Proceedings of the British Cardiac Society

THE 56th ANNUAL GENERAL MEETING of the British Cardiac Society was held at The Rupert Beckett Lecture Theatre at Leeds University on Wednesday and Thursday, 13 and 14 April 1977. The President, W. Somerville, took the Chair during private business. At the scientific sessions the Chair was taken by W. Whitaker.

Loss of electrically active myocardium during anterior infarction in man

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A method of 72 point praecordial electrocardiographic mapping of RS ratio changes and the appearance of Q waves during acute myocardial infarction has been developed. Serial praecordial electrocardiographic mapping in 20 subjects with no evidence of cardiovascular disease showed that, when each patient was at rest and in the same position, pathological Q waves could not be found and the RS ratios varied less than ±5 per cent. Changing abnormal areas of R wave loss, RS ratio change, and Q waves could be outlined in patients with anterior myocardial infarction.

The serial changes in RS ratio showing loss of R wave in 40 patients with uncomplicated anterior infarction showed that the regional loss of electrically active myocardium progressed rapidly and was complete within 6 hours from the onset of chest pain.

In these patients creatine kinase ~MB (CKMB) activity (in units ml⁻¹) was first detected in the plasma between 6 and 10 hours and reached a peak at 19.5±1.7 hours (mean ±1SD) after the onset of chest pain.

In this group of patients the regional loss of active myocardium occurred before the appearance of MBCK activity in the plasma. This time course and the relation to the release of plasma MBCK activity is important when considering interventions aimed at salvage of myocardium during infarction of the heart.

Myocardial scintigraphy on a coronary care unit using mobile gamma camera; an aid to positive diagnosis in patients with chest pain

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Sixty-one cardiac scans were performed on patients admitted with chest pain to the coronary care unit. Imaging was performed between 4 hours and 8 days after the onset of chest pain, 2 hours after injection of Tc⁹⁹m stannous pyrophosphate using a mobile gamma camera at the bedside.

In a control group of 37 patients with clinical, electrocardiographic, and enzymic criteria typical of infarction, 34 had positive scans (24 out of 25 transmural and 10 out of 12 subendocardial). Of a group of 11 patients with chest pain without infarction, 9 had negative scans. These results, obtained by 5 observers independently without knowledge of the diagnosis, are highly significant (P<0.001).

Three patients with clinical evidence of infarction, but conduction defects making the electrocardiogram difficult to interpret, had positive scans.

Of 13 patients with crescendo angina, 10, including a further 5 preoperative patients, had positive scans. None of these 13 had new electrocardiographic abnormalities or raised enzymes. These results support the recent concept that patients with crescendo angina may have ongoing myocardial necrosis undetectable by conventional methods. The dividing line between crescendo angina and subendocardial infarction appears artificial.

Influence of location of myocardial infarction on right and left ventricular ejection fraction

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Left ventricular ejection fraction can be estimated from the high frequency fluctuations in count rate over that ventricle after the intravenous injection of a bolus of radioisotope. Since no assumptions are
made about ventricular shape, the technique is applicable in the presence of wall motion abnormalities which may accompany myocardial infarction. It is theoretically also a valid method for the estimation of right ventricular ejection fraction, which is difficult to assess using standard radiological methods.

Right and left ventricular ejection fractions were estimated in 31 subjects. In 10 normal controls the mean left ventricular ejection fraction was 0·68 ± 0·06 (SD) and the mean right ventricular ejection fraction was 0·61 ± 0·05. Left ventricular ejection fraction was depressed in anterior (0·48 ± 0·06), anteroinferior (0·41 ± 0·05), inferior (0·50 ± 0·07), inferoposterior (0·54 in 3 cases), and posterior (0·50 in 1 case) infarction. Right ventricular ejection fraction was depressed in inferior (0·47 ± 0·05), anteroinferior (0·48 ± 0·09), inferoposterior (0·53 in 3 cases), and posterior (0·54 in 1 case) but not anterior (0·58 ± 0·08) infarction.

Right ventricular ejection fraction, which can be determined simultaneously with that of the left ventricle, is a potentially useful measure of right ventricular involvement in myocardial infarction.

99m-Tc imidodiphosphate; a new radiopharmaceutical for positive myocardial infarction imaging

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To demonstrate the uptake of 99m-Tc imidodiphosphate (99m-Tc IDP) by damaged myocardial cells, acute myocardial infarction was induced in 10 rats by ligation of the left coronary artery; they were imaged serially with a standard 11½ in 37PM tube scintillation camera after injection of 500μCi of the tracer. A control group underwent thoracotomy without infarction. Correlation was made between radiopharmaceutical uptake and the degree of myocardial damage determined histologically from sections of the entire heart of the sacrificed animals.

Twenty patients with electrocardiographic and enzymatic evidence of acute myocardial infarction were imaged in the coronary care unit with a mobile low energy (Pho Gamma) scintillation camera 60 minutes after injection of 10 mCi of 99m-Tc IDP. Serial images, obtained for 8 days after admission, showed a high target to non-target ratio. Blood clearance data were obtained in another group of patients undergoing whole body bone scanning with the same radiopharmaceutical. Comparison with similar data for other 99m-Tc labelled phosphates in clinical use (PYP, EHDP, MDP) showed rapid blood clearance.

These results and their relevance in patient management suggest that 99m-Tc IDP, not previously reported in clinical use, is at present the best radiopharmaceutical available for positive myocardial imaging.

Flux of plasma lipoproteins into human arterial intima in vivo

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A role of plasma lipoproteins in atherogenesis is supported by epidemiological data and by analyses of arterial lipoprotein levels. In an ongoing study we are measuring the net rates of lipoprotein entry into arterial intima from plasma in patients undergoing arterial surgery.

Fourteen patients (serum cholesterol 3·06 to 9·9 mmol/l triglyceride 1·27 to 3·84 mmol/l), undergoing aortic or coronary surgery were studied, using autologous 123I low density lipoprotein (LDL) and 123I very low density lipoprotein (VLDL). Lipoproteins were injected 4 hours to 9 days before operation. From plasma and aortic intimal radioactivity net fluxes were determined for apolipoprotein B (apoB).

ApoB from LDL and VLDL, and ApoB from VLDL enter aortic intima. Vein intima showed insignificant activities.

Net flux of LDL-apoB into intima, per unit area, was directly correlated with plasma LDL levels. VLDL-apoB flux was most closely correlated, directly, with fractional catabolic rate of plasma VLDL. LDL-apoB net flux was also inversely related to plasma HDL concentration. These findings suggest that LDL enters the artery at a rate proportional to its plasma concentration, and that VLDL or its metabolic products also enter the intima.
Anatomical correction for classic transposition of the great arteries

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Three patients aged 20 months, 4 years, and 6 years with classic transposition of the great arteries had successful surgical correction by switching the great arteries and coronary arteries into their correct anatomical positions. A fourth patient, aged 10 days, whose left ventricular pressure was 25 mmHg after Rashkind had banding of the pulmonary artery and a left Blalock shunt to raise the left ventricular pressure to systemic levels as a preparation for subsequent arterial correction.

The first three patients were selected for this procedure because the left ventricular pressure was at systemic level because of a large ventricular septal defect in 2, and a duct and atrial septal defect in 1. Removal of an additional subpulmonary fibrous ring was accomplished after transection of the pulmonary artery in 2 patients.

In the first 2 patients where the ventricular septal defects were closed, the pulmonary artery pressure fell to 30 to 35 mmHg, right ventricular hypertrophy regressed, and the patients remain well 6 to 15 months later. In the third child, a large ventricular septal defect was left open after closure of a duct because of high pulmonary vascular resistance and represents a palliative anatomical correction. The child's effort tolerance improved and the systemic arterial saturation rose from 66 to 81 per cent.

If this logical surgical treatment for transposition of the great arteries has a place, the basic management of the infant must change.

Two-stage operation for anatomical correction of transposition of the great arteries with intact ventricular septum

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Anatomical correction of transposition of the great arteries (TGA) by reattaching the aorta, pulmonary, and coronary arteries to the appropriate ventricles is now feasible. The presence of a well-developed posterior ventricle, capable of supporting the systemic circulation (as in patients with additional ventricular septal defect) is essential for the success of the operation. In patients with TGA and intact ventricular septum, the posterior ventricle fails to develop, thus precluding the possibility of primary anatomical correction. To get over this difficulty we have used a first stage operation which consists of banding the pulmonary artery, aortopulmonary shunt proximal to the band, using a homologous vein graft, and atrial septectomy. This procedure was performed in an infant with TGA at the age of 2 weeks. The peak systolic RV/LV pressure ratio which was 3/1 before the first stage, changed to 1/1 at the time of operation and was found to be 1:3/1 after 3 months. Anatomical correction was then performed at the age of 6 months with a smooth postoperative recovery. The child has been followed up for 3 months. Postoperative left ventricular function, assessed by echocardiography and repeat left ventriculography, was found to be normal.

It is concluded that preliminary banding of the pulmonary artery with aortopulmonary shunt can render children with TGA suitable for anatomical correction.

Composite pericardial xenograft for right ventricular outlet reconstruction

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Glutaraldehyde treated composite pericardial xenografts were used between May 1972 and November 1976 for reconstruction of the right ventricular outlet in 24 patients with complex congenital cardiac anomalies. In 22 patients a diamond shaped pericardial patch with a monocusp valve was used while in 2 a complete conduit with a three-cusp valve was inserted. There were 3 early and 1 late (8 months) death unrelated to the xenograft. The 20 long-term survivors have been followed up for a total of 828 months (mean 46). Symptomatically all patients are now in grade I (NYHA).

Pressure recordings at the conclusion of operation showed that the right ventricular systolic pressure varied between 25 and 55 mmHg (mean 36) and the maximum gradient across the pericardial xenograft was 20 mmHg.

Haemodynamic studies were performed in 9 patients, 2 to 49 months (mean 20) after operation. Right ventricular systolic pressure varied between 25 and 60 mmHg (mean 40) and the gradient across the xenograft was between 5 and 20 mmHg (mean 12). Angiography revealed normal mobility and function of the pericardial valve cusps and mild to moderate pulmonary regurgitation.
The very good record of patients’ survival, lack of xenograft calcification, and maintenance of function with the passage of time, fully justify the continued clinical use of the pericardial xenograft for right ventricular outlet reconstruction.

**Side-to-side cavo-pulmonary anastomosis for the palliation of ‘primitive ventricle’**

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The Glenn operation, end-to-side anastomosis of the pulmonary artery to the superior vena cava, is an established palliative procedure for patients with ‘primitive ventricle and pulmonary stenosis’.

Experience with 14 cases during the past 8 years suggests that side-to-side anastomosis is preferable. As the pulmonary artery is not divided the shunt goes to both lungs. The postoperative course is much easier and the clinical result appears much better. It may be that preservation of pulsatile flow to both lungs is helpful.

During the earlier years the operation was done only in patients with extremely low damped pulmonary artery pressure, but more recently pressures up to 30/10 mmHg have been accepted, that being the pressure in a neonate operated on at 16 days with a most satisfactory result.

This operation, like the Glenn, reduces the output of the single effective ventricle rather than increasing it greatly as does a systemic to pulmonary artery shunt.

The anastomosis appears to grow with the child and the pulmonary artery pressure is open to clinical observation and catheterisation.

The operation forms a suitable preliminary to the Fontan procedure.

**Long-term clinical follow-up of patients with pericardial xenograft valve replacement**

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Glutaraldehyde stabilised pericardial xenografts were used between March 1971 and December 1976 for single valve replacement in 285 patients (176 aortic, 106 mitral, and 3 tricuspid). The 267 hospital survivors have been followed up for 9101 months (mean 36).

Actuarial analysis showed a projected survival rate (±SE) at 6 years of 90.1 (±7.5) per cent for patients with aortic and 92.1 (±4.9) per cent for patients with mitral replacement. The embolic rate was 0.58 and 1.7 episodes per 100 patient years respectively, without anticoagulant treatment.

Haemodynamic studies were performed in 30 patients with aortic replacement (AR) and in 27 patients with mitral replacement (MR) at mean intervals of 43.4 (range 27 to 59) and 40.2 (24 to 59) months after operation respectively. Significant haemodynamic improvement was noted in both groups. The mean peak systolic gradient in patients with AR was 6.4 mmHg at rest and 9.6 mmHg on exercise. The mean diastolic gradient in patients with MR was 6 mmHg at rest and 15 mmHg on exercise.

Comparison of data from sequential haemodynamic studies performed in 13 AR and 6 MR patients showed no significant changes between the circulatory parameters recorded at 10 and 42 months postoperatively.

Symptomatically 96 per cent of patients are now in grade I (NYHA). Microscopy demonstrated maintenance of structural integrity of all pericardial xenografts examined.

The very good record of patients’ survival and the low embolic rate fully justify the continued clinical use of the pericardial xenograft for valve replacement.

**Clinical and haemodynamic assessment of Hancock stent mounted heterograft in mitral position**

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Fifteen patients were assessed clinically and by cardiac catheterisation 4 to 32 months (mean 15 months) after isolated mitral valve replacement (12) or mitral and aortic valve replacement (4) with stent mounted porcine heterografts.

After operation, 12 of the patients improved from grades III (9 patients) and IV (3 patients) to grade I (9 patients) and II (3 patients). Three patients remained in grade III, one of whom had severe aortic regurgitation. A mid-diastolic murmur was present in 6 patients. One patient had a systolic murmur suggesting mitral regurgitation.

At cardiac catheterisation the average values were: mean pulmonary artery pressure 30 mmHg (15 to 40), mean pulmonary artery wedge pressure 2 mmHg (9 to 32), left ventricular end-diastolic pressure 18 mmHg (8 to 27), AVO₂ difference 4.1 ml per cent (2.9 to 5.6), cardiac index 2.7 ml/
min per m² (1.4 to 4.1), ejection fraction 51 per cent (10 to 74).

Angiography showed a competent prosthesis in 13 patients and moderate mitral regurgitation in one. In one patient the mean mitral valve diastolic gradient was 15 mmHg and in one it was not measured. In 13 patients it averaged 4.7 mmHg and values tended to be highest in those with smaller prostheses. In 6 patients with a mid-diastolic murmur it averaged 4.0 mmHg.

It is concluded that mitral stent mounted porcine heterografts are satisfactory in the majority of patients, but the smaller prostheses give larger gradients and in some patients the valve is obstructive. Some patients have a mid-diastolic murmur which does not indicate prosthetic valve malfunction.

**Induction of coronary artery spasm with ergometrine**

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Some patients with cardiac pain are found to have either normal coronary arteries or minimal obstructive disease (<50%). We investigated 27 such patients, 18 men and 9 women, aged 19 to 62. Up to 500 µg ergometrine maleate was administered intravenously in divided doses and the coronary arteriogram repeated. Two patients developed their typical pain, distinct ST segment changes, and diastolic narrowing of the right coronary artery of 71 and 64 per cent of the original measurement, respectively.

One patient developed 60 per cent narrowing of the right coronary artery and experienced typical pain without ST segment change. A further 3 patients had narrowing of all 3 coronary arteries by an average of 45 per cent of the original measurement (range 27 to 62%) but did not develop chest pain or electrocardiographic abnormalities in the leads being monitored. Isordil produced prompt vasodilatation in all cases to an average of 114 per cent of control.

We conclude that coronary artery spasm may be the cause of cardiac pain in some patients and that diagnosis may be assisted with the use of ergometrine. There are also clear therapeutic implications.

**Coronary artery ectasia**

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Ten male patients aged 37 to 71 were found to have coronary artery ectasia in a total of 850 studied with coronary arteriography.

Nine patients were severely incapacitated by angina and one by paroxysmal ventricular tachycardia. Six had had one or more myocardial infarcts before study. Five patients had hyperlipoproteinaemia but only 2 had a family history of coronary artery disease. Nine had been heavy smokers. Associated cardiovascular disease was subvalvar mitral regurgitation in 2 and hypertension in 2. Pernicious anaemia was found in 2 cases, 1 of whom had a collagen vascular disease.

The most common ectatic vessel was the circumflex in 6 patients followed by the right coronary artery in 4. Only 1 case had isolated ectasia with other coronary arteries normal. All others showed severe disease or total occlusion of the non-ectatic vessels. Only 1 patient had an ectatic left anterior

**Multistage treadmill testing in selection of patients for coronary arteriography**

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The formidable number of potential candidates for coronary arteriography demands the development of a diagnostic screening technique which will identify those patients in whom this investigation is most likely to be helpful.

We have studied 320 patients by subjective maximal treadmill testing using the Bruce protocol. In this paper we present the results obtained in 50 patients correlated with the findings on coronary arteriography and left ventriculography.

All patients in whom there was ST segment displacement of greater than 2.00 mm had either triple vessel disease or grossly abnormal left ventricular wall movement. ST segment displacement of less than 2.00 mm did not differentiate between single, double and triple vessel disease.

A fall in systolic blood pressure below the resting level was not diagnostic of left main stem disease.

When ST segment displacement was correlated with the percentage change in heart rate x percentage change in mean arterial blood pressure the accuracy of diagnosis was greater than with ST segment displacement alone. Using these values no patient with coronary artery obstruction of less than 50 per cent in any vessel had a positive treadmill result, and the number of false negative diagnoses was reduced from 10 to 2 per cent.

It is concluded that multistage treadmill testing is a useful, non-invasive procedure in the selection of patients for coronary arteriography.
descending coronary artery and a pacing-lactate study showed abnormal lactate metabolism in this case.

Coronary artery ectasia is most commonly a variant of occlusive arteriosclerotic coronary artery disease. Though said to have a poor prognosis, 9 patients followed for up to 2 years are still alive.

Correlation of regional myocardial wall motion with regional perfusion in stable angina pectoris using dual nuclide scintigraphy

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Myocardial wall motion is intimately linked to myocardial perfusion. This relation has been explored in a non-invasive manner during regional ischaemia in patients with stable angina pectoris. Using thallium-201 (T1201) as a marker of regional myocardial perfusion and technetium-99m (Tc99m) labelled autologous red cells as a central blood pool tracer, gated cardiac scintigrams were performed immediately after exercise thallium scintigrams in 25 patients with coronary artery disease.

Segmental quantification of thallium uptake in the left ventricle was correlated with segmental left ventricular wall motion in two planes. A linear relation was found between the degree of myocardial tracer uptake and corresponding myocardial wall motion (r = 0.70, P < 0.001). Regional akinesia was always associated with absent thallium uptake and the corollary that normal wall movement was never associated with absent thallium uptake was also true.

Practically this relation may be used to predict the likelihood of segmental necrosis or segmental ischaemia when defects are seen in exercise thallium scintigrams permitting economy and administrative convenience by dispensing with repeat rest thallium scintigrams.

Finally gated cardiac scintigraphy allowed visualisation of right ventricular movement not provided by thallium scintigraphy enabling right coronary occlusive disease to be predicted accurately in 4 patients increasing the sensitivity of diagnosis.

Unstable angina: clinico-arteriographic correlation and late results of surgical treatment

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Between June 1973 and December 1976, 54 patients with unstable angina (defined by a set of rigid clinical criteria) were studied. There were 50 men and 4 women with a mean age of 53.4 years. Forty patients (75%) had previously had stable angina, the remaining 14 (25%) presented with unstable angina of less than 2 months duration. Twenty-three patients (43%) had a previous myocardial infarction. Forty-eight patients were investigated during the acute phase at Harefield Hospital with no mortality. Of these, 7 patients (15%) were investigated during intra-aortic balloon counter pulsation (IABC) because of persistent severe angina. Fifty-two (98%) had severe narrowing of either the left main coronary artery or the left anterior descending artery, or both. Additional severe lesions in other arteries occurred in approximately 80 per cent. Thirteen patients (24%) required IABC before induction of anaesthesia. A total of 141 grafts was required in the 54 patients (2.8 grafts per patient). There were 2 early deaths (3.7%) and 2 late deaths (3.7%). Follow-up extended between 3 and 40 months (mean 19 months). Perioperative myocardial infarction occurred in 5 patients (9.3%). Thirty-seven patients (80%) were asymptomatic and 9 patients (20%) improved. Thirty-one patients (78%) returned to full-time work. Late myocardial infarction occurred in 2 patients (40%). Thirty-seven patients (75%) were reinvestigated by repeat coronary, graft, and left ventricular angiography between 2 weeks and 40 months (mean 19.3 months). The overall patency rate was 90 per cent. Left ventricular function, as assessed by ejection fraction and pattern of contraction, showed improvement in the majority of patients. It is concluded that patients with unstable angina can be investigated safely during the acute phase, and usually have severe lesions in the left main or proximal left anterior descending artery. The early and late results of surgical treatment have been encouraging. IABC is a valuable aid in the management of these patients.

Long-term follow-up of 100 per cent of 362 consecutive coronary bypass patients

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The first 362 patients at the Buffalo General Hospital to have coronary bypass surgery uncomplicated by ventricular resection, valve replacement, mammary implantation, or congenital heart lesions have been followed for a minimum of 1 year and to death or to the cutoff date. The 5-year survival rate was 87.3 per cent, and was unaffected
by the presence of 1-, 2-, or 3-vessel involvement, unstable angina, or history of a previous myocardial infarction. The presence of a main left coronary artery lesion or of an ejection fraction less than 0.40 affected survival adversely. Patients with 2- and 3-vessel disease did significantly better than analogous groups from the published reports who had been treated medically. After the 28 deaths in the first year survival was statistically indistinguishable from an age- and sex-matched sample of the U.S. population. In 147 patients chosen to match Gazes’s series of medically treated unstable angina the survival was better with surgery. The 30-day mortality in the initial Buffalo General Hospital series, 3.7 per cent, has since fallen to 1.6 per cent in the next 515 cases.

Assessment of myocardial damage after coronary surgery

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The electrocardiograms and left ventriculograms of 40 patients before and up to 36 months after coronary surgery have been subjected to detailed analysis. Ejection fraction in the group as a whole did not change significantly (0.64 ± 0.13 to 0.62 ± 0.13).

In group A (N=12) who had abnormal preoperative function (EF < 0.58) there was a significant improvement in ejection fraction (0.49 ± 0.10 to 0.55 ± 0.07). Using a change of 0.10 in ejection fraction as indicating a significant change, 7 patients in group A improved and 2 deteriorated after surgery. Wall motion analysis indicated that the changes only took place in preoperatively abnormal areas. In those patients with normal preoperative function (group B, N=28), 5 patients developed significant localised wall motion abnormalities. In 2 of these new inferior infarcts, and in 2 extensions of inferior infarcts, were seen electrocardiographically. In one patient a significant inferior wall motion abnormality appeared without electrocardiographic abnormalities. Three septal infarctions were not visualised on right anterior oblique ventriculograms.

After coronary surgery, deterioration in left ventricular function was seen either by extension of previous myocardial damage or by new infarcts. There was no evidence of global depression of function.

The incidence of myocardial damage when assessed by electrocardiogram and wall motion abnormalities in this group was 25 per cent.

Mechanism of left atrial filling in man

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Phasic left atrial filling was studied in 20 patients with mitral or aortic valve disease at the time of cardiac catheterisation using an intravascular electromagnetic flow velocity probe placed transseptally in a pulmonary vein. Recordings were made during quiet spontaneous respiration. Pulmonary vein blood velocity showed phasic variations closely following and inversely related to changes in the left atrial pressure. In patients in sinus rhythm with normal atrial pressure, forward flow in systole was biphasic with an early velocity wave resulting from atrial relaxation and a late wave which peaked soon after the nadir of the X pressure descent in the left atrium, coincidental with descent of the atrioventricular ring. Minimum forward velocity in late systole occurred with the peak of the left atrial V wave.

These velocity/pressure events were observed only in hearts in sinus rhythm with pronounced systolic descents in the left atrial pressure trace. A different left atrial filling pattern was seen in abnormal hearts where the X pressure descent was diminished as a result of left ventricular dysfunction, atrial fibrillation, or mitral regurgitation. In these patients, systolic forward flow in the pulmonary veins was delayed and diminished, occurring at the time when atrial pressure was rising.

The findings suggest that in the normal heart, left atrial filling is by atrial suction and mean left atrial pressure is low. In the presence of abnormal left heart function or atrial fibrillation, transmitted pulmonary artery flow fills the left atrium at the haemodynamic cost of a higher left atrial pressure.

Assessment of aortic regurgitation by transcutaneous aortovelography

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Using the haemotachograph, an ultrasonic Doppler-shift instrument, the instantaneous peak aortic velocity pattern was recorded transcutaneously in 25 normal subjects and 25 patients with aortic regurgitation.
In aortic regurgitation, there was significant retrograde diastolic flow that was not present in normals. The area under the systolic and diastolic waveform was proportional to the forward and backward stroke volume and the ratio between these two areas was used to give an estimate of percentage regurgitation which ranged from 0 to 70 per cent. The peak systolic value in patients with more than trivial regurgitation was higher than the range for normals, but there was no correlation between this value and percentage regurgitation.

The degree of aortic regurgitation in the 25 patients was also graded into mild, moderate, and severe, using clinical, echocardiographic, and aortovelo graphic criteria where available. Comparison of the aortovelo graphic percentage regurgitation with this grading gave good agreement in all groups. The percentage regurgitation in the three grades was 0 to 31 per cent, 32 to 41 per cent, and 42 to 70 per cent.

Ten of the patients to date have been catheterised and the percentage regurgitation assessed by comparison of ventricular output determined by single plane cineangiography and Fick cardiac output. A strong correlation has been obtained with the aortovelo graphic estimate. In the first 6 patients \( r = 0.92 \).

We conclude that transcatheter aortovelo graphic is a simple, accurate, non-invasive technique for the assessment of aortic regurgitation.

**Atypical aortic valve stenosis—a diffuse congenital cardiovascular disease—recognition and surgical management**

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In a consecutive series of 77 patients aged 4 to 16 years who had operation for congenital aortic valve stenosis there were 13 in whom the congenital disease was not confined to the aortic valve and open aortic valvotomy is not the ideal treatment.

In this group, the bicuspid or tricuspid aortic valve is cartilaginous, the aortic root is small often with slight supravalve narrowing, left ventricular subvalvar hypertrophy is pronounced with endocardial thickening over the septum, and echocardiograms show the disproportional ventricular septal thickening. Three had a history of failure and cardiomegaly in infancy which responded to medical therapy. Biopsy of the ascending aorta in 9 showed severe ‘higgledy piggledy’ disorder of the media. After operation, high subvalvar gradients were produced with isoprenalin in 10 despite good relief of the valvar obstruction.

The inevitable valve replacement needed 5 to 20 years after the first valvotomy was difficult owing to the small root and diffuse left ventricular obstruction. We believe that in these patients, who must be identified before the first operation, the correct treatment is complete removal of the aortic root and stenotic valve with reimplantation of the coronary arteries into an adult size homograft, as was first performed in 1965.

In 9 patients the 1- to 11-year follow-up has been good and investigations show relief of obstruction.

**Pulmonary vasculature in congenital heart disease**

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Different types of congenital heart disease can be regarded as vicarious experiments from which it is possible to derive information about the relation between structure and function in the developing lung. In the pulmonary circulation abnormal haemodynamic conditions modify structure even in utero and after birth rapidly influence the development of the acinar region. Before birth pulmonary and aortic stenosis produce different and opposite haemodynamic and structural effects altering the number of intra-acinar arteries formed and the size and wall structure of both pre- and intra-acinar vessels. When the haemodynamic abnormality arises after birth structural changes develop rapidly during the first weeks of life, often leading to the erroneous impression of persistence of fetal muscularity. In young children with ventricular septal defect and pulmonary hypertension an increase in resistance is associated with failure of the intra-acinar pulmonary circulation to develop normally and not with obliteration pulmonary vascular disease. Haemodynamic findings do not have the same structural implications in the immature as in the mature lung. Our findings suggest that in children with congenital heart disease the classical changes of pulmonary vascular disease are superimposed on an incompletely developed pulmonary circulation.

**Double inlet right ventricle**

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A morphologically right ventricle receiving both
atrioventricular valves is a rare but important anomaly. Described as a variant of single ventricle, others have documented similar cases exhibiting remnants of the left ventricle. We have studied 8 examples of the malformation at necropsy. In all the trabeculated pouch of the left ventricle was identified, to the left of the right ventricle in 7 and to the right in the other. Six were from situs solitus individuals, 2 from situs ambiguous patients. Three hearts, including both the latter, had common atrioventricular valves. In 2 of those, and 3 of the 5 with 2 valves, chords straddled the septum to arise from the trabeculated pouch. The greater part of both atrial orifices, however, drained to the right ventricle. In 3 hearts the pouch was devoid of tension apparatus. In all hearts a posterior septum was identified extending to the crux cordis. Therefore, though double inlet ventricles, these hearts were not primitive ventricles. Surgical corrective procedures would be similar in the two anomalies, but differentiation is important because of the variation in position of the conducting tissues. Clinical diagnosis had been difficult in our cases, but was possible by retrospective study of available angiograms. Morphogenetically, the hearts represent the endpoint of a spectrum characterised by straddling of the mitral valve.

**Diagnosis of ventriculoarterial discordance (transposition of great arteries) using contrast echocardiography**

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Using the standard left parasternal echocardiographic approach it is not possible definitely to differentiate the aorta from the pulmonary artery in the neonatal period. However, regardless of the relation of the great arteries at their origin from the heart, the arch of the aorta always crosses the bifurcation of the pulmonary artery superiorly and anteriorly. Thus when both great arteries are identified echocardiographically from the supra-sternal notch the aorta will always be the proximal great artery. The great artery connected most directly to the systemic venous return can be identified using a peripheral injection of 5 per cent dextrose and recording echocardiographically its passage through the echo beam. Using the supra-sternal approach the distal great artery will opacify when the great artery connections are concordant (normal), and when the connections are discordant (transposition) the proximal great artery will opacify. We used this technique retrospectively in 5 cases known to have transposition. Opacification of both great arteries occurred in all 5 cases, because of the bidirectional shunting. In 4, opacification of the aorta was more intense than that of the pulmonary artery. In 1 case with a large ventricular septal defect and free ventricular mixing both great arteries opacified equally. Using this technique we have subsequently accurately predicted the diagnosis in one neonate before catheterisation. We suggest that this technique is a useful diagnostic procedure in ventriculoarterial discordance (transposition) with intact ventricular septum.

**Comparison of real-time B-scan and M-scan echocardiography in total anomalous pulmonary venous drainage**

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Five children aged from 1 month to 8 years with total anomalous pulmonary venous drainage have been studied before operation by ‘Vidoson’ real-time B-scanning and in 4 cases also by M-scan echocardiography. The anomalous drainage was supracardiac in 2 children, at cardiac level in another 2, and infradiaphragmatic into the portal vein in 1 infant. In 1 child with the supracardiac variety, there was also transposition of the great arteries.

On M-scan the abnormalities previously described (Paquet and Gutzgesell, 1975) were confirmed in 3 cases, but the pulmonary venous chamber could not be identified in the child who also had transposition. In contrast, this chamber behind the left atrium was visualised in all cases on B-scan, and furthermore it was clearly different in the 3 types of anomalous drainage. The features of right ventricular volume overload were present on echocardiograms by both techniques in all cases with isolated total anomalous pulmonary venous drainage.

Postoperative studies were obtained in 1 child. Though the right ventricle was still enlarged, septal motion had become normal. The posterior venous chamber was no longer visible on M-scan, but on B-scan a smaller chamber could still be seen.

This study indicates that B-scan echocardiography is at least as good as the M-scan technique for diagnosing total anomalous pulmonary venous drainage and that it gives added information on the type of drainage involved.

**Reference**

Factors influencing prognosis of patients on pacemakers

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Between the years 1960 and 1974, 839 patients were paced for chronic atrioventricular block.

Analysis of survival compared with the general population showed that 169-9 deaths were expected according to standard mortality tables and 288 deaths occurred, giving a ratio of actual to expected deaths of 1.7:1.

As expected, those patients with a history of myocardial infarction or cardiac failure showed a higher than average mortality when paced. Mortality was not influenced if heart block had been established or intermittent, whether the ventricular rate was below or above 40 per minute or whether QRS duration was greater or less than 0.1 s.

Analysis of the age groups paced revealed the most important correlations. Between the ages of 80 and 89 years paced patients could expect to survive as long as others of the same age without heart block. There was, however, a very high mortality ratio of 4.46:1 for 90 patients in the age group 50 to 59 years. The reason for the high mortality ratio was uncertain but it may have been the result of the greater incidence of coronary artery disease in this group, and perhaps, therefore, further investigations with a view to coronary artery surgery should be considered for such patients. Preliminary studies will be discussed.

Relation between posture, pulse pressure, and electrophysiological properties of atrioventricular pathways in patients with paroxysmal supraventricular tachycardias

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In 7 patients with paroxysmal supraventricular tachycardia, measurements of femoral artery pressure during an intracardiac electrophysiological study were repeated at four different angles of head-up tilt (0, 15, 30, 45 degrees), permitting observation of the relation between pulse pressure, posture, and atrioventricular conduction and refractoriness.

Pulse pressure varied most at the onset of rapid fixed rate atrial pacing, the initial fall being greater with the patient tilted. Once the pulse pressure was stable it fell little more if the tilt was increased.

Changes in atrioventricular nodal conduction time (AH interval) at the onset of fixed right atrial pacing were not closely related to changes in pulse pressure, but shortened with increasing tilt once pulse pressure was stable.

Cycle length, atrioventricular nodal conduction time, and refractoriness, pulse pressure and posture being interrelated, may all vary during paroxysmal re-entry atrioventricular tachycardia: this relation was studied in 4 patients in whom such attacks could be induced.

Pulse pressure fell most rapidly during the latter part of continuous incremental atrial pacing: the fall was more pronounced at increased degrees of tilt. Both the cycle length at which second degree atrioventricular block occurred and the shortest RR interval during incremental atrial pacing shortened with increased tilt.

These findings help explain the clinical features and mechanisms of paroxysmal supraventricular tachycardias.

Recognition and implications of concealed pre-excitation

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In manifest ventricular pre-excitation both the normal and accessory atrioventricular pathways conduct anterogradely. We have recognised concealed pre-excitation in 21 of 66 cases of paroxysmal re-entry atrioventricular tachycardia, as well as in 6 of 13 with lone atrial fibrillation.

Of 79 patients who underwent intracardiac electrophysiological study, 45 had the Wolff-Parkinson-White syndrome (WPW); 17 had concealed pre-excitation with a normal resting surface electrocardiogram.

Of 11 with a partial atrioventricular nodal bypass, only 6 had the Lown-Ganong-Levine syndrome (LGL), the other 5 showed a normal PR interval. Lone atrial fibrillation occurred in 2 with concealed WPW and in 4 with hidden LGL.

Alternating cycle lengths and either a fixed ventriculoatrial or atrioventricular conduction time during treatment of paroxysmal re-entry atrioventricular tachycardia suggested the presence of an accessory pathway in 18; in 11 of these pre-excitation was otherwise concealed.

Bundle-branch block that developed during paroxysmal re-entry atrioventricular tachycardia and that prolonged its cycle length showed hidden WPW in 4. In 2 with established bundle-branch
block and in another with hypertrophic obstructive cardiomyopathy, the resting electrocardiogram obscured the WPW syndrome.

Three with an inverted P wave in lead I during paroxysmal re-entry atrioventricular tachycardia had concealed left-sided accessory pathways. In 4, pre-excitation became apparent after spontaneous atrial arrhythmias.

Knowledge of the presence of an accessory pathway in patients with paroxysmal arrhythmias often assists subsequent investigation, assessment, and management; these observations form a basis for revealing pre-excitation from the electrocardiogram in cases where this is otherwise concealed.

**Junctional recovery and conduction times in congenital complete atrophic ventricular block**

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Twenty patients with congenital, complete heart block were studied by intracardiac electrography and programmed stimulation. All patients had narrow QRS complexes and supra-Hisian block. HV intervals varied from 20 to 55 ms (mean 39 ± 11). The His depolarisation was validated by His bundle pacing.

Junctional conduction times were measured by isolated His bundle extrasystoles. The junctional conduction times varied from 45 to 120 ms (mean 75 ± 28). In 5 patients the junctional conduction time was significantly (P < 0.01) reduced after the administration of intravenous atropine (0.3 to 1.0 mg) and increased (NS) by intravenous verapamil (0.1 mg/kg) in 4 patients.

The recovery time of the natural pacemaker after various durations and frequencies of fixed rate His bundle pacing was measured. Maximum recovery time was achieved at frequencies above 100 bpm for durations of 1 minute or more. The maximum recovery time of the natural pacemaker did not correlate with symptoms. It was significantly reduced by atropine (P < 0.001) and insignificantly reduced by verapamil. The maximum recovery time after atropine correlated with symptoms.

The mean junctional conduction time, prolongation by verapamil and reduction by atropine, suggests a high atrioventricular nodal natural pacemaker. The post-atropine maximum recovery time of the natural pacemaker may determine the need for permanent pacing.