Results of Open-Heart Surgery in Patients with Pulmonic Stenosis and Intact Ventricular Septum

A Report of 108 Cases

By RAJENDRA TANDON, M.D., ALEXANDER S. NADAS, M.D., and ROBERT E. GROSS, M.D.

The clinical profile, hemodynamic data, and diagnostic criteria of patients with pulmonic stenosis and intact ventricular septum are well known.\(^1\)\(^{-6}\)

The results of surgery by the Brock method and moderate hypothermia have been amply documented.\(^1\)\(^{-6}\)\(^{-10}\) No results of a long-term follow-up of a large number of patients, operated upon by means of the pump oxygenator, are available at the present time. The purpose of the present publication is to present a large group of patients with pulmonic stenosis and intact ventricular septum operated upon by open-heart technic with use of a disc oxygenator, between 1957 and 1961. The preoperative clinical profile is presented briefly, only insofar as it pertains to the severity of the disease, and almost exclusively in charts. The surgical approach is presented briefly. Operative results and postoperative changes in the various clinical and hemodynamic parameters are surveyed in detail.

**Material and Methods**

One hundred and eight consecutive patients with pulmonic stenosis and intact ventricular septum operated upon at the Children’s Hospital Medical Center by means of cardiopulmonary bypass and a pump oxygenator in the 5-year period from 1957 to 1961, provided the material for this report. There were 56 males and 52 females in the series. They ranged in age (at the time of surgery) from 15 months to 29 9/12 years (fig. 1). No patient with pulmonic stenosis and intact ventricular septum below the age of 1 year was operated upon by this technic because of the limitations of open-heart surgery in the very young. A complete physical examination, cardiac fluoroscopy, radiograms, and a 12-lead electrocardiogram were available in all the patients preoperatively. In addition, phonocardiograms were obtained in 50 and cardiac catheterization—performed according to standard technic—in 81 cases. Cardiac catheterization data from elsewhere were available in an additional 11. Sixteen patients were operated upon on the basis of clinical evaluation only.

![Age distribution of 108 patients at operation.](http://circ.ahajournals.org/)

**References**

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PULMONIC STENOSIS

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Dyspnea

It

Preoperative

Dyspnea

symptomatology

Physical Examination

The pertinent features are presented in

figure 3. The systolic murmur was described

as of grade III intensity in 19; grade IV in

57; and grade V in 32 cases. The relation of the

systolic murmur to the aortic component of

the second sound was inadequately comment-

ed upon, and thus was evaluated only in pa-

tients in whom a phonocardiogram was avail-

able. The second heart sound was described

as widely split with diminished pulmonary

component in 57; single, in 45; moderately

split, in four; and not clearly delineated, in

two cases. The fourth heart sound was not

commented upon in most of the patients. It

should be stressed that no diastolic murmur

was noted preoperatively in any of the pa-

ents.

Radiologic Features

The radiologic findings are also summarized

in figure 3. The degree of cardiac enlarge-

ment was judged by the radiologist on the

basis of the transverse diameter in the poster-

anterior view of the radiograms. Most of the

patients were described as having a right ven-

tricular type of configuration of the cardiac

silhouette. In only five were the radiograms


Figure 2

Symptomatology in 108 patients at time of surgery.

All patients were operated upon by the trans-

pulmonic approach, with use of total cardi-

opulmonary bypass.11 The right ventricular

outflow tract was examined in every patient for
evidence of any subvalvular block and, where
indicated, a right ventriculotomy was performed
for relief of such additional obstruction. Postopera-
tive evaluation by clinical means (physical ex-
amination, electrocardiogram, and x-rays) is avail-
able in 95 patients; catheterization data were
obtained in 22 of these. Ten patients were lost
to follow-up. The minimum duration of follow-up
was 8 months, and the maximum 6 years, with
an average of 2 years, 9 months.

Results

Preoperative Findings

Symptomatology

The main features are summarized in figure

2. It may be seen that 28 patients were asym-

ptomatic. Dyspnea and fatigue varied from
mild to severe. The cyanosis, described in 47,
was persistent in 32 and appeared only after
crying, exertion, or exposure to cold in 15 pa-
tients. Three patients each had one epis-

dode of bacterial endocarditis, and one of
these had two episodes preoperatively.

Physical Examination

The pertinent features are presented in

figure 3. The systolic murmur was described

as of grade III intensity in 19; grade IV in


Figure 3

Findings at physical examination and radiologic fea-
tures at time of operation in 108 patients. CE, cardiac
enlargement; MM, mild or moderate; Gr, gross; PVD,
pulmonary vasculature diminished; MPA, prominent
main pulmonary artery.

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and fluoroscopy considered to be within normal limits, and even one of these patients had a right aortic arch.\textsuperscript{12}

\textbf{Electrocardiographic Features}

The electrocardiographic features are summarized in table 1, figures 4, 5, and 6. It should be emphasized here, on account of its importance in the postoperative follow-up, that in the precordial lead V\textsubscript{6}, the R/S ratio was less than 1 in 50 cases preoperatively, indicating complete reversal of the normal adult R/S progression. None of the patients had complete right bundle-branch block, as indicated by a QRS duration of 0.12 second or more preoperatively. A correlation between voltages in the right chest leads and P pulmonale, as well as strain pattern, is presented in figure 7.

\textbf{Phonocardiographic Findings}

Phonocardiograms were obtained in 50 cases (fig. 8). With one exception, a patient in whom the second sound was split only 0.05 second in expiration, in all others, in whom a pulmonary component of the second sound was recorded the split was 0.06 second or more. The systolic murmur was of ejection type in all and spilled through the aortic component of the second sound in 33 cases.

\textbf{Cardiac Catheterization Data}

The main features of cardiac catherization data, available in 92 cases, are presented in figures 9, 10, and 11.

Clinical data, as related to right ventricular pressure obtained at cardiac catheterization, are presented in figure 12. Since the phonocardiograms are available only in 38 of these 92 patients, no correlation in this regard is presented in the graph. There were 17 of 38 patients whose second sound was split in ex-

\begin{table}[h]
\centering
\caption{Electrocardiographic Findings}
\begin{tabular}{llll}
\hline
 & Preoperative (108 patients) & & Postoperative (93 patients) \\
 & No. patients & Percentage & No. patients & Percentage \\
\hline
Normal & 0 & 0.0 & 39 & 41.0 \\
Right ventricular hypertrophy* & 108 & 100.0 & 48 & 50.5 \\
Right atrial hypertrophy & 30 & 27.7 & 2 & 2.1 \\
ST and T-wave change & 25 & 23.1 & 1 & 1.0 \\
Right bundle-branch block† & 0 & 0.0 & 5 & 5.2 \\
\hline
\end{tabular}
\end{table}

*Criteria defined by Nadas.\textsuperscript{2}
†At the end of follow-up.
Figure 5

Height of R wave (mm.) in lead V₁ in 108 patients before operation (left) and in 88 patients after operation (right).

Figure 6

R/S ratio in lead V₆ before operation (left) and after operation (right).
piration by 0.08 second or more, and in 13 of these the right ventricular pressure was 100 mm. of mercury or more.

**Surgery**

*Type of Obstruction and Technic of Repair*

As indicated above, all the patients were operated upon by means of cardiopulmonary bypass. The types of lesion seen and the various procedures used for relief of stenosis are presented in table 2. Four patients had had a previous Brock valvulotomy with unsatisfactory results. Two of these had been done at this hospital and two elsewhere.

**Surgical Mortality**

The total mortality was three, representing 2.77 per cent. Two of these patients died within 48 hours of surgery. One of these, a 11/12-year-old boy with valvular pulmonic stenosis, had acute hemorrhage in the lungs, and at postmortem was found to have endocardial sclerosis of the left atrium and mitral valve. The postmortem in the second patient,
PULMONIC STENOSIS AND INTACT SEPTUM

The complications are summarized in table 3. Of the 108 patients 71 had an uncomplicated postoperative course and were discharged within 10 to 15 days. Among the minor complications there were seven patients who showed pulmonary complications: four had atelectasis, one a pneumothorax, and two had pneumonia, all responding to appropriate therapy and leaving the hospital by the fifteenth day, except one, who had to stay for 28 days, with persistent atelectasis. Mild to moderate congestive heart failure was noted postoperatively in five patients, all needing digitalis for 1 to 12 months. Four patients had transient arrhythmias (ventricular premature beats, second-degree heart block, and atrioventricular dissociation), due in two, probably, to digitalis administration. Two patients had one episode each of "post-pericardiotomy syndrome" following surgery—one 4

**Figure 10**

Resting right ventricular systolic pressure related to arterial oxygen per cent saturation in 86 cases. Note that saturations below 80 per cent are very rare in patients with right ventricular pressure below 100 mm. Hg. At the same time almost three fourths of the individuals with full arterial saturation have right ventricular pressures above 100 mm. Hg.

a 5-year-old boy with valvular pulmonic stenosis, narrow valve ring, and infundibular pulmonic stenosis, reaquired with the help of a patch, showed a hypoplastic right ventricle and relative narrowing of the tricuspid valve. The third patient, an 11 9/12-year-old girl, who came to this hospital with catheterization data and a diagnosis of tetralogy of Fallot from elsewhere, was thought to have valvular pulmonic stenosis with intact septum, and was operated on with this diagnosis. At surgery a transpulmonary valvulotomy was performed, but to exclude a ventricular septal defect a ventriculotomy was also done. She died 30 days later from wound infection, shock, and bleeding from dehiscence of right ventriculotomy. She had myocarditis and necrosis of muscles, most marked at the site of stitches in the right ventricular outflow tract post mortem.

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Table 2

Findings and the Procedure for Relief of Stenosis at Surgery

<table>
<thead>
<tr>
<th>Types of lesion</th>
<th>Total</th>
<th>Type of repair</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure valvular stenosis</td>
<td>87</td>
<td>Valvulotomy</td>
<td>87</td>
</tr>
<tr>
<td>Valvular and infundibular stenosis</td>
<td>2</td>
<td>Valvulotomy and patch</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valvulotomy and infundibular resection</td>
<td>1</td>
</tr>
<tr>
<td>Valvular and infundibular stenosis and narrow ring</td>
<td>5</td>
<td>Valvulotomy and patch</td>
<td>5</td>
</tr>
<tr>
<td>Pure infundibular stenosis</td>
<td>5</td>
<td>Repair with patch</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infundibular resection</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>without patch</td>
<td></td>
</tr>
<tr>
<td>Valvular stenosis and narrow ring (No infundibular stenosis)</td>
<td>7</td>
<td>Valvulotomy with stretching of ring</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nothing done about ring</td>
<td>3</td>
</tr>
<tr>
<td>Infundibular stenosis and narrow ring</td>
<td>1</td>
<td>Repair with patch</td>
<td>1</td>
</tr>
<tr>
<td>Supravalvular stenosis with small valves and small ring</td>
<td>1</td>
<td>Patch repair</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>108</td>
<td></td>
<td>108</td>
</tr>
</tbody>
</table>

Additional surgery done at the same time:
- Atrial septal defect: 2 cases—two closed by patch, because in one it was of sinus venosus type and in the other there was one anomalous pulmonary vein to right atrium.
- Patent ductus arteriosus closed in one case.
- Adhesive pericarditis in one case—the pericardium was stripped.

weeks, the other 6 months postoperatively.

Of the 14 who had major complications, three died as mentioned above. Three had neurologic complications—one a pure left arm monoplegia, and two remained unconscious for 5 days. One of these latter two recovered completely and was asymptomatic 7 months later, and the other was left with a left hemiparesis. Six patients had significant bleeding through the chest tube, necessitating reopening of the chest to control the bleeding. One of these also had thrombocytopenia postoperatively and developed significant hemopericardium on the ninth day. In the majority, the bleeding was a generalized ooze. Two patients had bleeding difficulty—one a gastro-

Table 3

Postoperative Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>No. patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>71</td>
</tr>
<tr>
<td>Minor</td>
<td>23</td>
</tr>
<tr>
<td>Major</td>
<td>14*</td>
</tr>
</tbody>
</table>

*Three of these died.

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intestinal hemorrhage 4 weeks postoperatively and the other persistent hematuria. All bleeding and coagulation studies were normal in these patients. Two patients needed tracheostomy for respiratory trouble and did well following it. One patient reportedly developed bacterial endocarditis 4 years postoperatively elsewhere.

**Postoperative Follow-up**

Table 4 indicates the duration of follow-up in 108 patients. Ninety-four patients have been followed for more than 1 year, the maximum follow-up being 6 years, with an average of 2 years 9 months.

**Symptomatology**

As against 28 of the 108 patients who were asymptomatic preoperatively, 86 of the 95 were without any symptoms postoperatively. Of the nine who were asymptomatic, there were six who had some effort intolerance and three who were described as having questionable cyanosis.

**Physical Examination**

In only four of the 95 patients was questionable cyanosis described; the rest showed no evidence of arterial unsaturation. Congestive heart failure was absent in all. The auscultatory findings should be commented upon in some detail. Figure 13 indicates the changes in intensity of the systolic murmur. It may be noted that 90 per cent of the patients had grade-II or grade-III murmurs postoperatively, and 4.3 per cent had no murmurs at all. This should be contrasted with the preoperative state, where over 80 per cent of the patients had murmurs of grade IV or greater intensity.

As indicated previously, not a single patient had a diastolic murmur preoperatively. By contrast, in 55 of the 95, a diastolic murmur was heard postoperatively. It is interesting to note that the diastolic murmur had, within a period of 3 years, disappeared after having been heard initially by several observers in one case. Contrariwise, in 11 cases a diastolic murmur first appeared sometime after the discharge from hospital. In seven of these, the murmur appeared 2 to 3 years postoperatively, and in the remaining four, less than 2 years after the operation.

**Radiologic Findings**

Cardiac enlargement was present in only two of the 84 patients with adequate radiologic follow-up. One clearly had tricuspid regurgitation, as evidenced by the jugular venous pulse pattern, regurgitant systolic murmur at the lower left sternal border and persistence of P pulmonale in the electrocardiograms, but only trivial postoperative gradient across the pulmonary valve (table 5, no. 9). The other patient with residual cardiac enlargement has a tremendous-sized right atrium. He has no residual murmurs, has not been recatheterized as yet, and the cause of right atrial enlargement is presently unknown, although Ebstein's anomaly should be considered in the differential diagnosis. Some degree of post-stenotic dilatation—although less than preoperatively—was present in 53 cases.
Electrocardiographic Findings

Adequate electrocardiographic follow-up is available in 95 patients. The shift in mean QRS axis in the frontal plane has been shown in figure 4. The main features of the postoperative electrocardiographic findings are presented in figures 5, right, and 6, right and in table 1. As is evident from figure 5, right,

Table 5
Preoperative and Postoperative Catheterization Data in 22 Patients

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Right ventricular pressure before surgery</th>
<th>Right ventricular pressure after surgery</th>
<th>After surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>122/13</td>
<td>45/-</td>
<td>3 wk.</td>
</tr>
<tr>
<td>15</td>
<td>115/5-10</td>
<td>106/0-15</td>
<td>2 wk.</td>
</tr>
<tr>
<td>16</td>
<td>200/10</td>
<td>34/6</td>
<td>2 yr.</td>
</tr>
<tr>
<td>17</td>
<td>125/10-12</td>
<td>55/2-12</td>
<td>2 wk.</td>
</tr>
<tr>
<td>19</td>
<td>155/5</td>
<td>52/9</td>
<td>3 yr.</td>
</tr>
<tr>
<td>21</td>
<td>130/-</td>
<td>35/2-10</td>
<td>8 mo.</td>
</tr>
<tr>
<td>22</td>
<td>105/2-5</td>
<td>40/-</td>
<td>1 1/3 yr.</td>
</tr>
<tr>
<td>29</td>
<td>90/4</td>
<td>54/0</td>
<td>6 mo.</td>
</tr>
<tr>
<td>41</td>
<td>220/-</td>
<td>28/6</td>
<td>1 1/2 yr.</td>
</tr>
<tr>
<td>44</td>
<td>175/4-7</td>
<td>38/4</td>
<td>1 yr.</td>
</tr>
<tr>
<td>50</td>
<td>147/0-2</td>
<td>32/-</td>
<td>1 yr.</td>
</tr>
<tr>
<td>51</td>
<td>105/5-10</td>
<td>30/-</td>
<td>1 1/2 yr.</td>
</tr>
<tr>
<td>55</td>
<td>125/-</td>
<td>36/3</td>
<td>2 yr.</td>
</tr>
<tr>
<td>56</td>
<td>90/7</td>
<td>30/4</td>
<td>1 1/2 yr.</td>
</tr>
<tr>
<td>93</td>
<td>180/10</td>
<td>80/4*</td>
<td>1 1/3 yr.</td>
</tr>
<tr>
<td>94</td>
<td>230/-</td>
<td>41/0-1</td>
<td>2 1/2 yr.</td>
</tr>
<tr>
<td>95</td>
<td>232/-</td>
<td>110/-</td>
<td>7 mo.</td>
</tr>
<tr>
<td>96</td>
<td>87/5</td>
<td>65/5*</td>
<td>3 1/2 yr.</td>
</tr>
<tr>
<td>99</td>
<td>204/16</td>
<td>98/-*</td>
<td>2 1/2 yr.</td>
</tr>
<tr>
<td>103</td>
<td>140/-</td>
<td>22/-</td>
<td>2 1/3 yr.</td>
</tr>
<tr>
<td>104</td>
<td>210/-</td>
<td>75/-*</td>
<td>2 yr.</td>
</tr>
<tr>
<td>106</td>
<td>Not done</td>
<td>58/6</td>
<td>2 wk.</td>
</tr>
</tbody>
</table>

*Showed less than completely satisfactory drop in pressure.

Figure 14
Timing of postoperative electrocardiographic changes in 95 patients. Key on right side indicates electrocardiographic patterns. Stippled columns indicate that the tracing, as noted, was obtained previous to the designated time and was carried through from a previous column. For instance, at 2 years there were 25 patients with normal tracings but in only 17 was an actual record obtained at this time; the normal tracing in the other eight was obtained at 1 year.
the height of $R_V$, has shown significant diminution, and from figure 6, right, the right ventricular dominance has shown good degree of regression. The P pulmonale disappeared in all but one and reappeared 3 years later in another. Of the 25 patients with ST and T-waves changes in the electrocardiogram preoperatively, there are 17 in whom these changes have disappeared completely and no information is available in two. Three others developed right bundle-branch block, but one of these lost it 2 years postoperatively. Only three of these six had ventriculotomies at surgery.

It is worth indicating at this point the time relationship of the various changes in the electrocardiogram (fig. 14). The change towards normal starts in less than 3 months. At this point 16 of the 95 patients who showed severe right ventricular hypertrophy preoperatively have electrocardiograms with only minimal, if any, right ventricular hypertrophy. The major shift occurs by the end of 1 year, at which time 43—almost half of the patients—showed normal electrocardiograms. By the end of three years, of 70 patients 33 had normal electrocardiograms and 37 only mild right ventricular hypertrophy. Nineteen individuals still had cardiograms indicating severe right ventricular hypertrophy; five had right bundle-branch block; and no information was available in one. No significant change in this distribution occurred beyond 3 years after operation. This same generalization applies to the height of $R_V$. Of the 46 patients with complete reversal of the R/S progression in the electrocardiogram preoperatively, 27 showed partial reversal (R/S ratio more than 1 in $V_6$) in less than 6 months and an additional 13 converted to partial reversal between 6 months to 1½ years; two developed right bundle-branch block and two died. Of the two patients in whom complete reversal has persisted, one (no. 99) has been catheterized (table 5) and the other is awaiting reevaluation. P pulmonale disappeared in less than 3 months in 17, and by 12 months in nine additional cases. In contrast, the ST and T-wave changes showed very gradual improvement, and at the end of 1 year only three patients showed reversion to normal.

At the end of our period of observation there were 36 of the 95 patients with normal electrocardiograms, although the mean QRS axis in the frontal plane in one is $-165^\circ$ and in another $+120^\circ$. Fifty-four were left with some degree of right ventricular hypertrophy. Thirty-six of these have been classified as showing mild right ventricular hypertrophy, indicating right ventricular pressure below systemic levels. Six of these have been recatheterized, and the right ventricular pressure indeed varied from 30 to 54 mm. Hg at rest. Out of 18 where the right ventricular hypertrophy was deemed to be severe, seven have been recatheterized and six were found to have right ventricular systolic pressure between 41 and 65 mm. Hg. One girl (no. 99) with Turner’s syndrome has residual right ventricular systolic pressure of 98 mm. Hg, pulmonary regurgitation, and tricuspid regurgitation. Among the other 11 with residual severe right ventricular hypertrophy by electrocardiogram, there are no postoperative catheterization data; however, eight of these still continue to show improvement in their electrocardiograms. Of the remaining three, two are showing increasing potentials of $R_V$, All three are waiting for reevaluation by catheterization. It should be restated that in one patient (no. 17) the P pulmonale has reappeared 3 years later, although the $R_V$ continues to show diminution in height.

**Postoperative Catheterization Data**

Twenty-two patients have been selectively catheterized and the results are presented in table 5. The basis of selection of these cases was predominantly dependent upon the persistence of significant abnormalities either in symptomatology, physical findings, x-rays, or electrocardiograms. Some were recatheterized at the surgeon’s request, since it was thought, at the end of the operation, that the obstruction may have been inadequately relieved. It may be seen in the table that a satisfactory drop in pressure occurred in all but two of the mild cases (no. 93 and 96). In an addition-
al two patients (no. 99 and 104) with maximal right ventricular hypertension preoperatively, a very satisfactory drop in pressure was accomplished, but the patient was still left with mild right ventricular hypertension. It is interesting to note that among the 22 patients recatheterized there was only one (patient no. 99) who was left, 3½ years postoperatively, with a right ventricular pressure that could possibly be considered as representing some indication for reoperation. It should also be re-emphasized that this group of 22 individuals was selected from the total of 95 because there was some reason to suspect that the operative results were less than completely satisfactory. Most of the others, as indicated in the section Electrocardiographic Findings, showed satisfactory enough regression of the clinical parameters that no repeat physiologic studies were deemed necessary. One final point worth stressing is that patients 15 and 95 were recatheterized twice, showing progressive postoperative drop in pressure.

Comment

It seems that satisfactory results have been achieved in this group of patients using the surgical technic presented. All patients had moderate-to-severe pulmonic stenosis, as indicated by symptomatology, electrocardiographic findings, and catheterization data. The selection of patients for cardiac catheterization largely depended upon (1) the presence of symptoms, specifically dyspnea on exertion, cyanosis, spells or congestive heart failure; (2) auscultatory findings of split of the second sound more than 0.06 second, confirmed by phonocardiograms; (3) the electrocardiographic finding of RV1 of 20 mm. or more. As illustrated by 16 patients in this series, preoperative catheterization was not thought to be indicated in cases in which auscultatory, radiographic, electrocardiographic, and phonocardiographic findings were consistent with classical severe valvular pulmonic stenosis with intact ventricular septum. In the last 2 years relatively more patients with pulmonic stenosis have been operated upon without prior catheterization. The indication for surgery in the catheterized patients depended upon a right ventricular systolic pressure of more than 75 mm. Hg at rest.

Good results are indicated by a small mortality (2.77 per cent), low incidence of serious complications (1.8 per cent) and good hemodynamic relief as measured by symptoms, electrocardiograms, and catheterization.

Table 6 indicates the over-all results obtained after a follow-up of 1 to 6 years in 108 patients.

Summary

A group of 108 consecutive patients with moderate-to-severe pulmonic stenosis and intact ventricular septum, operated upon by means of a pump oxygenator between the years of 1957 and 1961, has been presented.

The total mortality of the series was 2.77 per cent, and an additional 1.8 per cent were left with residual neurologic complications. Fifty per cent of the patients showed an excellent result as indicated by normal electrocardiograms or right ventricular pressure below 65 mm. Hg by cardiac catheterization. An additional 26 per cent had good results.
as indicated by the absence of symptoms, normal x-rays, mild electrocardiographic changes, and in three instances, slight right ventricular hypertension.

Ten per cent had unsatisfactory results based on significant residual abnormalities in the electrocardiograms, x-rays, or postoperative catheterization data.

References

How Medicine Became a Science

The latter part of the eighteenth century is noteworthy for the increase in knowledge of morbid anatomy and surgical pathology. In 1761 the publication of Morgagni's De Sedibus Morborum, a monument of observation in which he correlated the post-mortem findings with the symptoms which had been observed before death, marked an epoch in our knowledge of disease. About the same time John Hunter began that period of intense feverish activity in which he collected, dissected, observed and compared, and finally deduced opinions on which he based his teaching and from which present-day surgical pathology is ultimately derived. His example stimulated others. It was most likely the influence of John Hunter which inspired Edward Jenner and helped him towards the discovery of the value of vaccination against smallpox, and we should also note that Jenner's work was an inspiration to Pasteur fifty years later. It was the first example of experimentally acquired immunity.—Zachary Cope, Kt. Some Famous General Practitioners and other Medical Historical Essays. London, Pitman Medical Publishing Co., Ltd., 1961, p. 189.
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