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The Changing Pattern of Aortic Valve Repair

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ABSTRACT

The changes and improvements in the surgical treatment of aortic valve disease in 296 patients, who were operated on between 1953 and 1965, are illustrated and discussed in general terms. Several of the early techniques, such as transventricular dilation, insertion of a homograft aortic valve in the descending thoracic aorta, fabric replacement of one cusp or the entire valve, and ice-chip arrest of the heart, are now obsolete. Total replacement with a ball-valve prosthesis or an aortic valve homograft while the coronary arteries are perfused with blood is the currently popular technique. The results of a hemodynamic follow-up study two years after surgery are also included.

SOMMAIRE

Les auteurs font un exposé général des changements et améliorations apportés au traitement chirurgical des lésions valvulaires aortiques et illustrent leur exposé en passant en revue les 296 malades qui ont été opérés de 1953 à 1965. Plusieurs des premières techniques, comme la dilatation transventriculaire, l'insertion d'une valvule aortique par homœogreffe dans l'aorte thoracique descendante, le remplacement unicupulaire par une valve en tissu artificiel et l'arrêt cardiaque par hypothermie subite sont devenues désuètes. La technique consistant à remplacer complètement la valvule malade par une valve à bille-cage ou une homœogreffe de la valvule aortique, les artères coronaires étant soumises à une perfusion sanguine continue, est aujourd'hui la méthode de choix. L'article donne également les résultats des observations hémodynamiques faites pendant les deux années qui ont suivi l'opération.

THE aortic valve was the last of the four heart valves to yield to surgical repair. Since the first successful operation on this valve in 1950[1] a series of surgical techniques have been suggested, attempted, popularized, found wanting and abandoned. The rapid changes in the indications for surgery, surgical techniques and surgical results have naturally led to some misunderstanding and confusion. It is the purpose of this article to review in general terms the surgical procedures used and the results obtained in 296 patients with aortic valve disease who were treated surgically at the Toronto General Hospital between November 1953 and May 1965. The condition of 28 patients who were re-hospitalized for clinical and hemodynamic follow-up study 20 months after their valves had been repaired by direct-vision surgery is also reported.

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A major portion of this article is concerned with the results achieved with surgical procedures which have now been replaced by better and more advanced techniques. The changing techniques represent a steady progress in the surgical treatment of both aortic stenosis and aortic insufficiency. Lesions of the aortic valve are particularly treacherous in that they produce severe myocardial damage while the patient's symptoms are still mild, and dangerous in that there is frequently a rapid progression from the onset of symptoms to the death of the patient.

The techniques of aortic valve repair which are no longer used include: transventricular dilation, insertion of a homograft aortic valve in the descending thoracic aorta, and partial or complete cusp or valve repair with prosthetic material such

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as Teflon or Dacron fabric. There are still a few patients in whom the techniques of calcium debridement or bicuspidization are indicated, and congenital aortic stenosis without calcification is still treated by commissurotomy. The great majority of aortic valve lesions are now repaired by valve excision and complete replacement with a ball valve of the Starr-Edwards or McGovern type or by a homograft aortic valve. The changes in surgical technique have been reflected not only in a much lower operative mortality but also in a more rapid and permanent return to normal cardiac function.

CLINICAL MATERIAL

All of the patients in this series were over 16 years of age. In Table I, which is reproduced from an article published in this Journal in 1959, the operative procedures used in the first 65 patients of the series are tabulated.[2] It will be noted that only four of these patients (6%) were operated upon with a technique which allowed the surgeon actually to see the valve as it was repaired.

TABLE I.—THE METHOD OF REPAIR IN 65 PATIENTS WITH AORTIC VALVE DISEASE OPERATED ON UP TO JANUARY 1959

Closed-heart repairs		61
Aortic valvular stenosis	42	
Combined aortic and mitral stenosis	15	
Homograft valve in descending thoracic aorta	4	
Open-heart repairs		4
Aortic stenosis	4	

In Table II the procedures used in the 231 patients who were operated on between January 1959 and May 1965 are tabulated. In 175 of these patients (76%) the valve was repaired under direct-vision. In Table III the techniques used in direct-vision repair of the 175 damaged valves are tabulated. Forty-four were treated by procedures which did not involve the use of any prosthesis, 43 by some form of partial valvular prosthesis (either replacement of one or two cusps in their entirety or extension of the free edge of each cusp), and 88 by complete excision and replacement of the valve. This series does not include patients operated on for subvalvular or supravalvular stenosis.

TABLE II.—THE METHOD OF REPAIR IN 231 PATIENTS WITH AORTIC VALVE DISEASE OPERATED ON FROM JANUARY 1959 TO MAY 1965

Closed-heart repairs		56
Transventricular dilation	52	
Homograft valve in descending thoracic aorta	4	
Open-heart repairs		175

DEFINITION OF TERMS

A "closed-heart procedure" is one in which the valve is repaired while the heart is still actively pumping blood and supporting the circulation. The surgeon cannot see the valve, but must guide his instruments within the heart by touch. Extracorporeal circulation is not required.

TABLE III.—THE METHOD OF REPAIR IN 175 DIRECT-VISION OPERATIONS ON THE AORTIC VALVE

No prosthesis		44
Commissurotomy	12	
Valvoplasty	9	
Debridement	10	
Bicuspidization	13	
Partial prosthesis		43
Monocusps	21	
Cusp extension	22	
Complete prosthesis		88
Starr-Edwards	80	
Others	8	

An "open-heart procedure" is one in which the aorta is opened and the valve clearly seen while the repair is performed. Extracorporeal circulation is necessary to maintain the circulation during the period of time that the aorta is open.

CLOSED-HEART PROCEDURES

Transventricular Dilation

The 52 patients who were treated by transventricular dilation since 1959 ranged in age from 29 to 62 years of age (average: 46 years). All of these patients had calcified valves with pure or predominant aortic stenosis. None were in Class I of the New York Heart Association classification of symptoms and 54% were in Class III or IV (Table IV). The average preoperative pressure gradient across the aortic valve during systole was 78 mm. Hg; this was reduced to 33 mm. Hg at the completion of operation. The hospital mortality was 17%, identical with that reported in the series operated on prior to 1959.[3]

Nineteen of the patients (37%) had stenosed mitral valves opened during the same operation and two patients had closed trivalvular (aortic, mitral and tricuspid) dilation. The 21 multivalvular procedures carried no increase in risk over that of aortic valve dilation alone (two deaths in 21 cases, or 9.5% mortality).

TABLE IV.—THE NEW YORK HEART ASSOCIATION CLASSIFICATION OF PATIENTS WITH CARDIAC DISEASE

Class I.	Patients with cardiac disease, but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea or anginal pain.
Class II.	Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea or anginal pain.
Class III.	Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary activity causes fatigue, palpitation, dyspnea or anginal pain.
Class IV.	Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.

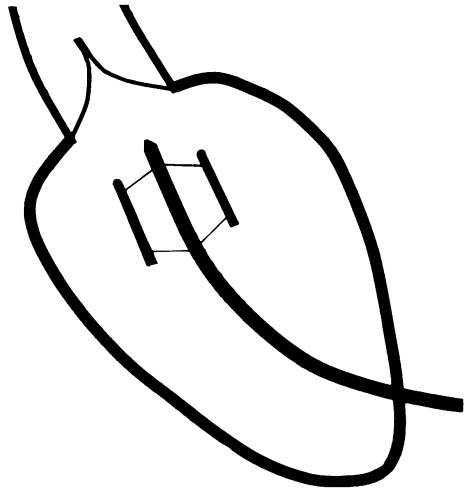

Fig. 1.—In the now obsolete technique of transventricular dilation, the stenosed aortic valve was opened with a dilator introduced through the left ventricle.

As the safety of open-heart repair increased, this operation was performed less and less frequently. It could not be used on patients with significant aortic insufficiency, it was occasionally a cause of aortic insufficiency, and the dilated valve was prone to restenosis. This operation is now obsolete (Fig. 1).

Homograft Aortic Valve in Aorta Distal to Left Subclavian Artery

Eight patients were treated by the insertion of an aortic valve from a cadaver into the descending thoracic aorta immediately distal to the left subclavian artery (Fig. 2). These patients, all of whom suffered from severe aortic insufficiency, ranged in age from 19 to 52 years (average: 34 years). All were severely disabled by their cardiac lesion: all were in Class III or IV of the New York Heart Association classification. Four of the eight also had severe mitral insufficiency.

These patients, who were all operated on prior to 1963, were offered this palliative procedure because of the grave nature of their condition and the risk of open-heart repair of the aortic valve at that time. All eight survived and left hospital greatly improved over their preoperative condition. There were two late deaths; the other six, when recatheterized in 1964, showed excellent function of their homograft valves.

This operation was devised by Murray[4] in 1956, and in clinical and hemodynamic reviews by Kerwin, Lenkei and Wilson[5] and Bigelow *et al.*[6] the homograft valve has been shown to function normally for periods up to eight years. Homograft rejection was not observed in the necropsy specimens. The experience gained in these procedures led to the successful subcoronary placement of the homograft aortic valve in 1964.[6]

OPEN-HEART REPAIR

One of the main reasons for the higher risk of open-heart aortic valve surgery, as compared to the surgery of other cardiac lesions, was the need to approach the valve through the open aorta. The myocardium became hypoxic. In the earlier operations in this series, the application of crushed ice to the heart afforded some protection from the effects of hypoxia.[7] This technique was found to be inadequate for lengthy valve repairs and was replaced by direct coronary artery perfusion. The manually held metal coronary perfusion

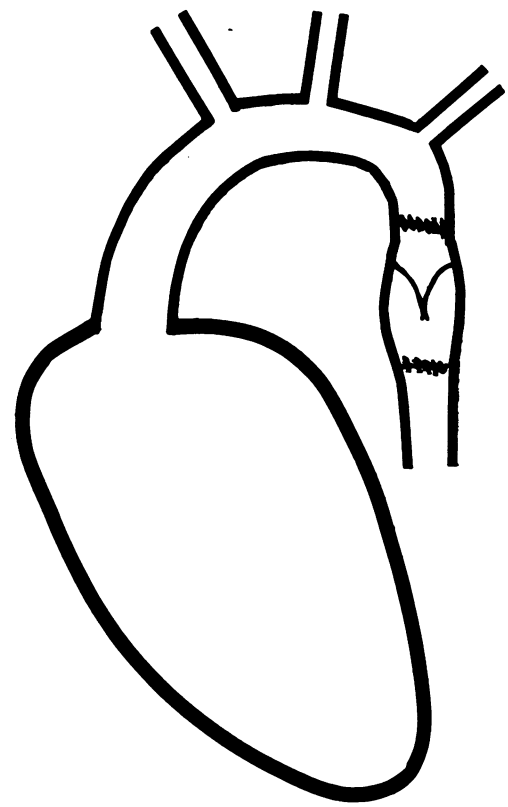

Fig. 2.—In this now obsolete technique for the correction of aortic insufficiency, the aortic valve from a cadaver was placed in the thoracic aorta immediately below the left subclavian artery.

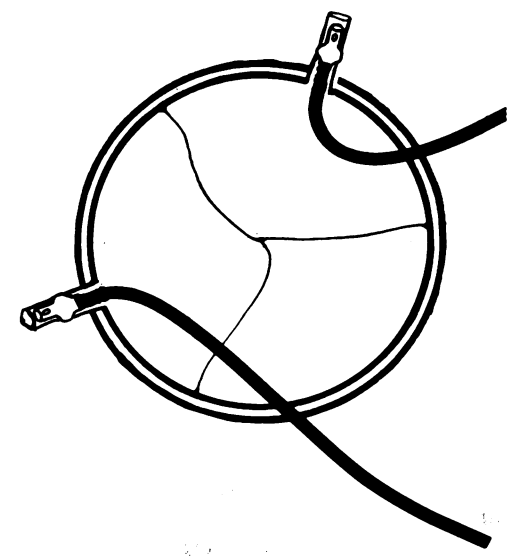

Fig. 3.—Cardiac hypoxia is now prevented by direct perfusion of each coronary artery with blood. The cannulae are held in place by self-inflating balloons.

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cannulae that were initially used were cumbersome and occasionally dangerous. They were replaced by cannulae with self-inflating balloon cuffs. The cannulae have side holes immediately beyond the balloon to avoid the possibility of perfusing only one of the two main branches of the left coronary artery in patients with an early bifurcation of this vessel (Fig. 3).

At the present time each coronary artery is perfused with a separate pump and the pressure in each perfusion line is monitored. The autoregulation of the coronary vascular bed allows it to accept the flow it needs as long as the pressure is within a physiological range.[8] The flow rate is not arbitrarily set but is slowly increased until a pressure of 125-150 mm. Hg is achieved. Flow rates have averaged 300 c.c./min. in the left coronary artery and 150 c.c./min. in the right. We currently perfuse the coronary arteries with blood at the same temperature as the whole body perfusion, i.e. at mild hypothermia levels of 30-33° C.

Direct-Vision Commissurotomy

Twelve patients were treated by direct-vision incision of fused commissures (Fig. 4). These patients were young, ranging in age from 14 to 39 years (average: 24 years). Their valve lesion (aortic stenosis in all 12 patients with minimal associated aortic insufficiency in two) was not severely disabling despite an average aortic systolic gradient of 98 mm. Hg (range: 32-164). Two patients had symptoms on normal activity (Class III), nine on slight exertion (Class II) and one on strenuous activity (Class I).

At operation the aortic valve was found to be bicuspid in 10 cases and tricuspid in two. Valve calcification was minimal in two and absent in 10. Incision of the fused commissures in these congenitally malformed valves was a relatively innocuous procedure, the average period of cardiopulmonary bypass being less than 50 minutes in the overall group.

Of the two deaths in this group (17%), one occurred three days postoperatively, apparently as the result of cerebral fat embolism. The other death occurred early in the series as the result of severe aortic incompetence, a complication which was more dreaded at that time, when procedures were not available for its correction. The 10 surviving patients had uneventful postoperative recoveries and all were alive and well when contacted in January 1964.

Debridement

Ten patients with heavily calcified valves were treated by decalcifying or sculpturing the valve. This group of patients was relatively older, with an age range of 35-63 years (average: 49 years). Four were in Class II and six in Class III of their disease. Aortic stenosis was the predominant lesion in all, with an average systolic gradient of 108 mm. Hg.

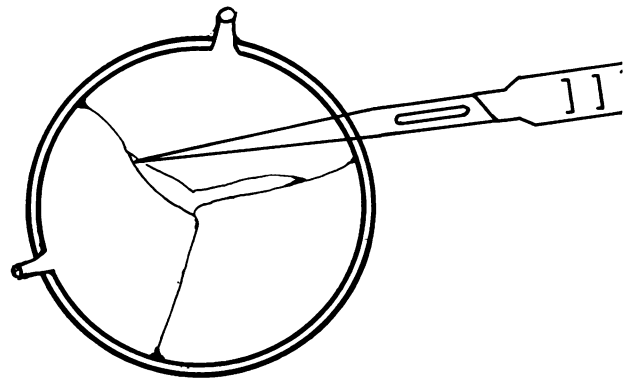

Fig. 4.—Incision of the fused commissures in a patient with congenital aortic stenosis without calcification of the cusps.

Aortic insufficiency, present in four patients, was either trivial or mild.

At operation all of the valves were heavily calcified and six appeared bicuspid. The average duration of bypass was 59 minutes. Every effort was made to perform as complete a debridement as possible. Three hospital deaths occurred, one on the third postoperative day from a coronary embolus of calcified material.

At follow-up in 1964, there had been no late deaths, and all seven patients were in Class I of the New York Heart Association classification. A persistent systolic gradient averaging 73 mm. Hg was present in the three patients who were catheterized at follow-up. This gradient may be the result of either unrelieved or recurrent stenosis. At the present time this procedure is rarely used and is restricted to patients with minimal calcification in whom complete debridement can be ensured.

Bicuspidization

The conversion of a tricuspid aortic valve to a competent bicuspid valve by excision of the non-coronary cusp and adjacent aortic root tissue was first described by Garamella *et al.*[9] and Starzl *et al.*[10] This method of repair of aortic insufficiency was thought to be suitable for a valve in which the primary lesion was a dilated annulus or an isolated lesion of the non-coronary cusp. Bigelow, Sapirstein and Aldridge[11] have recently stressed the value of overcorrection in order to prevent recurrent aortic insufficiency.

Bicuspidization was performed in 13 patients, ranging in age from 15 to 54 years (average: 34 years) (Fig. 5). Five patients had suffered from rheumatic fever, two from bacterial endocarditis, two from ankylosing (Marie-Strümpell) spondylitis, one from Marfan's syndrome, and one from an aneurysm of the sinus of Valsalva. Two patients did not fit into any of the above groups. Nine out of the 13 were in Class III or IV of their disease.

The preoperative diagnosis was pure aortic insufficiency in nine instances, predominant aortic insufficiency with minimal aortic stenosis in one, mixed aortic insufficiency and aortic stenosis in two, and combined aortic and mitral incompetence in

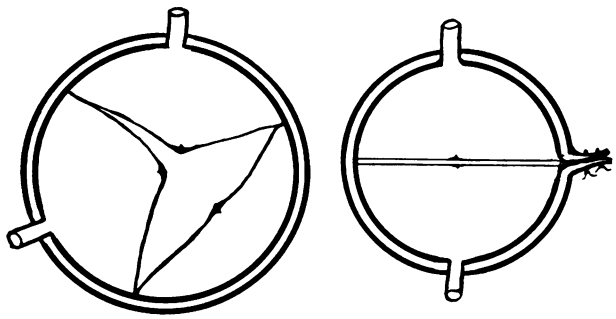

Fig. 5.—A competent bicuspid aortic valve can be formed by excising the non-coronary aortic valve cusp and a portion of the aortic wall.

one. Minimal aortic calcification was noted preoperatively in one patient.

Four of these patients died in hospital. At the clinical and hemodynamic follow-up in 1964, there had been two late deaths, and one patient who had suffered a recent myocardial infarction was unable to return to hospital; the other six were all in Class I of the New York Heart Association classification. The degree of persistent aortic insufficiency varied from mild to moderate: none had significant aortic stenosis. There had been no systemic emboli. The recurrence of aortic incompetence relatively soon after surgery in the patients with spondylitis and Marfan's syndrome suggested that the inadequacy of the connective tissue in these patients makes them unsuitable candidates for this procedure. The procedure is still considered useful in properly selected patients.

The Development of Current Principles of Prosthetic Replacement of the Aortic Valve

Bicuspidization was often impossible in patients with gross aortic insufficiency due to prolapsed cusps, ruptured cusps, or cusp perforations secondary to bacterial endocarditis. In the period between 1960 and 1962, these valves were repaired by techniques such as cusp suspension, plication of the commissures, and direct suture of cusp perforations. It was difficult to achieve a functionally normal valve with these techniques and when an initially satisfactory valve was achieved, the long-term results were often unsatisfactory. It became apparent that there was a group of patients whose valves required the addition of new material.

The first prosthetic valves were made of plastic fabric and were moulded in the shape of a single aortic cusp. The monocusps of Hufnagel (Dacron and Silastic) and Bahnson (Teflon) were in this category. They were initially used to replace a single irreparably damaged cusp. The short-term function of such prosthetic leaflets was satisfactory and the principle of the fabric prostheses was extended to complete valve replacement. Complete valve prostheses of Teflon were designed by McGoon and Muller. Follow-up examination indicated that the long-term function of both the fabric prosthetic leaflets and the valves was unsatisfactory. Eventual thickening and rigidity frequently led to recurrent stenosis, cusp fracture, and valvular insufficiency.[12]

The long-term results were better when an incompetent valve with flexible and either noncalcified or minimally calcified cusps was repaired by the technique of cusp extension. None of the valve tissue was excised and the free edges of each cusp were extended with semilunar prostheses of Teflon coated with polyurethane.[13] It was believed that even if the fabric of such a prosthesis should stiffen with time, the flexible valve tissue at the base of the cusp would maintain adequate mobility (see Fig. 6).

The 22 patients in whom cusp extension was performed ranged in age from 24 to 58 years (average: 39 years). Over half of these patients were already in Class III or IV of their disease. The operations were performed in 1961 and 1962.

There was no calcification of the cusp tissue in 14 patients and slight calcification in eight. Severe aortic insufficiency either pure or predominant was present in all. Significant mitral valvular dysfunction was also present in one-third of this group of patients.

In the 18 patients in whom all three cusps were extended, the average duration of heart-lung bypass was 110 minutes; coronary perfusion was carried out in all cases, with additional ice-slush hypothermia in three. There were five hospital deaths in this series (27%); one was a result of fat embolism at 11 days and one of a dissecting aneurysm of the aorta at 15 days.

At the follow-up examination at an average period of 15 months after surgery, 10 of the 11 patients examined were in Class I of the New York Heart Association classification and one was in Class II. There had been two late deaths in this period, one from bacterial endocarditis and one from a detached cusp. In the eight patients who

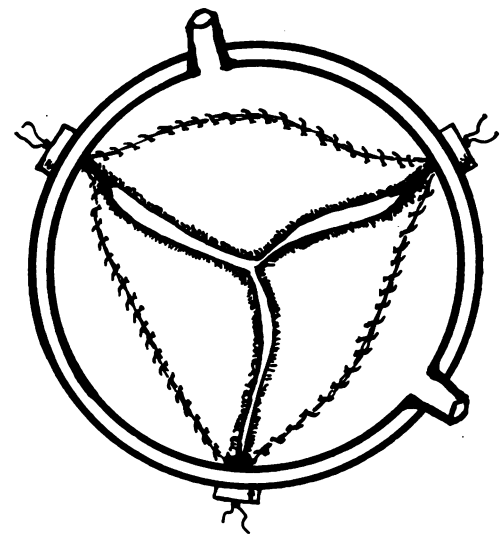

Fig. 6.—The free edge of each cusp is extended by leaflets of Teflon covered with polyurethane. No valve tissue is removed.

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underwent repeat cardiac catheterization, there was evidence of only minimal aortic stenosis (average aortic systolic gradient of 18 mm. Hg) and the end-diastolic pressure in the left ventricle was near normal (average of 13 mm. Hg). The degree of aortic insufficiency was improved over the preoperative state in each patient, but some degree of aortic insufficiency was demonstrated in each case on angiographic examination: it was severe in only one. There had been no systemic emboli.

Although the results of this particular method of fabric prosthetic repair were adequate, the inability to obtain complete valve competency and the tendency for a fabric prosthesis to stiffen have caused it to be superseded by better techniques.

The Starr-Edwards Valve and Total Replacement of the Aortic Valve

It was increasingly apparent that normal aortic valve function was most easily obtained by complete excision of all the deformed valve tissue and complete valve replacement. The fabric prostheses functioned well over the short term but poorly over the long term. The Starr-Edwards valve (a Silastic ball in a metal cage) has become increasingly popular as a method of aortic valve replacement. It is easy to insert, does not leak and does not produce significant stenosis (see Fig. 7).

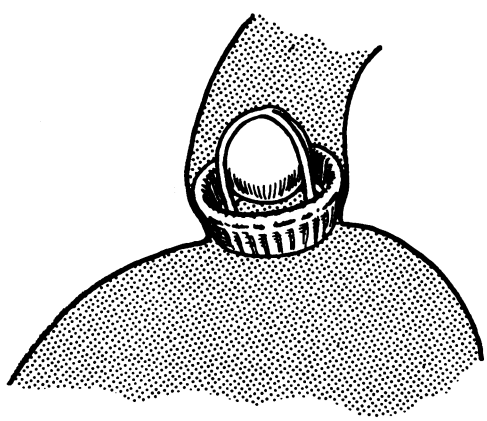

Fig. 7.—The Starr-Edwards ball valve used for total replacement of the aortic valve.

The Starr-Edwards valve has been used to replace the aortic valve in 80 patients: in 75 patients, the aortic valve alone was repaired; in five patients, the mitral valve was also repaired at the same operation. As is true with any new surgical technique, the results early in the series are not comparable to those achieved later. In the group of 75 patients whose aortic valve alone was replaced, the hospital mortality in the first 25 patients was 48%. This figure was reduced to 20% in the last 50 patients. In the last eight months, during which 25 patients have been operated on, the hospital mortality has been 4%.

When the first five patients in whom the Starr-Edwards aortic ball valve had been inserted were readmitted to hospital nine months after surgery for repeat cardiac catheterization and evaluation, the valves were continuing to function in a very satisfactory fashion. All of the patients had returned to Class I of the New York Heart Association classification. At the present moment, the insertion of this valve is the standard surgical treatment for the deformed aortic valve.

There is a small but significant incidence of peripheral emboli from the Starr-Edwards valve, and continuous anticoagulant therapy is indicated wherever possible.

Future Trends in Aortic Valve Surgery

The McGovern ball valve is similar in concept and design to the Starr-Edwards valve but is fixed in position by a mechanical suturing device. As it can be rapidly inserted, the length of time that the coronary arteries must be perfused is shortened. It has been used in only three patients in this series, and its future role is still debatable.

There has been a continuous and increasing interest in the role of the homograft aortic valve. Reports from the Toronto group[4-6] have shown that such a valve will continue to function well for periods as long as eight years. This is the longest follow-up of any of the present techniques of aortic valve replacement. Recent reports from New Zealand[14] and England have suggested improved techniques for the insertion of this valve in a subcoronary position and have presented results comparable to those achieved with the ball-valve prosthesis. The homograft aortic valve is an appealing replacement for the damaged aortic valve and a bank of such valves has been recently established.

DISCUSSION

Experience in the surgical treatment of aortic valve disease has indicated that there is no single or easy road to success in this extremely difficult field of surgery. There has been a rapid progression of reparative techniques from their first description to widespread popularity and then their relegation to history. The constant search for better methods of protecting the myocardium during the period when the aorta is open and for the optimal method of repairing the damaged valve is evident throughout this paper.

It is just nine years since the first reported attempts of surgeons to use cardiopulmonary bypass to allow time for a careful aortic valve repair.[15] An indication of the increasing success of these repairs over both the short and long term is evident in the reported statistics. There has been only one hospital death in the last 25 patients with isolated aortic valve replacement. When 28 patients with open-heart aortic valve surgery other than simple commissurotomy re-entered hospital in late 1963 and 1964 for a clinical and hemodynamic assessment of their condition 20 months after opera-

tion, 26 of the 28 were in Class I of the New York Heart Association classification (asymptomatic with normal activity) and the other two were in Class II.[16]

These results are gratifying despite the awareness that no single technique is yet ideal and that the perfect method of aortic valve repair is still awaited.

SUMMARY

Two hundred and ninety-six patients with aortic valve disease were operated upon in the 11½-year period from November 1953 to May 1965. The changing pattern in the surgical techniques and the results of surgery are presented. The findings of a follow-up assessment of the clinical and hemodynamic status of 28 patients who were admitted for evaluation 20 months after open-heart surgery are also included.

In the past eight months, during which time 25 patients have been operated upon, the hospital mortality associated with replacement of the aortic valve with the Starr-Edwards valve has been reduced to 4%.

This is a survey of patients operated upon in the Cardiovascular Division of the Toronto General Hospital. Patients were contributed to this series by: Dr. W. G. Bigelow, Dr. D. R. Wilson, Dr. J. A. Key, Dr. R. O. Heimbecker, Dr. R. J. Baird, Dr. A. S. Trimble, and Dr. P. E. Blundell.

The follow-up evaluation was performed by Dr. E. D. Wigle and Dr. C. J. Labrosse.

The illustrations were drawn by Mr. Gordon Price.

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PAGES OUT OF THE PAST: FROM THE JOURNAL OF FIFTY YEARS AGO

ABSCESS OF THE OVARY AND OTHER FORMS OF PELVIC SEPSIS

Abscess of the ovary is a comparatively rare disease and usually follows the termination of pregnancy, either full term or premature. In such a case, the patient will probably progress very favourably for a week or ten days, when the temperature begins to rise, the pulse rate becomes increased and the patient experiences pain in one or other side. Examination will reveal enlargement of the ovary together with exquisite tenderness in that region. The ovary will steadily increase in size until it may be readily palpated through the anterior abdominal wall. This is a good example of the infecting organism travelling by means of the blood stream or lymphatic channels, as there is frequently no infection of the uterus, the germs gaining entrance to the system through a tear in the perineal body, and thence spreading up and outwards through the broad ligament to the ovary. Only very recently I operated upon the wife of a physician. She had suffered a complete laceration of the perineum at childbirth, repair of which was attempted but failed. Septic pelvic peritonitis resulted, and finally settled in a mass on the left side. This was treated by hot air with marked benefit but it would not resolve. On opening up the abdomen, this mass was found to be the left ovary which was the size of a billiard ball and which was embedded in a mass of adhesions. The tube ran over this and was simply somewhat hard and thickened. The organisms had here entered through the lacerated perineum and traversed the broad ligament to the ovary. When the cellular tissue of the pelvis is affected, it is usually as the result of infection during the emptying of the pregnant uterus. It may follow either a full term delivery or an abortion, especially when the latter has been brought about by artificial means. The onset is usually heralded by a chill, which is followed by elevation of temperature, increase in the rate of the pulse, which is full and bounding, pain and localized tenderness. The latter, at first, is spreading but later on becomes localized over the diseased area as a rule. On making a pelvic examination, a mass is to be felt within the cavity. This mass is hard, is confined to the base of the broad ligament or the side of the pelvis and its lower border is ill defined, the mass gradually fading away towards its lower and lateral aspects. The sensation which it imparts to the examining finger has been aptly compared to that which would be produced if plaster of Paris were poured into the pelvis. The upper surface, however, is well defined and rounded, being composed of inflammatory exudate, coils of intestine and the omentum, which usually tries to cover over, and thus limit, any inflammatory focus within the abdomen or pelvis.

While pelvic peritonitis is usually caused by the spread of the inflammation from one of the above-mentioned conditions, what may be fitly described as an "irritative peritonitis" undoubtedly exists. This form is seen to result from the escape of fluid into the peritoneal cavity where the uterus is perforated by a douching curette. It also may occur even in virgins where they expose themselves to cold, as by taking a cold bath or getting their feet wet during the menstrual period. Here one sometimes sees a reflux of blood from the uterus along the tube and so into the peritoneal cavity where it acts as a foreign body and thus sets up inflammation.

Finally, one may have a troublesome pelvic inflammatory mass arising from infection of blood clot left in the abdomen after an urgent operation for a ruptured ectopic sac.

The *prognosis* depends largely upon the nature of the attacking organism. When this is the gonococcus, the prognosis is good but it is much more grave when streptococci are present.

The mass may resolve completely, leaving the patient with a comparatively healthy pelvis. Pus, even, may be entirely absorbed but this happy termination is not very common. The sac may remain *in statu quo* ready to have the inflammation relighted on the slightest provocation. It may rupture into one or other of the adjacent cavities, such as the peritoneal cavity, the bladder, rectum, vagina or uterus, or else externally through the skin. In the case of one patient, recommended to me by the late Professor J. C. Cameron, cellulitis followed the delivery of a full-term child. When first seen, the mass was low in the base of the broad ligament and well to the side of the uterus. It gradually worked up between the layers of the broad ligament, under the fascia of the pelvis, until it lay entirely in front of the peritoneum of the anterior abdominal wall, incision through which permitted the escape of about 750 c.c. of pus, drainage of the succeeding cavity being followed by cure.—A. L. Lockhart, *Canad. Med. Ass. J.*, 5: 9, 1915.