but the insufficiency persisted. When the aorta was reopened, the insufficiency was found to result from inadequate coaptation of the leaflets. The suture of a small piece of Ivalon to the inadequate leaflet resulted in complete disappearance of the diastolic thrill but the patient died 2 days later.

In 1957 Wible et al. described a prosthesis made from a spring covered with Nylon fabric, which was placed over the top of the insufficient valve to close the defect during diastole. This prosthesis was inserted in animals that were observed over a 20-month period with encouraging results. Roe and coworkers have also reported experiments with a molded monomolecular silicone subcoronary aortic valve. Neither of these valves has been used clinically. More recently Garmella and associates reported the treatment of experimentally induced aortic insufficiency by excision of the posterior leaflet and the creation of a bicuspid valve. Initial results were poor, but, in later experiments, careful coaptation of the newly formed commissure resulted in no significant degree of aortic stenosis or insufficiency in the surviving animals. Numerous other experimental methods, including transplantation of the homologous aortic valve, pericardial pedicles, vein grafts, and injection of sclerosing solutions around the valve, have proved unsatisfactory.

**Operative Procedures**

In our clinic, the pump oxygenator has been used at every operation for aortic insufficiency but each procedure has been modified to suit the particular type of deformity encountered. The initial portion of the operation was essentially the same regardless of the anatomic configuration of the lesion.

The patient was placed in a supine position and the right external iliac and common femoral arteries and the heart and ascending aorta were exposed through inguinal and median sternotomy incisions. Heparin, 1.5 mg. per Kg. of body weight, was administered, and the right common femoral artery and the superior and inferior venae cavae were cannulated. The perfusion was begun, and the aorta was clamped immediately proximal to the innominate artery. A longitudinal incision was made in the aorta beginning anteriorly 1
Symposium—Surgery in Valvular Disease

Figure 1
Perfusion of left coronary artery. Insert shows perfusion cannula.

Of paramount importance is coronary artery perfusion (fig. 1). We initially attempted to perfuse both coronary arteries but, because of the relatively small field and certain technical difficulties, perfusion of the left coronary artery was considered and found adequate. A quarter-inch Tygon tubing connected the arterial perfusion line to a cannula fashioned from a malleable silver laryngeal anesthesia cannula by placing an 8-mm. metal ball 8 mm. from its tip to limit introduction into the left coronary orifice. Flows measured from this cannula have varied from 240 to 450 ml. per minute, depending upon the rate of perfusion. Although ventricular fibrillation occurred in some instances during and after closure of the aorta, it has always been easily reversed with electric countershock defibrillation.

The procedures for repair according to various types of aortic insufficiency are as follows:

Rheumatic Calcific Insufficiency

This type, accompanied by some degree of stenosis, is very common. Frequently incision of the commissures alone relieved the stenosis and greatly reduced the insufficiency. When calcification was severe, excision of as much calcium as possible often resulted in much thinner, more supple valve leaflets (fig. 2). Occasionally a plane of separation was found that facilitated removal of the calcium deposits. In our experience, however, this plane has been uncommon. In some instances only a small central opening remained after the calcium had been excised. Then the free edge of one of the leaflets was extended with a small piece of compressed polyvinyl sponge (fig. 3). This was most easily achieved by splitting the sponge along one side, so that the free edge of the leaflet could be inserted between the 2 edges of the sponge and secured in place with interrupted sutures. The sponge may also be molded in this configuration. The distal end of the sponge should be tailored so that it overlaps the leaflets.

Often there was massive calcific replacement of the valve leaflets, which prevented calcium removal or resulted in destruction of the leaf-
Figure 3

Correction of aortic insufficiency by a leaflet-extension procedure. A prosthetic extension has been sutured to the free edge of the posterior aortic valve leaflet.

Figure 4

Approximately one half of the deformed calcified aortic valve has been removed and a prosthetic leaflet has been sutured to the annulus to fill the defect. The cusp-like configuration of the normal valve leaflet is reproduced.

leaflet when removal was attempted. When this occurred, we excised a portion of the valve and inserted a large prosthetic leaflet tailored initially from highly compressed polyvinyl sponge, but more recently from Teflon fabric (fig. 4). The leaflet should be somewhat redundant in the transverse direction and should be long enough to overlap the remaining leaflet or portion of the leaflet by 0.5 to 1 cm. The prosthesis was sutured to the annulus with interrupted silk or Dacron sutures so as to form a deep cusp. This cusping effect was necessary to prevent regurgitation of the leaflet into the left ventricular cavity with diastole. Care should be taken to prevent its covering either coronary orifice during diastole.

Isolated Rheumatic Aortic Insufficiency

This type of disease is usually associated with little or no calcification, and 1 of 2 procedures may be used to correct it.

1. The commissures adjacent to the posterior cusp should be incised and the annulus narrowed with mattress sutures, if the annulus is only slightly dilated and if there is only moderate retraction of the valve leaflets. Incisions are made through the commissures adjacent to the posterior leaflet and into the annulus. Mattress sutures of heavy silk or Dacron should enter the aortic wall approximately 8 mm. from the commissure and emerge an equal distance from the commissure in the other sinus. When tied in place, these sutures invaginate the annulus and aortic wall and reduce its circumference (fig. 5). The commissures should be carefully coapted at their origin by placing 1 or 2 mattress sutures near the free edge of the valve leaflets. Care should also be taken to close completely the incision in the aortic wall to prevent leakage of blood after the heart is started.

2. The posterior valve cusp is removed when there is marked annular dilatation and retraction of the valve leaflets. The arteriotomy is extended down to the base of the sinus and the annulus and aortic wall are excised to within approximately 3 mm. of the commissures. Mattress sutures are placed along the edges beginning at the lower pole of the incision and tied in place, thus abutting the posterior borders of the right and left valve leaflets to form a new posterior commissure.
Figure 5
Annulus-constricting procedure to relieve aortic insufficiency. The annulus is incised at the commissures. Inserts show mattress sutures placed so that the annulus is constricted to approximate the valve leaflets.

Figure 6
Creation of a bicuspid aortic valve. The posterior valve leaflet, wall of aorta, and portion of annulus are excised. Insert shows approximation of the posterior aspects of the right and left leaflets to create a bicuspid valve.

Insufficiency Resulting from Bacterial Endocarditis
Subacute bacterial endocarditis usually produces punctate holes or destroys the free edge of one or more leaflets so that improper abutment results in severe insufficiency. When the former occurs, simple closure of the opening with mattress sutures suffices (fig. 7). When the valve cusps are destroyed, complete replacement of the valve is necessary. In 1 patient, an attempt to replace only 1 leaflet resulted in destruction of the other 2 relatively normal leaflets, possibly by the prosthesis. At a subsequent operation, it was necessary to place another leaflet of compressed polyvinyl sponge opposite the one previously inserted to create a subcoronary bicuspid prosthetic valve (fig. 8). These leaflets were secured in a cusp-like fashion along the annulus with interrupted sutures. Both leaflets were redundant longitudinally and were sutured at the commissure to prevent invagination into the right ventricle during diastole. The index finger fitted loosely in the valve opening and the size was therefore thought adequate.

Marfan's Syndrome
In this syndrome, dilatation of the ascending aorta and valve ring results in insufficiency. Treatment of the valve by posterior leaflet excision and formation of a bicuspid aortic valve is the procedure of choice. The aorta should be completely freed from the pulmonary artery and, after excision of redundant aortic wall and closure of the aortotomy, it should be supported with an encircling band of Dacron or Teflon fabric to prevent future dilatation. On occasion a bicuspid valve may be present in Marfan's syndrome and one or both commissures may be incomplete or cleft. The incomplete commissure should be opened to the annulus and the cleft should be closed by an annular constricting procedure.
Chronic Dissecting Aneurysm of the Aorta and Aortic Insufficiency

This type of insufficiency is characterized by a circumferential tear in the intima of the ascending aorta approximately 2 to 4 cm. above the aortic valve and was encountered in 2 cases, one of which was associated with Marfan's syndrome. Dissection proximally beneath the valve had occurred and an endothelial lining had developed. The valve partially invaginated into the left ventricular chamber with each diastole thus producing severe insufficiency. In order to correct this type of deformity, the aneurysm must be excised. Usually, it cannot be completely excised and the short remaining dissection proximally can be closed by including both layers in the anastomosis to a finely woven Teflon prosthesis to re-establish aortic continuity. An annulus-narrowing procedure is necessary to relieve the insufficiency and the formation of a bicuspid valve is preferred.

Selection of Patients

For the selection of patients for operation, the following criteria have been used to substantiate the diagnosis of aortic insufficiency: (1) a loud, blowing aortic diastolic murmur usually transmitted along the left sternal bor-
lieved the insufficiency. This patient’s course was satisfactory until the second postoperative day, when he developed sudden cardiac arrest and damage of the central nervous system. He died 36 hours later.

Six patients had aortic stenosis and insufficiency or developed severe insufficiency after a stenotic valve was opened. In 1 of these (no. 5), a leaflet-extension procedure was performed after completion of the valvulotomy. This patient has angina on exertion possibly related to coronary artery disease but otherwise has a fair result. Two patients with stenosis and insufficiency had aortic valvulotomies and excision of calcific plaques from the valve leaflets. One patient (no. 6) died during the operative procedure of left ventricular failure; the other (no. 7) is asymptomatic and is normal hemodynamically. Three others had excision of a portion of the valve and insertion of a prosthesis. In 2 of these patients, highly compressed polyvinyl sponge was used. One (no. 8) is well and asymptomatic; the other (no. 9) died of an overwhelming mediastinal infection and septicemia. A transventricular valvulotomy had been performed 4 years ago on the third patient (no. 10), who developed subacute bacterial endocarditis 9 months later. At the second operation, approximately two thirds of the deformed calcified valve was excised and replaced with a Teflon valve leaflet (fig. 9). This patient had a lower nephron syndrome but is doing well at the present time. His stenosis and insufficiency are completely relieved.

Four patients had aortic stenosis and insufficiency complicated by significant involvement of the mitral valve. In 2 of these (nos. 11 and 12), mitral and aortic valvulotomies were performed, and calcium was removed from the aortic valves. Both have achieved excellent improvement. In 1 of the remaining 2, mitral and aortic valvulotomies were performed, and a leaflet-extension procedure with compressed polyvinyl sponge was used. In 1 (no. 13), the aortic insufficiency was relieved but a period of hypotension after the perfusion resulted in irreversible central nervous system damage, and death ensued 2 days after the operation. The other (no. 14) had severe congestive failure with mitral and aortic stenosis and insufficiency and marked tricuspid regurgitation. In addition to a mitral valvulotomy and aortic valvulotomy, an annulus-constricting procedure was performed on the aortic valve. Mitral insufficiency was still present to such an extent that a plastic reparative procedure was performed on the mitral valve but the patient died toward the end of this operation.

Two patients had severe aortic insufficiency as a result of subacute bacterial endocarditis. The first (no. 15) was found to have a bicuspid valve with 2 perforations, each approximately 6 mm. in diameter, in one leaflet and one perforation, approximately 8 mm. in diameter, in the other leaflet. The 2 smaller perforations were closed with mattress sutures, and the larger perforation was reinforced with a Teflon fabric prosthesis placed on the aortic side of the valve. The insufficiency, although not completely relieved, was considerably improved. The patient seemed to progress satisfactorily but died suddenly on the fifth day probably because of ventricular fibrillation. Another patient (no. 16) had subacute bacterial endocarditis 6 months

Figure 8
Complete subcoronary replacement of the aortic valve. A bicuspid prostatic valve has been formed by 2 leaflets sutured to the aortic annulus.
### Table 1

**Analysis of Cases**

<table>
<thead>
<tr>
<th>Case, Sex, Age, Date</th>
<th>Lesion</th>
<th>Procedure</th>
<th>Perfusion time</th>
<th>Left coronary perfusion</th>
<th>Results and remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1. Aortic insufficiency secondary to rheumatic fever</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. OS, M, 42 5-20-59</td>
<td>Aortic insufficiency; dilated annulus; slightly thickened leaflets</td>
<td>Annulus constriction at posterior commissures</td>
<td>48 min.</td>
<td>Yes</td>
<td>Excellent; insufficiency completely relieved</td>
</tr>
<tr>
<td>2. DH, M, 35 5-5-59</td>
<td>Aortic insufficiency; dilated annulus, leaflets only slightly thickened</td>
<td>Creation of bicuspid valve</td>
<td>40 min.</td>
<td>Yes</td>
<td>Excellent; insufficiency completely relieved</td>
</tr>
<tr>
<td>3. JH, M, 45 5-6-59</td>
<td>Aortic insufficiency; dilated annulus; only slightly thickened leaflets</td>
<td>Creation of bicuspid valve</td>
<td>1 hr. 15 min.</td>
<td>Yes</td>
<td>Insufficiency completely relieved; died suddenly 2nd postoperative day of ventricular fibrillation</td>
</tr>
<tr>
<td>4. RM, M, 50 4-30-59</td>
<td>Retracted right leaflet, relatively normal appearing valve</td>
<td>(1) Ivalon extension of right leaflet; (2) Removal Ivalon extension, creation of bicuspid valve</td>
<td>(1) 46 min. (2) 1 hr. 40 min.</td>
<td>Yes, both procedures</td>
<td>1. Considerable insufficiency still present; 2. Insufficiency completely relieved; died 3rd postoperative day following acute ventricular fibrillation and central nervous system damage</td>
</tr>
<tr>
<td>5. RB, M, 43 6-5-58</td>
<td>Calcific aortic stenosis and aortic insufficiency</td>
<td>Valvulotomy, Ivalon leaflet extension</td>
<td>30 min.</td>
<td>No</td>
<td>Good, has had angina recently</td>
</tr>
<tr>
<td>6. PK, M, 51 6-23-59</td>
<td>Aortic insufficiency and aortic stenosis, calcific</td>
<td>Valvulotomy, excision of calcium from valve leaflets</td>
<td>1 hr. 50 min.</td>
<td>Yes</td>
<td>Died during operation of severe left ventricular failure</td>
</tr>
<tr>
<td>7. EB, M, 43 7-2-59</td>
<td>Calcific aortic stenosis and aortic insufficiency</td>
<td>Valvulotomy, excision of calcium from valve leaflets</td>
<td>30 min.</td>
<td>Yes</td>
<td>Excellent</td>
</tr>
<tr>
<td>8. JP, M, 53 11-26-58</td>
<td>Severe calcific aortic stenosis</td>
<td>Valvulotomy, excision of valve leaflet; replacement with Ivalon valve leaflet</td>
<td>1 hr. 9 min.</td>
<td>Yes</td>
<td>Excellent; all symptoms relieved to present</td>
</tr>
<tr>
<td>9. PL, M, 38 3-25-59</td>
<td>Severe calcific aortic stenosis</td>
<td>Valvulotomy, excision of ½ valve; replacement with Ivalon valve leaflet</td>
<td>53 min.</td>
<td>Yes</td>
<td>Died 32 days postoperatively from mid-colonial infection and septicaemia</td>
</tr>
<tr>
<td>10. CO, M, 47 7-8-59</td>
<td>Aortic stenosis and aortic insufficiency, calcific</td>
<td>Resection 2/3 valve; insertion Toblon valve leaflet</td>
<td>1 hr. 8 min.</td>
<td>Yes</td>
<td>Transventricular valvulotomy, 1946, and subsequent subacute bacterial endocarditis. Aortic stenosis and aortic insufficiency completely relieved; transient lower nephron syndrome</td>
</tr>
<tr>
<td>11. HJ, M, 31 6-26-59</td>
<td>Aortic insufficiency, aortic stenosis, calcific; mitral stenosis and mitral insufficiency</td>
<td>Aortic valvulotomy, excision of calcium from leaflets, mitral valvulotomy</td>
<td>48 min.</td>
<td>Yes</td>
<td>Excellent; aortic insufficiency and aortic stenosis relieved. Still has minimal mitral insufficiency</td>
</tr>
<tr>
<td>12. EH, F, 45 12-4-58</td>
<td>Calcific aortic stenosis and aortic insufficiency; mitral stenosis and mitral insufficiency</td>
<td>Aortic and mitral valvulotomy; excision calcium from aortic valve</td>
<td>38 min.</td>
<td>Yes</td>
<td>Excellent, asymptomatic</td>
</tr>
<tr>
<td>13. FY, M, 37 1-7-59</td>
<td>Calcific aortic stenosis and aortic insufficiency; mitral stenosis and mitral insufficiency</td>
<td>Aortic and mitral valvulotomies; Ivalon extension of posterior leaflet</td>
<td>1 hr. 35 min.</td>
<td>Yes</td>
<td>Stenosis and insufficiency completely relieved; Died of central nervous system damage following period of hypotension</td>
</tr>
<tr>
<td>14. MM, F, 18 6-30-59</td>
<td>Aortic insufficiency and aortic stenosis; mitral insufficiency and stenosis; tricuspid insufficiency</td>
<td>Aortic valvulotomy, annulus constriction, mitral valvulotomy; Repair of insufficiency of mitral valve</td>
<td>2 hrs. 20 min.</td>
<td>Yes</td>
<td>Died shortly after operation of severe congestive failure</td>
</tr>
</tbody>
</table>
Table 1 (cont'd)

<table>
<thead>
<tr>
<th>Group 2</th>
<th>Aortic insufficiency secondary to subacute bacterial endocarditis</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. GC, M, 28</td>
<td>Three perforations of the bicuspid valve</td>
</tr>
<tr>
<td>16. LW, F, 34</td>
<td>Perforation of left leaflet</td>
</tr>
<tr>
<td>1.6-59</td>
<td>Destruction of right leaflet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 3</th>
<th>Marfan's syndrome or dissecting aneurysm, or both</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. CT, M, 61</td>
<td>Dissecting aneurysm and aortic insufficiency</td>
</tr>
<tr>
<td>12-6-58</td>
<td>Marfan's syndrome, dissecting aneurysm; circumferential intimal tear, aortic insufficiency</td>
</tr>
<tr>
<td>18. AP, F, 38</td>
<td>Marfan's syndrome, dissecting aneurysm; questionably congenital</td>
</tr>
<tr>
<td>7-7-59</td>
<td></td>
</tr>
<tr>
<td>19. WW, M, 18</td>
<td>Marfan's syndrome; cleft bicuspid valve; questionably congenital</td>
</tr>
</tbody>
</table>

At present 11 of these 19 patients are well or markedly improved. The mortality rate appears high, but all of these patients had severe valvular disease and a number had multivalvular disease. In addition, all had previously, with destruction of the free edge, medial one third of the right leaflet. A perforation in the left leaflet, approximately 5.5 mm in diameter, was closed with a silk mat...
been in congestive heart failure or were in failure at the time of operation. Several had significant sclerosis of the coronary artery as well. Experience with these patients brought forth information that we believe will offer a progressively improving mortality rate. First of all, the selection of patients is of utmost importance. The type of patient such as (no. 3), who had severe cardiac enlargement and congestive failure and an extremely low myocardial reserve, will present a much greater risk than one whose disease is not so far advanced. Multivalvular lesions, especially mitral insufficiency in association with aortic insufficiency will also greatly increase the risk and reduce the chance of benefit. For the patient with nonecalcific isolated aortic insufficiency, a procedure to reduce the size of the annulus and to allow coaptation of the valve leaflets is the only one that will relieve the insufficiency other than complete valve replacement. If the annulus is small, we have used the annulus-constricting operation; if it is large, the formation of a bicuspid valve is satisfactory and will completely relieve the insufficiency.

When severe calcific stenosis and insufficiency are present, an annulus-constricting procedure is not satisfactory. A complete valvotomy should first be performed, with removal of as much calcium as possible, and every effort should be made to utilize the patient's own tissues. When this cannot be done, a synthetic prosthesis may be used. Some of the new synthetic materials, such as Teflon, have great tensile strength, do not deteriorate when implanted in living tissues, and can withstand great wear. One must also remember that such a prosthesis is well lubricated by the stream of blood, and this reduces wear. It is of utmost importance that the prosthesis be placed so that the cusp-like configuration of the normal valve leaflet is retained, for this is perhaps the most important factor in preventing regurgitation of the leaflet into the left ventricle. It should also be broad enough to allow adequate opening and should overlap the remaining valve tissue centrally about 0.5 cm. That total prosthetic valve replacement is possible has been demonstrated by the patient whose valve continues to function satisfactorily 10 months after operation. It is entirely probable that extremely calcified or deformed aortic valves will be replaced as better artificial valves, which may be expected to last a normal lifetime, are developed.

Of considerable interest is speculation as to whether or not a prosthesis will develop an infection when placed in an area where bacterial valvulitis has been present. In our 3 patients who had subacute bacterial endocarditis, 1 did not live sufficiently long for evaluation but there is no evidence of an infection on these foreign bodies in the other 2, one having been observed for 10 months.

We are convinced that a direct attack upon the insufficient aortic valve is the procedure of choice at the present time with the goal of totally correcting aortic insufficiency. With further experience and investigation, it is probable that more satisfactory methods will evolve with an accompanying lower mortality rate.

**Summary**

The natural history of patients with aortic insufficiency and the previous experimental and clinical operations devised for its relief are reviewed.

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Methods that have been used at the University of Virginia Hospital for treatment of aortic insufficiency are reported. These procedures include the release of the fixed valve leaflet and removal of calcium from it, aortic valve leaflet extension with suture of a small piece of compressed polyvinyl sponge or Teflon fabric to the edge of one of the leaflets, excision and replacement of a portion of the valve with a synthetic leaflet, and complete subcoronary replacement of the valve with a prosthesis. To relieve isolated rheumatic aortic insufficiency, an annulus has been constricted or a bicuspid aortic valve has been created. Insufficiency resulting from perforation of one or more valve leaflets by subacute bacterial endocarditis has been treated by closure of the perforations.

Nineteen patients underwent 21 operations for the correction of aortic insufficiency. All had been in, or were in, heart failure, and several had significant coronary artery disease or multivalvular disease. Eleven of the 19 patients were well or markedly improved. Eight died during or after the operative procedure.

It is concluded that a direct attack upon the insufficient aortic valve is the procedure of choice at the present time.

**Summario in Interlingua**

Es presente un revista de historia natural de patientes con insufficientia aortie e del operationes elaborate experimentalmente e aplicate clinicamente pro su alleviamente usque al tempore presente.

Es reportate le methodos usate al Hospital del Universitate Virginia in le tractamento de insufficientia aortie. Iste methodos include le liberation de fixate segmentos valvular e le elimination de calcium ab illlos, le extension de un segmento del valvula aortie per medio del sutura de un micre pieca de comprime spongia de polyvinyl o de Teflon contra le margine de illlo, le excision de un portion del valvula e su reimplacamento per un segmento synthetie, e le complete reimplacamento subcoronari del valvula per un prosthes. Pro alleviar isolate insufficientia rheumatic del valvula aortie, un anulo has essite con-

**References**


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