

Disease processes and diagnostic techniques



1. Surgery and the mechanisms of surgical disease 3

DISEASE PROCESSES

2. Managing physiological change in the surgical patient 9
3. Immunity, inflammation and infection 27
4. Shock and resuscitation 52

DIAGNOSTIC TECHNIQUES

5. Imaging and interventional techniques in surgery 59
6. Screening for adult disease 88



Surgery and the mechanisms of surgical disease

1

A SHORT HISTORY OF SURGERY	3	PRINCIPAL MECHANISMS OF SURGICAL DISEASE	5
		Congenital conditions	5
APPROACHES TO SURGICAL PROBLEMS	4	Acquired conditions	6

A SHORT HISTORY OF SURGERY

There can be no doubt that the first surgeons were the men and women who bound up the lacerations, contusions, fractures, impalements and eviscerations to which man has been subject since he appeared on Earth. Since man is the most vicious of all creatures, many of these injuries were inflicted by man upon man. Indeed, the battlefield has always been a training ground for surgery. Right up to the 15th century, surgeons dealing with trauma were surprisingly efficient. They knew their limitations—they could splint fractures, reduce dislocations and bind up lacerations, but were only too aware that open wounds of the skull, chest and abdomen were lethal and were best left alone, as were wounds involving major blood vessels or spinal injuries with paralysis. They observed that wounds would usually discharge yellow pus for a time; indeed this was regarded as a good prognostic sign and was labelled 'laudable pus'.

The 15th century heralded a new and dreaded pathology—the gunshot wound. These injuries would stink, swell and bubble with gas. There was profound systemic toxicity and a high mortality. Of course, we now know that this was the result of clostridial infection of wounds with the extensive anaerobic tissue damage caused by shot and shell. The surgeons of those times were shrewd clinical observers but they surmised that these malign effects were due to gunpowder acting as a poison, for it was not until centuries later that the bacterial basis of wound infection began to be understood. At that period the remedy was to destroy the poison with boiling oil or cautery. Boiling oil was the more popular since it was advocated by the Italian surgeon Giovanni da Vigo (1460–1525), the author of the standard text of the day, *Practica In Arte Chirurgica Compendiosa*. These treatments not only produced intense pain but also made matters worse by increasing the amount of tissue necrosis.

The first scientific departure from this barbaric treatment was taken by the great French military surgeon Ambroise Paré (1510–1590) who, while still a young man, revolutionised the treatment of wounds by using only simple dressings, abandoning cautery and introducing ligatures to control haemorrhage. He established that his results were much better than could be achieved by the old methods.

Ignorance of the basic sciences behind the practice of surgery was slowly overcome. The publications of *The Fabric of the Human Body* in 1543 by Andreas Vesalius (1514–1564) and of *The Motion of the Heart* by William Harvey (1578–1657) in 1628 were two notable landmarks.

Surgical progress however was still limited by two major obstacles. First, the agony of the knife: patients would only be prepared to undergo an operation to relieve intolerable suffering (for example from a gangrenous limb, a bladder stone or a strangulated rupture) and, of course, the surgeon needed to operate at lightning speed. Second, there was the inevitability of suppuration, with its prolonged disability and high mortality, which was often as high as 50% after amputation. Amazingly, both these barriers were overcome within a couple of decades of each other.

In 1846, William Morton (1819–1868), a dentist working in Boston, Massachusetts, introduced the use of ether as a general anaesthetic. This was followed a year later by chloroform, employed by James Young Simpson (1811–1870) in Edinburgh, mainly in midwifery. These agents were taken up with immense enthusiasm across the world in a matter of weeks.

The work of the French chemist Louis Pasteur (1822–1895) demonstrated the link between wound suppuration and microbes. This led Joseph Lister (1827–1912), who

was then a young professor of surgery in Edinburgh, to perform the first operation under sterile conditions in 1865. This was treatment of a compound fracture of the tibia in which crude carbolic acid was used as an antiseptic. The development of antiseptic surgery and, later, modern aseptic surgery progressed from there.

So at last, in the 1870s, the scene was set for the coming enormous advances in every branch of surgery whose breadth and successes form the basis of this book.

Prof. Harold Ellis CBE MCh FRCS

APPROACHES TO SURGICAL PROBLEMS

What do surgeons do?

Surgeons are doctors who do operations, i.e. cutting tissue to treat disease, the patient usually being under some form of anaesthesia. However, the range of work individual surgeons undertake varies widely, depending on the culture in which they work and the resources available, the nature and breadth of their specialisation, what other specialists are available, and the local needs. The principles of surgery—access, dissection, haemostasis, repair, reconstruction, preservation of vital structures and closure—are similar in all specialties.

A **general surgeon** usually means one who principally undertakes general surgical emergency work and elective abdominal gastrointestinal (GI) surgery. In geographically isolated areas and regions where resources are scarce, such a surgeon might also undertake some gynaecology, urology, paediatric surgery, orthopaedic and trauma surgery and perhaps basic ear, nose and throat (ENT) and ophthalmology, and even obstetrics. Conversely, in developed countries, there is an increasing trend towards greater specialisation. Gastrointestinal surgery, for example, is often divided into 'upper' and 'lower' GI surgery, and upper GI surgery itself may further divide into the subspecialties of hepatobiliary, laparoscopic, pancreatic and gastro-oesophageal cancer surgery.

Surgeons should not be thought of simply as 'cutting and sewing' doctors. The perceived drama of surgery may be superficially attractive but good surgery is rarely dramatic. Only when things go wrong does the drama increase, and this is often not comfortable. Surgery is an art or craft as well as a science, and judgement, coping under pressure, taking decisive action when necessary, teaching and training skills and people management skills are essential qualities. Operating skills can be learnt by most people, but the skills involved in deciding when it is in the patient's best interests to operate are absolutely essential and must also be actively learnt and practised.

Surgeons also play an important role in the diagnostic process, using both clinical skills and appropriate investigations as part of their armamentarium. In this context, many surgeons undertake various forms of diagnostic and therapeutic endoscopy. These include gastroscopy, colonoscopy, urological endoscopy, thoracoscopy and arthroscopy. In addition, the indications for laparoscopic surgery, supported by the outcomes of good quality clinical

trials, continue to broaden as equipment and skills become increasingly sophisticated.

What sort of patients come to surgeons?

Different types of surgeon practise in very different ways, depending on their specialty and their level of responsibility for emergency work. In the UK, most patients are referred to surgeons by another doctor, e.g. family practitioner, accident and emergency (ER) officer or internal physician. The exceptions include patients suffering trauma who self-refer or are brought to a hospital by ambulance. In some other countries, patients are able to self-refer to the specialist they feel is most appropriate. Regardless of the route of referral, surgical patients fall into the following categories:

- **Emergency/acute**, i.e. symptoms lasting minutes to hours or up to a day or two—often obviously surgical conditions such as traumatic wounds, fractures, abscesses, acute severe abdominal pain or gastrointestinal bleeding
- **Intermediate urgency**—usually referrals from other doctors based on suspicious symptoms and signs and sometimes investigations, e.g. suspected colonic cancer, gallstones, renal or ureteric stones
- **Chronic conditions** likely to need surgery, e.g. varicose veins, hernias, arthritic joints, cardiac ischaemia or rectal prolapse

The diagnostic process

In order to manage surgical patients appropriately, a **working diagnosis** needs to be formulated to guide whether investigations are necessary and if so, their type and urgency, and to determine what intervention (i.e. treatment) is necessary. The process initially depends upon whether immediate life-saving intervention is required or, if not, the perceived urgency of the case. For example, a patient bleeding from a stab wound might need pressure applied to the wound immediately whilst resuscitation and detailed assessment are carried out. At the other end of the scale, if the symptoms suggest the patient has a rectal carcinoma, a systematic and timely approach is needed to obtain visual and histological confirmation of the diagnosis by **endoscopy** (colonoscopy plus biopsy) and radiological **imaging** (e.g. barium

enema, CT scan). **Tumour staging** (see Ch. 13) endeavours to determine the extent of spread of a carcinoma in order to direct how radical treatment needs to be. Treatment may be **curative** (surgery, chemotherapy, radiotherapy) or **palliative** if clearly beyond cure (stenting to prevent obstruction, local tumour destruction using laser, palliative radiotherapy).

Formulating a diagnosis

The traditional approach to teaching surgical diagnosis is for the student to attempt to correlate a patient's symptoms and signs with recognised sets of symptoms and signs listed as characterising each disease. While most diagnoses match their 'classical' descriptions at certain stages in their evolution, this may not be so when the patient initially presents for treatment. Patients com-

monly present before a recognisable pattern has evolved or else at an advanced stage when the typical clinical picture has become obscured. The diagnostic process can also be confusing if all the symptoms and signs expected for a particular diagnosis are not present, or if some of the symptoms and signs seem inconsistent with the working diagnosis.

This book seeks to develop a more logical and reliable approach to diagnostic method than simple pattern recognition by attempting to explain how the evolving pathophysiology of the disease and its effect on the local anatomy bring about the various clinical features. The overall aim of this understanding is to target investigations and interventions that give the best chance of cure or symptom relief with the least harm to the patient.

PRINCIPAL MECHANISMS OF SURGICAL DISEASE

Surgical patients present with disorders resulting from inherited abnormalities, environmental factors or a combination of these in varying proportion. These are summarised in Box 1.1, providing a useful 'first principles' framework or *aide-mémoire* upon which to construct a differential diagnosis. This is particularly useful when the symptoms and signs do not immediately point to a diagnosis. This approach is often referred to as the 'surgical

sieve'. However, it should not become a substitute for logical thought based on the clinical findings.

CONGENITAL CONDITIONS

The term **congenital** defines a condition that is present at birth, as a result of genetic and/or environmental influences in utero such as ischaemia or incomplete

Box 1.1 The surgical sieve

When considering the causes of a particular condition, it may be helpful to run through the range of causes listed here. However, this should be only a first step and not a substitute for thought. This approach gives no indication of the likely severity, frequency or importance of the cause.

Congenital

- Genetic
- Environmental influences in utero

Acquired

- Trauma—accidents in the home, at work or during leisure activities, personal violence, road traffic collisions
- Inflammation—physical or immunological mechanisms
- Infection—viral, bacterial, fungal, protozoal, parasitic
- Neoplasia—benign, premalignant or malignant
- Vascular—*ischaemia*, infarction, reperfusion syndrome, aneurysms, venous insufficiency
- Degenerative—osteoporosis, glaucoma, osteoarthritis, rectal prolapse
- Metabolic disorders—gallstones, urinary tract stones
- Endocrine disorders and therapy—thyroid function abnormalities, Cushing's syndrome, pheochromocytoma

- Other abnormalities of tissue growth—hyperplasia, hypertrophy and cyst formation
- Iatrogenic disorders—damage or injury resulting from the action of a doctor or other health care worker; may be misadventure, negligence or, more commonly, system failure
- Drugs, toxins, diet and exercise
 - Prescription drugs—toxic effects of powerful drugs, maladministration, idiosyncratic reactions, drug interactions.
 - Smoking—atherosclerosis, cancers, peptic ulcer
 - Alcohol abuse—personal violence, traffic collisions
 - Substance abuse—accidents, injection site problems
 - Atmospheric pollution—pulmonary problems
 - 'Western diet'—obesity, atherosclerosis, cancers
 - Lack of exercise—obesity, osteoporosis, aches and pains
 - Venomous snakes, spiders, scorpions and other creatures—local and systemic toxicity
- Psychogenic—Munchausen syndrome leading to repeated operations, problems of indigent living, ingestion of foreign bodies, self harm
- Disorders of function—diverticular disease, some swallowing disorders

developmental processes such as malrotation of gut or maternal ingestion of drugs such as thalidomide. Congenital abnormalities of surgical interest range from minor cosmetic deformities such as right through to potentially fatal conditions such as some congenital heart defects, urethral valves and various gut atresias.

Congenital abnormalities may become manifest at any time between conception and old age, although the majority are evident at birth or appear in early childhood. Some disorders are diagnosed *antenatally*, for example, fetal gut atresias presenting during pregnancy with grossly excessive amniotic fluid (polyhydramnios). There are expanding specialist areas involving *intrauterine* surgical interventions or fetal surgery, for example for urinary tract obstruction or congenital diaphragmatic hernias. In the *neonatal* period, abnormalities such as urethral valves (which may present with obstructive renal failure) may become evident. During *infancy*, conditions such as congenital hypertrophic pyloric stenosis come to light. In *childhood*, incompletely descended testis may become evident, although this may be suspected much earlier. Finally, some congenital disorders may present at *any stage* from birth to early adulthood. For example, a patent processus vaginalis may be the precursor to an inguinal hernia even into late middle age.

Whilst many congenital abnormalities give rise to disease by direct **anatomical effects**, other abnormalities produce disease by more subtle **disruption of function**, with the underlying disorder only revealed on appropriate investigation. For example, ureteric abnormalities which allow urinary reflux from the bladder predispose to recurrent kidney infections.

ACQUIRED CONDITIONS

Acquired surgical disorders result from direct or indirect damage inflicted by trauma or disease or from the body's response to these, or else present as an effect or side effect of treatment. For example, obstruction of the bladder outlet may result from benign prostatic hypertrophy, from the fibrotic response to gonococcal urethritis or from damage inflicted during urethral instrumentation. The classification detailed here provides a framework to help consider the causes of surgical disease, but it should be remembered that particular conditions may fit under more than one heading, and that the mechanism behind some surgical disorders is still poorly understood.

Trauma

Tissue trauma, literally injury, includes in its wider sense damage inflicted by any physical means, i.e. mechanical, thermal, chemical or electrical mechanisms or ionising radiation. Common usage, however, tends to imply mechanical injury, either blunt or penetrating, as caused by accidents in industry or in the home, road traffic collisions, fights, firearm and other missile injuries or natural

disasters such as floods and earthquakes. Damage varies according to the nature of the causative agent, and the visible surface injuries may give little indication of the extent of deep tissue damage as, for example, in head injuries or bullet wounds.

Inflammation

Many surgical disorders result from inflammatory processes, most often stemming from infection. However, inflammation may also result from physical irritation, particularly by noxious chemical agents, e.g. gastric acid/pepsin in peptic ulcer disease or pancreatic enzymes in acute pancreatitis.

Inflammation may also result from immunological processes which play a part in the inflammatory bowel disorders of ulcerative colitis and Crohn's disease. Whether they constitute cause or effect is not yet known. Autoimmunity, in which an immune response is directed at one or more of the body's own constituents, is recognised in a growing number of surgical diseases such as Hashimoto's thyroiditis and rheumatoid disease.

Infection

Primary infections commonly presenting to surgeons include soft tissue infections such as abscesses and cellulitis, primary joint infections and tonsillitis. Typhoid may cause caecal perforation and abdominal tuberculosis may be discovered at laparotomy. Amoebiasis may cause ulcerative colitis-like effects. Preventing and treating infection is also an important factor in many surgical emergencies such as acute appendicitis or bowel perforation. Despite the rational use of prophylactic and therapeutic antibiotics, postoperative infection remains a common complication of surgery.

Neoplasia

Certain **benign tumours** such as lipomas are very common and are excised mainly for cosmetic reasons. Less commonly, benign tumours cause mechanical problems such as obstruction of a hollow viscus or surface blood loss, e.g. gastric leiomyoma. Benign endocrine tumours may have to be removed because of excess hormone secretion (see *Endocrine disorders* later). Finally, benign tumours may be clinically indistinguishable from malignant tumours and are removed or biopsied to obtain a histological diagnosis.

Malignant tumours may present with signs and symptoms resulting from the primary tumour, the effects of metastases ('secondaries') and in some cases, systemic effects such as cachexia. Malignant tumours are responsible for a large part of the general surgical workload.

Vascular disorders

A tissue or organ becomes **ischaemic** when its arterial blood supply is impaired; **infarction** occurs when cell

life can no longer be sustained. **Atherosclerosis** leads to progressive narrowing of arteries which often results in **chronic ischaemia** causing symptoms such as angina pectoris or intermittent claudication. It also predisposes to **acute-on-chronic ischaemia** when diseased vessels finally occlude. Other common causes of acute arterial insufficiency are thrombosis, embolism and trauma involving blood vessels. Arterial embolism is a cause of acute ischaemia of limbs, intestine or brain; these emboli often originate in the heart. If the blood supply is restored after a period of ischaemia, for example by embolectomy, further damage can ensue as a result of **reperfusion syndrome**.

When a portion of bowel becomes strangulated, the initial mechanism of tissue damage is venous obstruction and this fairly rapidly progresses to arterial ischaemia and infarction.

An **aneurysm** is an abnormal dilatation of an artery resulting from degeneration of connective tissue. This may rupture, thrombose or generate emboli.

Chronic venous insufficiency in the lower limb causing local venous hypertension is responsible for the majority of chronic leg ulcers.

Degenerative disorders

This is an inhomogeneous group of conditions characterised by deterioration in one or more of the body tissues as life progresses. In the musculoskeletal system, **osteoporosis** decreases the density of bone and impairs its structural integrity, making fragility fractures more likely such as crush fractures of vertebrae or fractures of the femoral neck. Spinal disc and facet joint degeneration is common, causing back pain and disability, and osteoarthritis is widely prevalent, particularly in later life. The almost universal musculoskeletal aches and pains of later life are probably caused by degeneration of muscle, tendon, joint and bone.

Other degenerative disorders include age-related retinal macular degeneration, glaucoma, the inherited disorder retinitis pigmentosa, and certain neurological disorders (Alzheimer's, Huntington's and Parkinson's disease, bulbar palsy). Atherosclerosis and aneurysmal arterial diseases are often non-specifically labelled degenerative but their pathogenesis is gradually being elucidated.

Metabolic disorders

Metabolic disorders may be responsible for stones in the gall bladder (e.g. haemolytic diseases causing pigment stones) or in the urinary tract (e.g. hypercalciuria and hyperuricaemia causing calcium and uric acid stones respectively). Hypercholesterolaemia is a major factor in atherosclerosis and hypertriglyceridaemia is a rare but important cause of acute pancreatitis.

Endocrine disorders and hormonal therapy

Hypersecretion of certain hormones, as in thyrotoxicosis and hyperparathyroidism, may require surgical removal or reduction of glandular tissue. Endocrine tumours, both benign and malignant, may present with metabolic abnormalities such as hypercalcaemia caused by a parathyroid adenoma, Cushing's syndrome resulting from an adrenal adenoma or episodic hypertension caused by a pheochromocytoma.

Diabetes mellitus, particularly when poorly controlled, may result in a range of complications of surgical importance, for example retinopathy and cataract formation, as well as predisposing to atherosclerosis.

Hormone replacement therapy in postmenopausal women brings mixed benefits: it slows osteoporosis and reduces the risk of colorectal cancer whilst slightly increasing the risks of breast and endometrial cancer. There is also some evidence of an increased rate of thromboembolism, as there is with higher oestrogen-containing oral contraceptive pills.

Other abnormalities of tissue growth

Growth disturbances such as **hyperplasia** (increase in the number of cells) and **hypertrophy** (increase in the size of cells) may give rise to surgical problems, in particular benign prostatic hyperplasia, fibroadenosis of the breast and thyroid enlargement (goitre).

In surgery, the term **cyst** is imprecisely used to describe a mass which appears to contain fluid because of its characteristic fluctuance and transillumination. A cyst is defined as a closed sac with a distinct limiting membrane that develops abnormally in the body. A variety of different pathological processes produce cysts (see p. ●●). Most are benign but some may be associated with malignant change in the wall.

Iatrogenic disorders

Iatrogenic damage or injury is that resulting from the action of a doctor or other health care worker. It may be an unfortunate outcome of an adequately performed investigation or operation, e.g. perforated colon during colonoscopy or pneumothorax as a result of attempted aspiration of a breast cyst. This type of injury could be termed **surgical misadventure**. However, if the damage results from a patently wrong procedure, e.g. amputation of the wrong leg or removal of the wrong kidney, then **negligence** is likely to be proven. Such wrong site surgery is easily avoided by preoperative site marking. Other potentially negligent actions include retained surgical swabs after laparotomy or arterial trauma during central venous line insertion. Complications of bowel surgery such as anastomotic leakage may result from poorly performed surgery but can occur in expert hands; only carefully audited results can demonstrate whether the surgeon

is proficient. Wrong drugs or doses are usually iatrogenic and are covered under the next heading.

It is unusual for iatrogenic problems to be simply due to one person's failure. More often it is a **system failure**, with inadequate checks and balances in the system.

Drugs, toxins and diet

Problems with prescribed drugs include unavoidable **toxic effects** of certain chemotherapeutic agents, e.g. neutropenia, and the **side effects** of drugs such as non-steroidal anti-inflammatory drugs (NSAIDs) causing duodenal perforation, or codeine phosphate causing constipation. Drug **allergy**, **idiosyncrasy** or **anaphylaxis** may result from individual responses to almost any drug, and **interactions** between drugs may cause adverse effects. In this respect warfarin is a prime culprit. Maladministration of drugs may also cause problems with, for example, the wrong drug being given for intrathecal chemotherapy causing paralysis. In many countries, venomous creatures such as spiders, snakes or scorpions cause toxic and sometimes fatal harm.

Cigarette **smoking** is the biggest single preventable cause of death and disability in developed countries. Cigarette smoke is highly addictive and contains an array of carcinogens in the tar, vasoconstrictors in the form of nicotine, and carbon monoxide that preferentially binds to haemoglobin. Not surprisingly, it is a powerful factor in a huge range of diseases including cardiovascular disorders affecting the heart, limbs and brain, dysplasias and cancers of the lung, mouth and larynx, respiratory disorders such as pneumonias, chronic obstructive pulmonary disease (COPD) and emphysema via small airways inflammation, stillbirth and peptic ulcer disease. Smoking compounds the atherogenic effects of diabetes and is also strongly associated with premature skin ageing.

Environmental pollution almost certainly affects health: for example, micro-fine particles produced by diesel engines cause pulmonary inflammation.

Alcohol and substance abuse may have a surgical dimension: alcohol may lead to personal violence or road traffic collisions as a result of intoxication; cannabis smoke is carcinogenic and causes dysplasias and pre-malignant lesions of the oral mucosa as well as contributing to mental health problems of acute anxiety and psychotic-like paranoid thoughts. Misdirected injection of opioids and other drugs may cause abscesses, false aneurysms and even arterial occlusion.

The so-called 'Western diet' rich in fat and calories and low in vegetables, fruit and fibre is associated with a range of diseases including colorectal and breast cancers, obesity, dyslipidaemias, diabetes and hypertension. This is particularly so when combined with a sedentary life. Dietary fibre protects against colorectal adenomas and carcinomas as well as diverticular disease.

Psychogenic disorders

Psychogenic disorders are not often a source of surgical disease but Munchausen syndrome patients may present with abdominal pain and become subjects of repeated laparotomies, psychiatric patients living rough may suffer with exposure and frostbite, and others may repeatedly cause self harm or swallow foreign bodies, even such items as razor blades or safety pins.

Disorders of function

A range of common disorders are defined by the abnormalities of function they cause, although in most cases their pathogenesis remains ill understood. The gastrointestinal tract is particularly susceptible, with conditions such as idiopathic constipation, irritable bowel syndrome and diverticular disease.