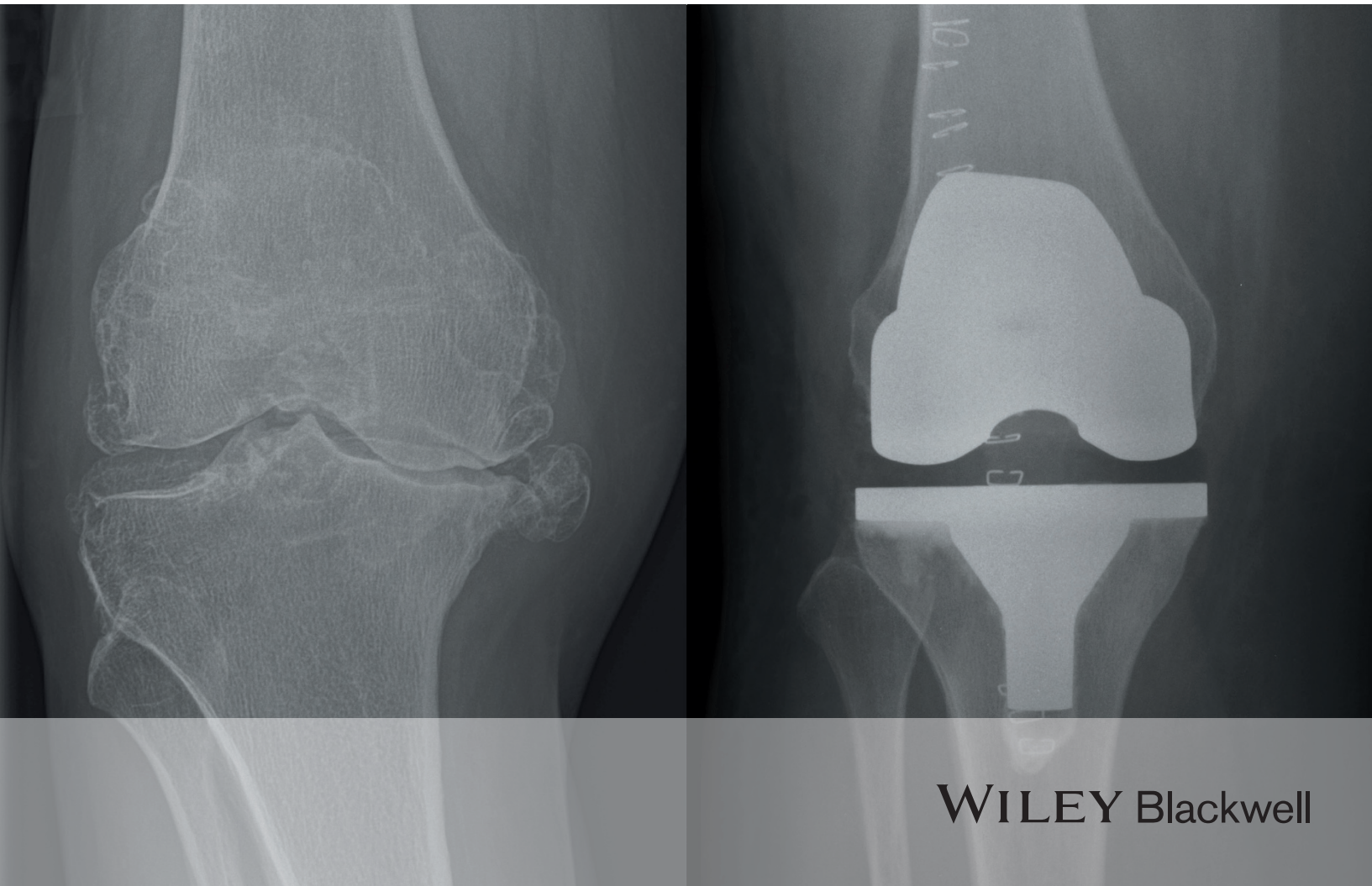
ABC of Orthopaedics and Trauma

Edited by Kapil Sugand and Chinmay M. Gupte



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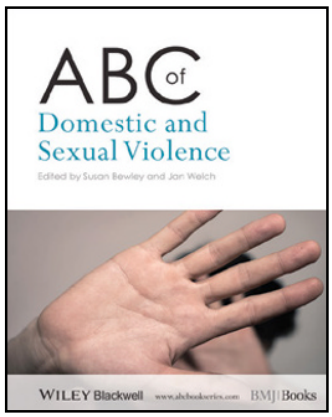

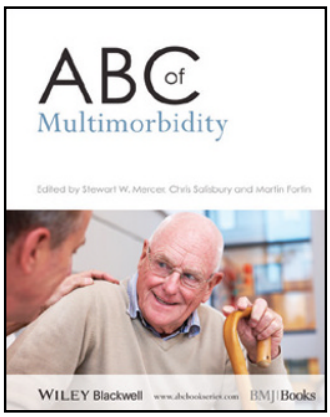

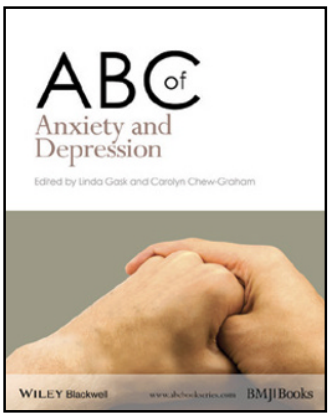

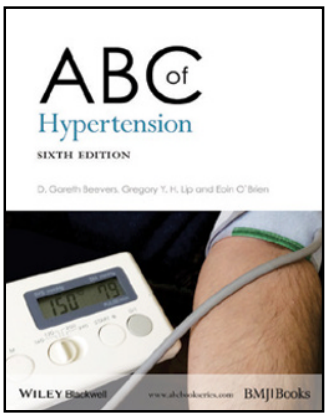

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KS: To my support network: my mother Poonam, family, colleagues and friends for their constant support and faith in me. I thank Mr. Gupte, my supervisor and mentor, for his guidance, motivation, and help.

CMG: To my wife, Thia, and my two wonderful children, India and Adi, for their unbridled support, encouragement and forebearance.

Contents

Foreword

ABC of Orthopaedics and Trauma

Students of medicine have a tough life in many ways: the body of knowledge continues to grow at a pace, so any supposed 'core of knowledge' has a definite date stamp. For this reason, the ABC of Orthopaedics and Trauma, in its first edition, is a useful snapshot of the state of our understanding in 2018 – a world of 3D printing and holograms, as well as the ancient arts of fracture reduction. Chinmay Gupte and Kapil Sugand have assembled a bright group of co-authors who have scoped out each field, and condensed it to be comprehensible and readable introduction to our world. Key to this project has been an editorial style that allows the reader to survey the whole field at a similar level – quite a feat across so many areas.

For every anatomic site, and in both the fields of trauma and orthopaedics, the reader will find the principles of the diseases we treat, and the foundations on which our management strategies are based. So the common approaches and operations for common conditions, are easily accessible, and basic sciences and mechanics are also explained, with illustrations of the important points, and a few key references.

In 2018, a physical library is no longer an essential key to student life, but the core text books continue to have an important place for the successful student – chapter layout and illustrations help us understand and retain information in a structured way. So this book will have a place on the shelves of students around the world, and its physical layout will be part of the memories that will serve its readers for their working life. Congratulations to all the contributors, and happy reading to this new generation of students and clinicians – it is an exciting world. Come and join us!

Prof. Justin P Cobb
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Preface

Trauma and orthopaedics is a vast speciality covering the entire musculoskeletal and peripheral nervous systems. As it is a standard service in every hospital regardless of size or geography, it is considered a core topic within international medical education curricula. We have compiled a user-friendly reference guide to assist audiences in finding essential facts easily in an overview of everyday practice. This book will provide a framework for managing common conditions for use of junior doctors, general practitioners, medical students, physician's associates, physiotherapists, and other allied healthcare professionals. Since this book is the first of its kind for the ABC series, we would welcome feedback to consistently improve the content. Feel free to email your comments and feedback to ks704@ic.ac.uk.

Abbreviations

ACJ	Acromioclavicular Joint
ACL	Anterior Cruciate Ligament
ACPP	Anticitrullinated Peptide/Protein Antibodies
AFB	Acid Fast Bacilli
ALP	Alkaline Phosphatase
AIN	Anterior Interosseous Nerve
AIS	ASIA (American Spinal Injury Association) Impairment Scale
AS	Ankylosing Spondylitis
ASIA	American Spinal Injury Association
ATLS	Advanced Trauma Life Support
AVM	Arterio-Venous Malformation
AVN	Avascular Necrosis
BCIS	Bone Cement Implantation Syndrome
BMD	Bone Mineral Density
BMI	Body Mass Index
BOAST	British Orthopaedic Association Standards for Trauma
CAOS	Computer-Assisted Orthopaedic Surgery
CB	Conduction Block
CEO	Common Extensor Origin
CKD	Chronic Kidney Disease
CN	Cranial Nerve
COX	Cyclooxygenase
CRIF	Closed Reduction And Internal Fixation
CRP	C-Reactive Protein
CRPS	Complex Regional Pain Syndrome
CTPA	CT Pulmonary Angiogram
CTS	Carpal Tunnel Syndrome
CVA	Cerebrovascular Accident
CVS	Cardiovascular System
DAS	Disease Activity Score
DCO	Damage Control Orthopaedics
DDH	Developmental Dysplasia of Hip
DHS	Dynamic Hip Screw
DIP	Distal Interphalangeal (joints)
DMARD	Disease-Modifying Antirheumatic Drugs
DVT	Deep Vein Thrombosis
DXA/DEXA	Dual-Energy X-ray Absorptiometry
EA	Enteropathic Arthritis
eGFR	Estimated Glomerular Filtration Rate
EMG	Electromyography
ESR	Erythrocyte Sedimentation Rate
ETC	Early Total Care
EUA	Examination Under Anaesthesia
FBC	Full Blood Count
FCU	Flexor Carpi Ulnaris
FDP	Flexor Digitorum Profundus
FDS	Flexor Digitorum Superficialis
FRAX	Fracture Risk Assessment Tool
GI	Gastrointestinal
GUM	Genitourinary Medicine
HA	Hydroxyapatite
HBL	Horizontal Beam Lateral
HIV	Human Immunodeficiency Virus
HRT	Hormone Replacement Therapy Human
IBD	Inflammatory Bowel Disease
IgG	Immunoglobulin G
IM	Intramedullary
IMRT	Intensity-Modulated Radiation Therapy
IV	Intravenous
LCL	Lateral Collateral Ligament
LFCA	Lateral Femoral Circumflex Artery
LFT	Liver Function Test
LOAF	Lumbricals (1 and 2), Opponens Pollicis, Abductor Pollicis Brevis and Flexor Pollicis Brevis
MBD	Metabolic Bone Disease
MC	Metacarpal
MCL	Medial Collateral Ligament
MCP	Metacarpophalangeal (joints)
MFCA	Medial Femoral Circumflex Artery
MPFL	Medial Patellofemoral Ligament
MRI	Magnetic Resonance Imaging
MT	Metatarsal
MTC	Major Trauma Centre

MTP	Metatarsophalangeal (joint)
MUA	Manipulation Under Anaesthesia
NCS	Nerve-Conduction Studies
NICE	National Institute for Health and Care Excellence
NOF	Neck Of Femur
NOGG	National Osteoporosis Guidelines Group
OA	Osteoarthritis
OPAT	Out Patient Antibiotic Therapy
ORIF	Open Reduction and Internal Fixation
PCL	Posterior Cruciate Ligament
PET	Positive Emission Tomography
PHILOS	Proximal Humerus Internal Locking System
PICC	Peripherally Inserted Central Catheter
PIPs	Proximal Interphalangeal (joints)
PLC	Posterolateral Corner (knee)
PMMA	Polymethyl Methacrylate
PNI	Peripheral Nerve Injury
POP	Plaster of Paris
POSI	Position of Safe Immobilisation
PsA	Psoriatic Arthritis
PTH	Parathyroid Hormone (rh prefix – recombinant human)
RA	Rheumatoid Arthritis
RANK	Receptor Activator of Nuclear Factor
ReA	Reactive Arthritis
RF	Rheumatoid Factors
RICE	Rest, Ice Compression and Elevation
SD	Standard Deviation
SERM	Selective Oestrogen Receptor Modulator
SLE	Systemic Lupus Erythematosus
SPA	Spondyloarthropathy
TB	Tuberculosis
TFCC	Triangular Fibrocartilage Complex
TFT	Thyroid Function Test
TKR	Total Knee Replacement
TNF	Tumour Necrosis Factor
TSA	Total Shoulder Arthroplasty
U&E	Urea and Electrolytes
UC	Ulcerative Colisis
UHMWP	Ultra-High-Molecular-Weight Polyethylene
UKR	Unicompartmental Knee Replacement
USS	Ultrasound Scan
VAC	Vacuum-Assisted Closure
VMO	Vastus Medialis Oblique
VTE	Venous Thromboembolism
WCC	White Cell Count
WHO	World Health Organisation

CHAPTER 1

General Overview

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OVERVIEW

- Orthopaedics is one of the oldest surgical practices since ancient civilisations.
- With an ever-growing and ageing population, there is a greater global clinical burden of trauma and elective orthopaedics.
- Fracture classifications can help with management plans, either nonoperative or operative treatment.
- Poor management of fractures and dislocations can lead to loss of function, long-term disability, and chronic pain, as well as deterioration in quality of life.

Introduction

Trauma and orthopaedics is an ancient practice of surgery. Records from Ancient Egypt, for example, document the splintage of fractures, wound care, and the reduction of shoulder dislocation. The art and skill of managing musculoskeletal injuries depends on adequate history, thorough examination, patient selection, and meticulous operative technique. Orthopaedic surgeons are trained not only to manage fractures but also to treat deep-seated infection, degenerative disease, tumours, and congenital deformities, as well as the repair of soft tissue like muscles, nerves, tendons, ligaments, and minimally invasive access surgery.

Epidemiology

There is an increasing demand for orthopaedic surgeons, owing to an ever-growing population. Immigration patterns and an ageing population have further contributed to the clinical burden worldwide. The World Health Organisation (WHO) predicts that by 2020, trauma will be the third most common cause for the global burden of disease, and that one in two people in the world will require at least one orthopaedic procedure in their lifetime. Trauma services have been centralised in more economically developed countries, where specialist centres manage complex trauma effectively. However, there is a discrepancy in the infrastructure of the trauma services in less economically developed countries, which leads to increased mortality and chronic disability rates, which are potentially avoidable. Furthermore, specific registries have collated information including demographics, indications and complications, in order to improve the orthopaedic service provided to patients.

Definitions

Trauma and orthopaedics, like any other speciality, has its own jargon and terminology. There are 300 bones in newborns and 206 in adults, divided into the midline axial skeleton (head, spine, ribs, and pelvis) and the appendicular skeleton (limbs), seen in Figure 1.1a. Movements of the body are seen in Figure 1.1b.

Some popular terms include the following:

- Trauma: any injury, bony or soft tissue
- Joint: articulation between two or more bones
- Arthro-: related to a joint
- Arthrocentesis: joint aspiration
- Arthroscopy: insertion of a minimally invasive camera into a joint
- Arthroplasty: joint reconstruction
- Arthrodesis: joint fusion
- Displacement: deviation of fracture fragment from original anatomical site
- Intra-/extra-articular: inside/outside joint
- Stable fractures: those able to withstand physiological loading, without further displacement (usually extra-articular and minimally displaced)
- Open fracture: bone breaching soft tissue and skin, to be in contact with outside environment (as opposed to closed)
- Revision surgery: successive surgical attempts at achieving the desired result

History

Taking a thorough history is the cornerstone of medical practice. It is important that as much information as possible about the patient's symptoms and medical background is ascertained, in order reach a

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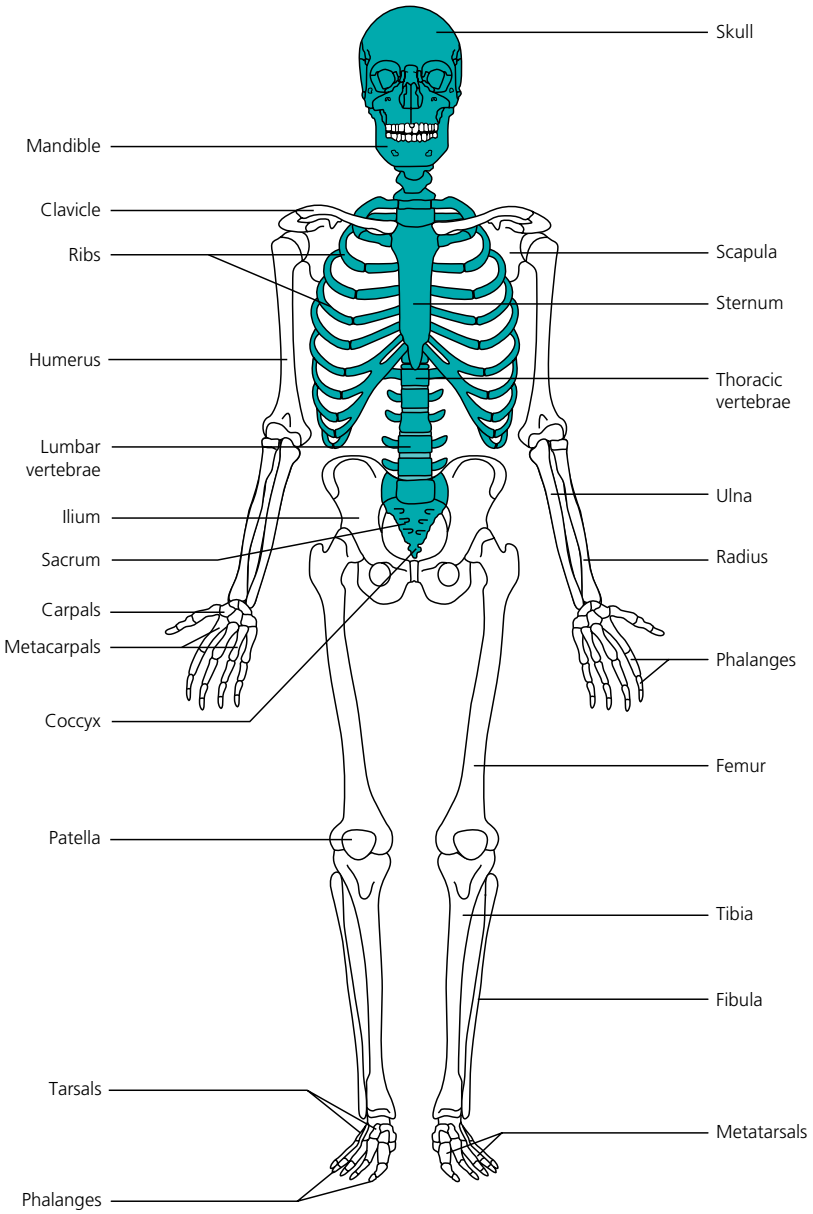

The skeleton

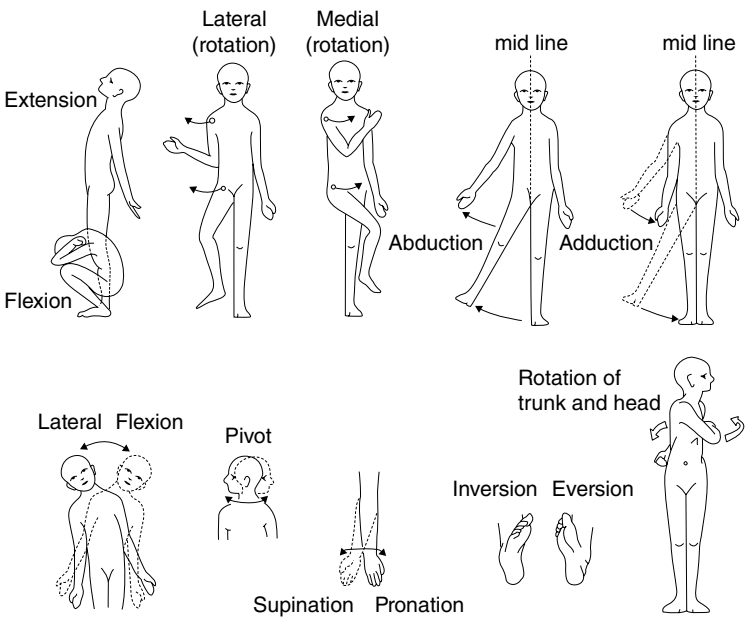

Figure 1.1 (a) Human skeleton and (b) movement of the body

Table 1.1 Orthopaedic history

- Age
- Occupation and dominant side
- Pain (mnemonic – SOCRATES)
  - Site
  - Onset – sudden vs. progressively worsening?
  - Character – sharp, dull, ache, stinging?
  - Radiation
  - Associations – any trauma, fever, swellings?
  - Timing – at rest, night pain, constant or intermittent?
  - Exacerbating/relieving factors – what position makes the pain better/worse?
  - Severity – grade out of 10?
- Associated symptoms
  - Stiffness, snapping, clicking, squeaking, deformity, numbness, weakness, locking, giving way, swelling
- Function
  - How far can patient walk on a flat surface?
  - Difficulty with stairs?
  - Need any walking aids?
  - Can patient participate in sports?
  - Is patient able to work?
- Past medical and surgical history
  - History of trauma
  - Other joints affected
  - Treatments already given (e.g. injection, physiotherapy etc.)
- Systems review
- Family history
- Social history

list of differential diagnoses and to offer optimal management options. It is said that 80% of the diagnosis is within the medical history. An orthopaedic approach to history taking is seen in Table 1.1.

Examination

A systematic examination is essential in orthopaedic practice. The impression gained from the history is tested and further information is ascertained. The management options, and whether surgical intervention is necessitated, depends on the extent of disease and its consequent functional limitation and quality of life. As the idiom goes, a good surgeon knows when to operate, but the best surgeon knows when not to operate. The general principles of examining in orthopaedics are to (1) look, (2) feel, and (3) move as well as any (4) special tests (Figure 1.2).

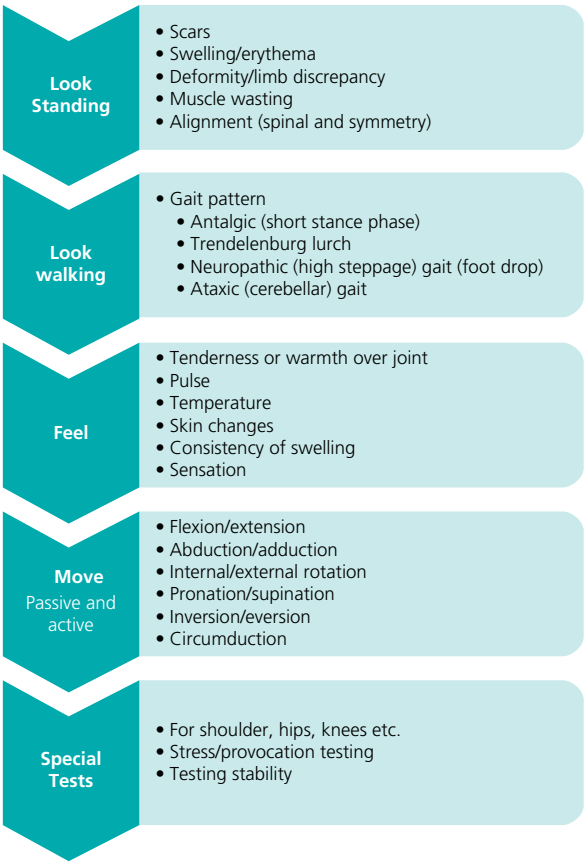

Figure 1.2 Orthopaedic examination

Reading radiographs

Regardless of speciality, all doctors and medical students are expected to interpret basic orthopaedic plain radiographs (do not refer to them as X-rays). Competency in reading radiographs is based on the following six points of information:

1. Anatomical site: which bone and which part of bone? Long bones are divided into proximal, middle, and distal thirds.
2. Number of fragments: simple (two-part) vs. multifragmentary (formerly referred to as comminuted).
3. Fracture pattern: transverse vs. oblique (>30°) vs. spiral.
4. Is the fracture displaced vs. undisplaced (Figure 1.3)?
5. Is the fracture translated/ angulated/ rotated?
6. Extent of displacement/angulation/rotation/tilt in X/Y/Z planes.

Examples of presenting radiographs

Figure 1.4 is "*an AP and lateral radiograph of the right tibia and fibula of [patient name] taken on [date] at [time]. There is a two-part transverse fracture of the junction between middle and distal third of the tibia, with 15% anterolateral translation and 10° angulation in the* x *plane.*"

Figure 1.5 is "*an AP and lateral radiograph of the right tibia and fibula of a skeletally immature (growth plates present and not fused) patient, named [patient name], taken on [date] at [time]. There is a displaced multifragmentary fracture of the fibula and a minimally displaced two-part oblique fracture of the tibia, both at the junction of middle and distal thirds of the diaphysis. Both have 20° valgus angulation and anterior tilt.*"

Note that angulation and translation is always described of the distal fragment, relative to the proximal fragment. Look for fracture dislocations near joints. Valgus refers to deviation *away* from the midline in the coronal plane, whereas varus is *towards* the midline. Malrotation is more common in the shoulder, hip, and ankle.

An aide-memoire is va**L**gus is **L**ateral to midline.

Common fracture classifications

There are numerous fracture classifications (Table 1.2) to describe the severity of injury, energy of trauma, and to guide your management options. Each classification has an eponymous name, often of the surgeon who developed it. The ideal classification describes the

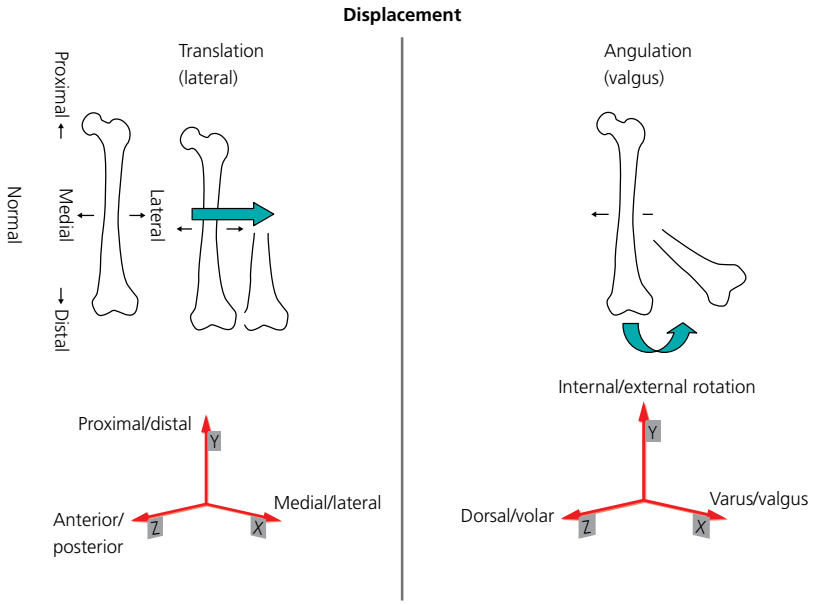

Figure 1.3 Displacement in three planes

Figure 1.4 AP and lateral radiograph of the right tibia and fibula

Figure 1.5 AP and lateral radiograph of the right tibia and fibula of a skeletally immature patient

severity of injury in terms of anatomy, displacement, stability, and prognosis. Since most fall short of this ideal, it is up to the orthopaedic surgeon to not simply follow guidelines but to deliver optimal healthcare with a patient-centred approach. It is the duty of every surgeon to offer the right treatment, to the right person, at the right time, and in the right place.

Principles of fracture fixation

An international community, known as AO (Arbeitsgemeinschaft für Osteosynthesefragen), has developed protocols, standards, and guidelines that have been adopted worldwide for the past half a century. There are four AO principles of fracture fixation:

Table 1.2 Common fracture classifications

Classification	Site
Salter Harris	Paediatric physeal plate
Neer	Proximal humerus
Tile	Pelvis
Garden	Intracapsular neck of femur
Weber	Distal fibula
Schatzker	Tibial plateau
Gustillo-Anderson	Open fractures
Denis	Spine
Tscherne	Soft tissue disruption

1 *Fracture reduction to restore anatomical relationships*
Joints require their surfaces to be anatomically reduced to perfection.
Bones require functional reduction by restoration of their length and alignment.
2 *Fracture fixation providing absolute or relative stability as the "personality" of fracture, patient, and injury requires*
The goals are to maintain the reduction with or without metalwork and to achieve sufficient stability. Stability leads to less pain, early range of movement, and physiotherapy, to achieve full function. Two options for stability are absolute versus relative. Absolute stability is usually due to fixation with plates and screws and means that there is no movement at the fracture site, thereby bypassing the callus-formation stage of fracture healing, to allow direct bone healing. Relative stability is usually achieved by splinting, nailing, or bridging and means that there is some movement at the fracture site, which allows callus formation and indirect bone healing.
3 *Preservation of blood supply to soft tissues and bone*
Fracture healing relies on biomechanics and biology, among other factors. The soft tissue envelope and blood supply to the fracture site need to be viable, to allow adequate fracture healing. If the soft tissue is heavily disrupted, then a staged procedure, with primary stabilisation (using external fixation), followed by secondary stabilisation (definitive fixation) ought to be considered. Elevation of the limb pre- and post-operatively is essential, to minimize swelling. Other postoperative instructions include offering (i) adequate analgesia, since the body does not heal if in pain, and (ii) venous thromboembolic prophylaxis (TED stockings and low molecular weight heparin).
4 *Early and safe mobilisation of the injured part and the patient as a whole*
The management plan does not end as soon as the operation is over. The last step of any management plan is rehabilitation. The duty of the health care team is to restore patients to their premorbid level of functional ability, or to the closest scenario, using means such as physiotherapy.

Principles of fracture management

Fracture management consists of the 4Rs: Resuscitate → Reduce → Rest (hold) → Rehabilitate (Figure 1.6).

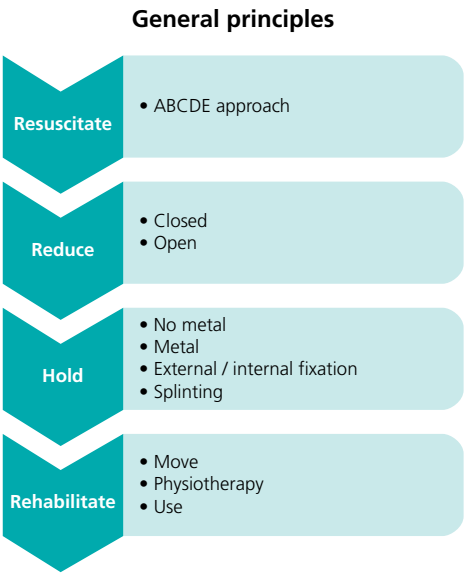

Figure 1.6 General principles of fracture management

Complications of fractures

Fractures can lead to multiple complications, both locally to the fracture site and systemically (refer to Chapter 16, Table 16.4). Systemically, venous thromboembolism and infection are the commonest complications. Other complications specific to the fracture site are myriad and can consequently lead to chronic pain, disability, and deformity. Complications can be divided into *general vs. specific* or *immediate vs. early vs. late*. Of particular note, there is a misconception that compartment syndrome tends only to occur in closed fractures, but it can also occur in open fractures.

Education and training

Trauma and orthopaedics is one of the most popular choices of surgical speciality, and the demand for these surgeons is increasing. However, there has been a dramatic change in the quality of education and demands of the career. Compared to previous generations, where their working week was usually over a 100 hours per week, current working restrictions set by the European Working Time Directive and Accreditation Council for Continuing Medical Education for North America have nearly halved the working week. This has also reduced the number of dedicated training hours in the operating theatre, to a predicted 80% reduction. Like general surgical specialities, there is a further inclination to adopt safer training practices to train future generations of surgeons, in a safe and controlled environment, while upholding patient safety. Some of this has been achieved by simulation, using virtual-reality simulators, multimedia online platforms, and holograms (Figures 1.7 and 1.8).

Future of trauma and orthopaedics

Orthopaedics has modernised after the implementation of technology. Computer-assisted orthopaedic surgery (CAOS) has aided implantation of prostheses in both hip and knee arthroplasty, with three-dimensional (3D) preoperative planning, for real-time, intraoperative use. Another method of improving

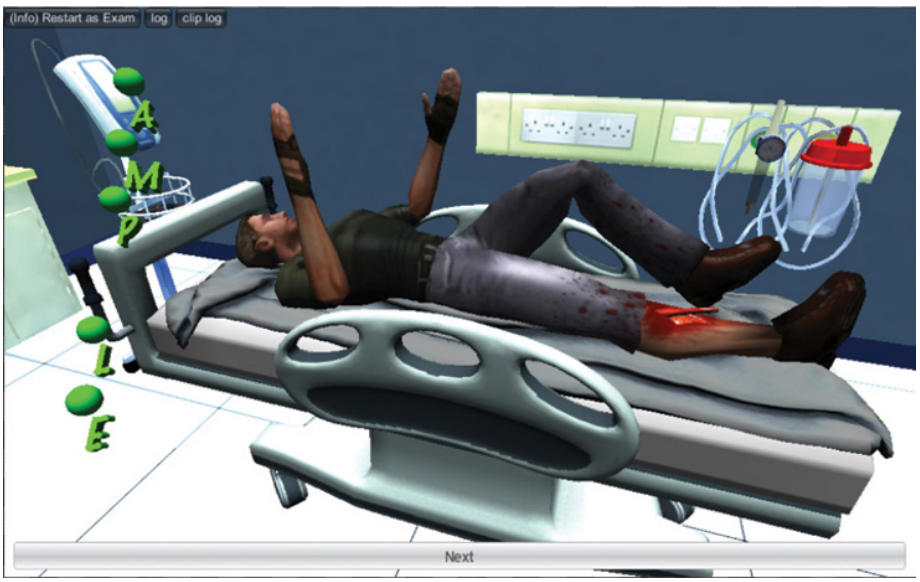

Figure 1.7 Multimedia online platform

Figure 1.8 Holography-assisted learning in orthopaedics (HALO)

preoperative planning and patient satisfaction, is the use of 3D printing. Personalised models can be printed, using data from CT and MRI scans, to visually give the surgeon and patient a much more realistic understanding of the injury or disease process, prior to operating.

Currently, there are prostheses of differing sizes, but they often do not take into account anatomical variations. The next step in orthopaedic practice will be the use of patient-matched implants, to improve outcomes. 3D printing has created personalised implants in other surgical specialities. The better the implant fit, the longer the likely lifespan and the lower the likelihood of mechanical complications, including the need for revision surgery. Biological treatments are currently being developed and used in clinical trials, not only to heal diseased bone but to cure it. Stem cells harvested from bone marrow may have the potential to restore the integrity of the articular surface. The shape of joints can also be restored with the use of 3D biosynthetic scaffolding.

Further reading

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