PATHWAYS TO SURGICAL DIAGNOSIS

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Introduction

AT THE TIME when Lord Moynihan developed his many contributions to general and abdominal surgery, international relations were not as close as they are fortunately to-day amongst surgeons all over the world. Nevertheless, the Moynihan-clamp made his name familiar even to German theatre nurses. This symptom may well be taken as a sign of the brilliant technical skill for which the man, whose name is to be honoured by this annual lecture, was so famous.

Referring to the human attitude in his daily professional work, Sir Geoffrey Keynes, in his Moynihan Centenary lecture in 1965, recalled the simple truth of his often-repeated saying: *'The most important person at an operation is the patient, for whom Surgery may be often one of the most important events in his life.'* Our profession has always been particularly aware of this fundamental fact and furthermore that there cannot be any surgical therapy without adequate diagnosis.

Classical and special methods of diagnosis

Amongst 30,000 clinical diagnoses of different aetiology and location, surgery—according to the German statistician Leiber—has to deal with around 6,000 diseases and 2,000 traumatic situations. In almost every case our pathways to surgical diagnosis lead to the positive or negative decision on surgery in which the final responsibility of our profession lies.

For every one of our patients the *classical methods of diagnosis* (without any ancillary aids) remain indispensable (Fig. 1). Of the five senses of the examining physician even the somewhat atrophied sense of smell has its place in cases of coma, gas gangrene or other infections. Only the gustatory nerve has had to make way for the more sophisticated means of demonstrating reducing sugars in urine.

According to an estimate of the old Viennese school of internal medicine, the *patient's history* provides an important clue in 70–80% of cases. Quite apart from its importance for the human contact between patient and surgeon which more often than not represents the first step towards therapy, the history often sets the diagnostic signals. This point may be illustrated by a 17-year-old girl with organic hyper-

This Moynihan Lecture, given on 1st April 1971, is dedicated by the author to Professor Rudolf Nissen, formerly Professor of Surgery, University of Basel, Switzerland. Nissen reaches his 75th birthday this month (9th September), which is also the 40th anniversary of the first pneumonectomy—performed by Nissen.

insulinism whose graphic description of early morning drowsiness and the stimulating effect of the ingestion of sugar solution finally led to the removal of two separate pancreatic adenomas.

Inspection and *palpation* are the very basis of every surgical examination, often leading to the diagnosis within fractions of a second, as may be the case with some superficial skin lesion, with an advanced breast cancer, with an aneurysm of the abdominal aorta, pulsating under our fingers, with a case of gastrointestinal bleeding due to *Osler's* disease or an ileal invagination caused by *Peutz-Jeghers* syndrome, showing the haemangiomas or melanomas on the lips. The accuracy of the necessary thinking process depends upon the flexible memory and the stored

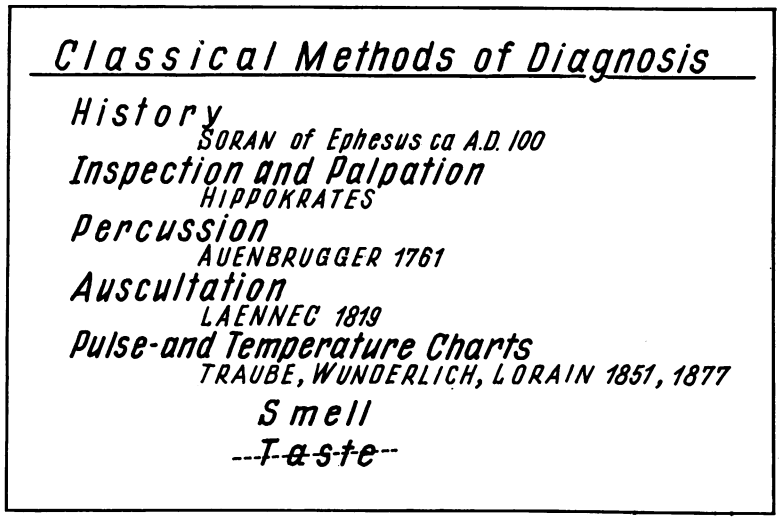


Fig. 1. Classical methods of diagnosis.

knowledge in the cerebral computer of the examining surgeon, not to forget imagination and some luck.

Percussion and auscultation of the chest has to-day been largely replaced by X-rays, and yet it offers a quicker hint to the presence of postoperative pleural effusion or pneumothorax. The stethoscope, too, must remain within the surgeon's reach, as witness of the presence or absence of bowel sounds in the abdomen, the systolic hiss of an arterial stenosis or the palpable and audible machinery murmur of an a-v. fistula.

Furthermore, it is a matter of daily experience (particularly on accident units) that the continuous observation of *pulse* and *blood pressure* has retained its place successfully (and at the same time so cheaply) in the detection of existent or imminent shock even in this electronic and nuclear age.

Such a résumé is intended to underline the importance of the classical methods of examination, which even to-day suffice in a substantial proportion of our routine surgical cases. The same applies to acute emergencies (haemorrhage, tension-pneumothorax or cardiac arrest), in which the mere suspicion demands immediate surgical intervention in order to avert a life-threatening situation.

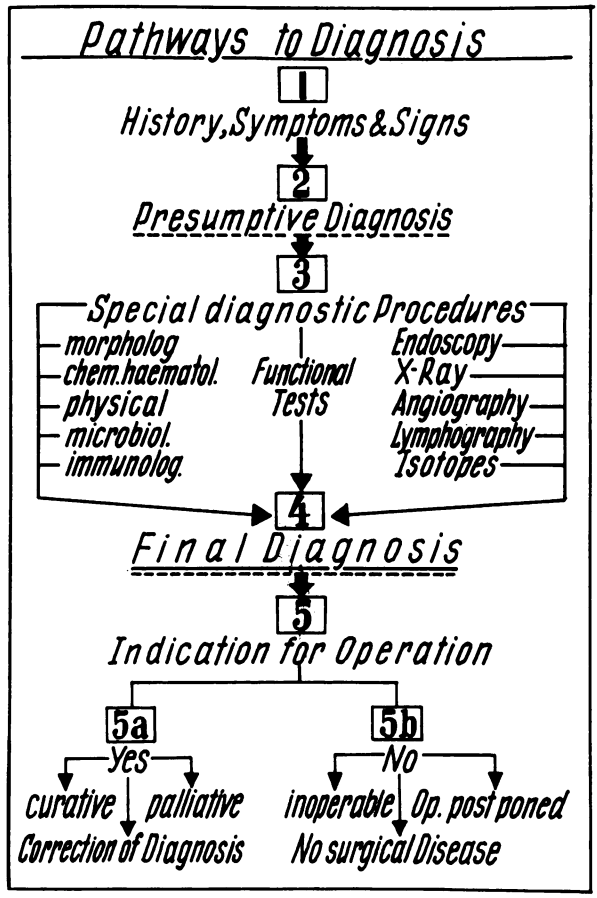


Fig. 2. Pathways to surgical diagnosis.

Also in the majority of the elective or more complicated surgical cases *simple clinical examination*—sometimes with the help of time and by means of repetition—provides a presumptive clinical diagnosis regarding the kind and location of the disease in every case (Fig. 2). This will then be largely confirmed or excluded by *special diagnostic procedures*. These owe their development to the advances of scientific medicine within the last 100 years, manifesting themselves in numerous

laboratory tests with contributions ranging from morphology, biochemistry, microbiology, physics and on to immunology. Much of this leads directly to the diagnosis, as in the case of biopsy in malignant disease. More important, however, is the contribution of most laboratory procedures to the general assessment of operability and for the maintenance of pre-, intra- and postoperative homeostasis.

Finally, much has become detectable as to the shape and function of numerous organs that was hitherto invisible. Endoscopy, conventional X-ray procedures with or without contrast media, angiography, lymphography and scintigraphy have refined and extended the classical method of inspection. With their aid the final surgical diagnosis is made and the indication for operation is confirmed or negated. In the positive case a curative or palliative intervention results, provided that the

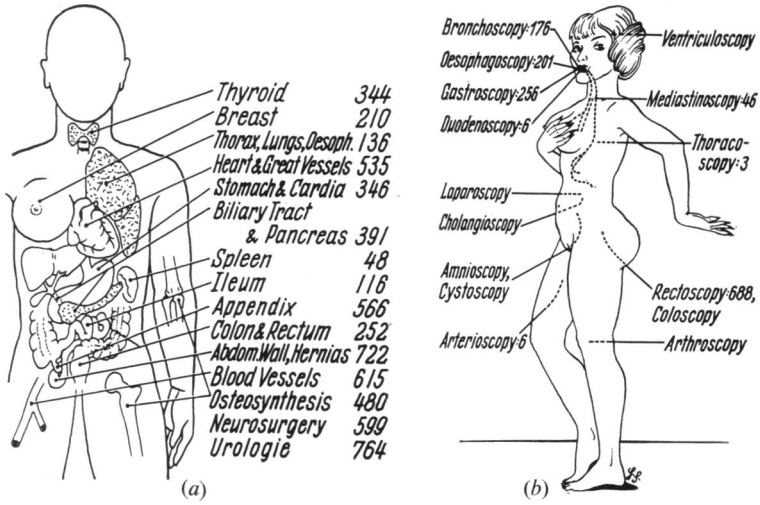


Fig. 3. (*a*) Operations (1969: 8,491 on 10,262 hospitalized patients) and (*b*) endoscopies (1970), Surgical Clinic, Heidelberg University.

diagnosis is confirmed on the operating table. In the negative case, the operation does not take place, because the optimal time has not yet arrived (delayed or postponed operation) or because of inoperability or the absence of a surgical ailment.

Prospective study

The importance of each of these diagnostic procedures for the single case can easily be demonstrated. With the aim of not leaving the question of their frequency and distribution and particularly their relevance entirely to common impression, we carried out a prospective study in our department (Fig. 3). The Heidelberg clinic with its 480 surgical beds appears to be particularly suited for a study of this kind. Besides general surgery, all specialities (from neurosurgery, urology,

cardiac, vascular, plastic and traumatic surgery) are here gathered under one roof and all have to treat the very mixed clientèle of a university and a provincial hospital as well.

In the last quarter of 1969 some 50 different diagnostic procedures were registered which were applied in the care of 2,784 consecutive in-patients. In order to facilitate this comprehensive review it was expedient to gather certain procedures together into seven main groups, although these again were linked in every conceivable combination. Symptoms and signs were registered together with the final diagnosis in so far as this was characterized by *pathological anatomy* and *localization*.

The analysis (Fig. 4*a* and *b*) showed that in a first group of 559 patients the diagnosis was made entirely with the aid of physical

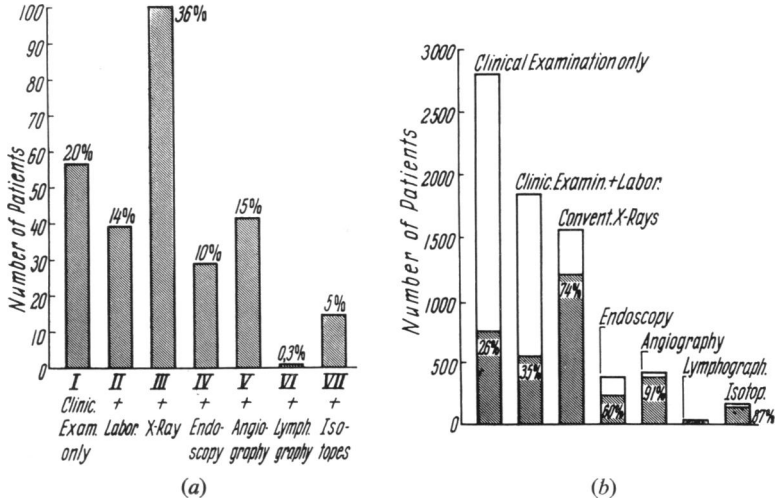


Fig. 4. Frequency (*a*) and efficiency (*b*) of diagnostic procedures in 2,784 patients.

examination in the classical sense. That is 20% of the sample, including hernias, hydroceles, skin tumours, etc. A further group comprised 399 patients (= 14% of the total) in whom, according to the widest sense of the term, laboratory tests were used, such as biopsy of a rectal polyp or the examination of blood and urine in cases of an acute abdomen.

In the remaining groups III–VII, clinical examination and for the most part laboratory tests are included. The burden of diagnosis, however, rested on conventional X-rays, endoscopies, angiographies, isotope procedures or lymphographies. Overall two-thirds of all patients were examined in one way or another by X-rays. The group of conventional X-rays for diseases of the stomach and gut, the biliary tract, the lungs as well as for fractures made up 36%. Endoscopy—usually in combination with conventional X-ray examination—was

used in 10%, angiography in 15% and isotope methods in 5% of this group of patients. Only lymphography with less than 1% played a minor rôle.

In order to obtain information on the practical significance of the various methods the data-sheet for each patient not only contained a list of all the diagnostic procedures utilized, but also the *decisive diagnostic method* had to be specified. The answer to this question was naturally subjective. It was given by the residents (i.e. the coming surgical generation) and it is an attempt at assessing something like an efficiency quotient for each diagnostic procedure from its frequency and effectiveness. Accordingly only 35% of all lab-tests were of decisive significance, the field being led by the histological findings of biopsies. In comparison, the effective field of routine chemical and haematological examinations was smaller, since these serve more of a monitoring function. It would certainly be hard to find a majority of surgeons in favour of the sole diagnostic value of the white-cell counts or haemoglobin and haematocrit estimations as other diagnostic methods. On the other hand none of us would be so nihilistic as to deny the value of clotting factor examination in haemophilia, serum amylase in pancreatitis, acid phosphatase in prostatic carcinoma, etc. In contrast to this, 74% of all X-ray examinations contributed important information as well as 60% of all endoscopies, proctoscopy with nearly 100% and mediastinoscopy with 40% working opposite ends of the scale. The proportion of decisive findings reached the top of 90% for angiographies, making a significant contribution to our diagnostic endeavours mainly in cardiovascular surgery.

Special evaluation of diagnostic methods

So much for the general background of surgical diagnosis as seen at our Heidelberg clinic. The following remarks are concerned with the demonstration of some special clinical pictures in which, in our view, modern methods of the kind mentioned have provided real progress in reaching a diagnosis. However, this does not mean that a correct diagnosis before or during operations could not have been reached without their use in many of these cases which follow.

The lady in Figure 3 (*b*) demonstrates the manifold possibilities of endoscopy with its well-known advantages of intraluminal inspection and biopsy. The figures in the picture give the number of each examination carried out in our clinic in 1970. Suffice it to point to the importance of mediastinoscopy in saving many a patient with bronchial carcinoma from an unnecessary exploratory thoracotomy.

Modern flexible fiberscopes open up hitherto unexplored vistas. To-day they have proved their value especially in oesophageal and gastric disorders. Thus, tumours of the fundus that may escape the

radiologist can be detected. On the other hand, radiological findings can be substantiated by biopsy evidence of malignancy. Amongst the causes of upper g.i.-tract bleeding that go undetected by barium meal, acute gastric erosions can be visualized. Whilst coloscopy reaches gradually up to the caecum and ileum, duodenoscopy gives a direct view of the papilla. This opens new possibilities not only for the diagnosis of papillary carcinoma but also for retrograde visualization of the common bile and pancreatic ducts.

This leads us on to *conventional X-ray methods*, which—with or without contrast media—contribute the lion's share of our daily diagnoses. Two examples serve to illustrate well-established procedures.

(*a*) Direct liver puncture by means of percutaneous transhepatic

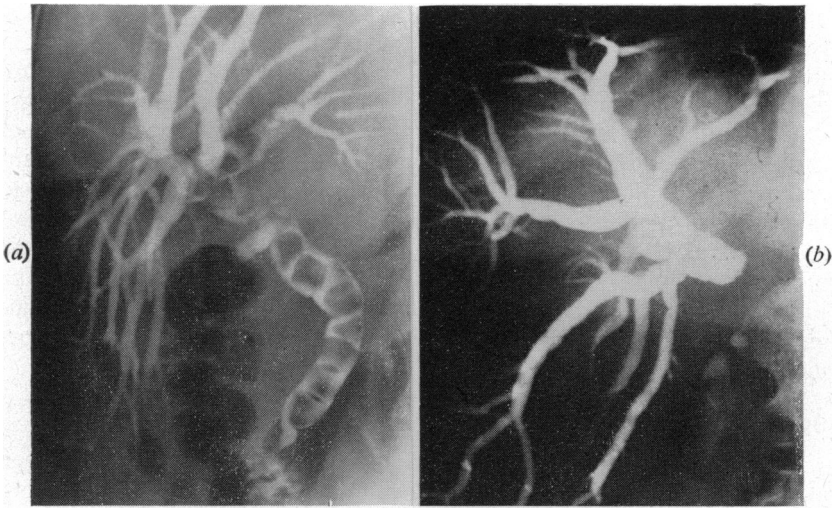


Fig. 5. Transhepatic percutaneous cholangiography: (*a*) choledocholithiasis; (*b*) bile duct obstruction by a tumour.

cholangiography (P.T.C.) has opened new possibilities in the differential diagnosis of obstructive and hepatogenic jaundice. In the case of the former the rate of correct diagnosis as regards localization now approaches up to 90%. Furthermore, the aetiology of obstruction (stone, tumour or stricture) can usually be ascertained, especially in combination with other methods such as hypotonic duodenography. Amongst 250 'P.T.Cs.' of our clinic—practically without complications—there were numerous cases of apparently certain hepatitis with equivocal enzyme values that turned out to be of mechanical origin. On the other hand, laparotomies were avoided because in cases of hepatitis the biliary passage was shown to be patent or because inoperability was proved by intrahepatic tumour obstruction.

(*b*) Another useful adjuvant to our clinical and morphological techniques of examination is galacto- and mammography. It is a matter of common experience that early cases of carcinoma may thus be detected that escape palpation especially in voluminous breasts. Nevertheless, mass-mammography for carcinoma of the breast is no more likely to be the answer to early cancer detection on a large scale than is mass radiography of the chest for bronchial carcinoma. Here the clinical examination will certainly maintain priority.

Finally, there is a kaleidoscope of clinical examples to illustrate the *diagnostic significance* of *scintigraphy* and *angiography*. The latter has proved its worth, not only for the extremities, but also for the viscera of the three main cavities of the body. We consider ourselves fortunate in having a division of diagnostic radiology under Professor Wenz in our surgical clinic.

Since Moniz, carotid angiography has been of help in cerebral trauma. In recent times, this method has also proved valuable in the *definition* of *cerebral death*. Absence of internal carotid and vertebral filling in cases of cerebral trauma or increased pressure in addition to clinical absence of reflexes and zero E.E.K. tracing facilitates an early declaration of death. This procedure, recommended by the German Surgical Society since 1968, has proved an excellent guide for the continuance or cessation of efforts at reanimation as well as for transplantation surgery.

Selective or complete angiography of the cerebral arteries has led to the recognition of extracranial occlusions in some cases of *stroke*. A considerable number of these are amenable to surgery. The most frequent case is an acute thrombosis superimposed on an arteriosclerotic plaque. The chances of complete recovery are dramatically improved, if arterial reconstruction can be performed within the 8-hour limit.

A 13-year-old boy developed a right-sided hemiplegia and aphasia 24 hours after falling on his head from a vaulting-horse. Carotid angiography (Fig. 6*a*) excluded the expected intracerebral lesion and showed an occlusion of the internal carotid instead. Blunt trauma had led to an intimal tear with apposition-thrombosis right up to the base of skull. A ringstripper removed the thrombus and a vein patch helped to fix the intima, with complete recovery.

Parathyroid adenomas usually escape angiographic detection unless they exceed $\frac{1}{2}$ cm. in diameter. Then, however, angiography may provide a clue as to a dystopic localization. The results of scanning (with 75-selenium-methionine) have not always satisfied our nuclear physicists when watching our operative findings, so that even to-day the operation of parathyroid adenoma still includes some of the thrills of hunting.

Benign and malignant *thyroid diseases* are the special province of radio-iodine scanning, where its value is undisputed. In our endemic goitre region solitary 'cold' nodules are malignant in only 8%. The amazing scope of scintigraphy, particularly in localizing atypically situated thyroid tissue (from lingual thyroid to distant metastasis of a

carcinoma), is demonstrated by this example of a true thoracic thyroid. It was located in the posterior mediastinum and had no parenchymal or vascular connections with the normal cervical thyroid.

Angiography of the pulmonary vessels for congenital anomalies, infections or tumours occasionally leads to important additional findings, as in the case of a demonstrated 'coin lesion' that clearly represented an *a.-v. aneurysm* (Fig. 6*b*).

The modern possibilities of therapy in the case of massive *pulmonary embolism* make the differential diagnosis as against similar clinical pictures, such as myocardial infarct or insufficiency, particularly urgent. Westermark's sign of the 'translucent lung' helps to arouse a suspicion,

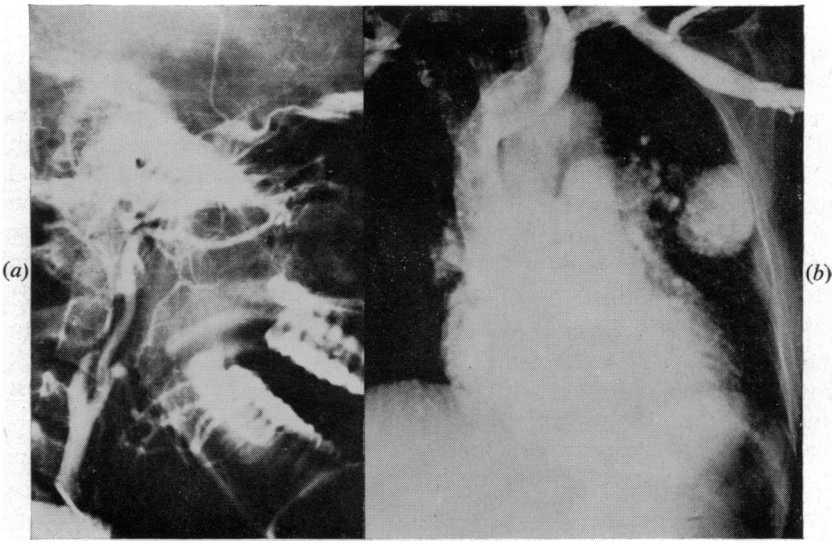


Fig. 6. (*a*) Acute thrombosis of the carotid artery after blunt trauma. (*b*) Arterio-venous fistula of the lung in Osler's disease.

that can best be confirmed by serial angiography performed right next to the operating theatre. At the present this is probably quicker and simpler than a scintigraphic examination.

The progress made during the past 20 years in the field of *cardiovascular surgery* would be unthinkable without the topical diagnosis provided by angio- and cardiography. X-ray pictures of the coronaries with localized stenosis have set the stage for reconstructive procedures for coronary insufficiency. The mere quantity of work awaiting us here may well open up a new subdivision within cardiac surgery in the future.

The number of fatal traffic accidents has reached lamentable proportions in Germany—some 19,000 in 1970. Amongst the road victims there is a considerable number of ruptures of the aorta (Fig. 7*a*) at

the site of predilection; the isthmus. Amongst those who reach the hospital alive, aortography defines the extent of the lesion, the reconstruction of which, with the aid of left-heart bypass, has become a routine procedure. The possibility of mistaking an aortic aneurysm or diverticulum (Fig. 7*b*) for a mediastinal tumour on the plain chest film was brought home to us by this 12-year-old boy. Only after unexpected pulsation was encountered during right thoracotomy was aortography performed. It led to a second left thoracotomy with resection and interposition of a prosthesis.

Scintigraphy of the liver by demonstrating displacement of the organ can help to explain changes in right diaphragmatic contour. This can occur cranially for instance in diaphragmatic hernia, relaxation or after

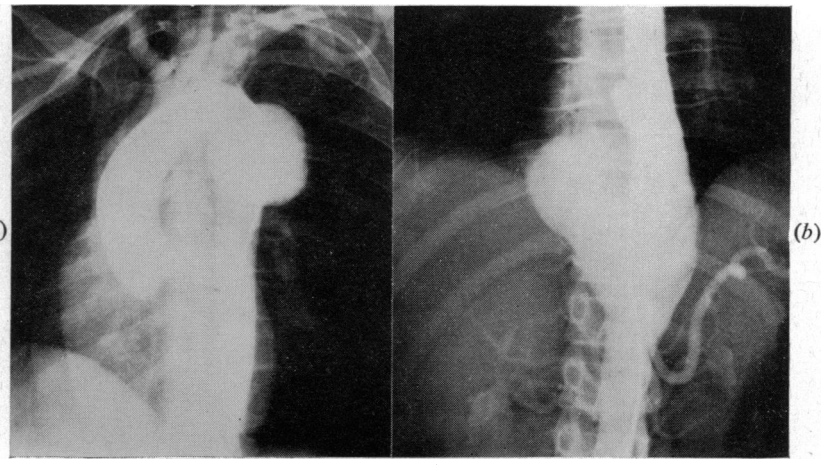


Fig. 7. (*a*) Aortic aneurysm after traumatic rupture (*b*) Congenital diverticulum of thoracic aorta.

pneumonectomy (Fig. 8). Similarly caudal displacement of the liver can help to demonstrate a subphrenic abscess. Haematomas, abscesses, echinococcal cysts and above all metastases may all give rise to intrahepatic filling defects, when the diameter of the lesion exceeds 2.5 cm.

Selective angiography has proved useful but by no means indispensable in certain cases of *blunt abdominal trauma.* Ruptured parenchymal organs, such as the *liver, spleen or kidney* (Fig. 9*a*) can be visualized in a manner hitherto unknown, thus helping to determine the site of the incision. Nevertheless, in blunt trauma of the abdomen, we can never depend upon the angiographic diagnosis. Too many injuries with radiologically invisible tears of the mesentery, the pancreas

or even the gut have proven the limits of these additional procedures as well as the value of the classical examination.

In cases of *haemolytic jaundice* investigation with marked chromium (Cr^{51}) demonstrates not only the reduced survival time of erythrocytes but also their premature burial in the graveyard of the spleen by showing an increase in the spleen-liver quotient. This enables the surgeon to foretell more accurately the possible palliation by splenectomy.

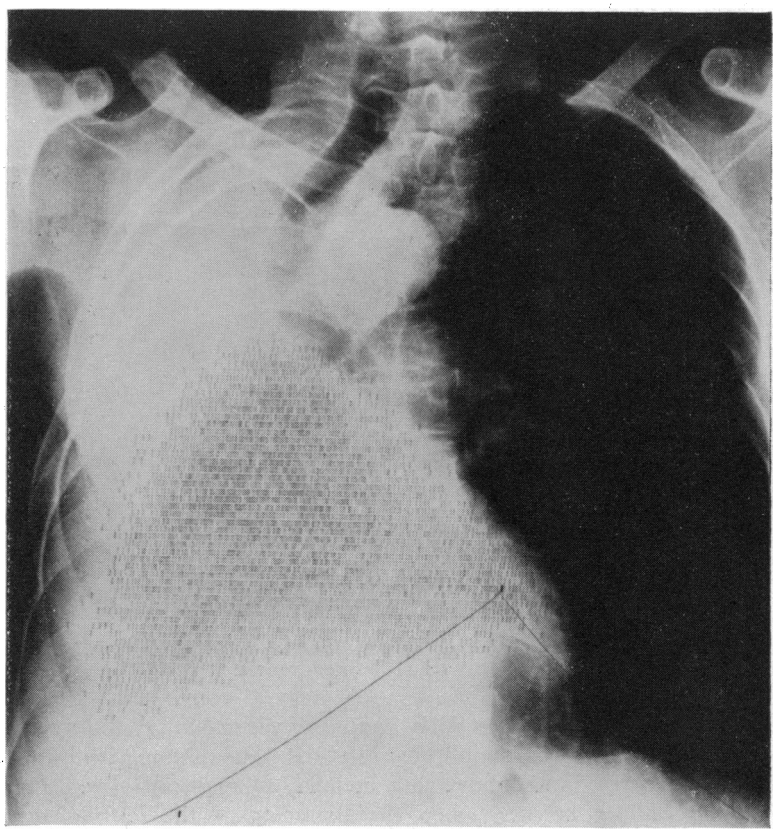


Fig. 8. Chest plate and liver scintigram after pneumonectomy.

Amongst the operable forms of hypertension *renal artery stenosis* has come to be of increasing importance. In more than 100 operated cases the Anger camera has proved to be a very useful screening test that causes the patient a minimum of discomfort. But it remains for angiography to demonstrate the exact anatomical situation, as in this 26-year-old patient (Fig. 9*b*) with a blunt abdominal trauma. Aortography showed total occlusion on the left and severe stenosis of the

right renal artery due to traumatic dissection of the intima opposite the origins of the renal arteries.

The angiographic demonstration of adrenal tumours like a *phaeochromocytoma* can not only confirm the diagnosis of yet another operable form of hypertension. By preoperative localization it also helps

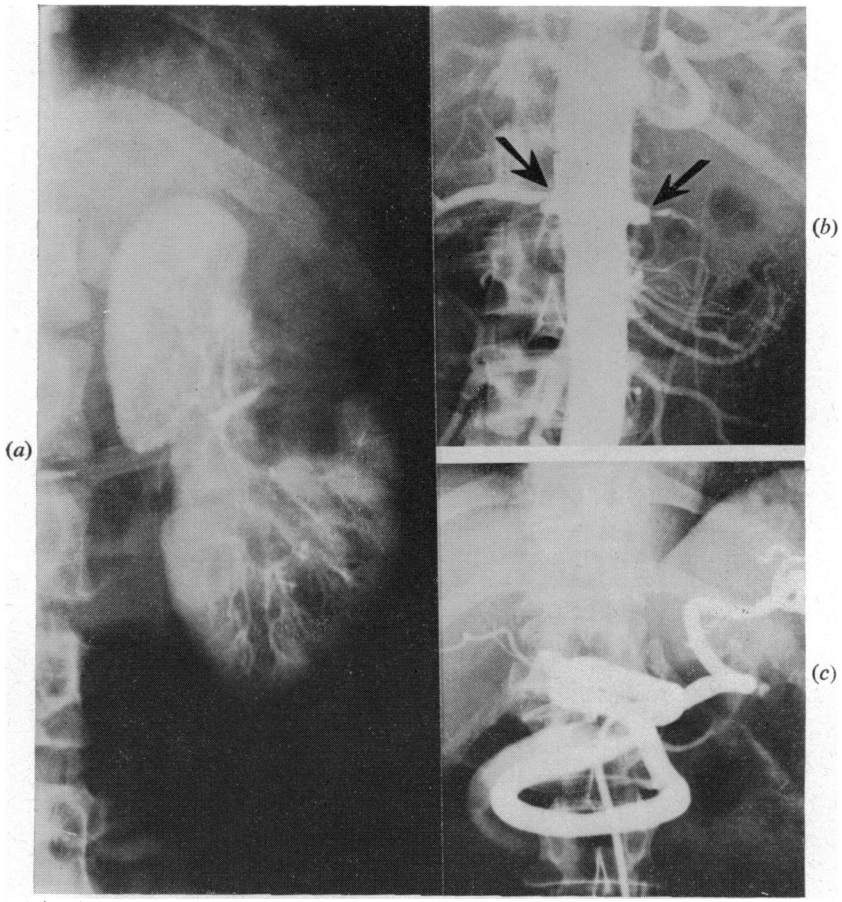


Fig. 9. (*a*) Rupture of kidney demonstrated by selective renal arteriography. (*b*) Lesion of both renal arteries by abdominal trauma. (*c*) Arterio-venous fistula of gastroepiploic vesssels after partial gastrectomy.

determine the site of the incision. The same applies to *Cushing's syndrome*, in which angiography may differentiate between an adenoma (Fig. 10*a*) or carcinoma and the more common bilateral hyperplasia.

Amongst the diseases of the *pancreas*, the insulinomas can occasionally—by no means always—be recognized by increased vascularity. In carcinoma of the pancreas, displacement of the pancreatico-duodenal

artery and the ingrowth of atypical vessels into the tumour area can give important clues. However, this method is not yet satisfactory when it comes to the all-important early diagnosis. The same applies to scanning with 75 Se-Methionine.

Angiography has been useful also in the *localization* of *gastro-*

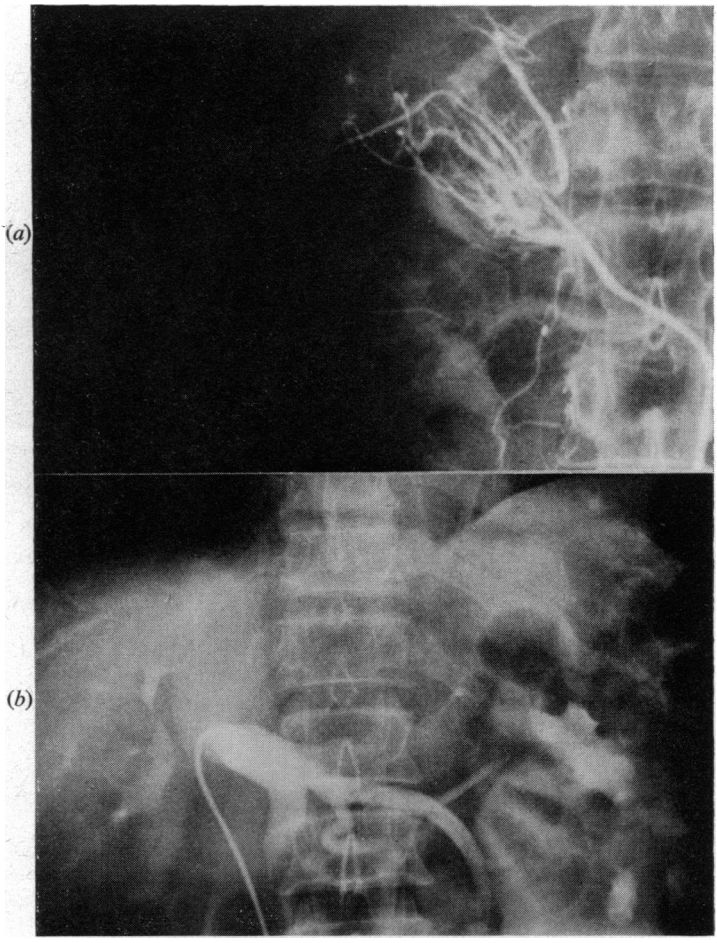
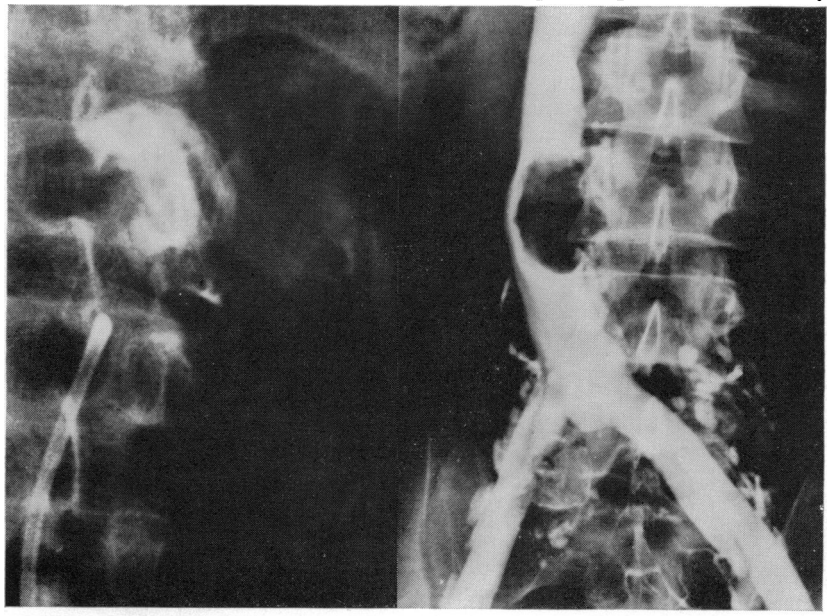


Fig. 10. (*a*) Adrenal adenoma in Cushing's disease. (*b*) Demonstration of patent porto-caval shunt by catheter-cavogram.

intestinal haemorrhage. Although fluoroscopy and endoscopy should have preference here, an increasing number of sources of bleeding are being found that have escaped conventional examination. In the stage of actual bleeding—whenever this exceeds 1.5–2 ml. per minute—it may be possible to observe an intraluminal smudge of contrast medium

as in Figure 11 (*a*) after a partial gastrectomy. Also tumours of the small intestine, occasionally causing melaena, can be visualized by angiography.

In patients with bleeding *oesophageal varices* (which comprise 15–20% of all our G.-I. bleeders) we would not like to miss a pre-operative demonstration of the portal vein. The differential diagnosis between intra- and extrahepatic block and the extent of possible thromboses help in planning the operation and the most suitable incision. Splenoportography in addition gives information on the portal pressure, whereas coeliac angiography in its venous phase provides the only



(*a*) (*b*)

Fig. 11. (*a*) Gastric bleeding, intraluminal smudge of contrast medium shown by angiography. (*b*) Impression of lymph node metastasis on vena cava inferior (catheter cavogram).

means of visualizing the portal vein in post-splenectomy bleeders. If a previously splenectomized patient bleeds again after a shunt operation, the portocaval anastomosis can be reached angiographically via the inferior vena cava. In the patient of Figure 10 (*b*) the shunt was patent and the cause of bleeding was finally found, as often, in the stomach.

Another form of portal hypertension can arise due to an increase in blood volume as a result of congenital or acquired *arterioportal fistulae*. Figure 9 *(c)* shows an iatrogenic arterioportal fistula of the gastro-epiploic vessels which had developed after partial gastrectomy at the site of a mass ligature.

In the region of the small intestine obstructive processes of the mesenteric vessels are amenable to arteriographic examination. In cases of *mesenteric embolism* selective arteriography should be performed as soon as possible, so as to establish the diagnosis and permit embolectomy before gangrene supervenes. Unfortunately the number of patients saved by embolectomy alone (that is without some more or less extensive bowel resection) is small. More fortunate are those patients in whom chronic mesenteric arterial obstruction leads to the warning symptoms of abdominal angina and malabsorption.

The principal domain of angiography will always be the chronic and more rarely the acute occlusive disease of the lower limbs. Here it gives information as to indications, operative technique and results. More rarely it is applied in fractures with peripheral ischaemia in order to distinguish between spastic, organic or traumatic lesions of the arterial wall.

Direct visualization of peripheral veins and both venae cavae has special significance in post-thrombotic conditions and in the search for metastases. The circumscript impression on the inferior vena cava due to a metastatic lymph node of a genital carcinoma led us to assume an inoperable situation (Fig. 11*b*).

Conclusion

In closing (after having finished my manuscript during a recent flight), I would like to say that surgeons in general spend most of their professional lives, not in the diagnosis, but in the treatment of their patients, largely before, during or after an operation. Therefore, they cannot indulge in a 'l'art pour l'art' attitude as regards diagnostic pathways which after all are only the 'runway' for reaching the destination of surgical cure. Within two decades, mainly thanks to achievements of other medical disciplines, our diagnostic 'take-off' has become faster, smoother and straighter. All the more it is our responsibility to observe the minimal optimum of diagnostic economy and thereby also to avoid certain risks of present-day diagnostic procedures. Only with these permanent safety regulations, the patient's care —according to Lord Moynihan's quotation at the beginning of this lecture—will receive the maximum benefit of to-day's progress.

Acknowledgements

I am indebted for the angiographies to Professor Wenz and Dr. Beduhn of the radiological division, for the prospective study to the co-operation of many staff members and for the illustrations to Mrs. Matthes and Mr. Kramer, all in the surgical department of Heidelberg University. Professor Trede helped me in translating the manuscript—even during some cloudy skiing days in the Alps.

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ANNOUNCEMENTS

Courses and Symposia

A SYMPOSIUM ON THE TREATMENT OF VARICOSE VEINS BY INJECTION AND COMPRESSION will be held at the Floyd Auditorium, Stoke Mandeville Hospital, on 15th October 1971 (Chairman: Sir Edward Muir, M.S., F.R.C.S.). Admission by invitation. Some tickets available on application to G. J. Hadfield, T.D., M.S., F.R.C.S., Surgical Tutor, Stoke Mandeville Hospital, Aylesbury, Bucks.

ROYAL POSTGRADUATE MEDICAL SCHOOL, HAMMERSMITH HOSPITAL. Applications are invited from Consultants, Senior Registrars, and University Teaching and Research Staff for the following Specialist Courses: Recent Advances in Surgical Gastroenterology, 18th–22nd October 1971; Recent Advances in Peripheral Vascular Surgery, 8th–12th November 1971; Recent Advances in Surgery of the Head and Neck, 14th–18th February 1972.

Further details from the Secretary, Royal Postgraduate Medical School, Hammersmith Hospital, Ducane Road, London, W.12.

PRIMARY AND FINAL F.R.C.S. Day Release Course at Plymouth lasting two terms commencing mid-October. Enquiries to M. W. Reece, F.R.C.S., Department of Surgery, Freedom Fields, Plymouth, Devon.

UROLOGY. A day course on Urology is to be held on 20th November, 9.15 a.m.–5.30 p.m., at the Charles Hastings Postgraduate Medical Centre, Worcester Royal Infirmary, Ronkswood Branch, Newtown Road, Worcester, WR5 1HW. Enquiries to C. P. Nicholas, F.R.C.S., Surgical Tutor.

SECOND WORLD CONGRESS OF THE INTERNATIONAL COLLEGE OF DIGESTIVE TRACT SURGERY will be held at Strasbourg 9th to 11th June, 1972. President Prof. L. F. Hollender. Details from Dr. J. J. Kohler, Service de Chirurgie Generale 3, Centre Hospitalier Universitaire, Universite Louis Pasteur, 1 Place de l'Hospital, 67 Strasbourg, France.

Department of Surgical Sciences

A RESEARCH FELLOW is needed to work in the Department of Surgical Sciences on Cardiovascular problems and particularly preservation and transplantation of the heart. The appointment will be for one or two years and on the Registrar/Lecturer scale, salary depending upon experience. Candidates should preferably have F.R.C.S. Applications should be submitted to The Personnel Officer of the College by 15th October 1971.