CURRENT OPERATIVE SURGERY

Vascular Surgery

Edited by

Crawford W. Jamieson, MS, FRCS

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Consultant Surgeon, St Thomas's Hospital,
Consultant Vascular Surgeon, Hammersmith Hospital,
part-time Senior Lecturer, Royal Postgraduate
Medical School, London

Baillière Tindall London Philadelphia Toronto
Mexico City Rio de Janeiro Sydney Tokyo Hong Kong

Baillière Tindall
W. B. Saunders

1 St Anne's Road
Eastbourne, East Sussex BN21 3UN, England

West Washington Square
Philadelphia, PA 19105, USA

1 Goldthorne Avenue
Toronto, Ontario M8Z 5T9, Canada

Apartado 26370—Cedro 512
Mexico 4, DF Mexico

Rua Evaristo da Veiga 55, 20° andar
Rio de Janeiro—RJ, Brazil

ABP Australia Ltd, 44–50 Waterloo Road
North Ryde, NSW 2113, Australia

Ichibancho Central Building, 22–1 Ichibancho
Chiyoda-ku, Tokyo 102, Japan

10/fl, Inter-Continental Plaza, 94 Granville Road
Tsim Sha Tsui East, Kowloon, Hong Kong

First published 1985

Typeset and printed in Great Britain by Butler and Tanner Ltd, Frome and London

British Library Cataloguing in Publication Data

Vascular surgery—(Current operative surgery)
1. Blood vessels—Surgery
I. Jamieson, Crawford
617'.413 RD598.5
ISBN 0-7020-1082-0

List of Contributors

John J. Bergan MD, Magerstadt Professor of Surgery and Chief, Division of Vascular Surgery, Northwestern University Medical School, Chicago, Illinois, USA; Attending Surgeon, Northwestern Memorial Hospital, Chicago, Illinois 60611, USA.

Ramon Berguer MD, PhD, Professor of Surgery, Wayne State University School of Medicine, 4201 St Antoine, Detroit, Michigan 48201, USA; Chief, Section of Vascular Surgery, Director, Acute Stroke Unit, Clinical Director, Vascular Surgery Laboratories, Harper-Grace Hospitals; Consultant Surgeon (Vascular Surgery), Detroit Receiving Hospital, Hutzel Hospital, Children's Hospital.

Philip G. Borozan MD, Division of Vascular Surgery, University of Illinois at Chicago, PO Box 6998, Chicago, Illinois 60680, USA.

H. Dardik MD, FACS, Clinical Associate Professor of Surgery, UMDNJ–New Jersey Medical School, Newark, New Jersey; Chief, Department of Surgery and Vascular Surgical Service, Englewood Hospital, Englewood, New Jersey, USA.

R. G. DePalma MD, Professor and Chairman, Department of Surgery, George Washington University School of Medicine, The H. B. Burns Memorial Building, 2150 Pennsylvania Avenue NW, Washington, DC 20037, USA.

D. Preston Flanigan MD, Chief, Department of Surgery, Division of Vascular Surgery, The University of Illinois College of Medicine at Chicago, Box 6998, Chicago, Illinois 60680, USA.

William R. Flinn MD, Assistant Professor of Surgery, Northwestern University Medical School, Chicago, Illinois; Attending Surgeon, Northwestern Memorial Hospital, Chicago, Illinois; Attending Vascular Surgeon, Veterans Administration Lakeside Medical Center, Chicago, Illinois, USA.

J. D. Gruss MD, Head of the Department for Vascular Surgery, Kurhessisches Diakonissenhaus, Goethestrasse 85, 3500 Kassel, FRG.

Crawford W. Jamieson MS, FRCS, Consultant Surgeon, St Thomas's Hospital, London; Consultant Vascular Surgeon, Hammersmith Hospital, London; part-time Senior Lecturer in Vascular Surgery, Royal Postgraduate Medical School, London, UK.

Avril O. Mansfield ChM, FRCS, Consultant Surgeon, St Mary's Hospital, London W2 1NY, UK; Senior Lecturer in Vascular Surgery, Royal Postgraduate Medical School, London.

P. G. Qvarfordt MD, PhD, Clinical Instructor in Vascular Surgery, University of California, San Francisco, California, USA.

D. B. Ross MD, PC, Presbyterian Professional Plaza, Suite 138, 1721 East 19th Avenue, Denver, Colorado 80218, USA.

James J. Schuler MD, Department of Surgery, Division of Vascular Surgery, The University of Illinois College of Medicine at Chicago, Box 6998, Chicago, Illinois 60680, USA.

Dimitrios G. Spigos MD, Department of Surgery, Division of Vascular Surgery, The University of Illinois College of Medicine at Chicago, Box 6998, Chicago, Illinois 60680, USA.

R. J. Stoney MD, Professor of Surgery, School of Medicine; Co-chief, Vascular Service, University of California, San Francisco, California, USA.

Felix E. Weale MS, PhD, FRCS, Surgeon, Dartford and Gravesham Health District, Gravesend and North Kent Hospital, Bath Street, Gravesend, Kent DA11 0DG, UK.

John H. N. Wolfe MS, FRCS, Consultant Surgeon, St Mary's Hospital, London W2 1NY, UK; Honorary Senior Lecturer, Royal Postgraduate Medical School, Hammersmith, London.

James S. T. Yao MD, PhD, Professor of Surgery, Northwestern University Medical School, Chicago, Illinois; Director, Blood Flow Laboratory, and Attending Surgeon, Northwestern Memorial Hospital, Chicago, Illinois 60611, USA.

Preface

The evolution of surgical procedures is slow and there is relatively little new surgical practice in any speciality from year to year. Such change as there is is seldom gradual, but is more frequently associated with sudden advances in technique as new materials or new concepts become available. For this reason, comprehensive atlases of surgical procedures tend to be dull and uninteresting to the majority of experienced surgeons, offering them very little with which to improve their armamentarium. The published descriptions of new operations in surgical journals tend to be rather over-brief, due to the stringent requirements of editing in scientific periodicals. In particular, there is a natural reluctance on the part of an inventor of a new procedure to dwell over-long upon its hazards and complications.

This, and the other volumes in this series of surgical textbooks, has been designed to fill this gap. It is not conceived as a comprehensive textbook of vascular surgical techniques, many of which are well established and have received wide recognition. Instead, it focuses upon several specific aspects of vascular surgical technique in which I feel changes have occurred in the last few years which have altered my surgical practice and therefore, I presume, that of my colleagues. The contributors to the book have been told that the book is designed to be read by experienced practising vascular surgeons, not merely surgeons in training, and that any potential hazards, complications or snags in the procedure must be emphasized as fully as possible. I have attempted, in my instructions to the authors, to ask the sort of questions that I have been asking myself about the operations they describe and the ones which I hope would be put to them in a personal conversation on watching them perform the operation themselves. The contributors have, I hope, by these means achieved a more personal approach to the description of surgical procedures with which some vascular surgeons may not be fully familiar and which, we hope, they will consider adding to their armamentarium.

Crawford W. Jamieson

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1

Management of Aneurysms Involving the Visceral Arteries

Crawford W. Jamieson
John H.N. Wolfe

INTRODUCTION

Aneurysms involving the visceral arteries present a formidable problem and most vascular surgeons have only limited experience of their treatment. The complexity of the operation derives from the necessity to maintain blood supply to the gut, kidneys and spinal cord. The extensive dissection and consequent blood loss, ischaemia of vital organs and thoracoabdominal incision militate against an uncomplicated course in these patients, who are usually elderly. Fortunately, significant progress has been made in recent years in simplifying the procedure and managing postoperative problems so that morbidity and mortality have become more acceptable. Nevertheless, the hazards of the operation are such that the outlook with conservative management should be balanced against the morbidity of surgery.

High aortic aneurysms are divided into suprarenal aneurysms (type I) and the very extensive type II aneurysms (Figure 1.1). Discussion in this chapter will be confined to the type II aneurysms and those high abdominal aortic aneurysms which involve the visceral arteries (type III).

PROGNOSIS

There is little information on the natural history of these rare aneurysms but they may have a five-year survival of about 50%.[1]

A third of the patients die of rupture of the aneurysm but at least half die of other associated atherosclerotic disease. Five per cent of abdominal aortic aneurysms involve the renal arteries and some of these also involve the superior mesenteric and coeliac arteries. Abdominal aneurysms greater than 7 cm in diameter have a rate of rupture of approximately 30% per annum and aneurysms between 7 and 5 cm in diameter have an incidence of rupture of approximately 12% per annum.[2] These figures apply mainly to aneurysms below the renal arteries but may probably be extrapolated to those which are more extensive. They pose therefore a very serious threat to life but not an immediate inevitable death sentence. The best operative results are those of Stanley Crawford, who has been able to report an operative mortality of only 9%, but few could emulate this achievement.[3] These aneurysms should be treated only by surgery when they are massive or clearly increasing in size when assessed by serial ultrasound or CAT scans. The risk of rupture is then so high that the benefits of surgery outweigh the risks.

History of the operation

Etheridge[4] was the first to report a successful homograft repair of a thoracoabdominal aneurysm in 1955. Using an aortic bypass shunt he anastomosed the homograft to the aorta above the aneurysm and then progressively revascularized the major visceral arteries by suturing them directly to the homograft. In 1956 DeBakey[5] reported four patients in whom the aneurysm had been bypassed by homografts. A shunt was used following the death of the first patient from renal

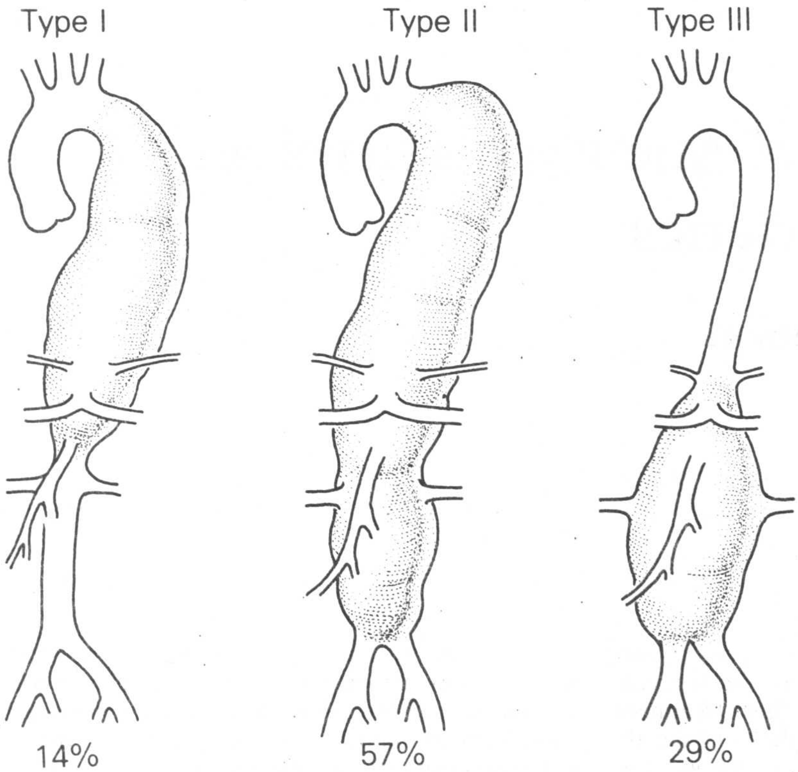


Figure 1.1 *Classification and relative incidence of thoracoabdominal aneurysms.*

failure. When Dacron became available he modified the technique and sutured the graft end-to-side proximally and distally to act as a shunt. Side arms of Dacron were subsequently sutured to the visceral vessel with the minimum ischaemic time (Figure 1.2). The aneurysm sac was then sutured off. In 1965 he reported the results of 42 of these operations with an operative mortality of 26%. In 1973 Stanley Crawford introduced his simple concept of inserting the graft into the aneurysm and suturing the orifices of visceral vessels to side holes in the graft (Figure 1.3).[6] This greatly reduced the extent of the dissection and consequent blood loss but prolonged ischaemia of the vital organs in the hands of any but a very swift surgeon.

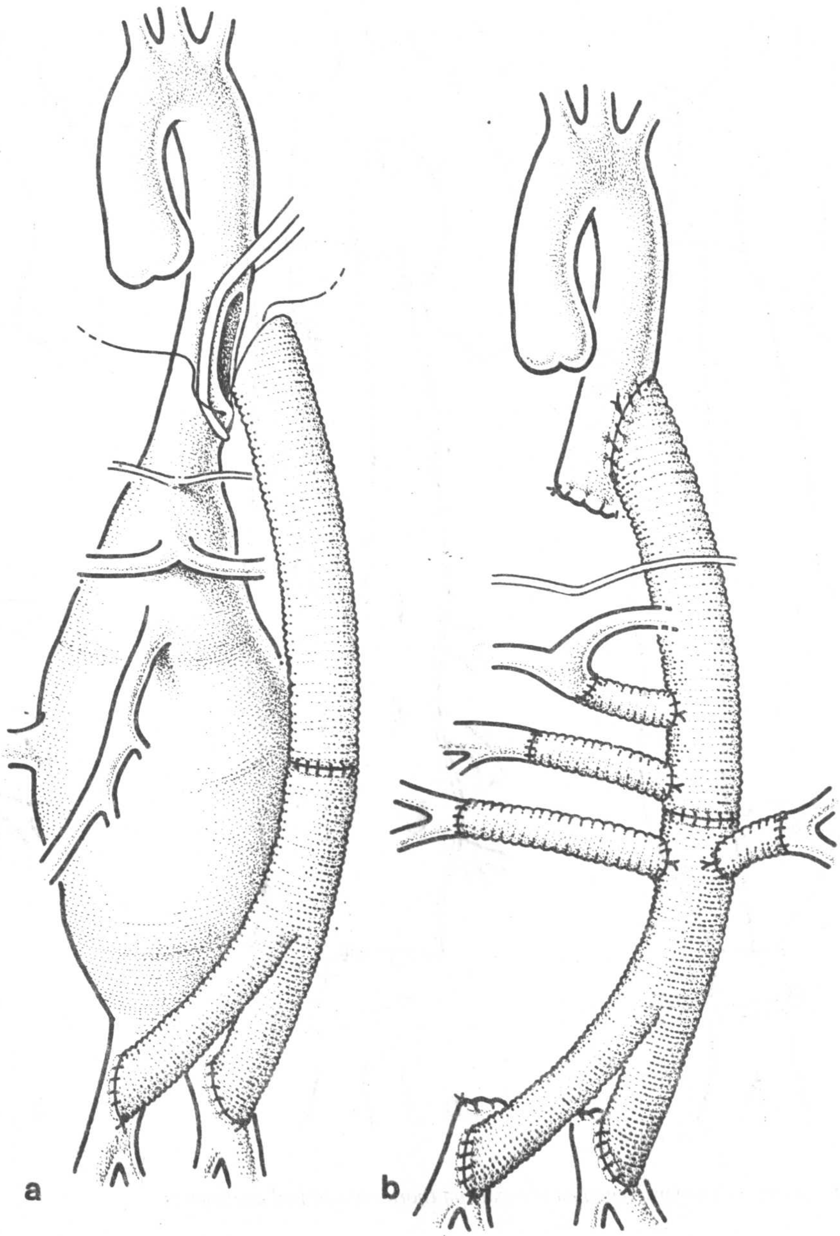
Various methods have been proposed to reduce this ischaemia. In the 1960s Connolly used the left atriofemoral shunt[7] and Dillon recommended a femoral vein to artery shunt using an oxygenator pump.[8] More recently Korompai and Hayward have also used an external shunt.[9] These systems, however, require full systemic heparinization, resulting in increased blood loss, so they have been abandoned by most surgeons. Bosher and Brooks[10] have modified Stanley Crawford's technique by advocating total body hypothermia, but this also increases blood loss since clotting is negligible below 27°C. The simplicity of Stanley Crawford's approach remains appealing and, with slight modifications, it has been used by Cooley,[11] Hollier[12] and ourselves.

PRESENTATION AND INVESTIGATION

Presentation

Since thoracoabdominal aneurysms remain asymptomatic for varying lengths of time they may be an incidental finding on clinical examination or radiography. Abdominal or back pain are the usual symptoms and about 5% of patients have backache due to vertebral erosion. Occasionally either paraparesis or paraplegia are the presenting symptoms due to thrombosis of the aortic branches supplying the spinal cord or local aortic dissection. Some patients present with embolic episodes to the lower extremities or viscera and patients very occasionally present with aortoduodenal or aorto vena caval fistulas.

Figure 1.2 *DeBakey's method of resecting thoracoabdominal aneurysms.*



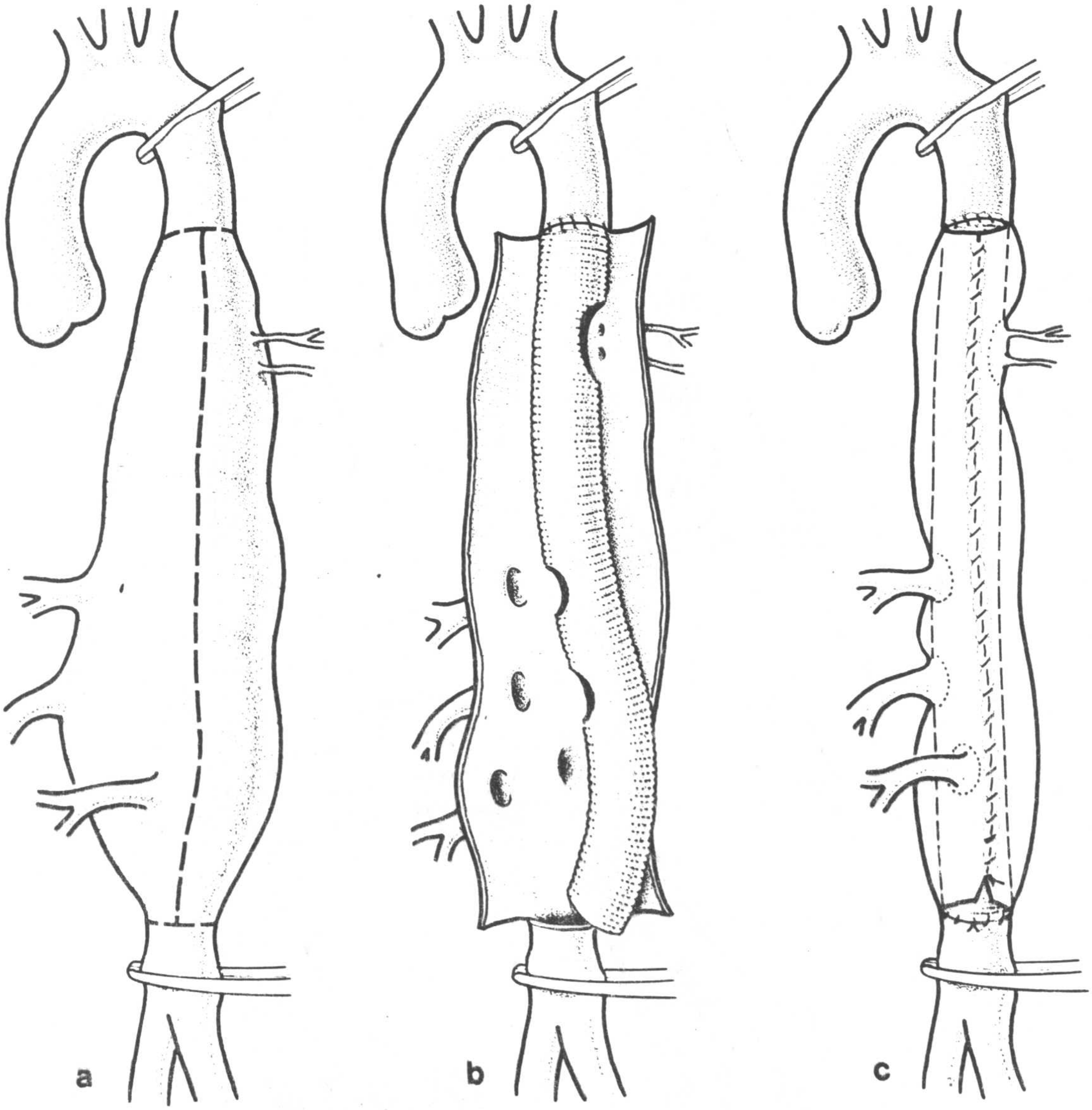


Figure 1.3 *Stanley Crawford's method of repairing thoracoabdominal aneurysms.*

Investigation

Thorough preoperative investigation is mandatory (Table 1.1).

Table 1.1 Preoperative assessment of patients with a complex abdominal aneurysm.

Blood	Full blood count and platelets
	ESR
	Urea, electrolytes and creatinine
	Glucose
	Liver function tests
	VDRL
	Group and crossmatch 20 units of blood (fresh if possible)
Cardio-respiratory	ECG
	Chest X-ray
	Arterial blood gases
	Respiratory function tests
Renal	Intravenous pyelogram
Gastric	Gastroscopy
Vascular	CAT of aneurysm
	Arteriography for extent of aneurysm, stenosis of visceral branches and distal arterial disease
	Ankle Doppler pressures

Figure 1.4 *Arteriogram of patient with Marfan's syndrome and thoracoabdominal aneurysm.*

The cause and associated diseases

Although approximately 85% of these aneurysms are arteriosclerotic in origin, a significant minority are due to some other underlying pathology (Table 1.2). In earlier series 19–26% of aneurysms were syphilitic[1,13] and these aneurysms often occur in the suprarenal aorta.[14] In Crawford's series 7% of the patients had Marfan's syndrome (Figure 1.4) and patients with other collagen disorders that affect the media of the arterial wall such as Ehlers–Danlos syndrome may also develop aneurysms. If there is an underlying collagen disorder, the hazards of surgery are greatly increased but staged operations resulting in the replacement of almost the entire aorta may nevertheless succeed in a few patients.[15] The clinical features of Marfan's syndrome are well known and the diagnosis may be made on clinical signs. Ehlers–Danlos syndrome can also be recognized by the highly elastic skin, hypermobile joints and poor healing of scars. Tuberculosis may cause a mycotic aneurysm and trauma may result in late aneurysm formation. Aortic dissection may also result in aneurysm formation.

Table 1.2 Causes of thoracoabdominal aneurysm.

Arteriosclerosis
Marfan's syndrome
Ehlers–Danlos syndrome
Syphilis
Chronic dissection
Trauma

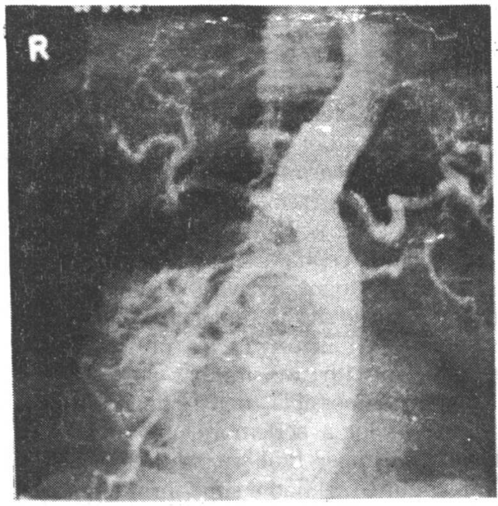


Figure 1.5 *Mesenteric aneurysms in a patient with thoracoabdominal aneurysm.*

In the majority of patients the aneurysm is a manifestation of generalized atherosclerosis with its attendant problems. Symptomatic cardiac disease is present in 15–30% of patients and hypertension in 30–40%.[1,16] Approximately 10% of patients have cerebrovascular disease and 10% have peripheral arterial disease. Fifteen per cent of patients have other associated aneurysms so that femoral and popliteal aneurysms should be carefully sought and other intra-abdominal aneurysms detected by selective angiography (Figure 1.5). Coexistent stenosis of mesenteric or renal vessels must also be detected, particularly if Stanley Crawford's technique is to be used, as these vessels are not fully exposed during the operation. Preoperative assessment of renal function by estimation of serum urea, creatinine and electrolytes, and descending urography should alert the surgeon to those patients that require further assessment of renal circulation. Approximately 20% of patients have chronic obstructive airways disease and respiratory function studies are mandatory to determine whether they can survive the thoracoabdominal incision. A further 20% have associated peptic ulceration and routine preoperative gastroscopy is probably useful.

The extent of the aneurysm

The maximum diameter of the aneurysm may be assessed by ultrasound or CAT scanning but these investigations may occasionally be misleading. Accurate preoperative assessment of the abdominal major branches of the aorta is required and these may be a displaced cephalad by aneurysmal expansion. Careful aortography with selective views of vessels not clearly shown on a free flush film must be obtained. It is unwise to puncture the aneurysm directly with translumbar aortography and it is usually impossible to negotiate the tortuous iliac vessels for a perfemoral approach. An approach via the upper limb is required. One of our patients (Figure 1.5) had a superior mesenteric artery aneurysm which was not diagnosed preoperatively and its subsequent rupture following an otherwise successful operation led to his demise. Fuller preoperative aortography might have avoided this tragic outcome.

OPERATIVE DETAILS

Anaesthetic considerations

The considerable advances in anaesthetic technique[17] and postoperative management have complemented surgical improvements. A double-lumen endobronchial tube is inserted following anaesthetic induction with agents that do not produce cardiac depression. Rapid fluid replacement may be necessary and at least two 12 or 14 gauge peripheral lines should be inserted. A central venous line may be inserted to monitor right atrial pressure and a Swan–Ganz catheter should be used to monitor left atrial pressure. A radial arterial line allows frequent monitoring of blood gases, electrolytes and arterial blood pressure during and after surgery.

It is mandatory that the patient is not at all dehydrated prior to operation, which is a problem that may be easily overlooked, since many patients are treated with diuretics. Preoperative arteriography may also deprive the patient of oral fluid intake. Intravenous fluid should be started before surgery and a diuresis promoted as the operation commences. Sodium nitroprusside is given immediately the aorta is clamped to maintain circulatory stability and to avoid a serious rise in peripheral resistance. The infusion should be discontinued prior to releasing the clamp and rapid volume replacement given to avoid hypotension. Sodium bicarbonate may also be administered to avoid acidosis on release of the aortic clamp and hypercalcaemia may develop during prolonged visceral ischaemia. The considerable blood loss may result in coagulation defects and a deficiency of ionized calcium. These problems are reduced by the use of autotransfusion[18] but fresh frozen plasma and platelets may be required. Fresh blood should also be available for transfusion if possible. Ventilatory support must be given until the patient is stable and there is little to be gained by hasty extubation of these critical patients.

Position and incision

Full exposure can be attained through a thoracoabdominal incision. The patient is placed in a semi-lateral position with the right arm supported on the arm rest (Figure 1.6). The incision varies according to the upper extent of the aneurysm. For abdominal aneurysms involving the visceral arteries with an upper extremity around the diaphragm, the incision extends from the right iliac fossa to the bed of the eighth rib (Figure 1.6). In

Figure 1.6 *Position of the patient and incision for high abdominal aneurysms.*

Figure 1.7 *Incision for thoracoabdominal aneurysms.*

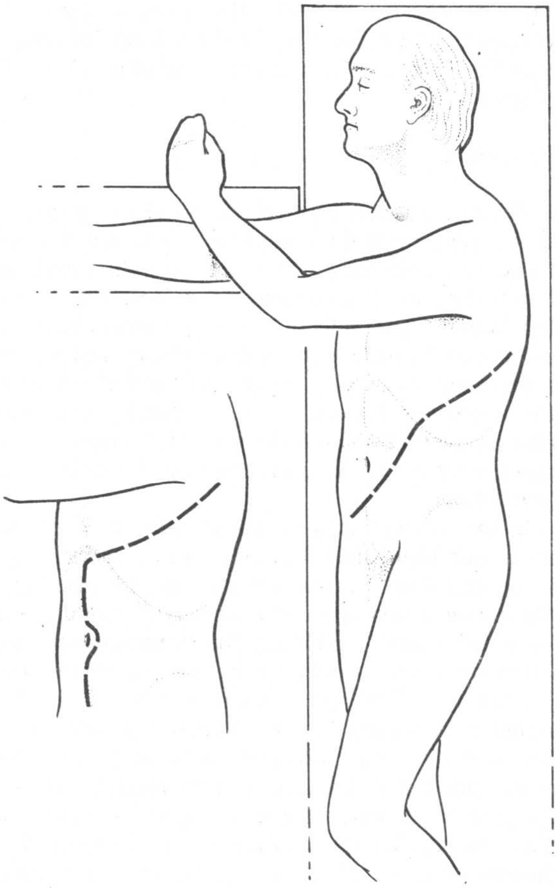
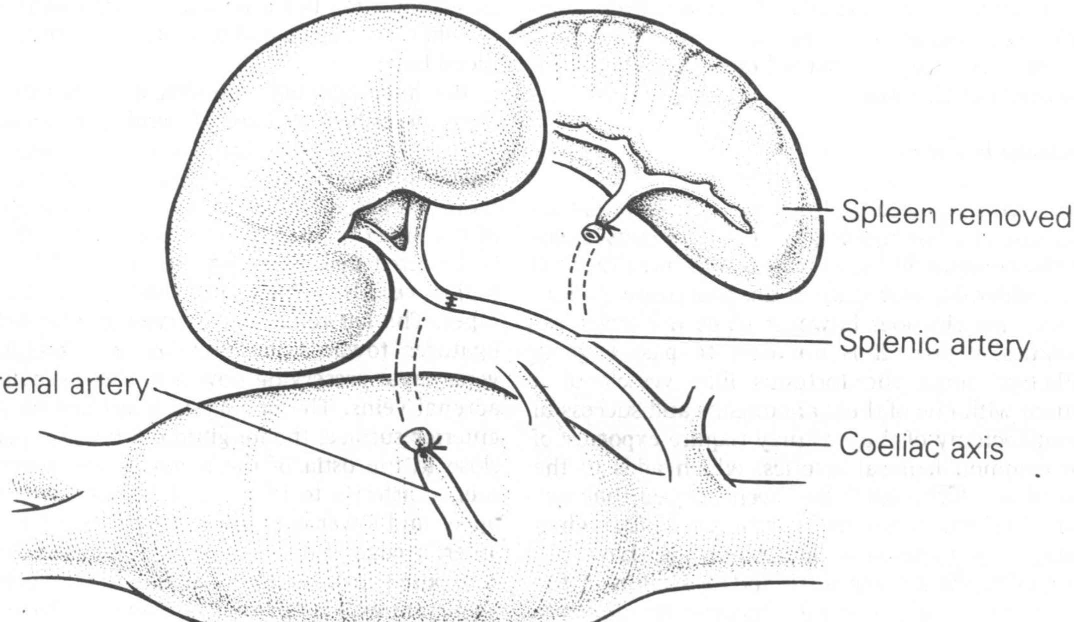


Figure 1.8 *Initial splenorenal anastomosis if the aneurysm ends below the coeliac axis.*



more thoracic aneurysms the incision should be carried through the bed of the sixth rib, extending into the abdomen as a midline abdominal incision (Figure 1.7).

Procedure

Following a thorough exploration of the abdomen the diaphragm is divided radially between the costal margin and the aortic hiatus. The first decision is whether to dissect anterior or posterior to the left kidney. The spleen, tail of pancreas and left colon can be mobilized to the right by developing a relatively avascular plane and the full extent of the aneurysm is then revealed. Stanley Crawford also mobilizes the left kidney to the right with the other viscera, but we prefer to leave it undisturbed (see below).

If the coeliac axis is above the neck of the aneurysm then the left kidney can be vascularized as an initial step. A splenectomy is performed and the splenic artery is anastomosed end-to-end to the left renal artery; the kidney then remains perfused when the aorta is clamped below the coeliac axis (Figure 1.8). The anastomosis is easier if the left kidney is mobilized forward with the other viscera. The aorta is then mobilized proximal to the neck of the aneurysm leaving enough room to suture the graft to the neck. Excessive proximal dissection may compromise important intercostal vessels and therefore the spinal blood supply, so mobilization should be limited and sufficient only for proximal aortic control and incision of the sac. Both common iliac arteries are controlled and the surgeon is then faced with his second decision: whether to use systemic heparin.

Systemic heparin

The excessive bleeding from large areas of dissection and the haematological disorders consequent on the subsequent blood transfusion have resulted in considerable morbidity in this procedure. Failure to use heparin does however place the lower extremities at risk. It is not easy to pass Fogarty catheters down the tortuous iliac vessels of a patient with one of these aneurysms and successful thrombectomy of the legs may require exposure of the common femoral arteries, which adds to the procedure. Although it has been advised that systemic heparin is not used, it is our policy, when oozing is not excessive and blood loss has been acceptable during exposure and dissection of the aneurysm, to use systemic heparin in moderate doses (1.5 mg per kg) and to reverse it upon completion of the anastomoses. Oozing from the anastomoses as they are sequentially performed may be controlled by the use of gauze soaked in topical thrombin. In our limited experience of this operation we have not found the blood loss to be excessive, nor suffered the consequences of static thrombosis in the lower extremities during the procedure.

Whether to open the aneurysm anterior or posterior to the left renal artery

Stanley Crawford, with his extensive experience of this procedure and superb operative technique, strongly recommends exposure of the aneurysm by rotating the left kidney forward and incision of the aneurysm once the aorta and iliac arteries are controlled, posterior to the left renal artery. This avoids dissection of the highly vascular lymphatic tissue in front of the aorta and around the visceral arteries, avoids division of the left renal vein, and gives excellent exposure of the interior of the aneurysm. He then sutures the visible ostia of the visceral arteries within the aneurysm sac to small windows cut in the side of his Dacron graft (Figure 1.3). This technique is highly appealing, but to a slightly less skilled surgeon it can be technically very difficult. It is easy to insert the posterior row of sutures, but the anterior aspect of the anastomosis of a floppy aneurysm wall, to a small window cut in the Dacron graft, is made under difficult circumstances and the success of the operation depends on there being no leak. A poor anastomosis is difficult to repair and would cause unacceptable blood loss.

We have adopted a modification of this procedure, described by Cooley[11] and also adopted by Perdue,[12] in which the anterior surface of the aneurysm is exposed (Figure 1.9). The lymphatic tissue over the left renal vein and around the base of the superior mesenteric artery and coeliac axis is dissected free, exposing the origin of these two major vessels, which are then controlled with tapes. The left renal vein is then divided between ligatures towards its insertion into the inferior vena cava, preserving flow into the testicular and adrenal veins. The aneurysm is opened on its left anterior surface, the longitudinal incision running close to the ostia of the superior mesenteric and coeliac arteries to join transverse incisions of the upper and lower extremities of the aneurysm. The anterior edge of the ostium of the left renal artery is exposed in a similar way so that a section of aneurysm wall is removed and all ostia have a free cut edge.

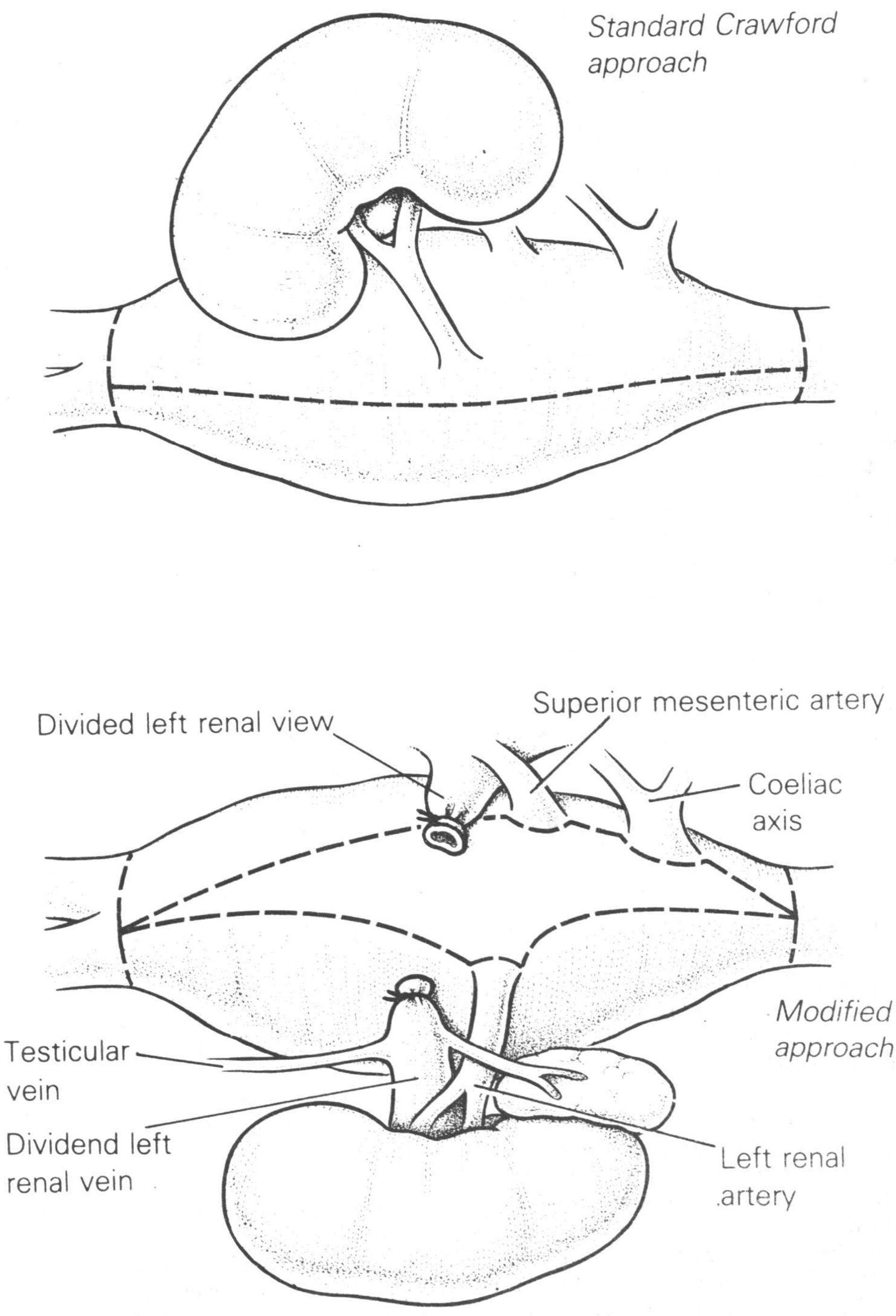


Figure 1.9 *Standard Crawford and anterolateral approaches to aneurysm.*

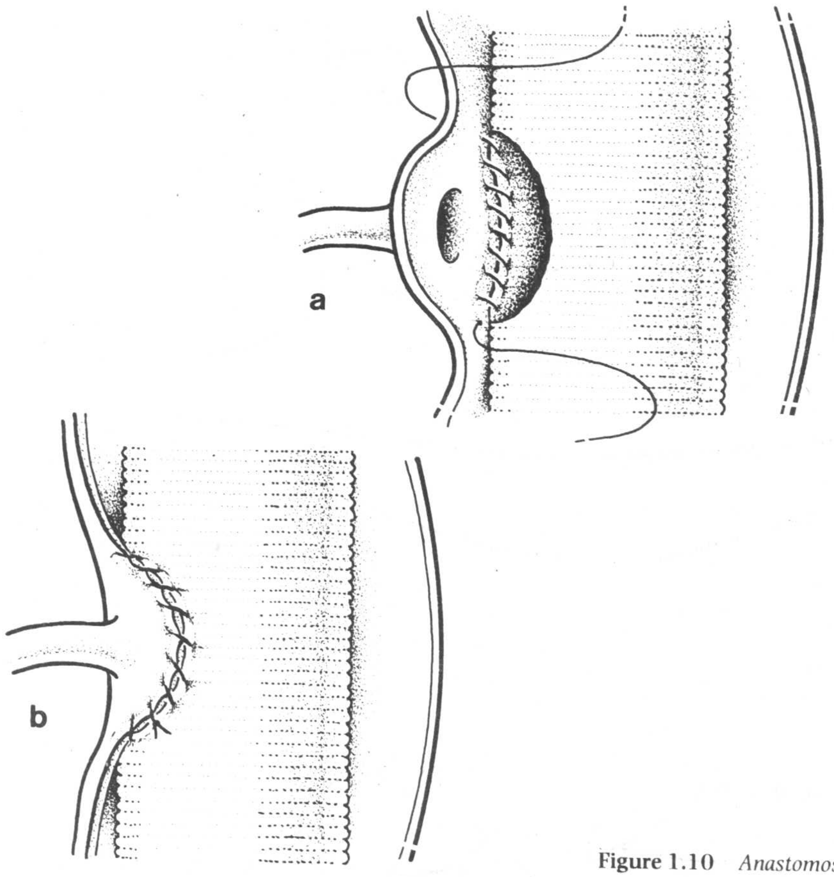


Figure 1.10 *Anastomosis of the visceral artery to the graft.*

Although this modification requires considerably more dissection than Crawford's technique and involves the division of the left renal vein, it does allow the surgeon to make the anastomoses of the major visceral arteries to the windows cut in the side of the aortic graft under much better control. The posterior layer is inserted in exactly the same way as in Crawford's technique, but the anterior layer, which is otherwise difficult, is inserted between the cut edge of the aneurysm wall and the cut edge of Dacron like any other arterial end-to-end anastomosis (Figure 1.10). Leakage is thereby minimized. Exposure and dissection of the origins of the visceral arteries also allows undiagnosed proximal stenosis to be recognized and corrected at the same procedure by short extensions of Dacron graft from the main aortic graft.

We suggest that there is probably a place for both approaches and that in patients with a small aneurysm in which the left renal artery lies towards the anterior aspect of the aneurysm and posterior exposure is easy, the Crawford's technique is preferable, but in very large aneurysms, particularly those with associated problems of stenoses of one or more of the visceral arteries, the anterior technique is safer and easier, especially if the surgeon has relatively little experience of this operation. This latter technique will now be described in detail.

Control of the aneurysm

The spleen is gently held forward so that the lienorenal ligament can be divided. The spleen and pancreas, stomach and left colon can then be swept forward in a plane anterior to the left kidney, ureter and testicular vessels. Care must be taken to avoid damage to the splenic and left colic vessels. The testicular vein is thus exposed throughout its length to its junction with the left renal vein. The