ORTHOPAEDICS

FOR PRIMARY HEALTH CARE

Volume 2

Symptom-Based Approaches to Common Orthopaedic Pathology

Edited by Michael Held

ORTHOPAEDIC DEPARTMENT

UNIVERSITY OF CAPE TOWN

ORTHOPAEDICS FOR PRIMARY HEALTH CARE

Volume 2:
Symptom-Based Approaches to Common Orthopaedic Pathology

Edited by Michael Held

LION
LEARNING
INNOVATION
VIA ORTHOPAEDIC
NETWORKS

Volume 2, October 2025

This volume is the second in the *Orthopaedics for Primary Health Care* series. Volume 1, titled *Orthopaedics for Primary Health Care: Principles of Orthopaedic Emergencies and Trauma*, was published in 2021 and is available at https://doi.org/10.15641/0-7992-2550-1.

Published by UCT Libraries Press, University of Cape Town

Acknowledgements

The publication process for this work was undertaken in collaboration with the Digital Open Textbooks for Development (DOT4D) initiative in the Centre for Innovation in Learning and Teaching (CILT) at the University of Cape Town.

Thanks and acknowledgements are due to Professor Maritz Laubscher for his support in the conceptualisation of this resource and the content creation process.

Editor

Michael Held <michael.held@uct.ac.za>

Publishing Manager

Michelle Willmers <michelle.willmers@uct.ac.za>

Production Assistant

Robyn Brown <brwrob028@myuct.ac.za>

CONTENTS

Basics

Page

1. Neurological symptoms 2–10
2. Knee and hip arthroplasty: Indication, surgical fitness and perioperative care.... 11–17

Atraumatic conditions

3. Multiple painful joints 19–25
4. Approach to a swollen, painful knee 26–30
5. Osteoarthritis 31–36

Emergency conditions

6. Low-energy fractures 38–45
7. Complications of fractures 46–52

Paediatric injuries and conditions

8. Approach to foot deformities in a child 54–60
9. Approach to a swollen, painful limb in a child 61–65

Spinal injuries and conditions

10. Spinal trauma 67–73
11. Nerve injuries 74–77

Lower limb injuries and conditions

12. Meniscus injury management 79–84
13. Anterior cruciate ligament injury 85–90

Skills

14. Cervical reduction 92–99

PREFACE

Informed by experts. Most patients with orthopaedic pathology in low- to middle-income countries are treated by non-specialists. A curriculum to prepare undergraduate medical students for this duty should reflect the local pathology and skills that are required to manage patients in a resource-restricted environment.

The contents of this textbook are aligned with the curriculum developed based on a modified Delphi consensus study with experts from Africa, Europe, and North America in the Learning Innovation via Orthopaedic Networks.

The chapters in this book were written by orthopaedic consultants, clinicians and medical students who have experience with local orthopaedic pathology and treatment modalities, as well as in medical education of undergraduate students and primary care physicians.

The second edition of this work also features new chapters created by students as part of a supervised student co-authorship initiative, in which students made use of ChatGPT as an aid in the authorship process.

All chapters in this work have been reviewed by local orthopaedic consultants.

In the first volume of this work, knowledge topics, skills, and cases concerning orthopaedic trauma and infection were prioritised. Acute primary care for fractures and dislocations ranked high. Furthermore, the diagnosis and the treatment of conditions not requiring specialist referral were prioritised. This second volume focuses on symptom-based approaches to common orthopaedic conditions. It also expands on the levels of student engagement with content co-creation.

Disclaimer

Although the authors, editor and publisher of this book have made every effort to ensure that the information provided was correct at press time, they do not assume and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause.

This book is not intended as a substitute for the medical advice of physicians. The reader should regularly consult a physician in matters relating to their health and particularly with respect to any symptoms that may require diagnosis or medical attention.

The information in this book is meant to supplement, not replace, orthopaedic primary care training. The authors, editor and publisher advise readers to take full responsibility for their safety and know their limits. Before practicing the skills described in this book, be sure that your equipment is well maintained, and do not take risks beyond your level of experience, aptitude, training, and comfort level.

Professor Michael Held
Orthopaedic Department, University of Cape Town
October 2025

BASICS

Chapter 1 – Neurological symptoms **2**

Ishta Ramguthy, Frances Verfuss, Anria Horn, Yammesh Ramguthy & Benjamin Blankson

Chapter 2 – Knee and hip arthroplasty: Indication, surgical fitness, and perioperative care **11**

Robyn Brown, Marc Nortje & Michael Held

Neurological symptoms

By Ishta Ramguthy, Frances Verfuss, Anria Horn, Yammesh Ramguthy & Benjamin Blankson

Learning objectives

- Understand the common neurological conditions in orthopaedic practice.
- Recognise the importance of comprehensive patient history and examination in diagnosing and managing neurological symptoms in orthopaedic patients.
- Describe the role of special investigations in diagnosing and understanding neurological conditions in orthopaedics.
- Explain non-surgical management options.
- Identify the key surgical interventions and the collaborative approach between orthopaedic surgeons and neurosurgeons in addressing severe or refractory neurological conditions in orthopaedics.

Introduction

There is an intricate interplay between the musculoskeletal system and the nervous system. In this chapter, we focus on the manifestations and management of neurological conditions that present in orthopaedic practice. Neurological symptoms encompass a wide array of signs and symptoms related to nerve compression, injury or dysfunction, which can significantly impact an individual's mobility, sensation and motor function. Carpal tunnel syndrome, lumbar radiculopathy (sciatica), cervical radiculopathy, spinal stenosis and other peripheral nerve entrapments frequently present in orthopaedic practice.

Applied anatomy

Understanding the nerve roots and their corresponding myotomes and dermatomes plays a pivotal role in localising neurological problems in orthopaedics. Knowledge of which spinal nerve roots supply myotomes and dermatomes enables clinicians to pinpoint the exact region affected by nerve compression or injury. Moreover, understanding the anatomical relationships between nerves and adjacent bones provides valuable insights into the potential sources of nerve impingement or irritation.

Clinical findings

History

In assessing neurological symptoms in orthopaedic patients, a comprehensive history is essential for accurate diagnosis and management. Age of onset and the progression of symptoms can provide crucial insights into potential underlying conditions. Additionally, inquiring about past medical history (including traumatic events, repetitive movements and occupational history) helps to identify factors that may contribute to nerve compression or injury.

Patients' complaints of numbness and paraesthesia serve as important indicators of nerve involvement. Pain in a specific dermatomal or peripheral

nerve sensory distribution may indicate an underlying neurological cause; and being aware of common neurological conditions is crucial to ensure early and accurate diagnosis.

Examination

During the examination of orthopaedic patients with neurological symptoms, a full neurological examination should be performed. Observing the patient's appearance and deformities can provide valuable diagnostic information; for example, a claw hand may indicate an ulnar nerve lesion. Assessing motor and sensory function helps localise nerve damage.

***Figure 1**: Claw hand with an ulnar nerve lesion (Source: Mcstrother, CC BY)*

Evaluating muscle tone, power and tendon reflexes aids in identifying abnormalities associated with neurological conditions, distinguishing between upper motor neuron (UMN) and lower motor neuron (LMN) damage, and pinpointing the affected nerve or nerve root. Additionally, evaluating cerebellar and cortical function can reveal neurological abnormalities beyond the peripheral nervous system.

Additional injuries and conditions to note

Carpal tunnel syndrome: This is a common condition characterised by compression of the median nerve as it passes through the carpal tunnel in the wrist. Patients may experience symptoms like pain, numbness or paraesthesia in the thumb/fingers, weakness and reduced wrist mobility.

Lumbar radiculopathy (sciatica): This occurs when a nerve root in the lower back is compressed or irritated, leading to symptoms such as pain, tingling and numbness that radiate down the leg. It often results from a herniated disc, spinal stenosis or degenerative changes in the lumbar spine.

Cervical radiculopathy: Involves compression or irritation of a nerve root in the neck region. Patients may experience pain, tingling and weakness that radiate into the arm and hand following a specific dermatomal pattern. Conditions like cervical disc herniation or foraminal stenosis can lead to cervical radiculopathy.

Peripheral nerve compression: Peripheral nerve compressions, such as cubital tunnel syndrome (compression of the ulnar nerve at the elbow), can cause symptoms like tingling, numbness and weakness in specific areas supplied by the affected nerve.

Spinal stenosis: Narrowing of the spinal canal can lead to compression of the spinal cord or nerve roots. Patients may experience neurological symptoms like limb weakness, paraesthesia, bowel and bladder dysfunction, neurogenic claudication, and difficulty mobilising. Lumbar and cervical spinal stenosis are the most common types in orthopaedics, with lumbar stenosis presenting with a LMN picture and cervical stenosis with myelopathy or UMN disorders. Treatment involves bony decompression of nerve structures.

***Figure 2**: Anterolisthesis of L4 on L5 with flattened and hypointense L4/5 disc showing herniation posteriorly and severe spinal stenosis with cauda equina compression*

Fractures: Fractures can directly or indirectly affect the nerves or spinal cord through nerve and spinal cord compression, bone displacement and fragments (which can cause nerve stretching and damage), blood supply interruption (which reduces blood flow to nerve tissue), and traumatic brain injury from skull fractures. For example, vertebral compression fractures cause compression of the spinal cord or nerve roots, leading to neurological deficits such as pain, weakness or sensory disturbances. All these lead to various neurological symptoms depending on the location and severity of the injury.

Spinal injuries: These can cause a wide range of neurological symptoms. The physical trauma can vary from ligamentous strains to vertebral fractures and fracture-dislocations, potentially affecting the spinal cord and nerve roots through compression, energy transfer or blood supply disruption. Subsequent biochemical changes can exacerbate the initial neurological damage.

Moreover, indirect injuries resulting from falls or violent movements pose a significant risk, subjecting the spine to various forces such as axial compression, flexion, lateral compression, flexion-rotation, shear, flexion-distraction and extension.

During the examination, one should assess for shock. Neurogenic shock, which is characterised by the loss of sympathetic pathways in the spinal cord, can lead to peripheral vessel dilation, hypotension and bradycardia. Spinal shock, which is a temporary physiological dysfunction, manifests as flaccid muscles, absent reflexes (particularly, absent bulbocavernosus reflex, anal tone and perianal pin-prick sensation), and lost sensation below the injury level.

Myelopathy: A complex neurological condition characterised by dysfunction or damage to the spinal cord. It manifests because of various orthopaedic factors, including cervical spondylosis, herniated discs, spinal fractures and degenerative disc disease, creating a cascade of symptoms that can profoundly impact patients. These conditions pose a risk of compressing the spinal cord, leading to a range of neurological deficits, such as muscle weakness, sensory abnormalities, difficulty with walking and fine motor skills, loss of balance and coordination, and abnormal reflexes.

During the examination, meticulous assessment for signs of myelopathy, including gait disturbances, upper motor neuron signs and specific sensory deficits, is essential. Tailored interventions, including conservative measures like physiotherapy and spinal bracing, as well as surgical options for decompression and stabilisation, aim to restore spinal stability, alleviate compression and enhance patient outcomes.

Special investigations

In orthopaedics, thorough investigations are vital for diagnosing neurological symptoms and understanding the intricate musculoskeletal-nervous system interplay.

Plain x-rays in initial assessments show bone pathology, fractures and dislocations which may impact the central and peripheral nervous system.

Magnetic resonance imaging (MRI) reveals cord anatomy and pinpoints compression sites, assists in determining the extent and location of lesions and aids in brain imaging. It is the investigation of choice for radiculopathy and myelopathy and is essential in preoperative planning.

***Figure 3**: MRI showing bulge of the L2 vertebral body and extradural fluid components resulting in severe spinal canal stenosis with cauda equina compression and L1/2 and L2/3 neural foraminal compromise*

Computed tomography (CT) is also valuable for identifying bone fragments' relationship with nerve structures. CT or MRI are best suited for detecting narrowing of the spinal canal, commonly caused by osteophytic overgrowth due to disc degeneration and osteoarthritis of facet joints.

Positron emission tomography (PET) is a functional scan used to isolate specific brain activity regions.

Nerve conduction studies are important in assessing nerve function post-injury, localising the level of nerve involvement, and in cases with two different sites of nerve compression or involvement (e.g. neck and wrist).

Myelography, a diagnostic technique, employs a contrast material combined with real-time fluoroscopy, a specialised form of x-ray imaging. This procedure is valuable in identifying abnormalities within the spinal cord. Notably, myelography serves as an alternative for patients who cannot undergo MRI.

Complementary blood, cerebrospinal fluid investigations, muscle and nerve biopsies, and diagnostic local injections can help in a comprehensive diagnostic approach.

Management

Non-surgical

Orthotics and physiotherapy

Modern orthoses, designed with advanced materials, significantly improve the quality of life for patients with orthopaedic-related neurological symptoms. Orthotics provide external support and alignment to the musculoskeletal system to stabilise and improve functional movement.

Collaborating with physiotherapists, these customised devices optimise stability, muscle strength, flexibility and functional mobility. Regular follow-ups ensure proper fitting and address any changes for improved muscle function and natural movement.

For spinal injuries, immobilisation using orthotics like back braces or cervical collars aids healing and prevents further damage. Physiotherapy employs targeted exercises, stretches and manual techniques to minimise pain and enhance mobility, strength and flexibility.

In carpal tunnel syndrome, wrist splints and braces alleviate pressure on the median nerve, reducing tingling and numbness.

In cases of radiculopathy, physiotherapy exercises help relieve pressure on affected nerve roots and additional treatments like nonsteroidal anti-inflammatory drugs (NSAIDs) and epidural steroid injections help reduce inflammation and pain.

In spinal stenosis, a comprehensive non-surgical approach combining physiotherapy, pain medications and epidural injections, focuses on improving flexibility and spinal stability.

***Figure 4**: Lightweight orthosis (Source: Orthodontist101, CC BY-SA)*

Self-management strategies

Education on posture, exercises and lifestyle modifications empowers patients to actively participate in managing their neurological symptoms and maintaining long-term well-being.

Surgical

Surgical management of neurological symptoms in orthopaedics is a critical intervention aimed at addressing structural causes and providing relief for patients with severe or refractory conditions.

Procedures are tailored to the specific underlying neurological pathology, such as nerve compression, nerve injury or spinal cord compression. Surgical interventions may include discectomy for herniated discs causing radiculopathy, carpal tunnel release for median nerve compression, or ulnar nerve transposition for ulnar nerve entrapment.

In complex cases, nerve grafting or nerve transfers may be employed to restore function in cases of peripheral nerve injuries. Collaborative efforts between orthopaedic surgeons and plastic surgeons are often necessary in these cases. Collaboration with neurosurgeons is often required in the management of compressive pathologies affecting the central nervous system, especially when addressing conditions affecting the spinal cord.

Surgical management requires a thorough evaluation of clinical presentation, imaging studies and the overall health status of the patient. Post-operative rehabilitation and physiotherapy are crucial components of surgical management, aiding in the recovery process and optimising functional outcomes.

***Figure 5**: Posterior internal fixation of an unstable vertebral fracture*

Key takeaways

- Neurological symptoms in orthopaedics involve signs and symptoms related to nerve compression, injury or dysfunction; affecting mobility, sensation and motor function.
- Common neurological conditions encountered in orthopaedic practice include carpal tunnel syndrome, lumbar radiculopathy (sciatica), cervical radiculopathy, myelopathy, spinal stenosis and peripheral nerve entrapments.
- Special investigations, such as plain x-rays, MRI, CT, myelography, PET scans, blood tests, cerebrospinal fluid investigations and muscle biopsies, aid in diagnosis.
- Non-surgical management may include orthotics, physiotherapy, pain management and self-management.
- Surgical interventions tailored to specific underlying neurological pathologies, such as nerve compression, injury or spinal cord compression, play a critical role in providing relief and restoring function in severe or refractory cases.

Assessment

1. A 60-year-old patient presents with complaints of weakness and tingling in the right arm and hand. The symptoms radiate from the neck to the arm and the patient reports difficulty in performing fine motor tasks. Physical examination reveals reduced sensation in the right index and middle fingers and a positive Spurling's test. Which condition is most likely responsible for these symptoms, and what additional investigation is crucial for confirming the diagnosis?

A. Lumbar radiculopathy; CT of the lumbar spine

B. Carpal tunnel syndrome; electromyography (EMG) and nerve conduction studies

C. Cervical radiculopathy; MRI of the cervical spine

D. Spinal stenosis; plain x-rays of the spine

The answer is (C). The patient's presentation with radiating symptoms from the neck to the arm, along with reduced sensation in specific fingers test, strongly suggests cervical radiculopathy. MRI of the cervical spine is crucial for confirming the diagnosis, as it can reveal the site and extent of nerve root compression or irritation.

2. Which of the following is NOT part of the surgical management of neurological symptoms in orthopaedics?

A. Nerve grafting

B. Discectomy

C. Epidural steroid injections

D. Nerve transfers

The answer is (C). Epidural steroid injections are part of non-surgical management, specifically used for reducing inflammation and pain in cases of radiculopathy. The other options are all part of surgical management, addressing specific underlying neurological pathologies.

3. A patient presents with difficulty walking, muscle weakness and paraesthesia in both legs. Imaging reveals compression of the spinal cord. What is the most likely diagnosis?

A. Carpal tunnel syndrome

B. Lumbar radiculopathy

C. Peripheral nerve compression

D. Spinal stenosis

The answer is (D). The patient's presentation of difficulty walking, muscle weakness and paraesthesia in both legs, along with imaging showing compression of the spinal cord, is indicative of spinal stenosis, which can occur in conditions like cervical or thoracic spinal stenosis.

4. A 50-year-old patient presents with neurological symptoms characterised by tingling, numbness and weakness in specific areas supplied by the ulnar nerve. The symptoms are worsened when the elbow is flexed or pressure is applied to the medial elbow. Which condition is most likely responsible for these symptoms?

A. Carpal tunnel syndrome
B. Lumbar radiculopathy
C. Ulnar nerve compression (cubital tunnel syndrome)
D. Cervical radiculopathy

The answer is (C). The patient's presentation of symptoms in specific areas supplied by the ulnar nerve, along with the aggravation of symptoms with elbow flexion or pressure on the medial elbow, is indicative of ulnar nerve compression at the cubital tunnel.

5. A 50-year-old patient presents with neurological symptoms, including weakness and reduced mobility in the wrist and hand. Physical examination shows a weakened grip and reduced sensation in the affected hand. Which surgical procedure is most appropriate for this patient?

A. Carpal tunnel release
B. Laminectomy with discectomy
C. Ulnar nerve transposition
D. Cervical fusion

The answer is (A). The patient's presentation of neurological symptoms, including weakness and reduced mobility in the wrist and hand, along with findings of a weakened grip and reduced sensation, indicates that carpal tunnel release is the most appropriate surgical procedure to address carpal tunnel syndrome and restore function in the affected hand.

References and further reading

Dunn. R., Kruger, N., Apley, A.G., & Solomon, L. Injuries of the spine. In A. Blom, D. Warwick, M.R. Whitehouse (Eds.). Apley & Solomon's System of Orthopaedics and Trauma. (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 835–61.

Dunn R, Kruger N, Apley AG, Solomon L. The back. In A. Blom, D. Warwick, M.R. Whitehouse (Eds.). Apley & Solomon's System of Orthopaedics and Trauma. (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 514–5.

Eastwood D, Apley AG, Solomon L. Neuromuscular disorders. In A. Blom, D. Warwick, M.R. Whitehouse (Eds.). Apley & Solomon's System of Orthopaedics and Trauma. (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 232–255.

Fox M, Warwick D, Srinivasan H, Apley AG, Solomon L. Peripheral nerve disorders. In A. Blom, D. Warwick, M.R. Whitehouse (Eds.). Apley & Solomon's System of Orthopaedics and Trauma. (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 282.

Houlden H, Charlton P, Singh D. Neurology and orthopaedics. Journal of Neurology, Neurosurgery & amp; Psychiatry. 2006;78(3):224–32. doi:10.1136/jnnp.2006.092072

Martini FH, Nath JL, Bartholomew EF. The appendicular skeleton. In: Fundamentals of Anatomy & Physiology. eleventh, global ed. Harlow, England: Pearson; 2018. p. 297.

Mineiro J, Lanca N, Apley AG, Solomon L. The neck. In: Blom A, Warwick D, Whitehouse MR, editors. Apley & Solomon's System of Orthopaedics and Trauma. Tenth ed. Boca Raton, Florida: CRC Press; 2018. p. 455–8.

Myelopathy [Internet]. 2021 [cited 2023 Aug 10]. Available from: https://www.hopkinsmedicine.org/health/conditions-and-diseases/myelopathy

OpenAI. ChatGPT [Internet]. San Francisco, CA: OpenAI; c2021 [cited 2023 Aug 2]. Available from: https://openai.com/chatgpt

Wakeley C, Apley AG, Solomon L. Diagnosis in orthopaedics. In A. Blom, D. Warwick, M.R. Whitehouse (Eds.). Apley & Solomon's System of Orthopaedics and Trauma. (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 10–2.

Knee and hip arthroplasty: Indication, surgical fitness and perioperative care

By Robyn Brown, Marc Nortje & Michael Held

Learning objectives

- Understand the indications for knee and hip arthroplasty in patients with severe joint dysfunction.
- Recognise the importance of evaluating surgical fitness and assessing risk factors before recommending joint arthroplasty.
- Describe the perioperative care and management of patients undergoing knee and hip arthroplasty procedures.

Introduction

Knee and hip arthroplasty are commonly performed orthopaedic procedures to address severe joint dysfunction, alleviate pain, and improve patients' quality of life. This chapter aims to provide guidelines on indications for arthroplasty, evaluation of surgical fitness, and perioperative care associated with knee and hip arthroplasty.

Indications

Patients with severe pain and bone-on-bone arthritis that greatly affects their daily lives will benefit from arthroplasty surgery with reliably predictable outcomes. Prior to the specialist referral, surgical fitness should be evaluated and optimised, including the evaluation and management of psychological disorders.

Severe arthropathy causing bone-on-bone arthritis are most commonly due to osteoarthritis, inflammatory conditions (such as rheumatoid arthritis) or sequalae of previous trauma or infection. Regarding knee arthroplasty, if only one compartment is involved (such as the medial side) partial knee replacement should be considered in a patient without inflammatory arthritis and a stable knee.

Figure 1: *Bilateral knee anterior-posterior (AP) x-rays showing endstage bone-on-bone arthritis. This is a prerequisite for predictable outcomes after total knee arthroplasty. Eccentric joint space narrowing, subchondral sclerosis, osteophytes and small cysts can also be seen and are indicative of osteoarthritis.*

Figure 2: *Mechanical alignment x-ray image of the left leg showing severe varus malalignment due to the progressive knee arthropathy*

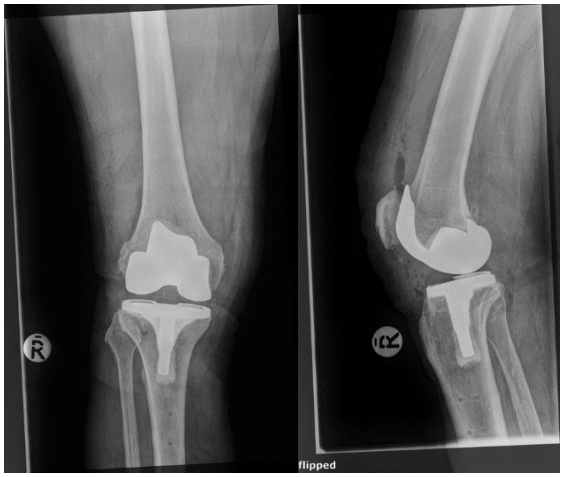


Figure 3: *AP (left) and lateral (right) x-rays after cemented total knee replacement of the right knee. There is mild varus of the tibial component which recreates the original varus orientation of the knee. This could be measured precisely with robotic assisted surgery. The 2 small drill holes in the tibia are evidence of tracing pins which were placed for this robotic surgery.*

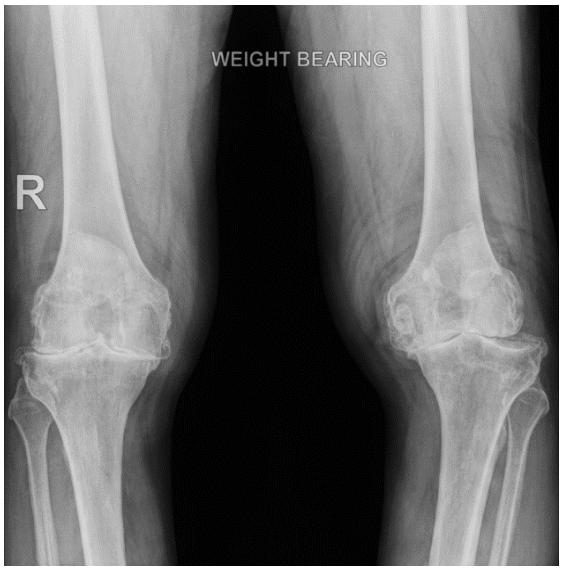


Figure 4: *Bilateral weight-bearing AP x-ray showing medial compartment bone-on-bone arthritis*

Figure 5: *Valgus AP-stress x-ray demonstrating a well maintained lateral joint space, supporting the decision for a partial medial compartment knee replacement*

Figure 6: *AP x-ray of a medial compartment partial knee replacement*

Surgical fitness and perioperative optimisation

Before recommending knee or hip arthroplasty, it is crucial to assess the patient's overall health and surgical fitness. Groote Schuur Hospital standard operating procedure guidelines are as follows:

Red flags (do not operate)

1. American Society of Anesthesiologists (ASA) = 3 (Physical status classification system)

2. Body Mass Index (BMI) >50/albumin <30 g/L

3. Anaemia (Haemoglobin [Hb] <10 g/dl)

4. Cardiac dysfunction/uncontrolled hypertension

5. Alcohol abuse, drug abuse, smoking (cotinine test)

6. Infection/open wounds

7. Haemoglobin A1C (HBA1C) >7.5%

8. Vitamin D insufficiency

9. Urinary tract infection (leukocytes and symptoms)

Yellow flags (think twice)

1. Psychiatric disorders, cognitive impairment, depression

2. Abnormal vitamin D levels

3. BMI >40

4. Age >80

Standard operating procedure

Perioperative care for knee and hip arthroplasty can be divided into non-surgical and surgical aspects to ensure comprehensive management of patients before, during and after the procedure.

Preoperative assessment	Weight, height, chest x-ray, electrocardiograph, albumin, haemoglobin, vitamin D, urea and electrolytes, HBA1C, check for alcohol/drugs/nicotine
In ward	Stop biologic agents, warfarin, aspirin, chlorhexidine full body wash, urine-dipstick, methicillin-resistant Staphylococcus aureus (MRSA) screen and treat with mupirocin
During operation	Shave with clippers in theatre, prophylactic antibiotics 2-4g Cefzol within 30min to incision**,** skin prep: clean with chlorhexidine in alcohol, impervious drapes, close doors, masks, eliminate theatre traffic, no drains
Postoperative	Compression dressing 24h, thrombo-embolic deterrent (TED) stockings, calf pumps in high care unit, no Clexane for 6 hours, Aspirin 75mg on day 1, wound ooze: stop thrombolytics deep vein thrombosis (DVT) prophylaxis
Persistent oozing from wound	Stop thrombolytics, decrease physio, compression. After 7 days: revision surgery and washout

Non-surgical perioperative care

Preoperative education: To decrease anxiety and improve the recovery process, patients should receive information about postoperative pain management, wound care and mobility aids.

Medical optimisation: Prior to surgery, patients' overall health should be assessed and optimised. This includes managing any chronic medical conditions (such as diabetes or hypertension) to reduce the risk of perioperative complications.

Cardiovascular and respiratory evaluation: Preoperative assessment of cardiovascular and respiratory health is essential to determine the patient's fitness for surgery. Identifying any cardiovascular or pulmonary concerns will help the surgical team prepare for potential anaesthesia-related challenges.

Infection prevention measures: Patients should undergo appropriate screening for infections (such as urinary tract infections or skin infections) to reduce the risk of perioperative complications. These are contra-indications for any arthroplasty surgery.

Nutrition and medication management: Ensuring adequate nutrition and proper medication management before surgery is crucial for promoting healing and reducing postoperative complications. Albumin is a good marker for nutrition.

Physiotherapy and exercise programmes: Preoperative physiotherapy and exercise programmes can help strengthen muscles around the affected joint, improve joint range of motion, and optimise functional outcomes after surgery.

Surgical perioperative care

Anaesthesia selection: The choice of anaesthesia (general, regional or spinal) is determined based on the patient's health status, surgeon preference and the complexity of the surgery. Most commonly spinal anaesthesia is chosen for hip and knee arthroplasty.

Implant: The surgeon will select the appropriate surgical implants and approach based on the patient's joint condition and the type of arthroplasty (total, partial or revision). Most commonly, both sides of the joint are replaced by a metal component made from cobalt-chrome and a polyethylene liner acts as a bearing surface.

Intraoperative monitoring: Continuous monitoring of vital signs and blood loss helps ensure patient safety during the surgery. Administration of prophylactic antibiotics before surgery is used to prevent surgical site infections.

Pain management: Effective pain management strategies include local anaesthesia and postoperative pain medications. These are utilised to ensure patient comfort and promote early mobilisation.

Postoperative care: Close monitoring in an appropriate high care unit and subsequent ward care, including wound care, early ambulation (mobility) and physiotherapy to recover joint function and prevent complications.

Figure 7: *AP x-ray of hip osteoarthritis*

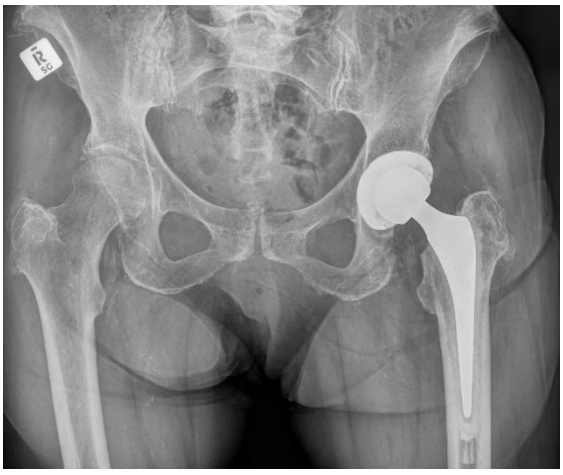


Figure 8: *AP x-ray of a total hip replacement*

Key takeaways

- Arthroplasty is considered for severe knee and hip joint pain in bone-on-bone arthritis with severe dysfunction and pain.
- Careful evaluation of the patient's overall health is crucial to determine surgical fitness and candidacy for arthroplasty.
- Conservative treatments are initially attempted and surgery is considered only if conservative options are ineffective.
- Imaging plays an important role in assessing joint condition and guiding surgical planning.
- Perioperative care involves preoperative optimisation, infection prevention and pain management.
- The choice of surgical approach and implants are personalised based on joint condition and patient factors.
- Pre- and postoperative physiotherapy is essential for successful recovery and joint function improvement.
- Knee and hip arthroplasty can provide long-term pain relief and improved joint function.
- Multidisciplinary collaboration ensures comprehensive patient care throughout the surgical journey.

Assessment

1. A 57-year-old patient with advanced avascular necrosis of the femoral head and persistent groin pain, resistant to conservative interventions, would most likely be recommended for?

A. Total hip arthroplasty

B. Core decompression

C. Hip resurfacing

D. Hip hemiarthroplasty

The answer is (A). Core decompression (B) is a contra-indication in advanced arthropathy, and total hip arthroplasty (A) is indicated.

2. Which of the following patient profiles poses the highest surgical fitness risk for knee arthroplasty?

A. A 65-year-old with controlled hypertension and moderate osteoarthritis

B. A 75-year-old with well-controlled diabetes and severe avascular necrosis

C. A 50-year-old smoker with mild rheumatoid arthritis and stable joint function

D. A 60-year-old with obesity and a history of stable knee pain without joint dysfunction

The answer is (D). Obesity increases surgical risk due to potential complications such as wound healing problems and increased stress on the cardiovascular system. The patient's history of stable knee pain without joint

dysfunction suggests that knee arthroplasty may not be immediately necessary, making the risks of surgery less favourable.

3. In perioperative optimisation, the yellow flag indicating potential complications is most relevant for patients with?

A. High BMI and severe joint instability
B. Osteoarthritis and documented vitamin D deficiency
C. Rheumatoid arthritis and cognitive impairment
D. Controlled hypertension and mild osteoporosis

The answer is (A). High BMI and severe joint instability pose a significant surgical risk. A high BMI is associated with increased anaesthetic and surgical complications. Severe joint instability may lead to suboptimal outcomes and postoperative complications.

4. Which intraoperative measure is NOT a standard part of the surgical approach for knee and hip arthroplasty?

A. Administration of prophylactic antibiotics
B. Minimally invasive techniques to minimise tissue trauma
C. Spinal anaesthesia for joint replacement surgery
D. Implantation of modular components to reduce wear and tear

The answer is (D). Implantation of modular components is not an intraoperative measure; It is a design feature of some implants to allow for interchangeability and future revisions. Prophylactic antibiotics (A), minimally invasive techniques (B) and spinal anaesthesia (C) are common intraoperative measures in arthroplasty procedures.

5. A patient with bilateral knee osteoarthritis presents with significant muscle weakness around the knees. What non-surgical perioperative measure should be emphasised to optimise surgical outcomes?

A. Intensive pain management plan
B. Cardiovascular fitness assessment
C. Early mobility post-surgery
D. Preoperative nutritional supplementation

The answer is (C). Early mobility post-surgery is essential for preventing complications such as deep vein thrombosis and improving joint function. While all options contribute to optimal outcomes, addressing muscle weakness through early ambulation is particularly important in enhancing joint recovery and reducing postoperative complications.

References and further reading

OpenAI. (2023). ChatGPT. (Mar 14 version) [Large Language model]. Available at: https://chat.openai.com/chat.

(2019). SOP arthroplasty Groote Schuur Hospital. Unpublished Word document

ATRAUMATIC CONDITIONS

Chapter 3 – Multiple painful joints **19**

Jeannie McCaul

Chapter 4 – Approach to a swollen, painful knee **26**

Temiloluwa Adewusi & Michael Held

Chapter 5 – Osteoarthritis **31**

Marc Nortje, Michael Solomons, Robert Dunn, Stephen Roche & Kim Tabelião

Multiple painful joints

By Jeannie McCaul

Learning objectives

- Evaluate a patient with multiple joint pains (polyarthralgia).
- Formulate a description of an x-ray.
- Develop a differential diagnosis of polyarthralgia.
- Outline a basic initial non-surgical management plan.
- Understand the indications and options for surgical management.

Case presentation

A 70-year-old obese female patient presents complaining of multiple painful joints. She localises the pain to both hips, both knees and her right elbow. She has had no recent trauma, no comorbidities and no family history of arthritis. She states that the pain started insidiously about 1 year ago and has gradually worsened. The pain is worse when the weather is cold, on movement and especially in the evening at the end of an active day.

Examination reveals swollen knees with mild synovitis, small effusions and palpable crepitus, but full stable range of movement. Passive rotation of both hips reveals groin pain and limited range of movement with fixed flexion contractures of 30º. Her right elbow similarly has decreased range of movement (10º to 100º), synovitis and crepitus. There is no neurovascular deficit.

***Figure 1**: Anterior-posterior (AP) x-ray of the patient's left hip shows markedly narrowed joint space, subchondral cysts and sclerosis, and osteophytes*

Blood tests

A rheumatic screen is negative.

Differential diagnosis

See the list at the end of the chapter. After correlation with the patient's history and examination findings and negative blood results, the diagnosis of osteoarthritis is made.

Management

Non-surgical

ELMPOPI:

Education: The patient is informed about the nature of the condition – a form of degeneration of the articular cartilage.

Lifestyle **M**odification: A discussion is held with the patient to see if avoiding activities that exacerbate the pain, such as long walks or sitting on low chairs, is an option. Weight loss is advised and a dietician is consulted.

Physiotherapy: Weight loss exercises that avoid causing more joint pain are commenced. Other specific exercises include dynamic stabilisation of the knees and gait training. A walking aid, such as a crutch or walking stick, is offered to the patient and she is educated on its use.

Occupational therapy: The occupational therapist (OT) provides an assistive device to allow the patient to open tight jars and taps without hurting her elbow. They discuss and consider hinged knee braces should her knees feel unstable in the future.

Pills: Paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs) and Tramadol are prescribed for the patient to use as required.

Injections: After 3 months of the above treatment, the patient requests an injection. A local anesthetic and steroid injection (LASI) is performed with aseptic technique into both knees. The patient reports transient improvement of the symptoms.

Blood tests

After 6 months of adequate therapy as above and successful weight loss to a body mass index (BMI) of below 40, the patient is still not coping with the pain in her lower limbs. A careful history and repeat examination reveal that the left hip joint is causing the most pain, and she is scheduled for a total hip replacement. The surgeon opts for a metal-on-polyethylene bearing surface and an uncemented cup and stem. In this case a single screw was used to secure the acetabulum sufficiently. The operation is successful and she elects to continue non-operative treatment for her other joints for the time being

Introduction

Polyarticular joint pain is a common complaint seen at primary care facilities. There is a wide differential diagnosis to the cause of polyarticular joint pain making the diagnostic process challenging. However, a comprehensive history and physical exam help point towards the most likely cause of the complaint.

In this chapter, a general approach to the differential diagnosis of polyarticular pain and the management thereof is provided. A case study is provided to demonstrate an approach to a patient complaining of multiple painful joints.

History

Ask for important components in the history such as:

Duration: How long has the pain been there?

Progression: Is it getting better or worse or the same? Are the joints mostly painful and stiff in the morning (suggestive of autoimmune inflammatory arthritis) or painful after exercise (suggestive of osteoarthritis)?

Associations: Is there any rash, synovitis or effusion? Is there any fever indicative of an infection? Is there weight-loss, night sweats or loss of appetite (suggestive of TB).

Aetiology: History of trauma? Symptoms suggestive of infection?

Previous or other joint pains? Previous

medical history? Previous surgical history?

Examination

Structure your examination into inspection, palpation and movement.

Look

Site: Determine location of the joint pains – which joints?

Any erythema, scars or sinuses?

Any swelling or bony deformity noted?

Feel

Temperature: Does the overlying skin feel warm?

Is there synovitis?

Is there an effusion? In the knee, for a small effusion, do the swipe test; for a large effusion, the patellar tap test.

Tenderness: Is it tender? Is it joint line pain or enthesitis (pain at insertion of ligaments)?

Move

What is the range of movement of the joint in degrees, both active and passive? If less than 10^0 or 20^0 and passive movement causes extreme pain, consider bacterial arthritis. If mechanically decreased range, consider osteoarthritis.

Is there crepitus on movement?

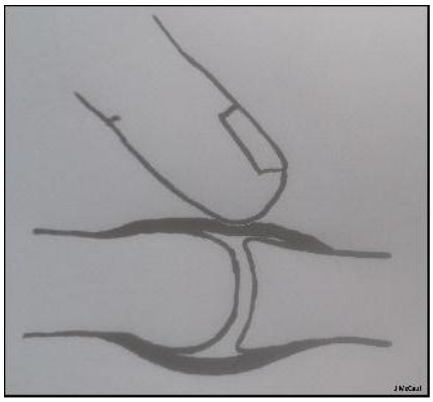


***Figure 2**: Synovitis – joint space is not easily palpable due to thickened synovium (feels like a blanket)*

Systemic examination

General examination.

Identify any other joints involved.

Special investigations

Plain film x-rays

On x-rays you will gain important information (see chapter on approach to orthopaedic x-rays).

Specifically look for:

- Identify view, patient and date.
- Is the patient skeletally mature?
- What joint is involved?
- Is there markedly reduced joint space without many osteophytes? And is there periarticular osteopaenia? – suggestive of rheumatoid arthritis.
- Is the joint space narrowing accompanied by osteophytes, subchondral cysts and sclerosis? – suggestive of osteoarthritis.
- Are there 'rat bite' erosions on the edges of the joint? – suggestive of gout.

***Figure 3**: Periarticular erosions in a patient with rheumatoid arthritis*

Blood tests

If suspecting an autoimmune or inflammatory disorder:

- Erythrocyte sedimentation rate (ESR), c-reactive protein (CRP), rheumatoid factor (RF), antinuclear antibody (ANA), anti-cyclic citrullinated peptide (CCP).

- Consider anti double-stranded deoxyribonucleic acid (ds-DNA) if suspicious of systemic lupus erythematosus (SLE), or human leukocyte antigen (HLA) B27 if suspicious of ankylosing spondylitis.

If suspecting an infection:

- Full blood count (FBC), ESR, CRP.
- Urea and electrolytes (U&E), especially if patient is ill.
- Consider viral studies, such as hepatitis and parvovirus.
- If suspecting a systemic disorder, especially endocrine, liver function tests (LFTs), thyroid studies, comprehensive metabolic panel (CMP), albumin, alkaline phosphatase (ALP).

Joint aspiration

- Should be performed with sterile technique.
- Inspect and record nature of aspirate: Frank pus? Keep nil per os (NPO) and refer to orthopaedic surgeon for arthrotomy in theatre. Straw-coloured? Consider tuberculosis (TB). Frank blood? Consider trauma or haemophilia.
- Send for: microscopy, culture and sensitivity (MC&S), TB GeneXpert polymerase chain reaction (PCR), TB culture, crystals.

Synovial biopsy

In cases of diagnostic dilemma, a synovial sample can be taken by an orthopaedic surgeon in theatre and sent for histology, TB PCR and culture, MC&S.

Differential diagnoses

The differential diagnoses of polyarthralgia are wide. History, examination and special investigations will help identify the cause.

More than 6 weeks?

Could be a systemic rheumatic condition such as: rheumatoid arthritis, SLE, Sjogren's syndrome, sarcoidosis, etc.

Consider osteoarthritis.

Consider amyloidosis (rare).

Less than 6 weeks and involving the spine?

Could be a spondyloarthropathy, such as: ankylosing spondylitis, psoriatic arthritis, inflammatory bowel disease (IBD). Juvenile idiopathic arthritis and reactive arthritis can also involve the spine.

Consider osteoarthritis.

Does it relapse and remit (come and go)?

Consider gout or pseudogout (crystals in the joint aspirate).

Consider haemophilia in a young male (recurrent bleeds into joints).

Is it a short history and an ill patient?

Consider infection: multiple bacterial arthritis (rare), gonococcal arthritis, viral.

Tuberculosis, especially if a slightly longer history or insidious onset.

Consider polyarthralgia accompanying a flu-like illness if no synovitis.

Does the patient have a rash or vasculitis?

Consider Henoch-Schoenlein purpura, polyarteritis nodosa, granulomatosis.

Does the patient have an endocrine disorder?

Hypo or hyperthyroidism or hyperparathyroidism can cause joint pain.

Does the patient have no synovitis or effusion, but tender trigger points?

Consider fibromyalgia.

Management

The management is directed to the cause:

- Osteoarthritis: conservative management, as above, refer to orthopaedic surgeon to consider arthroplasty or arthrodesis if it requires surgical management.
- Inflammatory or autoimmune: refer to rheumatologist to confirm diagnosis and consider disease-modifying antirheumatic drugs (DMARDS). See the American College of Rheumatology (ACR) 2010 diagnostic criteria for rheumatoid arthritis.
- Systemic or endocrine: treat supportively and refer to medicine or endocrinologist to consider targeted treatment.
- Infective: identify the organism and treat according to sensitivities. If bacterial, septic arthritis washout in theatre is mandatory.

Key takeaways

- Polyarticular arthritis has multiple causes, but narrowing down the differential diagnosis is primarily through history-taking and examination.
    - Are there signs of acute infection?
    - Are there constitutional symptoms?
    - What is the timeline?
    - What is the pattern of joint involvement?
    - Is this inflammatory or mechanical?
    - Are there associated symptoms?
- After answering these questions, appropriate investigations, including serologic, tissue or imaging studies can be added to further narrow your differential diagnosis.

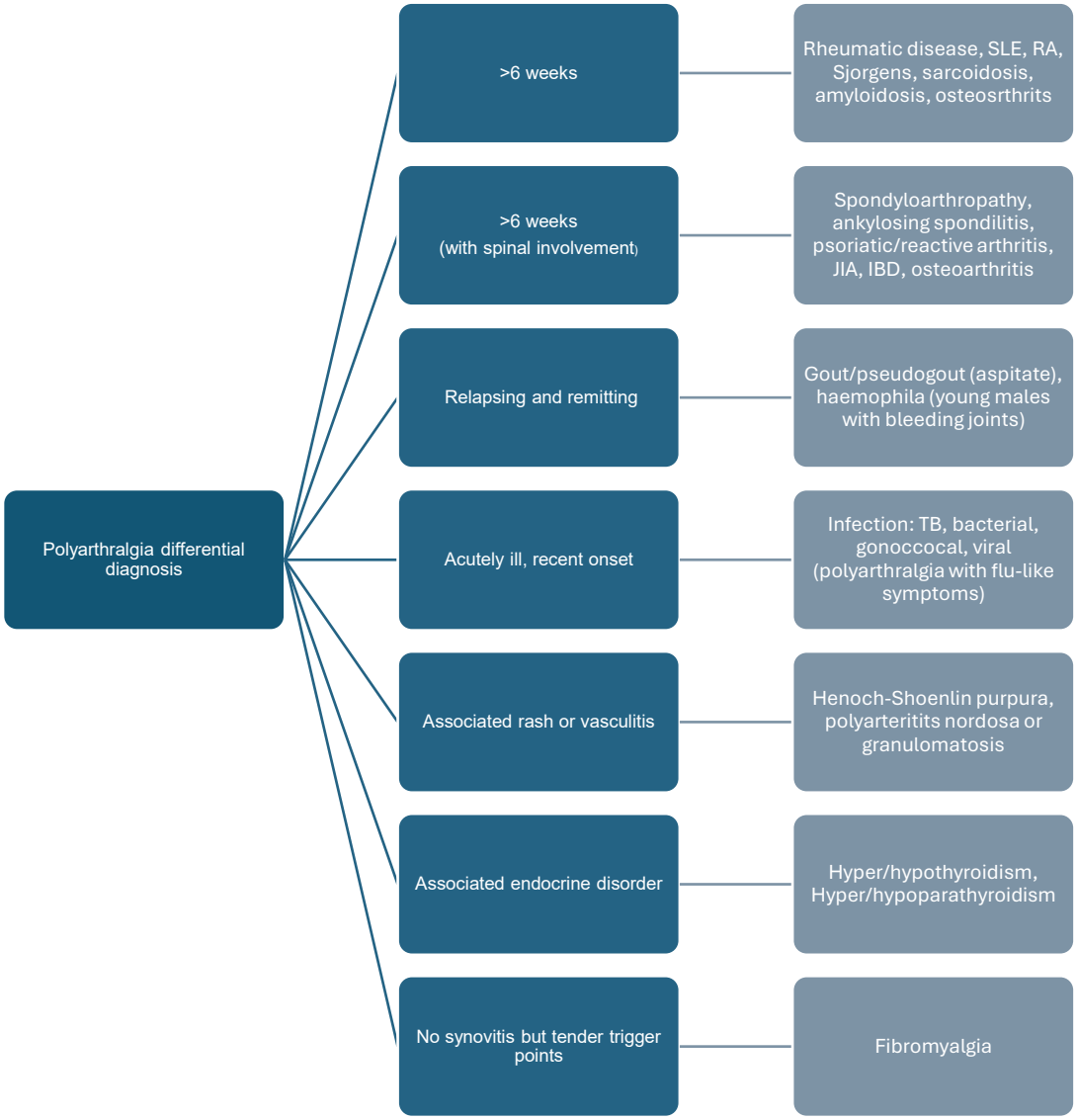


***Figure 4**: Diagnostic aid for forming a differential diagnosis for polyarthralgia*

Assessment

1. Mrs Pietersen is a 55-year-old woman with an extensive pack-year smoking history. She presents to you complaining of 2 months of swelling, stiffness and pain in her knuckles. The stiffness is worse in the morning and gets better throughout the day. On examination you palpate symmetrical synovitis of her metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints. What is the most likely diagnosis?

   A. Psoriatic arthritis
   B. Septic arthritis
   C. Osteoarthritis
   D. Rheumatoid arthritis

The answer is (D). Rheumatoid arthritis classically presents clinically with symmetrical pain, stiffness and swelling of the PIP and MCP joints. As it is an inflammatory arthritis, the associated stiffness is commonly worse in the mornings and improves with movement as the day progresses. A risk factor is smoking.

2. Which x-ray finding is most specific for osteoarthritis?

   A. Joint space narrowing
   B. Osteophytes
   C. Subchondral cysts
   D. 'Rat bite' erosions

The answer is (A). Joint space narrowing is common in many forms of arthritis; subchondral cysts are seen in late-stage rheumatoid arthritis; 'rat bite' lesions are seen in gout.

References and further reading

Bombei, B., Freilich, A., Pgy, D.O., & Larsen, D. (2019). Approach to polyarthritis for the primary care physician. Osteopathic Family Physician, 10(5), 24-31, https://www.ofpjournal.com/index.php/ofp/article/view/612.

Aletaha, D., et al. (2010) Rheumatoid arthritis classification criteria: An American College of Rheumatology/European League against rheumatism collaborative initiative. Arthritis & Rheumatism, 62, 2569-2591. https://doi/org/10.1002/art.27584

Dwyer, T. (n.d.).The bone school: Non operative management. Available at: http://52.62.202.235/miscellaneous/non-operative-management

Approach to a swollen, painful knee

By Temiloluwa Adewusi & Michael Held

Learning objectives

- Describe the clinical findings associated with an anterior cruciate ligament (ACL) tear.
- Understand and develop an appropriate approach to a knee effusion.

Case presentation

A 21-year-old male patient presents to your casualty unable to bear weight on his right knee a few hours after a twisting, non-contact injury during a soccer game. During this injury, he felt a "pop" in his knee, which showed immediate swelling. Thereafter, any attempt to put weight on the knee would cause it to "give out" and was associated with severe pain. On examination, you note diffuse swelling, with no other forms of visible trauma.

***Figure 1**: A right knee effusion (Source: James Heilman, CC BY-SA)*

The joint is tender to the touch. Furthermore, you note marked decreased range of motion. You confirm this by comparing it to the unaffected leg. The patient's regional neurovascular examination is normal. The Lachman and anterior drawer tests show more laxity than the uninjured knee. Both are positive of an ACL injury. You consider aspirating the joint (here you would see blood), but an anterior-posterior (AP) radiograph of the knee shows a flake fracture around the attachment of the anterolateral capsule (otherwise known as a Segond fracture). This is indicative of an ACL injury.

***Figure 2**: Lachman's test (Source: Mak-Ham Lam et al, CC BY-SA)*

The gold standard is still a magnetic resonance imaging (MRI) scan to confirm the diagnosis. In facilities where such resources are not available, ultrasound is also an acceptable diagnostic modality with relatively high rates of specificity. It is important to note that the accuracy can vary depending on operator skill and should thus be used accordingly. Finally, a knee aspiration can be considered as both a

therapeutic and a diagnostic procedure. It can lower the patient's pain and improve the sensitivity of physical examination findings.

***Figure 3**: A Segond fracture (Source: Hellerhoff, CC BY-SA)*

Management

Acute/supportive

Initial therapy includes analgesia, rest, ice and compression of the injured knee. In select cases, patients may need intra-articular lignocaine injections to better manage their pain. This also allows one to fully manipulate the knee during clinical examinations. Moreover, elevation of the affected lower extremity is also beneficial. Crutches are usually needed acutely to avoid weight-bearing.

Definitive

Most active, younger patients will benefit from ligament reconstruction with autograft to protect the meniscus and cartilage from further injury and allow return to activities which can often take 8–-12 months. Older, less active patients may be candidates for conservative non-surgical therapy. Here, treatment includes regular physiotherapy.

Summary

One of the most important questions to ask is if the knee swelling or pain occurred acutely or is chronic. If acute, we need to ask if this was traumatic or atraumatic. In knee injuries, an important point to understand is if the swelling was sudden (blood – hemarthrosis) or delayed (effusion).

With sudden traumatic swelling, the injury is most commonly an intra-articular ligamentous injury. For example, ACL or patella dislocations or fractures. When imaging is inconclusive or not available, an aspiration can help to differentiate this further. When fat globules can be seen on the surface of blood in the syringe, a fracture should be suspected. With clear pathology is indicated on available imaging, joint aspiration should be avoided.

In delayed swelling (i.e. that evening or the next morning), meniscus surgery should be considered. With acute, atraumatic, isolated knee swelling, septic arthritis must be excluded. Other conditions which can mimic this are gout or tuberculosis (TB), but these conditions are often recurring and can also involve other joints. Here it is key to obtain diagnosis via aspiration or tissue biopsy with a better yield. This should be assessed for bacterial and TB microscopy, culture and sensitivities, TB polymerase chain reaction (PCR) tests, white cell count, as well evaluating for crystals.

The most common conditions which affect multiple joints at multiple time points are osteoarthritis and inflammatory arthritis. Here, a disease pattern of small joints, extra-articular pathology and specific radiologic features help narrow down the diagnosis.

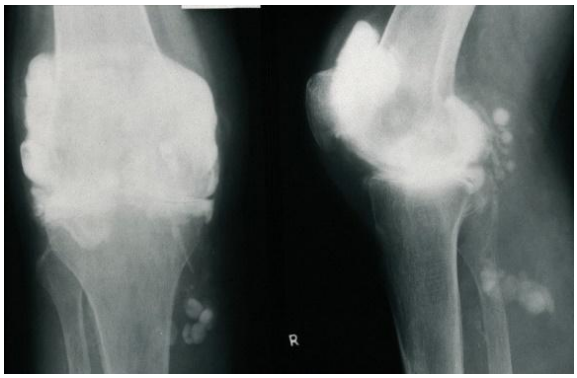


***Figure 4**: Rheumatoid arthritis of the knee (Source: MyArthritis, CC BY-NC)*

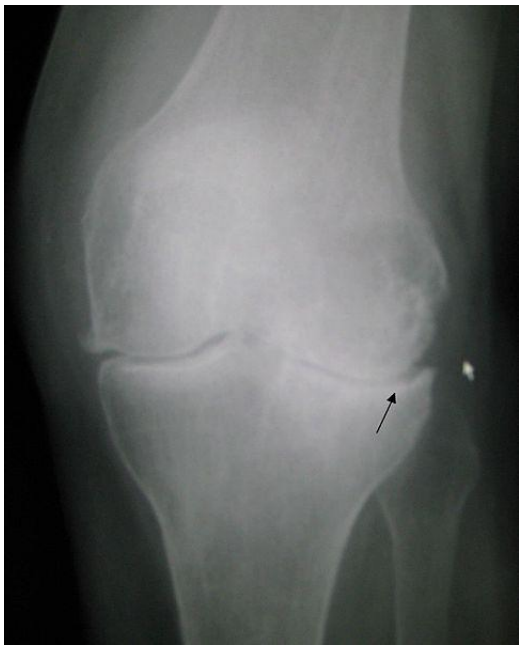


***Figure 5**: Osteoarthritis of the knee. Note the characteristic joint space narrowing, formation of osteophytes and increased subchondral density. (Source: James Heilman, CC BY-SA)*

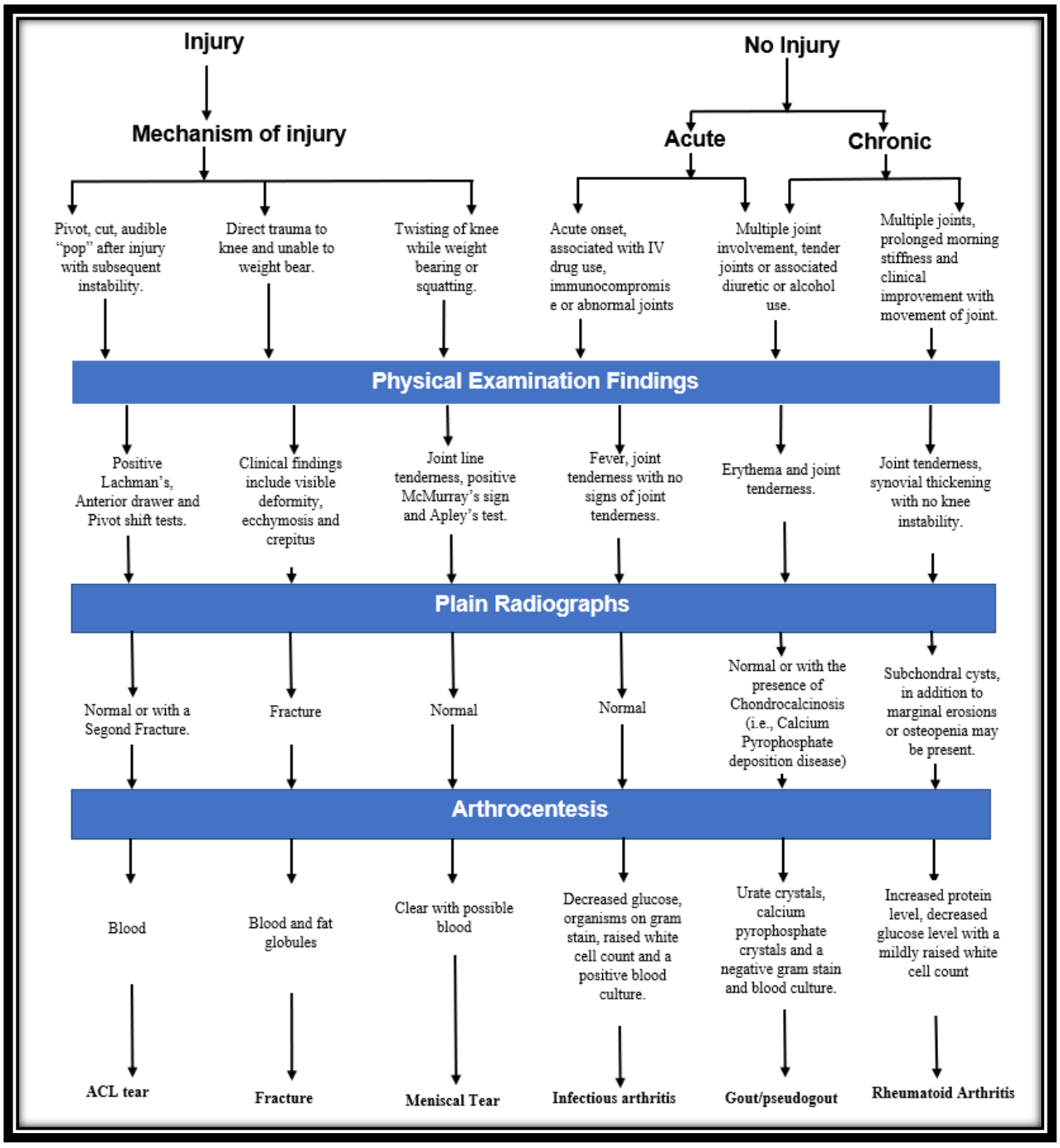


***Figure 6**: An approach one can employ when assessing a swollen knee in clinical practice*

References and further reading

Radswiki, T. & Yap, J. Anterior cruciate ligament tear. Reference article, Radiopaedia.org. (Accessed on 14 Sep 2022) https://doi.org/10.53347/rID-12490

Musahl, V. & Karlsson, J. Anterior cruciate ligament tear. New England Journal of Medicine, 380:2341.

Johnson, M.W. (2000). (2000). Acute knee effusions: A systematic approach to diagnosis. Am Fam Physician. 15(61)(8):2391-400. PMID: 10794580.

Wang, J. H., Lee J. H., Cho, Y., Shin, J. M. & Lee, B. H. Efficacy of knee joint aspiration in patients with acute ACL injury in the emergency department (2016). Injury. 47(8),1744-9. doi: 10.1016/j.injury.2016.05.025. Epub Accessed 2016 May 18. PMID: 27262773.

Osteoarthritis

By Marc Nortje, Michael Solomons, Robert Dunn, Stephen Roche & Kim Tabelião

Learning objectives

- Understand epidemiology and pathophysiology.
- Learn how to make a diagnosis with clinical and radiological features.
- Understand treatment options and management principles.

Introduction

Osteoarthritis (OA) is the most common form of arthritis. It's also known as degenerative joint disease, wear and tear arthritis and osteoarthrosis. It can be primary or secondary.

Primary OA is idiopathic and is associated with increasing age and obesity. The incidence of OA ranges from 10–20% in people over the age of 60 and females are affected more than males. It commonly affects the hands, shoulders, spine, hips and knees.

Secondary OA can be post-traumatic, post-infective or as a result of any condition that causes an abnormality in the shape of the joint surface or destruction of the articular cartilage.

The pathology involves softening and erosion of the articular cartilage resulting in bone-on-bone articulation. Typical radiological features are joint space narrowing, osteophyte formation, subchondral sclerosis and subchondral cysts.

Hip OA

Clinical findings

History

Insidious onset typically described as dull start-up pain felt in the groin, radiating down the front of the thigh. Occasionally presents as knee pain only. Consider referred pain from the back if the pain radiates below the knee. Activities of daily living (ADLs) affected are activities involving hip flexion, such as putting on shoes and socks, and sleep disturbance due to pain.

Examination

- Trendelenberg gait.
- There may be a leg length discrepancy (LLD).
- Loss of internal rotation is an early sign.
- Later on, a fixed flexion deformity (FFD) may occur (Thomas test).

Special investigations

Imaging

***Figure 1**: Anterior-posterior (AP) pelvis x-ray with OA of the right hip which shows joint space narrowing, osteophytes, sclerosis and cysts*

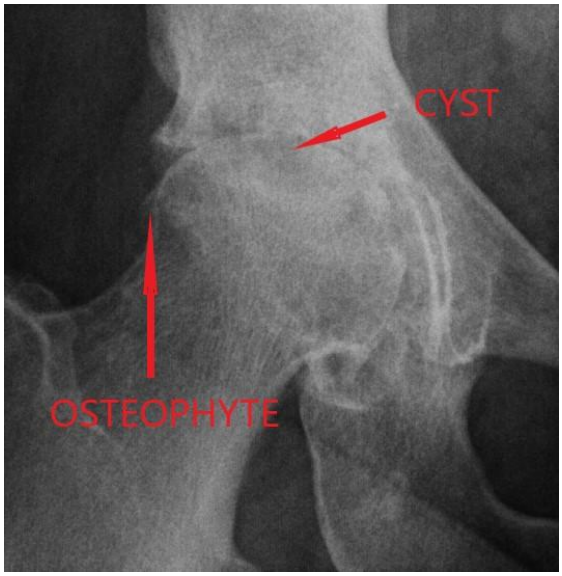


***Figure 2**: Magnified x-ray image of the right hip showing osteophytes, cysts and complete joint space obliteration with bone-on-bone contact*

Management

If conservative treatment fails and the patient wants surgery, refer to an orthopaedic surgeon.

Non-surgical

- Activity modification.
- Walking aids.
- Analgesia and nonsteroidal anti-inflammatory drugs (NSAIDs).

Surgical

- Total hip arthroplasty (replacement) (THA or THR).
- Arthrodesis (fusion) of the joint is not commonly performed nowadays.

Knee OA

Clinical findings

History

Start-up pain or stiffness that eases a little with movement. Can be worsened by walking up stairs and may be associated with clicking, locking or giving way.

Examination

- May have an effusion.
- There may be a varus or valgus deformity.
- Later on, a FFD may occur, typically at 10-15 degrees.

Special investigations

Imaging

***Figure 3**: X-ray of the left knee showing medial joint space narrowing, osteophytes and sclerosis with an irregular joint surface (no bone-on-bone contact yet)*

***Figure 4**: Lateral x-ray of the left knee indicating moderate osteoarthritic changes with osteophytes, joint space narrowing and subchondral sclerosis of the tibio-femoral and patellofemoral joint*

Management

Non-surgical

- Activity modification.
- Walking aids.
- Analgesia and NSAIDs.

Surgical

- Total knee arthroplasty (replacement) (TKA or TKR).

Hand OA

Clinical findings

History

Specific joints are painful with activity, unlike rheumatoid arthritis, which typically has a period of generalised, symmetrical, small joint morning stiffness.

Examination

- Distal interphalangeal joint (DIPJ) swellings or Heberden's nodes.
- Reduced range of motion and painful motion of the affected joints, commonly the base of thumb (BOT) and DIPJs.

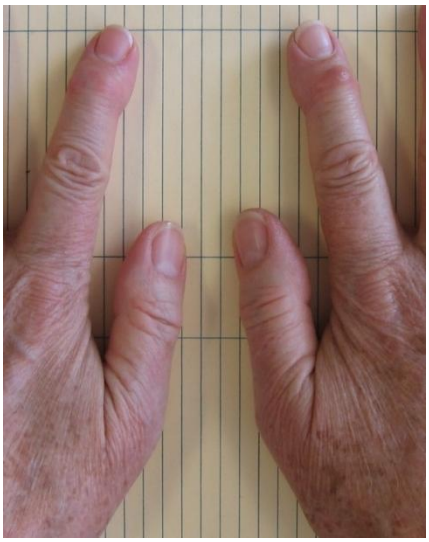


***Figure 5**: Clinical picture of the hands showing Heberden nodules which indicate osteoarthritic changes in the DIPJs*

Special investigations

Imaging

***Figure 6**: X-ray of the thumb showing BOT OA*

Management

Non-surgical

- NSAIDs
- Bracing or splinting.
- Steroid injections.

Surgical

- Arthrodesis.
- Interposition arthroplasty.

Shoulder OA

Clinical findings

History

Can involve the glenohumeral joint or the acromioclavicular joint (ACJ) and symptoms relate to the joint involved, difficulty doing overhead tasks and inability to sleep on the affected side.

Examination

- ACJ tenderness.
- Crepitus in the glenohumeral joint.

Special investigations

Imaging

***Figure 7**: AP x-ray of the left shoulder showing joint space narrowing and subchondral sclerosis of the glenohumeral joint. There is also narrowing of the subacromial space which points towards rotator cuff pathology. There is narrowing of the ACJ indicating OA.*

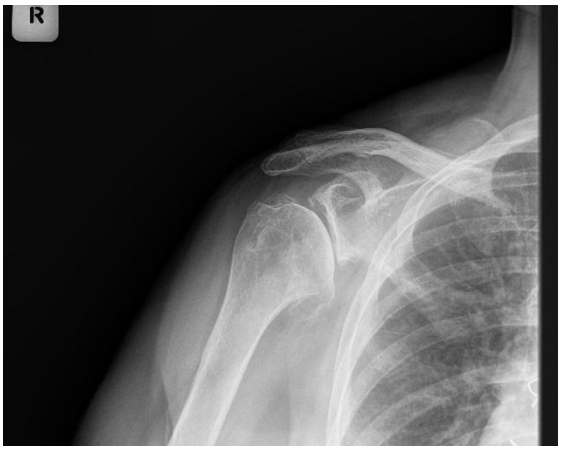


***Figure 8**: Glenohumeral joint OA*

Management

Non-surgical

- NSAIDs
- Activity modification
- Steroid injections.

Surgical

- Excision of ACJ.
- Total shoulder arthroplasty (TSA or TSR).

Spinal OA

Clinical findings

History

Cervical spondylosis presents with neck pain and stiffness. Radiating pain down the arms suggests radiculopathy. Lumbar spine OA and facet joint arthropathy presents with mechanical back pain; radiculopathy usually radiates down one leg.

Examination

- Tenderness over the spinous processes and there may be paraspinal muscle spasm.
- Pain and stiffness when assessing range of motion (ROM).
- Straight leg raise (SLR) positive for pain going down the leg. Note at what degree of hip flexion the pain starts. In severe cases, there is pain when performing SLR on the contralateral side.

Special investigations

Imaging

***Figure 9**: Lateral lumbar spine x-ray showing degenerate disk disease at L2/L3 with facet joint space narrowing, osteophytes and sclerosis*

Management

Non-surgical

- NSAIDs
- Physiotherapy

Surgical

- Fusion surgery

Key takeaways

- Diagnosis is made with history, examination (look, feel, move) and x-rays.
- Management starts with modification of activities and lifestyle, including weight loss if needed and splints or walking aids to alleviate pressure or reduce motion of the affected joint.
- Surgery (often major surgery) is reserved for failed conservative treatment and patients should be medically optimised.

Assessment

1. A 67-year-old patient presents with a 2-year history of gradually worsening hip pain that is starting to impact on their ADLs. Which one of the following is most commonly reported in hip OA?

A. Difficulty putting on shorts

B. Difficulty doing their shoes and socks

C. Needing to lean on the shopping trolley and

D. bend forward to ease the pain

E. Sleep disturbance

F. More than 30 minutes of morning stiffness

The answer is (B). Not being able to do their shoes and socks is a typical ADL affected by hip OA.

2. When performing the physical examination of a patient with hip OA, which one of the following statements is most correct?

A. There is an absolute LLD if the medial malleolus of both ankles do not line up next to each other

B. There is a LLD if one knee is flexed when standing

C. The femoral head can be palpated medial to the greater trochanter

D. Rotation range is usually determined with the patient lying supine and the hip flexed to 90 degrees

E. Abduction can be measured by measuring the angle formed between both lower limbs with the patient supine

The answer is (D). Flexing the hip and the knee to 90 degrees makes it easy to assess the degree of rotation.

References and further reading

Miller, M. D. & Thompson, S. (2019) Miller's review of orthopaedics (8th ed.). Elsevier, Amsterdam

EMERGENCY CONDITIONS

Chapter 6 – Low-energy fractures **38**
Ishta Ramguthy, Anria Horn & Yammesh Ramguthy

Chapter 7 – Complications of fractures **46**
Kerin Stead & Maritz Laubscher

Low-energy fractures

By Ishta Ramguthy, Anria Horn & Yammesh Ramguthy

Learning objectives

- Define low-energy fractures and explain their significance in orthopaedics.
- Recognise the common bones affected by low-energy fractures.
- Evaluate the clinical findings, history and examination techniques to diagnose and manage low-energy fractures.
- Differentiate imaging modalities to diagnose low-energy fractures based on their advantages and limitations.
- Understand the management options for low-energy fractures, including non-surgical approaches and surgical interventions when required.

Introduction

Low-energy fractures are a significant concern in orthopaedics. They encompass fractures resulting from minimal trauma or everyday activities that would not typically cause bone damage. Despite their seemingly minor cause, these fractures are surprisingly common and can have considerable consequences for patients.

These fractures predominantly affect the elderly, especially postmenopausal women, as age-related loss in bone density increases their vulnerability to low-energy injuries. Furthermore, low-energy fractures can result from bone cysts, infection and metastatic diseases due to their weakening effect on the bone structure, making it more susceptible to breaking under minimal force or stress.

The bones commonly affected by low-energy fractures include the distal radius, proximal femur, proximal humerus, distal fibula and vertebral bodies, leading to potential complications and reduced quality of life. Understanding the characteristics and impact of low-energy fractures is crucial in providing better management and preventive strategies.

Clinical findings

History

Patients who have experienced a low-energy fracture have signs of pain, injury, stiffness, swelling, deformity, instability, weakness or loss of function. These fractures are commonly observed in the geriatric population and are often the result of falls.

Commonly associated injuries include those affecting the head, pelvic region and lower extremities. The patients may report a history of a simple fall without any significant impact or force. However, it is crucial to thoroughly evaluate the patient's medical history, including any underlying conditions like dementia, haematologic diseases or liver disorders, as these factors may affect fracture management. Additionally, a detailed examination of the patient's medication history, particularly the use of anticoagulants and antiplatelet medications, is essential to assess the risk of bleeding

complications. It is also important to inquire about other factors contributing to osteoporosis, such as alcohol consumption and medication usage (e.g. steroids).

Examination

During the examination, you should:

- **Look** for any wrist deformities or abnormalities in shape and posture. Observe the skin for discolouration, bruising, wounds, ulceration and scars that give clues to previous history. Look for open wounds or blisters in the soft tissue.
- **Feel** the skin, soft tissue, bones and joints, while also checking for signs of tenderness.
- **Move** the patient actively and passively to assess the degree of mobility.

Additionally, assess the neurovascular status, particularly the radial pulse and major nerves crossing the wrist, such as the ulnar and vital median nerves. Obtaining dedicated wrist views and other relevant radiographs can provide valuable insights into the fracture pattern.

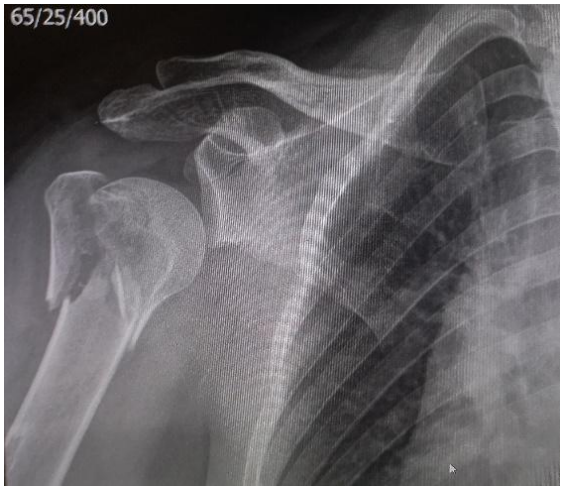


Figure 1: *X-ray showing a comminuted fracture of the proximal humerus*

Additional injuries to note

Vertebral compression fractures (VCFs) related to low-energy mechanisms often occur in the elderly, primarily due to osteoporosis. During a low-energy fall or trauma, the spinal column experiences rotation around a centre of axis, accompanied by an axial force due to flexion or extension of the spine. When this force exceeds the tolerable limits of the vertebral body, a compression fracture occurs, leading to the characteristic wedge-shaped deformity. These altered biomechanics may subject other spinal levels to additional stresses, increasing the risk of further fractures and progressive deformity.

Clinical findings in patients with vertebral compression fractures may include localised back pain, kyphosis, tenderness on palpation, limited spinal mobility, neurological symptoms and loss of height. Management includes conservative approaches such as orthosis/bracing or minimally invasive surgical procedures like vertebroplasty or kyphoplasty.

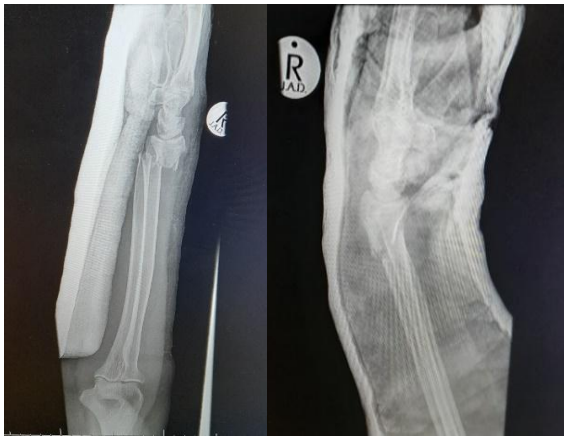
With severe osteoporosis, a low-energy hip fracture may occur from simple twisting movements, where the fracture itself causes the reported fall. These fractures are defined as occurring between the articular margin of the femoral head and 5cm below the lesser trochanter. They can be subdivided into intracapsular and extracapsular fractures, with intracapsular fractures affecting the blood supply to the femoral head.

Mortality and morbidity risks are significant following a hip fracture, with a substantial number of patients experiencing another fracture, commonly in the wrist or proximal humerus at the time of the fall. These patients would have a history of falling, severe hip pain and an inability to walk. Displaced fractures may lead to external

rotation and shortening of the affected leg, while impacted fractures can still allow some degree of walking. Treatment may include internal fixation and prosthetic replacement.

Figure 2: *Left neck of femur (NOF) fracture after a fall*

Distal radius fractures are frequently observed following low-energy falls or impacts on the wrist. Colles' fracture is a common type of distal radius fracture that occurs in the forearm near the wrist joint. This injury typically results from a fall onto an outstretched hand. Colles' fractures often affect older adults with decreased bone density such as those with osteoporosis. It involves a transverse fracture with dorsal displacement of the distal end of the radius bone, causing a characteristic "dinner fork" deformity of the wrist. Contrastingly, Smith's fractures occur after a fall onto the back of the hand, with a volar displacement of the distal fragment. Patients with these fractures may experience pain, swelling and limited wrist movement. Treatment options depend on the severity of the fracture, but may involve casting or splinting, closed reduction or surgical intervention with open reduction and internal fixation.



(A) *(B)*

Figure 3: *(A) Low-energy distal radius fracture, usually caused when trying to catch yourself after a fall; (B) x-ray after treatment with plaster of paris (POP) cast*

Figure 4: *"Dinner fork" deformity with Colles' fracture (Source: Sylvain Letuffe, CC0)*

Special investigations

In diagnosing low-energy fractures, various imaging modalities play crucial roles, each offering distinct advantages and limitations.

Plain radiography is commonly employed for initial assessments in the emergency department due to its speed, accessibility and relatively low radiation exposure. However, it has limitations in terms of spatial resolution and may not always detect subtle fractures.

Computed tomography (CT) is another valuable tool, particularly when vertebral fractures are uncharacterisable on x-rays or when suspected fractures are not visible on standard x-rays, such as undisplaced neck of femur fractures. CT provides high-spatial resolution and is rapid in obtaining images. Although it involves ionising radiation, CT is adequate in ruling out hip and pelvic fractures in elderly patients, making it a practical choice in the emergency setting.

Magnetic resonance imaging (MRI) offers superior sensitivity for detecting fractures and is particularly useful in identifying occult vertebral fractures. MRI provides high tissue resolution and does not involve ionising radiation, making it a safer option, especially in cases where repeated imaging is required. However, MRI is slower and not as universally available as other modalities.

Dual-energy x-ray absorptiometry (DXA) is useful for subclinical vertebral fracture screening, providing minimal radiation exposure and quick results. It is important to assess bone mineral density (BMD) in patients with low-energy fractures to diagnose osteoporosis. All patients with low-energy fractures should have a DXA scan, but it has limitations in spatial resolution and accessibility.

Figure 5: *X-ray showing a posteriorly displaced midshaft proximal femur fracture with medial angulation and an expanded intramedullary cavity following a low-velocity fall*

Management

Non-surgical

Non-surgical interventions focus on immobilisation and pain management. For stable fractures, immobilisation with casts, splints or braces may be employed to promote healing and prevent further injury. In some cases, weight-bearing restrictions or the use of assistive devices like crutches or walkers may be recommended to reduce stress on the affected area.

Pain control is achieved through analgesics and anti-inflammatory medications, allowing patients to remain comfortable during the healing process. Physiotherapy is often utilised to maintain joint mobility, prevent muscle atrophy and mitigate the risks of immobility-related complications, such as atelectasis and pressure sores in patients with immobilised fractures, especially in the elderly.

Prompt and essential initial management of hip fractures in the elderly is crucial for improved outcomes, reduced morbidity and mortality. Measures like skin traction for stabilisation and pain relief before surgery, deep vein thrombosis (DVT) prophylaxis to prevent life-threatening blood clots and optimising fluid balance for haemodynamic stability support better overall management and enhance recovery and quality of life.

Surgical

In cases where the fracture is unstable, significantly displaced or associated with intra-articular involvement, surgical intervention is often warranted. Orthopaedic surgical methods aim to achieve an anatomical reduction of the fracture fragments and stable fixation to facilitate proper healing and restore function.

Common surgical approaches include open reduction and internal fixation (ORIF) using screws, plates or nails, which provide stability to the fractured bone and allow early mobilisation. In more complex fractures, external fixation or minimally invasive techniques, such as percutaneous pinning, may be utilised. In some instances, such as NOF and humeral head fractures, joint arthroplasty or joint replacement may be considered to address severe joint damage resulting from the fracture.

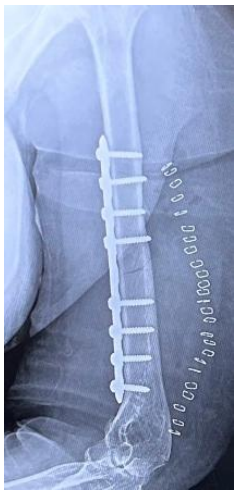


Figure 6: *Treatment of humerus midshaft fracture with ORIF plate fixation*

Figure 7: *Femur cephalo-medullary nail used to treat a proximal femur fracture*

Key takeaways

- Low-energy fractures are common orthopaedic concerns resulting from minimal trauma in everyday activities, particularly amongst the elderly.
- The wrist (distal radius), hip (proximal femur) and vertebral bodies are commonly affected by low-energy fractures in the geriatric population.
- Clinical evaluation should include thorough patient history, examination of soft tissue envelope and assessment of neurovascular status.
- Imaging modalities like plain radiography, CT and MRI play essential roles in diagnosing low-energy fractures, each offering specific advantages and limitations.
- Non-surgical management involves immobilisation, pain control and physiotherapy to promote healing and prevent further injury.
- Surgical intervention is indicated for unstable, displaced, or intra-articular fractures and includes methods such as ORIF, external fixation or joint replacement, depending on the severity of the fracture.

Assessment

1. A 70-year-old female patient with osteoporosis presents with a low-energy hip fracture. The fracture is displaced and the patient is deemed unfit for surgery due to medical comorbidities. What non-surgical management option is most appropriate for this patient?

A. Immobilisation with a cast

B. Immediate mobilisation and weight-bearing

C. Bed rest and pain management

D. Traction and physiotherapy

The answer is (A). Immobilisation with a cast is the most suitable non-surgical management option for displaced hip fractures in patients deemed unfit for surgery. It helps stabilise the fracture site and promote healing while minimising the risk of further injury.

2. Which imaging modality offers the highest spatial resolution and is most appropriate for evaluating complex intra-articular fractures, especially in the knee joint?

A. DXA

B. CT

C. Plain radiography

D. MRI

The answer is (B). CT provides the highest spatial resolution among the options listed and is particularly useful for assessing complex intra-articular fractures, especially in the knee joint. It offers detailed visualisation of bony structures and can aid in treatment planning.

3. A 78-year-old female patient with a low-energy hip fracture undergoes surgical management with ORIF. Postoperatively, she experiences persistent valgus deformity. What surgical technique could have helped prevent this complication?

A. External fixation
B. Minimally invasive percutaneous pinning
C. Joint arthroplasty
D. Bone grafting and osteotomy

The answer is (C). Joint arthroplasty, such as hip replacement, may be a more suitable option in elderly patients with severe low-energy hip fractures and underlying joint damage. It helps restore joint function and alignment, reducing the risk of postoperative deformities like persistent valgus deformity.

4. What is the most suitable surgical approach for managing unstable low-energy fractures with intra-articular involvement?

A. External fixation
B. Joint arthroplasty
C. Minimally invasive percutaneous pinning
D. ORIF

The answer is (D). ORIF provides anatomical reduction and stable fixation, facilitating proper healing in unstable low-energy fractures.

5. What is a potential complication associated with low-energy fractures in elderly patients on anticoagulant therapy?

A. Osteoporosis
B. Comminution
C. Compartment syndrome
D. Delayed union

The answer is (C). Elderly patients on anticoagulant therapy may be at risk of developing compartment syndrome following a low-energy fracture.

References and further reading

Baker, R., Whitehouse, M., Apley, A.G., & Solomon, L. Injuries of the hip and femur. (2018). In A. Blom, S. Warwick (Eds.), Apley & Solomon's System of Orthopaedics and Trauma. (10th ed.). Boca Raton, Florida: CRC Press; 885–90.

Donnally III, C.J., DiPompeo, C.M., & Varacallo, M. Vertebral Compression Fractures. [Updated 2022 Nov 14]. In StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448171/

Eggenberger, E., Hildebrand, G., Vang, S., Ly, A., & Ward, C. Use of CT vs. MRI for diagnosis of hip or pelvic fractures in elderly patients after low-energy trauma. (2019). Iowa Orthop J. 39(1):179-183. PMID: 31413692; PMCID: PMC6604520.

Láinez Ramos-Bossini, A.J., Ruiz Santiago, F., Moraleda Cabrera, B., López Zúñiga, D., & Ariza Sánchez, A. Imaging of low-energy vertebral fractures. (2023). Radiologia (Engl Ed). May-Jun;65(3):239-250. doi: 10.1016/j.rxeng.2023.01.006. Epub 2023 May 11. PMID: 37268366.

Maniar, H., McPhillips, K., Torres, D., Wild, J., Suk, M., & Horwitz, D.S. Clinical indications of computed tomography (CT) of the head in patients with low-energy geriatric hip fractures. (2015). Injury 46(11):2185–9. doi:10.1016/j.injury.2015.06.036

OpenAI. ChatGPT [Internet]. San Francisco, CA: OpenAI; c2021 [cited 2023 Aug 2]. Available from: https://openai.com/chatgpt

Wakeley, C., Apley, A.G., & Solomon, L. Diagnosis in orthopaedics. (2018). In A. Blom, D. Warwick, M.R. Whitehouse (Eds.), Apley & Solomon's System of Orthopaedics and Trauma, (10th ed). Boca Raton, Florida: CRC Press; 2018. p. 3–7.

Watts, A., Warwick, D., Apley, A.G., & Solomon L. Injuries of the wrist. (2018). In A. Blom, D. Warwick, & M.R. Whitehouse (Eds.), Apley & Solomon's System of Orthopaedics and Trauma. (10th ed.). Boca Raton, Florida: CRC Press; 2018. p. 797–800.

Complications of fractures

By Kerin Stead & Maritz Laubscher

Learning objectives

- Be able to identify the immediate and delayed complications associated with fractures.
- Understand the importance of history-taking and examination in identifying fracture-related complications.
- Understand the risk factors for complications of fractures.
- Be able to identify the different management options (surgical and non-surgical) for the various complications of fractures.

Introduction

Fractures are a relatively common injury that patients present with. It is important to be able to recognise complications arising from fractures as these can significantly impact a patient's recovery. Through a thorough history-taking and examination during check-ups, it is possible to identify complications and implement a management plan to prevent any long-term sequalae.

Complications of fractures

Immediate complications

Compartment syndrome: Compartment syndrome occurs when there is increased pressure within a limb muscle compartment from swelling or bleeding around the fractured bone. Increased pressure impairs circulation and leads to tissue hypoxia. This condition is painful and needs urgent treatment to prevent irreversible tissue damage.

Soft tissue injury: Local injury to the tissues around the fracture site.

Nerve or blood vessel damage: Fractures can cause damage to peripheral nerves or blood vessels, leading to sensory or motor function loss, or impaired blood flow.

***Figure 1**: Acute compartment syndrome*

Delayed complications

Malunion: Malunion happens when the bone fragments heal in a malaligned position. This can lead to functional impairment, deformity and chronic pain.

Delayed or non-union: Fractures can take longer than usual to heal or not heal properly at all, causing delayed or non-union. Soft tissue injury such as open fractures, poor blood supply, infection or insufficient immobilisation are potential causes.

Fracture-related infection: Infection can occur in open fractures or following surgery. Osteomyelitis is an infection of the bone.

Osteoarthritis: This is a long-term complication of fractures (especially intra-articular fractures) that impacts physical ability and can lead to chronic pain.

Deep vein thrombosis (DVT): This potential complication is due to immobilisation following fractures. The risk is higher in spinal, pelvic and leg fractures and can potentially lead to a pulmonary embolism.

Fat embolism syndrome: This is a risk, especially in long bone fractures. Fat droplets from the bone marrow may enter the bloodstream. These droplets can affect the lung, brain and other organs; for example, causing respiratory distress.

Joint stiffness and contractures

Muscle atrophy: This can occur when a fractured limb is immobilised for a long period of time, causing muscle wasting and weakness.

Figure 2: *Fracture malunion*

Clinical findings

History

A comprehensive history should be taken of the fracture and how it occurred to identify potential complications. Information about the mechanism of injury, time since the injury and patient's past medical conditions can help assess the severity of the fracture, the healing process and recognise risk factors for impaired fracture healing.

Risk factors

Age: Older patients generally have lower bone density, putting them at a higher risk of fractures. They may also have more complications during the healing process.

Type and location of the fracture: **Open** fractures and fractures near joints have a higher risk of complications compared to other fractures.

Severity of the fracture: Complex fractures or fractures that are severely displaced may take longer to heal and have a higher rate of complications compared to closed fractures.

Osteoporosis: Osteoporosis causes decreased bone density, which increases the risk of fractures and causes difficulties in fracture fixation.

Poor nutrition: Deficiencies of nutrients like protein and vitamin D can also impair bone healing and lead to complications.

Smoking and alcohol consumption: This can increase the risk of delayed or non-union, infections and other complications.

Delayed treatment: Untreated fractures can cause further damage to local soft tissues that would otherwise be preventable. Late presentation therefore increases the risk of complications.

Underlying medical conditions: Diabetes, peripheral vascular disease or autoimmune disorders can negatively impact the body's healing process and increases the risk of complications.

Medications: Corticosteroids and other medications negatively impact bone health, slowing the healing process.

Non-compliance with treatment: Not wearing casts, not attending follow-up appointments or not going to physiotherapy can slow the healing process and lead to complications such as contractures.

Examination

It is important to follow up with a patient after a fracture to check that they are healing well and that no complications have occurred. The following features indicate that there is a potential complication with the healing process:

- Severe pain that is worse than what would be expected during the healing process.
- Swelling or bruising around the fracture site that is severe or rapidly increasing. This could indicate infection or impaired healing.
- Deformity.
- Limited range of motion compared to the other unaffected limb.
- Skin changes – red and hot to the touch.
- Open wounds or pus near the fracture could indicate infection.
- Fever that is unexplained could indicate a systemic infection.
- Delayed healing.
- Crepitus could suggest malalignment or non-union. This is caused by bone ends rubbing against each other.
- Sepsis symptoms such as tachycardia, hypotension and confusion.

Special investigations

Imaging

X-rays are often used initially and provide useful information about the fracture pattern and alignment.

Computed tomography (CT) scans are valuable for when assessing complex fractures and intra-articular involvement.

Magnetic resonance imaging (MRI) is useful for identifying soft tissue injuries, ligamentous involvement and occult fractures.

Management

Immediate complications

Non-surgical

Rest, ice, compression and elevation (RICE) can be used to manage soft tissue injuries and help to reduce inflammation.

Any suspected nerve damage or blood vessels injuries should be investigated, monitored closely or urgently referred depending on severity.

Surgical

For compartment syndrome in the early stages, the immediate treatment involves a fasciotomy, which is a surgical technique to reduce pressure within the affected compartment, allowing for restoration of adequate blood flow and tissue perfusion.

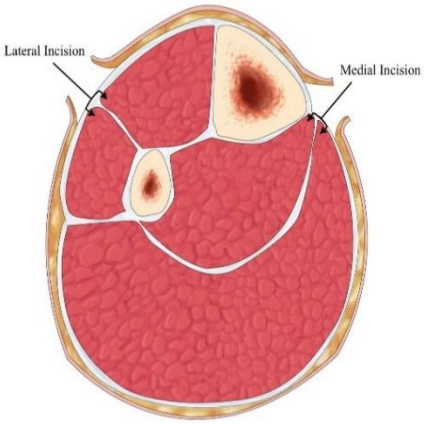


Figure 3: *Fasciotomy (Source: Cone & Inaba, CC BY-NC)*

In cases of severe blood vessel or nerve damage, surgical intervention should be done to restore blood flow and function to the affected area.

Delayed complications

Non-surgical

Non-surgical management of a DVT is preventative and includes compression stockings, anticoagulants and early mobilisation of the patient.

Physiotherapy can help to prevent joint stiffness and contractures through stretching and range of motion exercises.

Physiotherapy can also help to prevent and treat muscle atrophy of the affected limb.

Figure 4: *Skin traction to immobilise a hip fracture to limit movement at fracture site, decreasing pain and preventing complications*

Surgical

Surgical treatment can prevent complications. For instance, in the cases of AO (Arbeitsgemeinschaft für Osteosynthesefragen) type B or C fractures of the distal radius, operative fixation as opposed to conservative treatment can decrease the risk of complications of fractures, such as malunion, articular incongruity and osteoarthritis.

Corrective surgery is necessary to treat malunion; for example, osteotomy with the use of internal or external fixation devices. Surgical intervention is also required in most cases of fracture-related infection and non-union.

For fracture-related infections and osteomyelitis, the treatment always involves surgery (debridement of devitalised tissue) and systemic antibiotics.

In severe cases where a DVT leads to a pulmonary embolism, emergency surgery may be necessary.

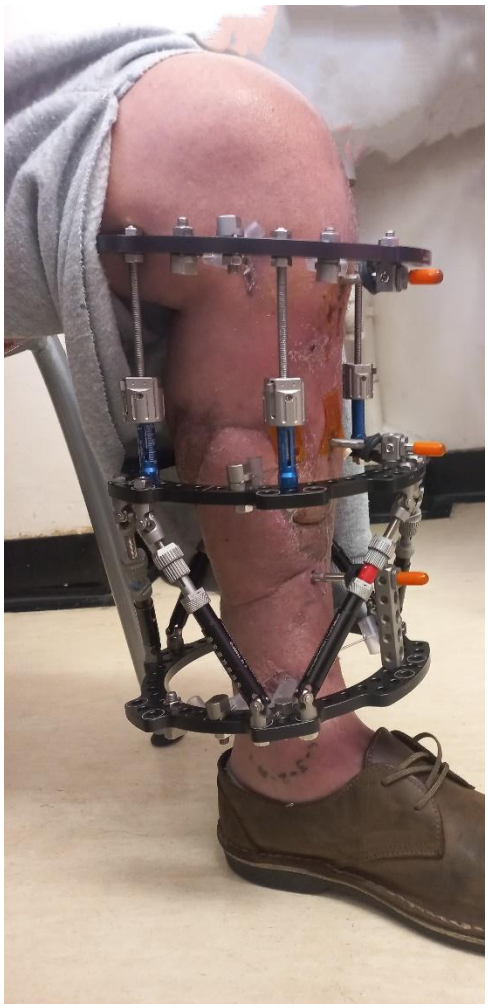


Figure 5: *External fixation device*

Key takeaways

- Fracture-related complications can significantly impact patient outcomes and can lead to functional impairment, deformity and potentially life-threatening conditions.
- History and clinical examination are essential for diagnosis and can help in identifying potential complications early on.
- There are a variety of complications of fractures, such as compartment syndrome, soft tissue injuries, malunion and non-union, and all have slightly different presentations.
- There are many risk factors for complications of fractures, so identifying these factors can help guide preventative measures.
- Management options vary based on the type and severity of the fracture and associated complications, and range between surgical and non-surgical options.
- Differential diagnosis helps rule out other conditions with similar presentations, such as degenerative joint disease.

Assessment

1. A 35-year-old man sustains a fracture in his forearm and undergoes conservative treatment involving immobilisation with a cast. After six weeks, he complains of weakness and wasting of muscles in the affected arm. What is the most likely complication he is experiencing?

A. Compartment syndrome

B. Muscular atrophy

C. Delayed or non-union

D. Fat embolism syndrome

The answer is (B). These symptoms of weakness and muscle wasting are consistent with muscular atrophy.

2. A 42-year-old woman sustains a closed fracture in her tibia following a fall. She complains of increasing pain and swelling in the affected leg. Upon examination, there is limited range of motion. The neurological examination is normal. What complication is the most likely cause of her symptoms?

A. Joint stiffness and contractures

B. Nerve or blood vessel damage

C. Osteomyelitis

D. Compartment syndrome

The answer is (D).

3. A 28-year-old male sustains a fracture in his femur after a motorcycle accident. He is treated with surgical intervention involving open reduction and internal fixation (ORIF). Two days after surgery, he develops sudden onset respiratory distress. What is the most likely complication he is experiencing?

A. Fat embolism syndrome

B. Infection

C. Delayed or non-union

D. DVT

The answer is (A). Symptoms of sudden onset respiratory distress following a femur fracture and ORIF are indicative of fat embolism syndrome.

4. A 50-year-old man sustains a fracture in his wrist due to a fall. After the fracture has healed, he notices that the bone fragments have not aligned correctly, leading to limited functionality and chronic pain. What complication is he likely experiencing?

A. Malunion

B. Compartment syndrome

C. Delayed or non-union

D. Joint stiffness and contractures

The answer is (A).

5. A 32-year-old woman sustains an open fracture in her arm during a car accident. She undergoes surgery to clean the wound and fixate the fracture. A few days after the surgery, she develops signs of infection at the surgical site, with redness, warmth and pus discharge. What complication is she likely experiencing?

A. Osteomyelitis

B. Compartment syndrome

C. Fat embolism syndrome

D. Infection

The answer is (A).

References and further reading

Cone, J. & Hinaba, K. Four-compartment fasciotomy of the right leg through two incisions. (2017). [cited 2023 Aug 7]. Available from: Lower extremity compartment syndrome | Trauma Surgery & Acute Care Open. (BMJ.com).

Depypere, M., Morgenstern, M., Kuehl, R., Senneville, E., Moriarty, T.F., Obremskey W.T., Zimmerli, W., Trampuz, A., Lagrou, K., & Metsemakers, W.J. (2020). Pathogenesis and management of fracture-related infection. Clin Microbiol Infec,. 26(5), 572-578. https://doi.org/10.1016/j.cmi.2019.08.006

Kalashnikov, M., Malik, V.D., & Kalashnikov, A.V. (2016). The effectiveness of the implementation of new technologies in the prevention of purulent complications of repeated surgeries for complications of fractures of the proximal femur of patients. Zaporozhskiĭ Meditsinskiĭ Zhurnal. 3,76-80. https://doi.org/10.14739/2310-1210.2016.3.76992

Knipe, H., El-Feky, M., & Haouimi, A. Fracture malunion. Reference article. Radiopaedia.org. Accessed on 27 Jul 2023. https://doi.org/10.53347/rID-77689

Myerson, M., & Quill, G. Late complications of fractures of the calcaneus. (1993). The Journal of Bone & Joint Surgery. 75(3).

Sharma, H., Khare, G.N., Singh, S., Ramaswamy, A.G., Kumaraswamy, V., & Singh, A.K. Outcomes and complications of fractures of distal radius (AO type B and C): volar plating versus nonoperative treatment. (2014). J Orthop Sci. 19(4), 537-544. https://doi.org/10.1007/s00776-014-0560-0

Singaram, S. & Naidoo, M. The physical, psychological and social impact of long bone fractures on adults: A review. (2019). Afr J Prim Health Care Fam Med. 11(1): e1-e9. https://doi.org/10.4102/phcfm.v11i1.1908

Takeda, S., Tatebe, M., Sakai, A., & Hirata, H. Two cases of unidentified acute compartment syndrome. (2018). BMJ Case Reports.bcr-2017-222377.

OpenAI. ChatGPT (Mar 14 version) [Large language model]. (2023). https://chat.openai.com/chat

PAEDIATRIC INJURIES AND CONDITIONS

Chapter 8 – Approach to foot deformities in a child **54**
Dehan Baard & Anria Horn

Chapter 9 – Approach to a swollen, painful limb in a child **61**
Anria Horn

Approach to foot deformities in a child

By Dehan Baard & Anria Horn

Learning objectives

- Understand the common foot deformities seen in paediatric patients.
- Identify the clinical features and examination findings associated with various foot deformities.
- Discuss the importance of early detection and management of foot deformities to prevent long-term complications.
- Familiarisation with non-surgical and surgical treatment options for paediatric foot deformities.
- Recognise the role of orthopaedic surgeons in the management of complex foot deformities in children.

Introduction

Foot deformities in children are common and can range from mild conditions to more complex abnormalities. As primary care providers, it is essential to recognise these deformities early and initiate appropriate management. This chapter aims to provide insights into the clinical presentation, diagnostic approach and treatment options for paediatric foot deformities. Some of the most common foot deformities include congenital clubfoot, pes planus (flatfoot) and pes cavus.

Pes planus (flatfoot)

***Figure 1**: Patient with pes planus (flatfoot). The absence of the arch can be noted.*

Clinical findings

History

Parents or caregivers may notice a flattening of the child's arch, especially when standing. It is nearly universal in children less than 2 years and typically resolves spontaneously between the ages of 2 and 3, when the ligaments and tendons in the foot and leg strengthen. Although it's rarely pathological, childhood flexible flatfoot might persist into adulthood and seldom requires intervention.

Examination

Look for a loss of the medial arch when the child stands. When examining the foot from the back, the heel is in valgus and the "too-many-toes" sign may be present.

Assess flexibility: The arch may reappear when the child rises on their toes (supple flatfoot), but it remains absent in stiff flatfoot.

Observe the child's gait: Flatfoot can lead to an inward rolling of the foot (pronation) during walking.

Figure 2: *Flatfoot with the "too-many-toes" sign. Usually only the 4th and 5th toes are seen but, in this sign, more may be seen.*

Special investigations

Imaging

X-rays are usually not required for diagnosis. In severe cases or when other conditions are suspected, referral for further imaging or specialist evaluation may be warranted.

Management

Non-surgical

- Most cases of paediatric flatfoot do not require surgery and can be managed conservatively.
- Physiotherapy and exercises to strengthen the foot and ankle muscles may alleviate pain and fatigue associated with flatfoot.
- Supportive footwear and orthotic inserts are the first line of treatment for symptomatic flatfoot.
- Nonsteroidal anti-inflammatory drugs (NSAIDs) can relieve pain.
- Surgery is rarely indicated and reserved for symptomatic flatfeet that do not respond to conservative measures.

Causes of a stiff or rigid flatfoot

- Tarsal coalitions.
- Neurological flatfeet (for example, in cases of cerebral palsy).
- Inflammatory conditions (for example, in cases of rheumatoid arthritis and juvenile idiopathic arthritis [JIA]).

Congenital clubfoot

Figure 3: *Inward turning of the feet in clubfoot (Source: Richard Masoner, CC BY-SA)*

Clinical findings

History

Parents and caregivers may notice a significant inward turning of the foot and restricted movement. Clubfoot is a birth defect (a congenital abnormality) where a child's foot points inward instead of forward. The condition is normally identified after birth.

Examination

- Observe the foot position: The foot is turned inwards and downwards (equinovarus deformity).
- Note muscle tightness and tendon contractures around the ankle and foot.
- Evaluate the range of motion in the affected foot and compare it to the other side.

Special investigations

- X-rays are not required for diagnosis as it is a clinical diagnosis. They are performed if the foot does not respond to serial casting.
- Antenatal ultrasound can diagnose congenital clubfoot.

Management

Early intervention is crucial for optimal outcomes.

Non-surgical

Non-surgical treatment involves Ponseti casting and stretching to gradually correct the foot position. This should be initiated as soon after birth as possible, within the first few days of life. The Ponseti method involves gentle stretching and serial casting according to a well-defined protocol. The cast should be changed weekly until the clubfoot is corrected. This is usually followed by an Achilles tendon tenotomy and a strict bracing protocol until the age of 4 years.

Surgical

In severe cases, or when the clubfoot doesn't respond to non-surgical methods, surgery may be indicated. Surgery involves releasing contracted ligaments and joints to correct the position of the foot. Surgery is associated with stiffness and pain in early adulthood. The child will have to wear a brace for up to a year after the surgery to keep the foot in the correct position.

A more in-depth explanation of clubfoot is available in the "Clubfoot" chapter.

Accessory navicular bone

Figure 4: *Dorsoplantar x-ray of the foot. Left image shows an accessory navicular bone on the left foot medial side (Source: Jakob Steenberg, CC BY-SA). Right image shows a normal right foot (Source: Mikael Häggström, CC0).*

Clinical findings

History

Children may present with pain and tenderness on the inner side of the foot, exacerbated by shoewear. An accessory navicular bone is an accessory ossicle adjacent to the medial side of the navicular bone. The accessory navicular bone can be seen as an enlargement of the navicular or as a sesamoid within the posterior tibial tendon.

Examination

- Patients will typically present with a flatfoot and pain over the medial side of the foot.
- Palpate the medial side of the foot to identify an accessory navicular bone.
- Assess for localised tenderness and swelling.

Special investigations

X-rays can confirm the presence of the accessory navicular bone.

Management

Non-surgical

- Most cases can be managed conservatively with rest, ice, compression and elevation (RICE).

- Orthotic inserts and supportive footwear can help alleviate symptoms.

Surgical

Rarely, surgical removal of the accessory navicular bone may be considered for persistent symptoms.

Pes cavus

Figure 5: *Lateral x-ray of the foot, showing a high arch in pes cavus (Source: Mikael Häggström, CC0)*

Clinical findings

History

Parents or caregivers may notice an exaggerated arch of the child's foot. Due to abnormal load bearing, the child may develop painful callosities under the metatarsal heads and under the lateral border of the foot. Frequent ankle sprains are also a common complaint.

Pes cavus, or more specifically pes cavovarus, is nearly always associated with an underlying neurological condition, specifically peripheral neuropathies such as Charcot-Marie-Tooth disease. A thorough neurological history needs to be obtained.

Examination

- Look for an abnormally high medial arch when the child stands.
- **Assess flexibility:** Arch typically remains high and rigid, even when the child rises on their toes.
- **Observe the child's gait:** Pes cavus can lead to an outward rolling of the foot (supination) during walking.
- Perform a thorough neurological examination looking for wasting of muscles, abnormal reflexes and sensation.

Special investigations

X-rays are typically performed to exclude underlying abnormalities and to quantify the severity of the deformity.

All cases of paediatric pes cavus should be referred to an orthopaedic surgeon for further evaluation, as it is seldom physiological.

Management

Non-surgical

Mild cavus deformity can be managed with supportive footwear and orthotics to distribute weight more evenly and improve pain and instability.

Surgical

Most cases of pes cavus in children will progress and eventually require surgery. For milder deformities, tendon releases and transfers are indicated. More severe deformities require osteotomies and sometimes fusions.

Curly toe (clinodactyly)

Clinical findings

History

Curly toe is a common deformity which is usually bilateral and may be hereditary. It is characterised by flexion and medial deviation of the toe. The adjacent toe may be overriding and is most commonly seen in the 3rd and 4th toes. Later in life, they may cause pressure symptoms and present with calluses, blisters or nail deformities.

Examination

- Look for a proximal interphalangeal (PIP) joint that rests in a flexed position, with or without a flexion deformity of the distal interphalangeal (DIP) joint.
- Fully and passively extend the PIP and DIP joints while the metatarsal

phalangeal (MTP) joint is held flexed to confirm the absence of capsular contractures.

- You might also find a varus posture of the toe with lateral rotation that leads to underriding of the adjacent toe.

Special investigations

Imaging studies such as x-rays and radiographs are not usually necessary in the evaluation and management of curly toe.

Management

Non-surgical

In some cases, the deformity will resolve spontaneously. Taping the curly toe to an adjacent toe in the first few months of life may improve the deformity. Surgery before the age of 6 is not recommended.

Surgical

- Surgery is indicated if the curly toe leads to pain, callosities or difficulty with shoewear.
- **Simple tenotomy:** A surgeon will make a small incision near the affected tendon and carefully sever or cut the tendon. This intentional cutting of the tendon releases its tension, allowing for greater flexibility and improved range of motion.
- **Transfer of the long flexor to the extensor apparatus:** A surgeon will move a tendon from the group of muscles responsible for flexing a toe to a position where it assists in extending the toe. This procedure aims to rebalance the forces acting on the toe.

Key takeaways

- **Paediatric foot deformities are common:** It is important to be able to distinguish normal variants from pathological conditions.
- **Paediatric flatfoot is the most common foot deformity**: It is considered a normal variant, rarely requiring treatment.
- **Early identification for optimal outcomes:** Recognising pathological foot deformities such as clubfoot or pes cavus promptly and initiating appropriate management is crucial for preventing long-term complications.
- **Clinical expertise and diagnostic proficiency:** The ability to identify clinical features and perform comprehensive examinations aids in diagnosing foot deformities. Mastery of these skills enhances accurate assessment and targeted interventions.

Assessment

1. A 10-day-old child presents with an inward turning and downward positioning of the foot. Physical examination reveals muscle tightness and contractures. Which of the following is the most appropriate initial management for this congenital foot deformity?

A. Surgical correction of the foot position

B. Application of rigid orthotic devices

C. Serial manipulation and casting using the Ponseti method

D. Observation without intervention

The answer is (C). The described foot deformity is consistent with congenital clubfoot and the most appropriate initial management is the Ponseti method, which involves serial manipulation and casting to gradually correct the foot position.

2. A 14-year-old child complains of persistent pain and tenderness on the inner side of the foot during physical activities. On examination, an accessory navicular bone is palpable and there is localised tenderness. What is the most appropriate management for this child's condition?

A. Immediate surgical removal of the accessory navicular bone

B. Supportive footwear and rest

C. Physiotherapy and stretching exercises

D. Serial casting using the Ponseti method

The answer is (B). Initial management of symptomatic accessory navicular bone involves conservative measures such as supportive footwear and rest.

3. A 6-year-old child presents with a noticeable flattening of the arch on both feet and the arch does not reappear when the child rises on their toes. Which of the following is the most appropriate initial management for this child?

A. Immediate surgical correction of the flatfoot

B. Prescribe orthotic inserts and observe for improvement

C. Referral for physiotherapy and exercises

D. X-rays to assess for underlying bone abnormalities

The answer is (D). The child presents with stiff flatfoot. This condition is always pathological and x-rays need to be assessed for underlying bone abnormalities.

4. A 9-year-old child presents with a bilateral flexion and medial deviation of the 3rd and 4th toes. The adjacent toe appears to be overriding. What is the term for this deformity?

A. Pes planus (flatfoot)

B. Pes cavus

C. Curly toe (clinodactyly)

D. Congenital clubfoot

The answer is (C). The described deformity of flexion and medial deviation of the 3rd and 4th toes, with the adjacent toe overriding, is known as curly toe or clinodactyly.

5. A 6-year-old child's parents notice a flattening of the child's arch when standing, but the arch reappears when the child rises on their toes. What type of flatfoot does this description indicate?

A. Supple flatfoot

B. Rigid flatfoot

C. Congenital flatfoot

D. Pathological flatfoot

The answer is (A). The description of a flattening of the arch when standing but reappearing when rising on toes indicates supple flatfoot. This type of flatfoot is more flexible and typically does not require surgical intervention.

References and further reading

Badii C. (2019). What you should know about flat feet. Healthline. [Internet]. 2019 Nov 6. Available from: https://www.healthline.com/health/pes-planus. Medically reviewed by Timothy Gossett, M.D.

Balasankar G, Ameersing L. (2015). Common Foot and Ankle Disorders in Adults and Children. Research Journal of Textile and Apparel. 2015;19(2):54-65. Available from: https://doi.org/10.1108/RJTA-19-02-2015-B008.

Cleveland Clinic. Flat Feet. Cleveland Clinic website. Available from: https://my.clevelandclinic.org/health/diseases/17005-flat-feet. Accessed [10 August 2023].

Kahn A. (2012). Clubfoot. Healthline. [Internet]. 2012 Jul 18. Available from: https://www.healthline.com/health/clubfoot. Medically reviewed by William Morrison, M.D.

Morrissy RT, Weinstein SL. Lovell, (2005). Winter's Pediatric Orthopaedics. United States: Lippincott Williams & Wilkins.

OpenAI. (2023). ChatGPT (Mar 14 version) [Large language model]. https://chat.openai.com/chat

Pediatric Orthopaedic Society of North America (POSNA). Curly toe. POSNA. Available from: https://posna.org/physician-education/study-guide/curly-toe. Accessed [10 August 2023].

Approach to a swollen, painful limb in a child

By Anria Horn

Learning objectives

- Know the differential diagnosis for a swollen, painful limb in a child.
- Know which pertinent questions to ask during the history taking.
- Know the key clinical features to aid diagnosis.
- Know which special investigations to perform.
- Know the indications for urgent referral.

Case presentation

A 2-year-old male presents with a history of limping and progressive swelling over the left lower leg and ankle.

The caregiver is uncertain of when exactly it started, but the swelling has been getting worse over the last 2 weeks.

There is no history of trauma or prior illness. The child is developmentally normal.

Examination reveals a large mass on the medial aspect of the lower leg. There are no skin changes noted over the mass, nor are there any scars.

The mass is soft. It is tender to palpation. It appears to be adherent to the underlying bone. It is not warm compared to the other leg.

The ankle can be moved passively, although the child does not move it actively. Distal pulses and movement are intact.

Vital signs are within normal limits.

***Figure 1**: A lesion in the metaphysis of the distal tibia*

There is a lesion affecting the medial distal metaphysis of the tibia. The lesion has sclerotic margins and is well demarcated. There is a significant soft tissue component as is evidenced by a soft tissue mass medially. There is some calcification in the lesion. There is a periosteal reaction on the medial diaphysis. These x-ray features are

suggestive of a slow-growing or chronic lesion. The differential diagnosis includes infection or a low-grade tumour.

Blood investigations reveal a raised C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), a mild anaemia and a raised platelet count.

Magnetic resonance imaging (MRI) was performed.

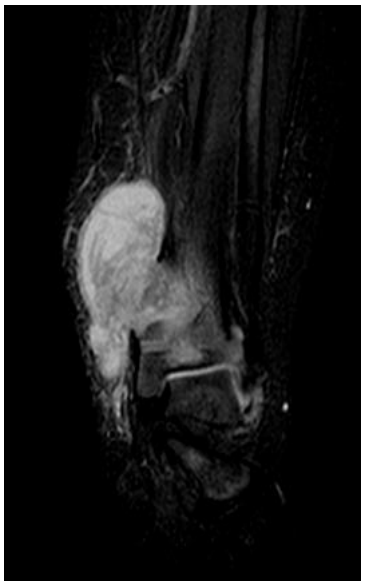


***Figure 2**: Coronal MRI scan showing a large bone abscess involving the metaphysis and epiphysis of the distal tibia, extending outside the cortex*

Radiologically and clinically, tuberculosis (TB) was diagnosed and this was confirmed on biopsy. The patient was treated medically and the lesion healed.

Introduction

When assessing a child with a painful, swollen limb, the diagnosis will typically fall into 1 of 4 categories: trauma, infection (acute or chronic), tumour (benign or malignant) and inflammatory.

The differential diagnosis can be narrowed down by a thorough history and clinical examination.

Once the differential diagnosis has been narrowed down, appropriate special investigations are performed and treatment instituted.

History

Duration: A condition that has been present for months and progressing slowly is less likely to require emergency treatment than a recent-onset, painful and swollen limb (for example, TB vs acute haematogenous osteitis).

Precipitating events: Was there a traumatic event preceding the swelling of the limb? If so, how soon after the injury did it start? Was there a preceding infection such as tonsilitis or otitis media? If the pain and swelling occurred immediately after a traumatic event, a fracture or other injury is most likely. If, however, there was a delay in onset of symptoms, bone or joint infection is highly likely.

Progression: Is the pain and swelling getting worse or better? Traumatic conditions tend to improve over time, unlike infectious or malignant conditions.

Associations: Constitutional symptoms such as malaise and weight loss are suggestive of chronic infections or malignancy. Other joint involvement is suggestive of an inflammatory condition. Fever is fairly non-specific, but typically absent in the traumatic setting.

Past medical and surgical history: This may give a clue to the underlying condition. Also ask if any treatment has been sought before and what this was.

Examination

Look

- Which part of the limb is involved? Is the swelling localised or diffuse?

- Is the skin inflamed (red)? If so, a superficial infection may be the cause.
- Is there induration or blistering? Suggestive of cellulitis or necrotising fasciitis.
- Is there a skin lesion or sinus? Chronic infection likely.
- Scarification? This would suggest a chronic or long-standing condition.
- Previous surgical scars?

Feel

- Warmth is indicative of inflammation or infection.
- Consistency: Tensely swollen limbs typically indicate trauma or a generalised infection. Fluctuant swelling indicates an abscess or haematoma. Soft, spongy swellings are unusual and may indicate a soft tissue mass or vascular malformation.
- Is there an associated joint effusion?
- Distal neurovascular status?

Move

Are you able to move the adjacent joints? Frozen joints are very typical of infections, but patients with fractured limbs are also reluctant to move the adjacent joints.

Special investigations

Plain film x-rays

X-rays will always be the first investigation you request. If there is a fracture, you will have your diagnosis and no further investigations will be required.

Do not routinely request contralateral limb x-rays, as they add additional cost and radiation and are not always necessary. Reserve those for cases of uncertainty.

In acute infections and inflammatory conditions, x-rays are typically normal, although you may be able to appreciate the soft tissue swelling.

***Figure 3**: An x-ray of a young child with chronic osteomyelitis of the tibia. Note the irregular cortices, areas of lysis and sclerosis, as well as the developing sequestrum and involucrum. There is a pathological fracture in the proximal metaphyses. The epiphyses are spared and the fibula appears normal.*

Blood investigations

Baseline tests to request are a FBC (full blood count), CRP and ESR. If you suspect an infection, take a blood culture at the same time. It is usually not necessary to test renal and liver function.

Normal baseline bloods exclude infection, malignancy and inflammation. Abnormal baseline bloods are non-specific, but there are certain trends to look out for:

- Acute infections usually have a very high CRP and a raised white cell count.
- TB typically has a raised ESR, normal white cell count, mild anaemia and high platelets.

- Malignant conditions often present with severe anaemia, very high ESR but modestly raised CRP.

Other investigations

MRI is the most specific investigation available. It can detect very early changes in cases of infection, and it can differentiate accurately between different pathologies that may cause a painful, swollen limb. Figure 4a shows a 12-year-old boy who presented with thigh swelling and pain. X-rays and blood investigations were normal. MRI demonstrated a large vascular malformation in the thigh.

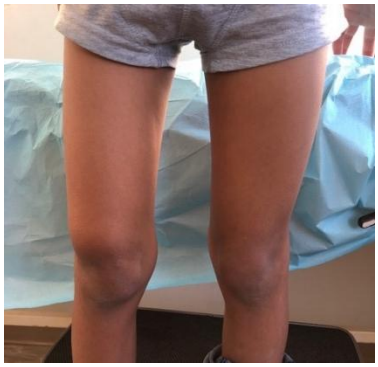


***Figure 4a**: 12-year-old boy presenting with thigh swelling and pain*

***Figure 4b**: MRI demonstrating large vascular malformation in the thigh*

Bone scans are very useful investigations if the exact location of the pathology is unclear. This is typically the case in young, limping children with swollen, painful limbs where examination is difficult and often inconclusive. Bone scans are very sensitive, but not very specific and are not widely available.

Ultrasound is widely available and inexpensive. It can distinguish between solid masses and collections and can diagnose the rare case of deep vein thrombosis in children. Ultrasound is quite user-dependent and not very accurate in detecting small sub-periosteal collections.

Biopsy

Patients presenting with a painful, swollen limb in the absence of acute trauma will most likely require a biopsy of some sort. In cases of clear infection, this will form part of the incision and drainage (I&D) of the abscess and lead to pathogen identification and antimicrobial sensitivity. In tumours, a biopsy is always required prior to the initiation of treatment.

Once you suspect a bone or joint infection or a tumour, the patient should be referred to a centre with the required expertise immediately.

Red flags

Features suggestive of sepsis:

- Fever.
- Tachycardia.
- Inability to weight-bear or actively move the joint.
- Rapidly progressive pain.
- Features suggestive of malignancy:
- Progressive pain and swelling in the absence of features of sepsis.
- Anaemia.
- Weight loss and malaise.

Key takeaways

- Second to trauma, infection is the most common cause of a painful, swollen limb in a child and should always be actively excluded.
- Although the differential diagnosis is broad, a targeted history and examination will aid in the diagnosis.
- Once infection or malignancy is confirmed or suspected, urgent referral is required.

References and further reading

Weinstein, S., & Flynn, J. M. (2014). Lovell and Winter's paediatric orthopaedics. 7th Edition. Wolters Kluwer, Philadelphia, USA.

Vajapey, S., & Horn, A. (2021) Tuberculosis of the extra-axial skeleton in children. South African Orthopeadic Journal, 20(1).

SPINAL INJURIES AND CONDITIONS

Chapter 10 – Spinal trauma **67**
Dehan Baard & Nicholas Kruger

Chapter 11 – Nerve injuries **74**
Michael Solomons

Spinal trauma

By Dehan Baard & Nicholas Kruger

Learning objectives

- Identify clinical features.
- Analyse imaging studies.
- Perform a comprehensive examination.
- Formulate differential diagnoses.
- Understand the importance of urgency.
- Comprehend multi-disciplinary management.
- Evaluate surgical and non-surgical options.
- Recognise rehabilitation needs.
- Appreciate prevention and precautions.
- Critically analyse clinical references.

Case presentation

A 32-year-old female patient arrives at the emergency department after a high-speed motor vehicle accident (MVA). She was the driver involved in a head-on collision. The patient is conscious but complains of severe pain in her neck and back. On further inquiry, she mentions numbness and tingling in both arms and legs. The medical history reveals no previous spinal problems or significant medical conditions.

A lateral x-ray of the cervical spine indicated a C5/6 facet dislocation, a serious injury, which can result in spinal cord compression.

***Figure 1**: A clinical photograph depicting the patient's position upon arrival at the emergency department. The cervical collar and backboard are in place and the patient is being carefully stabilised. (Source: Koroushtaherian, CC BY-SA)*

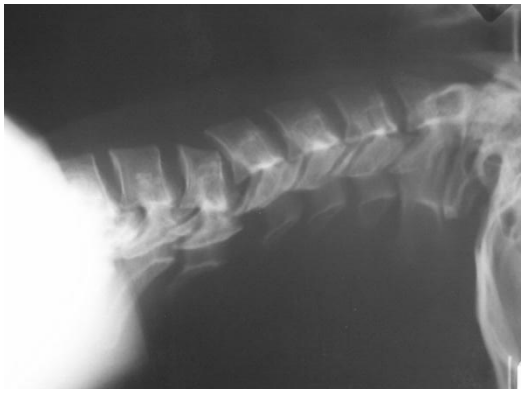


***Figure 2:** Lateral x-ray of the cervical spine indicating a C5/6 facet dislocation*

History

When dealing with potential spinal trauma, gathering a comprehensive history is vital for diagnosis and management. The most common causes of traumatic spinal cord injury worldwide are falls and road traffic injuries (RTIs). In South Africa, penetrating injuries from gunshot wounds and stabs are also common.

Mechanism of injury: How did the trauma occur? Was it a car accident, fall, sport-related incident or another cause?

Duration of symptoms: When did the patient start experiencing pain, numbness or other symptoms?

Neurological changes: Are there any changes in sensation or strength in the arms and legs?

Previous spinal conditions: Has the patient had any previous spinal issues or surgeries?

Medical history: Are there any underlying medical conditions that might affect the treatment plan?

Examination

Perform a thorough physical examination to assess the patient's spinal stability and neurological status. Perform a log-roll to assess the spine thoroughly.

Inspection: Look for signs of deformity, bruising or swelling around the spinal region.

Palpation: Gently feel for tenderness, abnormalities or instability along the spine. Crepitus or a gap on palpation of spinous processes are indicative of instability.

Movement: Assess the range of motion and the patient's ability to move their limbs. Be cautious not to exacerbate any potential injuries.

Undertake neurovascular examination. Evaluate peripheral pulses and sensory function in all extremities. Assess motor strength in the arms and legs.

Digital rectal examination is performed to assess pin-prick sensation and voluntary anal pinch. Absence of the bulbo-cavernosus reflex indicates the patient is in spinal shock.

Special investigations

In cases of suspected spinal trauma, the following investigations are crucial:

X-rays: Obtain anterior-posterior (AP) and lateral views of the affected region to identify fractures, dislocations or misalignments. Also, see the related chapter: "Approach to orthopaedic x-rays".

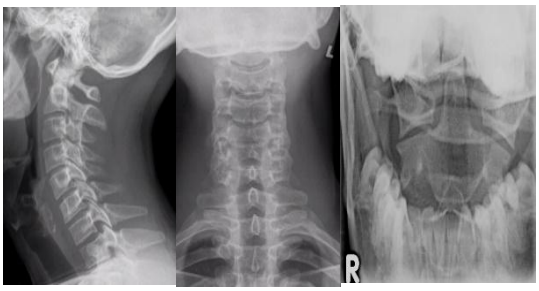


Figure 3: *Cervical spine trauma series showing (left to right) lateral, AP and open-mouth views to assess the C1/2 level*

Magnetic resonance imaging (MRI) or computed tomography (CT) scan: These imaging techniques provide detailed information about spinal cord injuries, nerve compression and soft tissue involvement.

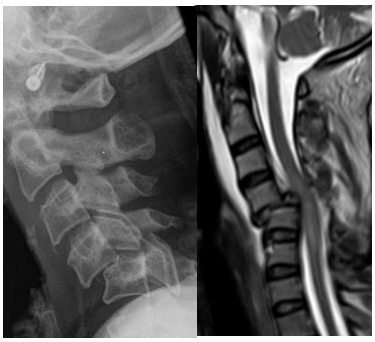


Figure 4: *Lateral x-ray of a C4/5 bifacet dislocation (left) and the sagittal T2 MRI showing associated spinal cord compression (right)*

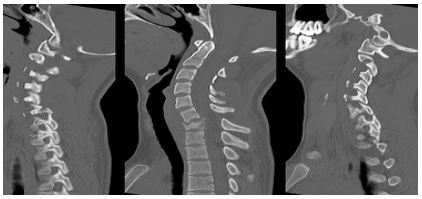


Figure 5: *CT scan images showing a C7 fracture dislocation, with C7 body compression and facet joint fracture with subluxation*

Differential diagnoses

Consider potential causes of the patient's symptoms, such as:

Spinal fractures: Vertebral body fractures, spinous process fractures or facet joint injuries.

Spinal cord injury: Compression, contusion or laceration of the spinal cord.

Disc herniation: Disc material pressing on nerves or the spinal cord.

The American Spinal Injury Association (ASIA) grading scale is used to describe neurological injuries:

- **ASIA A:** A complete spinal cord injury with no sensory or motor function preserved distal to the injured cord segment.
- **ASIA B:** An incomplete injury with sensory preservation distal to the injury, but complete motor function loss.
- **ASIA C:** An incomplete motor injury where there is some motor preservation distally, but functionally useless (0–2 MRC).
- **ASIA D:** An incomplete motor injury with useful motor function distal to the injured cord segment (4/5 MRC).
- **ASIA E:** Normal.

The MRC (Medical Research Council) scale for muscle strength is as follows:

- **Grade 5:** Normal
- **Grade 4:** Movement against gravity and resistance
- **Grade 3:** Movement against gravity over (almost) the full range
- **Grade 2:** Movement of the limb but not against gravity
- **Grade 1:** Visible contraction without movement of the limb (not existent for hip flexion)
- **Grade 0:** No visible contraction

Management

Immediate and appropriate management is crucial in spinal trauma cases, as this can improve the prognosis as well as prevent complications.

Stabilisation: Immobilise the patient's spine with a cervical collar and backboard to prevent further damage during transport.

Emergency referral: Urgently refer the patient to a specialised spinal trauma centre for a thorough assessment and management.

Collaborative approach: A multidisciplinary team of orthopaedic surgeons, neurosurgeons and radiologists should review the case together to determine the best treatment plan.

Non-surgical: Some minimally displaced cervical fractures can be managed conservatively in a rigid

cervical collar (Philadelphia collar) for 3 months and are expected to stabilise once bony union occurs. Unstable displaced cervical injuries of the C1 ring, C2 peg and C2 traumatic spondylolisthesis injuries are mostly managed in cervical skull-tong traction in bed for 6 weeks to maintain alignment, and then a further 6 weeks in a cervical collar until united.

Most stable thoraco-lumbar fractures are managed at home with a brace for pain control until united at 3 months.

Surgery: Unstable spinal fractures and dislocations are managed surgically to restore vertebral alignment, stability and decompression of neural tissue. This is achieved with a variety of spinal instrumentation which allows early mobilisation.

Rehabilitation: Provide comprehensive rehabilitation and physiotherapy, such as range of motion (ROM) exercises, gait training, manual dexterity, aerobic exercises, bladder and bowel training, and workplace assessment or retraining to aid in the patient's recovery and return to maximal function.

Figure 6: *Lateral MRI of the lumbar spine showing a L2 collapse and compressed nerves. Lumbar spondylosis and spinal tuberculosis (TB).*

Complications are common in spinal trauma and immediate and appropriate management is necessary to minimise risk of complications. These complications include but are not limited to:

Spinal instability and deformity: Severe spinal trauma can result in spinal instability and deformities, which may require surgical stabilisation and correction.

Neurological deficits: Spinal cord injuries can lead to partial or complete loss of sensation and motor function below the level of injury. This can result in paralysis or weakness in the limbs, loss of bowel and bladder control, and sensory disturbances. Neurogenic bladder can develop due to loss of innervation following spinal trauma, resulting in symptoms such as urinary tract infections (UTIs), urinary incontinence, frequency and urgency.

Paraplegia or quadriplegia: Severe spinal cord injuries can cause paraplegia (paralysis of the lower limbs) or quadriplegia (paralysis of all four limbs). The extent of paralysis depends on the level of the spinal cord affected. This can then lead to a deep vein thrombosis (DVT) and pressure sores.

Neurogenic shock: A severe spinal cord injury can disrupt the autonomic nervous system, leading to neurogenic shock. This condition results in low blood pressure, bradycardia (slow heart rate) and peripheral vasodilation.

Respiratory problems: Spinal trauma at higher levels of the cervical spine can impact the muscles involved in breathing, leading to respiratory difficulties and the need for ventilatory support.

Gastric ulcers: Spinal cord trauma can alter the equilibrium between parasympathetic and sympathetic neural pathways, as well as cause ischaemia of the gastric mucosa in various ways.

Contractures: Characterised by limited joint range of motion and deformity. This can lead to impairment in mobility and function, and lead to disability and pain. This can be due to the loss of innervation in spinal trauma.

Prevention

Spinal trauma can be avoided by:

- Avoiding or being safe around fall hazards such as ladders.
- Driving safely and wearing seatbelts in motor vehicles. Never speed or drink and drive.
- Wearing appropriate safety gear during sport and recreational activities.

Assessment

1. A 58-year-old male patient presents to the emergency department with after a high-speed MVA. He is conscious, but complains of neck and back pain, as well as weakness and numbness in both arms and legs. Physical examination reveals swelling and tenderness over the cervical and lumbar spine. What is the most appropriate immediate management for this patient?

A. Administer intravenous pain relief medications

B. Immobilise the cervical and lumbar spine with collars and backboards

C. Refer the patient for physiotherapy and rehabilitation

D. Perform emergency surgical decompression of the spinal cord

The answer is (D). The patient's presentation of neck and back pain, weakness and numbness in both arms and legs, along with swelling and tenderness over the cervical and lumbar spine, suggests a potential spinal cord compression. Immediate surgical decompression is the most appropriate management in this scenario.

2. A 40-year-old female patient arrives at the emergency department after a fall from a horse. She experiences severe pain in her neck and back, along with tingling in both legs. The medical history reveals no previous spinal issues or significant medical conditions. On examination, there are signs of vertebral body fractures and facet joint injuries. Which of the following imaging studies is crucial for further assessment?

A. CT scan of the spine

B. MRI of the spine

C. X-ray (AP and lateral views)

D. Ultrasound of the spine

The answer is (B). Given the patient's severe pain, tingling in both legs and signs of vertebral body fractures and facet joint injuries, an MRI of the spine is crucial for further assessment. MRI provides detailed images of the spinal cord, nerve roots and surrounding soft tissues, making it an excellent modality to evaluate the extent of the injury.

3. A 32-year-old male patient presents with a history of gradually worsening back pain and reports intermittent claudication. MRI reveals lumbar disc herniation with nerve compression. Which of the following management approaches is most appropriate for this patient?

A. Immediate surgical intervention

B. Bed rest and analgesics

C. Physiotherapy and exercises

D. Observation and conservative treatment with medications

The answer is (A). The patient's history of gradually worsening back pain and intermittent claudication, along with MRI findings of lumbar disc herniation with nerve compression, may indicate significant nerve impingement. In such cases, immediate surgical intervention may be necessary to relieve pressure on the nerve and prevent further complications.

4. In cases of suspected spinal trauma, which aspect of the comprehensive examination is essential for evaluating peripheral vascular supply and sensory function in all extremities?

A. Measurement of peripheral pulses

B. Assessment of motor strength

C. Evaluation of deep tendon reflexes

D. Examination of range of motion

The answer is (A). In cases of suspected spinal trauma, the measurement of peripheral pulses is essential for evaluating peripheral vascular supply. Checking pulses in all extremities helps assess blood flow and ensures that there are no vascular injuries or compromise following the trauma.

5. A 55-year-old male patient presents to the emergency department with severe back pain following a fall. On examination, there is swelling and tenderness over the lumbar spine. MRI reveals a burst fracture with retropulsion of bone fragments. What is the most appropriate management approach for this patient?

A. Immediate surgical intervention

B. Spinal bracing and pain medications

C. Bed rest and physiotherapy

D. Observation and conservative treatment with analgesics

The answer is (A). The patient's presentation of severe back pain, swelling and tenderness over the lumbar spine, along with MRI findings of a burst fracture with retropulsion of bone fragments, indicates a significant injury to the spine. In such cases, immediate surgical intervention is often necessary to stabilise the spine, decompress neural structures and prevent further damage to the spinal cord.

References and further reading

Avital, Y., Purcell, L.N., & Charles, A. (2022). Chapter 1. Traumatic spinal cord injury and outcomes in low-resource settings. In Diagnosis and treatment of spinal cord Injury. Elsevier.

Cleveland Clinic. Spinal cord injury. Cleveland Clinic website. Available from: https://shrturl.app/zvWVtP. Accessed [28 July 2023].

Diong, J., Harvey, L., Kwah, L., et al. (2012). Incidence and predictors of contracture after spinal cord injury - a prospective cohort study. Spinal Cord, 50(8):579-584. doi: 10.1038/sc.2012.25.

Ginsberg D. (2013). The epidemiology and pathophysiology of neurogenic bladder. Am J Manag Care, 19(10 Suppl):s191-s196.

Flint Rehab. (2021). How to maximize mobility with physiotherapy for spinal cord injury. Flint Rehab. Available from: www.flintrehab.com/physiotherapy-for-spinal-cord-injury/. Medically reviewed by Andrew Tran PT, DPT, NCS, CSCS.

Kewalramani, L.S. (1979). Neurogenic gastroduodenal ulceration and bleeding associated with spinal cord injuries. J Trauma, 19(4):259-65. doi: 10.1097/00005373-197904000-00008. PMID: 439182.

OpenAI. (2023). ChatGPT (Mar 14 version) [Large language model]. https://chat.openai.com/chat

Nerve injuries

By Michael Solomons

Learning objectives

- Understand the anatomy of a nerve.
- Understand the types of nerve injuries.
- Management and when to refer.

Anatomy of a nerve

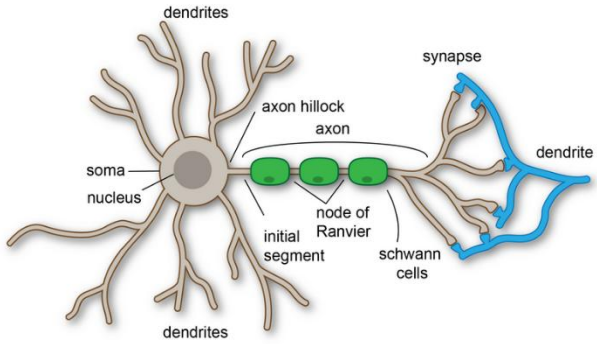


***Figure 1**: Anatomy of a nerve (Source: Curtis Neveu, CC BY-SA)*

While most other connective tissues are made of multiple cells, the functional unit of a nerve, the axon, is a single cell that, in the case of a motor nerve, might extend from the spinal cord to the foot.

The cell body sits in the anterior horn of the spinal cord and the end of this single cell sits on the motor end plate of the target muscle. This is why nerve injuries are devastating and associated with poor outcomes.

Depolarisation travels down the nerve by a relatively slow process. The myelin sheath allows the depolarisation to jump from the node of Ranvier to the next node of Ranvier, thereby accelerating the transmission in a process called saltatory conduction.

When other tissues are damaged, they can be replaced by fibroblasts, which can do a similar job to the host tissue. Nerves need to be replaced by nerves, otherwise the function is lost.

Types of nerve injury

Neuropraxia

Here the nerve is just "bruised", with a temporary inability to transmit the impulse from the cell body to the end organ. There is no intrinsic cell damage. Recovery should be 100% and can take anything from a few seconds – such as in the case of "funny bone" or a numb leg after sitting on a hard chair – to a few weeks.

Axonotmesis

Here the axon is damaged, but not the myelin sheath. The cell will make building blocks to send down to the damaged end to repair and regrow. The nerve can only grow down in an intact nerve tube. Recovery is incomplete, but fairly good. It is a slow process as nerves grow at 1mm a day.

Neurotmesis

Lumbar Here the whole nerve is divided by an extreme distraction force or a transection by a sharp object. Recovery is impossible unless it is surgically repaired.

After surgery, recovery is poor due to the inability to align the parts perfectly. In this sense, it is a macroscopic solution to a microscopic problem.

Management

General principles

There is a need to differentiate a neuropraxia (minor) from a neurotmesis (major).

Neuropraxia follows low-energy, non-penetrating trauma.

Consider that all nerves have a motor and a sensory component. Commit the peripheral nerve dermatomes to memory.

In neuropraxia, the sensation in that nerve's distribution might be intact.

If a high-energy or penetrating injury presents with nerve deficit, assume that it is neurotmesis and refer the patient to a hand or peripheral nerve surgeon.

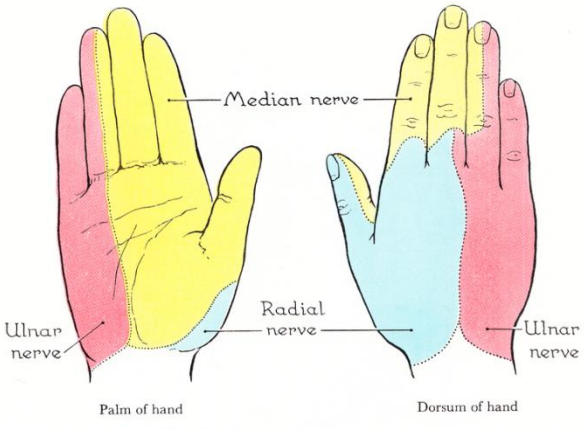


***Figure 2**: Dermatomes of the hand (Source: JCB Grant, CC0)*

Radial nerve

Supplies

Elbow extension

- Triceps

Wrist extension

- Extensor carpi radialis longus (ECRL)
- Extensor carpi radialis brevis (ECRB)
- Extensor carpi ulnaris (ECU)

Finger extension

- Extensor digitorum communis (EDC)
- Extensor indicis proprius (EIP)
- Extensor digiti minimi (EDM)

Thumb extension

- Extensor pollicis longus (EPL)
- Extensor pollicis brevis (EPB)
- Abductor pollicis longus (APL)

Presents with:

- Wrist drop
- Finger drop
- Thumb drop

Types:

- Saturday night palsy
- Associated with humerus fracture open or closed
- Penetrating

Management

If you suspect a neuropraxia, such as Saturday night palsy, then use a wrist extension splint to avoid contracture and refer to physiotherapy to maintain passive range of motion. There is expectant recovery.

If there is a penetrating injury, refer early to a nerve surgeon.

Ulnar nerve

Supplies

Extrinsics (muscles in forearm)

- Flexor carpi ulnaris (FCU)
- Flexor digitorum profundus (FDP) to little and ring fingers

Intrinsics (small muscles in hand)

- All interossei
- Hypothenar muscles
- Adductor pollicis
- Lumbricals to little and ring fingers

Presents with:

- Ulnar nerve claw - Hyperextended metacarpophalangeal joints (MPJs) of the little and ring fingers and a flexed position of the proximal interphalangeal joints (PIPJs) in the little and ring fingers.

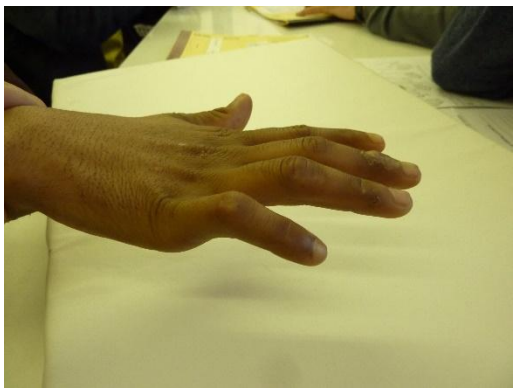


***Figure 3**: Ulnar nerve claw*

- Weak pinch - Tends to hyperflex the thumb interphalangeal (IP) joint (Froments sign).

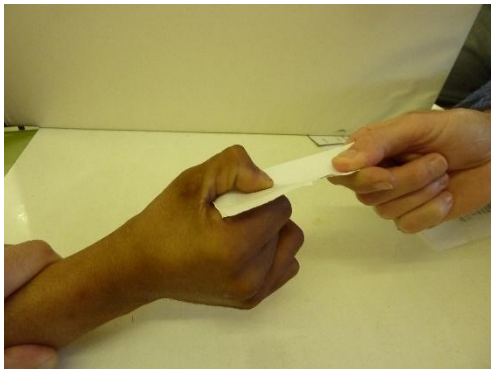


***Figure 4**: Weak pinch leading to a Froments sign when asked to pull a piece of paper*

Median nerve palsy

Supplies

Extrinsics (muscles in forearm)

- Flexor carpi radialis (FCR)
- Flexor digitorum profundus (FDP) to the index and middle fingers

Intrinsics (small muscles in hand)

- Thenar muscles – opposition, abduction, flexion
- Lumbricals of the index and middle fingers

Presents with:

- Inability to flex the thumb and index finger when trying to make a fist.
- High median nerve palsy only.
- Benediction sign/pointing sign/gun sign/trigger sign.

***Figure 5**: Benediction sign in a patient with median nerve palsy*

Other nerves

Brachial plexus

Obstetric:

- Usually occurs due to an obstructed labour with shoulder dystocia. Most patients recover but 10% need surgery.
- Refer at a maximum of 2 months for assessment if the patient has not recovered fully.

Traction:

- Low-energy: Associated with a dislocated shoulder. It is important that it is documented before reducing the shoulder. Most patients recover.
- High-energy: Associated with a fall from a height or a motorbike accident onto the shoulder. It needs early referral.

Peroneal nerve

- Injury occurs due to a direct blow to the peroneal nerve as it winds around the fibula neck or following major knee injury.
- It presents with foot drop.
- Orthosis and referral are required.

Sciatic nerve

- It can present with a substantial loss of function and sensation in the lower leg after a fracture of the pelvis or dislocation of the hip.
- Refer early.

LOWER LIMB INJURIES AND CONDITIONS

Chapter 12 – Meniscus injury management **79**
Robyn Brown, Kim Tabelião & Michael Held

Chapter 13 – Anterior cruciate ligament injury **85**
Kerin Stead, Michael Held & Maritz Laubscher

Meniscus injury management

By Robyn Brown, Kim Tabelião & Michael Held

Learning objectives

- Recognise the signs of meniscus injuries.
- Differentiate meniscus injuries from anterior cruciate ligament (ACL) tears, medial collateral ligament (MCL) injuries and other common knee problems based on clinical presentation and history.
- Conduct a systematic knee examination to assess swelling, tenderness and range of motion, and use appropriate special tests like the McMurray test to confirm meniscus injuries.
- Understand the role of x-rays and magnetic resonance imaging (MRI) scans in diagnosing meniscus injuries and ruling out fractures or other bony involvement.
- Determine suitable management strategies such as rest, physiotherapy and surgical options based on factors like injury severity, patient age and desired activity level.

Case presentation

A 24-year-old female patient presents with acute swelling on her left knee. The injury occurred during a soccer match when she twisted her knee while changing direction. The patient reports a popping sensation at the time of injury; she could still play on, but noticed a knee swelling that evening. There is no history of previous knee injuries or medical problems. On examination, the knee appears swollen and tender, with limited range of motion. There is no neurovascular deficit noted.

***Figure 1**: Clinical photograph depicting the swelling on the medial aspect of the left knee. The overlying skin shows no significant changes.*

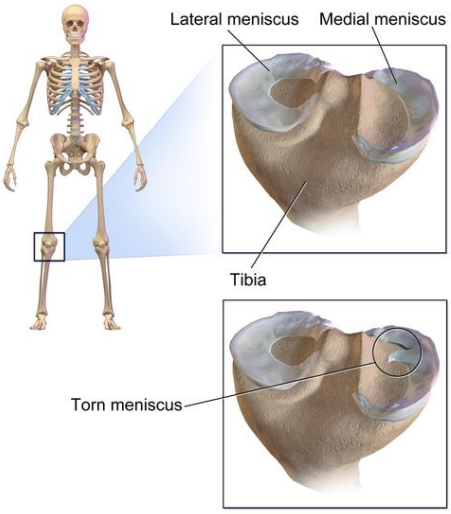


Figure 2: *Image showing intact and torn menisci (Source: BruceBlaus, CC BY-SA)*

History

The patient's history often strongly indicates the diagnosis of meniscus tears.

Injury mechanism: Usually this is a twisting injury with moderate, delayed swelling. The meniscus has limited perfusion and does not generate a large immediate haematoma as in ACL injuries.

Aggravating factors: Meniscus tears generate symptoms especially in flexion and when loading the knee.

Location and associated symptoms: Meniscus tears are often associated with clicking or locking and are most commonly painful around the joint line.

Examination

A systematic examination of the knee is essential, including:

- **Look:** Identify the location and amount of swelling in the form of an effusion.
- **Feel:** Palpate for tenderness, especially in the joint line. Feel for an effusion with the tap or wipe test. Please see the chapter on knee examination for this.
- **Move:** The end range (extreme flexion or extension) is most commonly painful in meniscus tears.

Special tests

Ligament tests: Rule out ligament laxity which can be associated with meniscus tears.

Meniscus tests: There are special tests for meniscus injuries, which usually include flexion of the knee as well as internal/external rotation of the tibia and varus/valgus force. Special tests include the McMurray, Steinman and Thessaly tests. These are unnecessary if there is joint line tenderness (the most sensitive test for meniscus injuries) and knee effusion.

Special investigations

Plain x-rays

Plain x-rays should be done to rule out fractures or any underlying bony pathologies.

MRI scan

An MRI scan is essential for identifying meniscus injuries and their severity as well as associated cartilage or ligament injuries.

Figure 3: *Weight-bearing x-ray showing no fractures or bony involvement*

Differential diagnoses

When evaluating sport knee injuries, it is essential to consider a range of possible differential diagnoses to ensure an accurate diagnosis and appropriate management. Here are some common differential diagnoses to meniscus tears:

ACL injury: ACL tears are common in sport involving sudden stops, changes in direction or direct blows to the knee. Patients may experience significant pain, swelling and instability.

MCL injury: MCL injuries should be ruled out, especially with medial joint pain. The maximum pain point is usually over the MCL insertion on the epicondyle down the proximal tibia. These injuries often result from direct blows to the outer knee, causing pain, localised swelling and tenderness along the inner knee. They often occur in contact sport.

Patellar tendinitis (jumper's knee): Overuse of the patellar tendon is common in sport involving repetitive jumping, which can lead to tenderness and pain below the kneecap.

Iliotibial (IT) band syndrome: Overuse or friction of the IT band, a thick band of tissue running along the outer thigh, can cause pain and inflammation on the outer side of the knee which can often present with a similar location of pain as lateral meniscus tears. However, the pain does not increase with flexion in IT band syndromes.

Lateral collateral ligament (LCL) injury: LCL injuries result from direct blows to the inner knee, leading to pain, swelling and tenderness along the outer knee, most commonly on its insertion over the epicondyle or fibula head.

Patellar dislocation/subluxation: The patella (kneecap) may partially dislocate or completely dislocate due to trauma or underlying structural issues, causing severe pain and instability. These dislocations cause immediate swelling due to haemarthrosis.

Plica syndrome: The irritation of the synovial plica within the knee joint can lead to pain and clicking sensations during movement. An MRI can best differentiate this pathology.

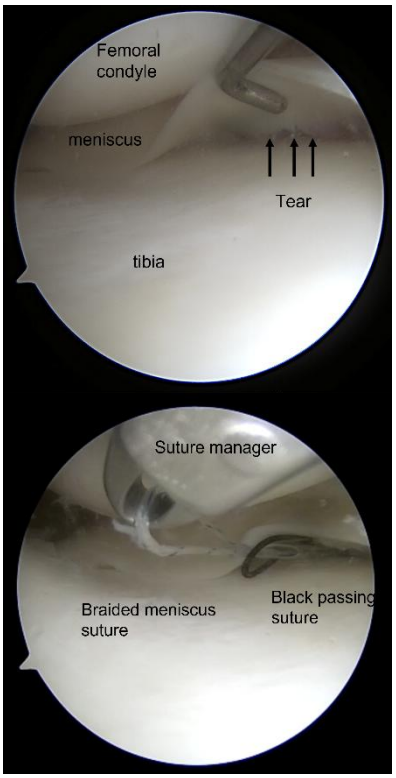


Figure 4: *Under-surface tear of the medial meniscus (top) sutured with an outside-in technique passing a braded suture to repair the tear (bottom)*

Figure 5: *Bucket handle meniscus tear (top) and meniscus sutures (bottom)*

Management plan

Diagnosis: Confirm meniscus tear through clinical examination and MRI scan.

Initial care: Administer protection, rest, ice, compression and elevation (PRICE) for pain and swelling management.

Conservative approach: For minor tears without mechanical symptoms, prescribe rest, physiotherapy and gradual return to activities.

Surgical evaluation: Refer to an orthopaedic specialist for thorough evaluation of MRI findings and the patient's functional needs.

Surgical consideration: Consider arthroscopic meniscus repair for active individuals with significant tears, aiming to restore function and prevent further damage.

Post-surgery rehabilitation: Emphasise structured rehabilitation for optimal recovery, focusing on range of motion, strength and functional activities.

Long-term management: Monitor patient progress and address any complications, ensuring a gradual return to sport activities when appropriate.

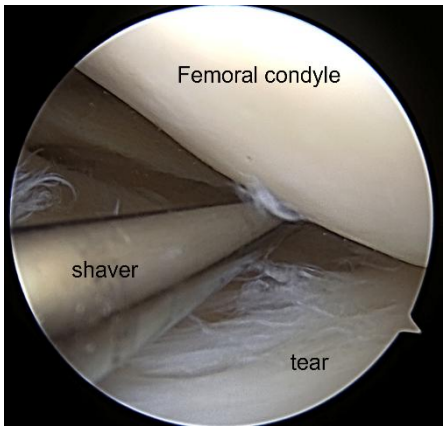


Figure 6: *Degenerative meniscus tear, not repairable*

Key takeaways

- Meniscus injuries often result from twisting injuries in the knee and may present with delayed swelling as well as pain during flexion and loading.
- Clinical examination, including joint line tenderness and special tests like McMurray and Thessaly, helps diagnose meniscus tears.
- MRI scans play a crucial role in identifying meniscus injuries and assessing their severity, along with associated ligament and cartilage injuries.
- Treatment varies based on the tear's extent; conservative approaches involve rest, physiotherapy and gradual return to activity.
- In selected cases, surgical options like arthroscopic meniscus repair may be considered to restore function and prevent further damage.

Assessment

1. A 24-year-old female patient presents with acute swelling on her left knee following a twisting injury during a soccer match. She reports a popping sensation at the time of injury and noticed knee swelling that evening. On examination, her knee is swollen and tender, with limited range of motion. There is no neurovascular deficit. Which of the following is the most appropriate next step in her management?

A. Immediate surgical intervention

B. Application of PRICE

C. Administration of corticosteroid injections

D. Prescribing nonsteroidal anti-inflammatory drugs (NSAIDs) and advising rest

The answer is (B). The application of PRICE is the most appropriate initial management for a suspected meniscus injury to reduce pain and swelling while awaiting further evaluation, such as an MRI scan, to confirm the diagnosis.

2. A 28-year-old athlete complains of lateral knee joint line pain that worsens with activities such as squatting and climbing stairs. Physical examination reveals no ligamentous laxity but some effusion. X-rays show no specific abnormalities. What is the most likely diagnosis?

A. Meniscal tear

B. Patellar tendinitis

C. Patellofemoral pain syndrome

D. Osteochondral fracture

The answer is (A). Lateral knee joint line pain that worsens with activities like squatting and climbing stairs, along with some effusion, is suggestive of a meniscal tear. Meniscal tears can cause pain and discomfort, especially when the torn fragment becomes caught between the joint surfaces during movement. The absence of ligamentous laxity and clicking, along with the location of pain and the aggravating activities, are indicative of a meniscal injury.

3. A 16-year-old basketball player presents with knee pain and a "clicking" sensation during knee movements. MRI shows a meniscal tear and the patient is otherwise healthy. What is the most appropriate initial treatment for this patient?

A. Arthroscopic meniscal repair
B. Non-weight bearing and analgesics
C. Physiotherapy and quadriceps strengthening exercises
D. Immediate surgical intervention

The answer is (C). In cases of a meniscal tear without significant mechanical symptoms or joint locking, conservative management with physiotherapy and quadriceps strengthening exercises is often the initial approach. Surgery may be considered if symptoms persist or worsen despite conservative management.

4. A 30-year-old marathon runner experiences acute swelling and limited range of motion in the left knee after a sudden twist during training. X-rays show no bony abnormalities, and MRI confirms a meniscus tear. The patient desires to return to running as soon as possible. What is the most appropriate management plan for this patient?

A. Immediate surgical ACL reconstruction
B. Conservative management with rest and bracing
C. Arthroscopic meniscus repair
D. Non-weight bearing and physiotherapy

The answer is (C). For active individuals who engage in high-demand sport such as running, meniscus repair will allow return to activity in 80% of patients and prevent early arthritis.

5. A 55-year-old recreational soccer player reports a recent injury to the knee, with localised tenderness and mild swelling. Physical examination reveals a stable joint, no clicking or locking, and no ligamentous laxity. MRI shows a horizontal meniscus tear. What is the most appropriate management approach for this patient?

A. Surgical intervention with meniscus repair
B. Conservative management with rest and physiotherapy
C. Immediate return to sport activities
D. Regular injections with cortisone

The answer is (B). Conservative management with rest, physiotherapy and gradual return to activities is the best management for older patients with chronic meniscus pathology (horizontal meniscus tears) without clicking or locking sensations.

References and further reading

OpenAI. (2023). ChatGPT (Mar 14 version) [Large Language model]. Available from: https://chat.openai.com/chat

Anterior cruciate ligament injury

By Kerin Stead, Michael Held & Maritz Laubscher

Learning objectives

- Understand the clinical presentation and examination findings of anterior cruciate ligament (ACL) injuries.
- Recognise additional injuries commonly associated with ACL injuries.
- Learn about the appropriate imaging and management strategies for ACL injuries.

Introduction

ACL injuries remain a prevalent knee injury, particularly among young athletes. In this chapter you will be provided with a comprehensive approach to understanding ACL injuries, their clinical findings, risk factors and diagnostic approaches. As this is such a prevalent injury, it is important to have good knowledge of the management and treatment of ACL injuries in order to improve patient outcomes.

The ACL is an integral stabilising structure within the knee joint. It consists of a dense fibrous band that connects the femur to the tibia. It is located within the joint and plays a crucial role by preventing excessive anterior translation of the tibia during rotational movements and weight-bearing activities.

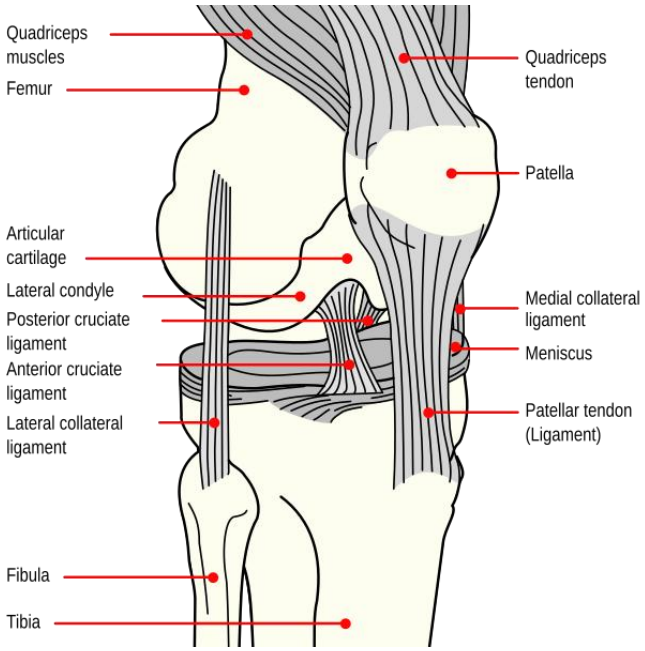


***Figure 1**: Schematic illustration of the knee joint anatomy (Source: Mysid, CC0)*

Clinical findings

History

The majority of ACL injuries happen during sport movements involving sudden stops, jumping manoeuvres or unplanned sidestepping.

Patients can often recall a specific event and are mostly unable to continue to compete. Patients frequently present complaining of swelling, a sensation of

instability and knee pain. ACL injuries are more common in male athletes.

Risk factors

Risk factors for ACL injuries can be broken up into intrinsic and extrinsic risk factors.

Intrinsic risk factors include an increased tibial plateau slope and a narrow intercondylar notch. Additional factors of an increased body mass index (BMI), hyperlaxity and family history have also been linked to increased rates of ACL injuries.

Extrinsic risk factors involve types of sport and positioning of play that predisposes a player to a pivoting motion or a shoe-surface interface causing increased ground friction.

Examination

Inspection

- Antalgic gait.
- Rapid swelling due to a large effusion.

Palpation and special tests

- Considerable tenderness in the knee joint.
- Positive Lachman test, which is the most reliable test for confirming ACL injury. The Lachman test assesses sagittal knee stability.
- Anterior drawer test, which looks for excessive anterior movement of the tibia relative to the femur, which would be indicative of an ACL injury.

Figure 2: *Anterior drawer test (see video showing difference between positive and negative anterior drawer test)*

Additional injuries to note

ACL injuries can occur with other injuries, such as:

- Medial collateral ligament (MCL) tears.
- Meniscal tears.
- Bone bruises.

These injuries, if present, may influence the treatment approach and prognosis and therefore should be carefully assessed.

Differential diagnosis

Knee instability can be caused by conditions other than ACL injuries, so it is important to keep the following conditions in mind for a differential diagnosis:

- MCL injury.
- Meniscus tear.
- Patellar dislocation.
- Fractures.

Special investigations

Imaging

X-rays appear normal, since the ligament does not appear on x-rays. They are mainly performed to rule out differentials like a fracture. MRI is therefore the imaging modality of choice, since it provides detailed images

of the knee's soft tissues, allowing for the accurate identification of ACL injuries and any associated injuries.

Figure 3: *Sagittal T2 MRI image showing a mid-substance ACL tear with disrupted fibres*

Management

Non-surgical

- Rest, ice, compression and elevation (RICE)
- Physiotherapy is extremely valuable for rehabilitation and gradual return to activity. Patients can focus on improving their range of motion, strengthening exercises and balance training to regain knee stability and function.

Surgical

Surgery is considered when non-surgical management fails or in patients who are competitive athletes or engage in high-demand activities.

The surgical technique typically involves reconstructing the torn ACL using a graft from the patient's or a donor's tissues (such as the patellar or hamstring tendons), to restore stability to the knee joint.

Arthroscopic ACL reconstruction is the preferred surgical approach, as it is less invasive and allows for faster recovery compared to traditional open surgery. The torn ACL is removed and tunnels are drilled through the bones to place the graft accurately. The graft is then secured in place using screws, staples or other fixation devices. Post-surgery, patients undergo a structured rehabilitation programme to gradually regain knee strength and function.

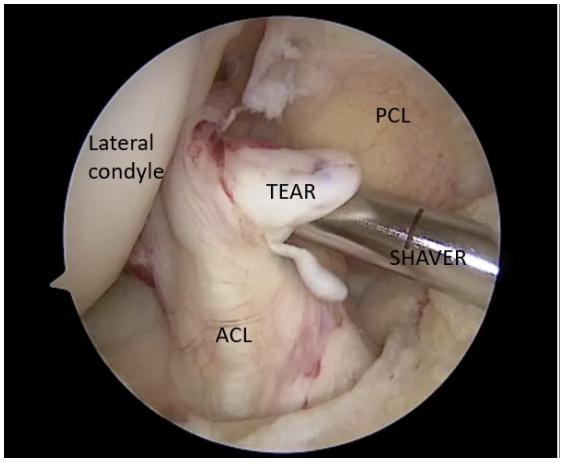


Figure 4*: Arthroscopic view of a partial ACL injury. The arthroscopic shaver marks the torn structure of the ACL.*

Prevention strategies

Prevention is extremely important due to potentially serious long-term sequalae, as well as an increased risk of re-injury. Neuromuscular training programmes have been shown to be effective in preventing ACL injuries. These focus on improving strength, balance and coordination to enhance knee stability during sport activities.

Proper warm-up exercises, stretching and ensuring athletes use appropriate footwear and sport equipment also play a role in reducing injury risk.

Key takeaways

- ACL injuries are common knee injuries, often seen in young athletes.
- History and clinical examination, such as the Lachman test and the anterior drawer test are essential for diagnosis.
- MRI is the imaging modality of choice to identify and evaluate ACL injuries.
- Non-surgical management such as RICE, nonsteroidal anti-inflammatory drugs (NSAIDs) and physiotherapy is the initial approach for most patients.
- For active individuals or when non-surgical management is insufficient, surgical reconstruction may be required. The preferred approach is arthroscopic ACL reconstruction.
- Early rehabilitation is crucial for optimal recovery and functional outcomes.
- Preventive measures, including neuromuscular training and proper warm-up, can help reduce the risk of ACL injuries in athletes.

Assessment

1. A 25-year-old male rugby player presents to the clinic with a history of sudden stops and changes in direction during a rugby game. He complains of knee pain, swelling and a feeling of knee instability. On examination, there is significant tenderness in the knee joint, and the Lachman test and anterior drawer test confirm the diagnosis of an ACL tear. What additional injury is commonly associated with ACL tears?

A. Medial meniscus tear

B. Posterior cruciate ligament tear

C. Patellar tendon rupture

D. Quadriceps muscle strain

The answer is (A). A medial meniscus tear is most commonly associated with an ACL tear.

2. A 20-year-old female soccer player presents to the emergency department after sustaining a knee injury during a match. She describes sudden pain and swelling in her knee after a jumping manoeuvre. On examination, there is antalgic gait, tenderness in the knee joint and pain on resisted adduction of the hip. MRI reveals an ACL tear. What is the most appropriate initial management strategy for this patient?

A. Immediate surgical reconstruction

B. NSAIDs and physiotherapy

C. Complete bed rest for one week

D. Continuous ice pack application for 48 hours

The answer is (B). NSAIDs and physiotherapy are the most appropriate initial treatment; surgical reconstruction is only done if necessary.

3. A 28-year-old male soccer player with a known history of ACL tear is being evaluated for surgical reconstruction. The surgeon plans to use a graft from the patient's own tissues. Which of the following graft options is commonly used in ACL reconstruction?

A. Allograft from a cadaver

B. Autograft from the contralateral knee

C. Xenograft from a pig’s tendon

D. Synthetic mesh material

The answer is (B).

4. A 9-year-old basketball player suffers from an ACL tear and undergoes arthroscopic ACL reconstruction. The surgeon removes the torn ACL and secures the graft using screws. Post-surgery, the patient is advised to undergo a structured rehabilitation program. What is the primary goal of this rehabilitation programme?

A. Regaining full range of motion in the knee

B. Gradually returning to high-demand activities

C. Achieving maximum knee stability within a week

D. Strengthening of the ankle and hip muscle only

The answer is (A).

5. A sport coach wants to implement preventive measures to reduce the risk of ACL tears in the team. Which of the following strategies has been shown to be effective in preventing ACL injuries among athletes?

A. Using appropriate footwear and sports equipment

B. Applying ice packs after each training session

C. Administering NSAIDs before every match

D. Implementing high-intensity interval training during the season

The answer is (A).

References and further reading

ACL rupture and Grade III MCL Tear [Internet]. 2008 [cited 2023 Jul 27]. Blogspot.com. Available from: https://1.bp.blogspot.com/_BBt5FH3wT9o/SPWPIB8ZLCI/AAAAAAAAAJQ/5JkGrIFSHmw/s400/acl2.jpg

Anderson, M.J., Browning, W.M., Urband, C.E., Kluczynski, M.A., & Bisson, L.J. (2016). A systematic summary of systematic reviews on the topic of the anterior cruciate ligament. Orthop J Sports Med. 4(3):232596711663407. https://doi.org/10.1177/2325967116634074

Ardern, C.L., Ekås, G., Grindem, H., Moksnes, H., Anderson, A., Chotel, F., Cohen, M., Forssblad, M., Ganley, T.J., Feller, J.A., Karlsson, J., Kocher, M.S., LaPrade, R.F., McNamee, M., Mandelbaum, B., Micheli, L., Mohtadi, N., Reider, B., Roe, J., & Engebretsen, L. (2018). International Olympic Committee consensus statement on prevention, diagnosis and management of paediatric anterior cruciate ligament (ACL) injuries. Knee Surg Sports Traumatol Arthrosc. 2018;26(4):989-1010. https://doi.org/10.1007/s00167-018-4865-y

Benos, L,. Stanev, D., Spyrou, L., Moustakas, K., & Tsaopoulos, D.E. (2020). Schematic illustration of the knee joint anatomy. Frontiersin.org. [Internet]. 2020 [cited 2023 Jul 27]. Available from:

Grevnerts, H.T. Sonesson, S., Gauffin, H., Ardern, C.L., Stålman, A., Kvist, J. (2021). Decision making for treatment after ACL injury from an orthopaedic surgeon and patient Perspective: Results From the NACOX Study. Orthop J Sports Med. 9(4):23259671211005090. https://doi.org/10.1177/23259671211005090

OpenAI. ChatGPT (Mar 14 version) [Large language model]. 2023. https://chat.openai.com/chat

Prodromos [Internet]. 2008. The anterior cruciate ligament reconstruction and basic science. Saunders/Elsevier.

SKILLS

Chapter 14 – Cervical reduction **92**
Edgar Majirija & Nicholas Kruger

Cervical reduction

By Edgar Majirija & Nicholas Kruger

Learning objectives

- Identify clinical features.
- Perform comprehensive examination.
- Analyse imaging studies.
- Identify indications for traction.
- Identify pre-requisites and contraindications to cervical spine reduction.
- Understand rationale for cervical traction.
- Understand urgency.
- Undertake pre-planning.
- Set up room, positioning and equipment.
- Apply procedure and reduction manoeuvres.
- Implement post-reduction care.
- Understand post-reduction considerations.

Clinical features

A high index of suspicion should always be maintained when dealing with trauma patients presenting with neck pain or injury mechanisms suggestive of potential cervical spine injury. Inebriated patients or patients presenting with altered consciousness should have cervical spine injuries actively ruled out.

High-energy mechanisms, including road traffic accidents, falls and sport injuries, are some of the more common mechanisms of injury. Penetrating injuries, such as gunshot and stab wounds, are also common.

Common presenting complaints include neck pain, neck stiffness, changes in sensation and strength in the upper and lower limbs.

Comprehensive examination

Apply advanced trauma life support (ATLS) principles in initial evaluation of the patient. Do a thorough physical examination to assess spinal stability and neurological status, including log-roll to assess entire spine.

Spinal examination

Inspection: Log-roll and look for deformity, bruising or swelling around the spinal region.

Palpation: Whilst patient is log-rolled and maintaining cervical spine precautions, feel for tenderness, bogginess, steps, gaps or crepitus. Crepitus, gaps or steps on palpation of spinous processes indicate instability.

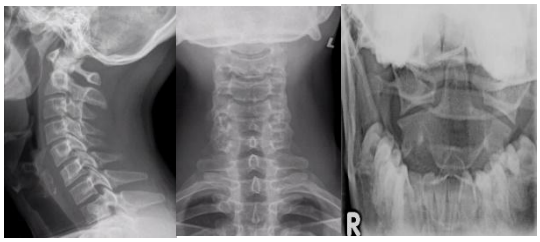
Movement: Assess ability to move limbs without exacerbating potential injuries.

Neurovascular examination

- Evaluate peripheral pulses in all extremities.
- Evaluate sensory function in all extremities and the trunk.
- Assess motor function and reflexes in the arms and legs.
- Tables for American Spinal Injury Association (ASIA) scores are a useful guide for assessing and tabulating findings.
- Rectal examination to assess for sensation and voluntary anal sphincter tone. Absence of bulbocavernosus reflex indicates spinal shock.

Investigations

X-rays: Anterior-posterior (AP), lateral, odontoid and Swimmer's views.



(A) ***(B)*** ***(C)***

Figure 1*: Cervical spine trauma series depicting (A) lateral, (B) AP, and (C) open-mouth view to assess the cervical spine*

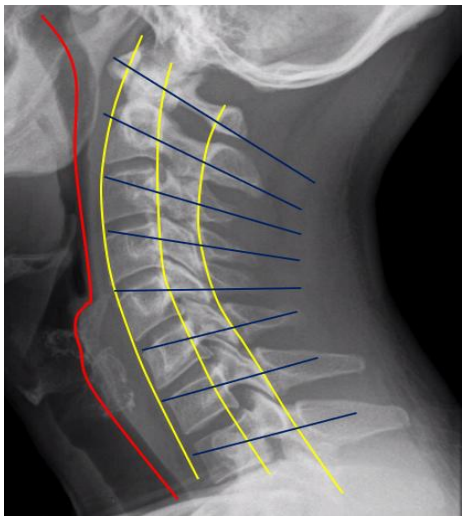


Figure 2*: Cervical spine AP showing alignment lines*

Computed tomography (CT): Provide detailed information about fractures, dislocations and canal dimensions.

Magnetic resonance imaging (MRI): Demonstrate soft tissue details, including disc and spinal cord injuries and neural compression. With cervical dislocations, MRI is not normally recommended, as it may unnecessarily delay reduction which delays indirect spinal cord decompression.

Indications for skull cervical traction

Cervical skeletal traction has two main indications:

1. **Maintaining spinal alignment** with unstable or malaligned fractures, which require in-line light traction of 5kg.

2. **Active reduction process** with sequential increasing weight until facet joints are aligned (cervical dislocations).

Indications for spinal alignment traction

- Vertebral body fractures.
- C1/C2 rotatory subluxation.
- Displaced odontoid fractures.
- Hangman's fractures.
- Sub-axial cervical fractures with malalignment.
- A hard collar is inferior to traction to maintain alignment and usually 6 weeks of traction is followed by a further 6 weeks in hard collar.

***Figure 3**: Vertebral body fracture with malalignment of cervical spine*

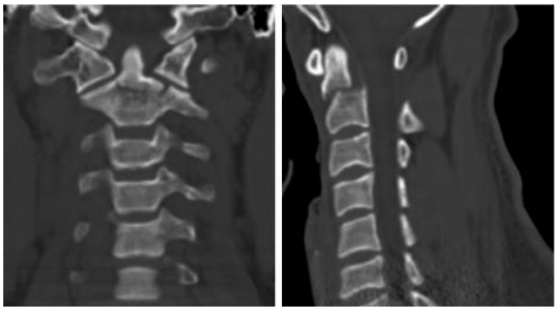


***Figure 4**: Displaced odontoid fracture*

Cervical injuries needing an active reduction process

Facet joint injuries – unilateral and bilateral facet dislocations – need active reduction.

***Figure 5**: X-rays of bifacet and unifacet fracture dislocations requiring urgent and active reduction*

Pre-requisites and contraindications for cervical spine reduction

Pre-requisites

- Awake, alert and cooperative patient.
- Constant neurological and physiological evaluation.
- Performed by experienced clinician with awareness of potential complications.
- Consent.

Contraindications

- Incorrect diagnosis.
- Skull fracture (relative contraindication). Technically only a displaced fracture of the petrous part of temporal bone is a contra-indication (pin-site location).
- Infection or degloving scalp injury.
- Children.

Consent

Obtain consent and explain procedure to the patient. Explain patient responsibilities during procedure.

Understand urgency

Cervical reduction and alignment for dislocations is considered an emergency procedure. Reduction should be obtained as rapidly as possible to reduce the risk of irreversible spinal cord injury. In addition, there is a South African constitutional court ruling that cervical dislocations need to be reduced within 4 hours of injury.

These injuries normally remain permanently unstable, even with reduction, as it is a disco-ligamentous injury with little healing potential and a 30% re-dislocation risk.

MRI is not required nor recommended as it does not add to the safety of reduction and causes unnecessary delays.

Once the dislocation is reduced, compression on the spinal cord is removed and definitive surgical stabilisation can take place at a more convenient time It is usually scheduled on the next available operating list. The standard operation is an anterior decompression fusion with a plate (anterior cervical discectomy and fusion [ACDF]).

Safety

Closed cervical reduction for cervical dislocations has a 80% success rate with less than a 1% chance of permanent neurological deficit and a 2–4% chance of transient neurological deterioration. It is very safe and every doctor needs to have the skill, if required in an emergency, to perform cervical reduction.

Rationale for cervical traction

- Indirect cord decompression.
- Maintain cervical alignment.
- Prevent secondary injury.
- Active reduction of dislocations.

Optimise neurological outcomes.

Closed reduction technique

Pre-planning

- Obtain manpower: nurses, assistants, porters, radiographer.
- Safe transfer of patient to reduction bed.
- Insertion of cones.
- Serial imaging during reduction.
- Definitive management.

Room, positioning and equipment set-up

Room: Emergency department, high care/intensive care unit (ICU), theatre, ward.

Positioning: Supine, neck in neutral, double mattress, bed in reverse Trendelenburg (10–20 degrees).

Equipment: Bed and double mattress, image intensifier, x-rays, pulley, weights, s-hook, orthopaedic rope/strong rope, intravenous (IV) line, analgesia, local anaesthetic, manpower.

Instruments: Callipers or tongs, surgical tray and blades.

***Figure 6**: Gardner-Wells tongs (top) and Cones callipers (bottom)*

Application procedure and reduction manoeuvres

Key points in application of pins for skull traction with Cones callipers or Gardner-Well tongs:

1. Site should be in line with external acoustic meatus to line up with the cervical spine.
2. Positioned 2–3cm above tip of the ear.
3. Proximal to the equator of greatest head circumference.
4. Palpate temporal artery and masseter.
5. Shave the area superior to the ear where the pins will be inserted.
6. Clean with povidone iodine or chlorhexidine.
7. Inject local anaesthetic such as Marcaine with adrenaline; preferably down to the periosteum and infiltrate the skin over the proposed pin-site.
8. Vertical skin incision; avoid temporal artery and masseter.
9. Blunt dissection with scissors to periosteum.
10. Screw in the pin till it just perforates the outer table of the skull. Over tightening of pins can result in penetration of the inner table of the calvarium while under tightening will result in slippage on application of weights.
11. Tie in ortho rope.
12. Apply weights.
13. Apply dressing to pin sites.

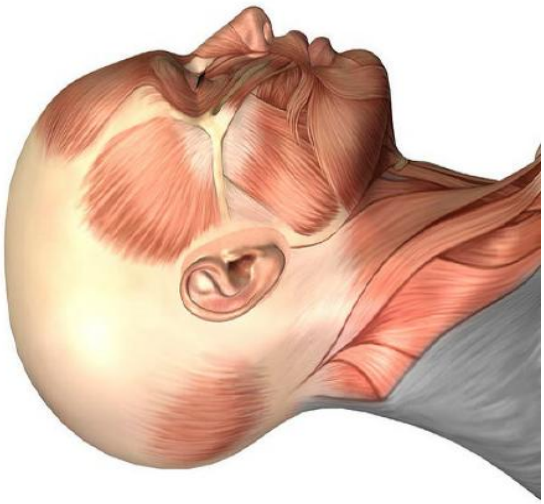


***Figure 7**: Positioning of pin*

***Figure 8**: Pin insertion procedure*

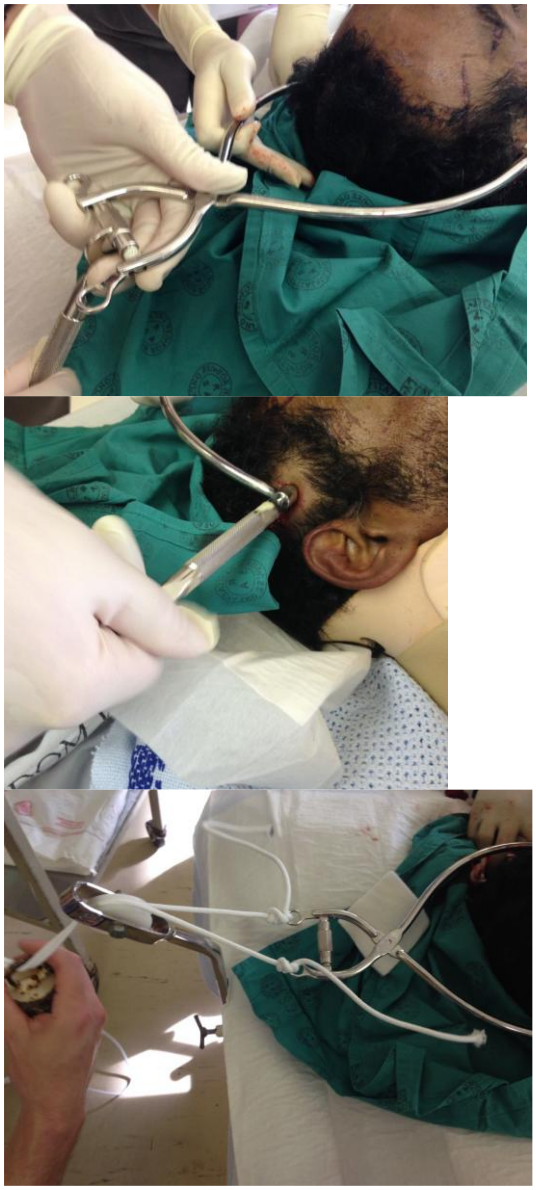


***Figure 9**: Tightening and application of weights*

Reduction manoeuvres for facet injuries or dislocations

1. Start with 5kg weights and take a perfect lateral x-ray that is centred at the dislocation level.
2. Neck flexion 20–30 degrees.
3. Increase weights by 5kg every 5 minutes.
4. Neurological examination and x-rays each time weights are added. Patient to report if worsening neurology or extreme pain.
5. Do not exceed 45kg.
6. Reduction manoeuvre to be performed after facet has reached perched position (tip to tip).
    - Whilst maintaining the traction, extend the neck by lowering the swan-neck pulley until the neck is extended by 10 degrees.
    - Check on x-ray that the facets have reduced.
7. Once reduction is obtained, weights are reduced to 5kg. Neurology reassessed and documented and x-rays repeated.

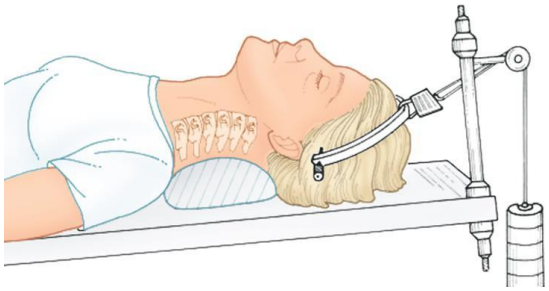


***Figure 10**: Correctly applied Gardner-Wells Tongs with Swan neck traction and weight*

Endpoints

- Reduction obtained.
- Worsening of neurological status or intractable pain.
- Over distraction on x-rays.
- Impractical to add further weights.
- Failure of reduction.

Complications of closed reduction

- Vertebral fracture.
- Additional dislocation.
- Pin slippage.
- Failed reduction.
- Pin site sepsis.
- Squint from 6th cranial nerve fall-out.

- Pressure sore on scalp.
- Bleeding of temporal artery.

Post-reduction care (standard spinal cord injury care)

- Pressure care.
- Prophylaxis for peptic ulceration.
- Deep vein thrombosis (DVT) prophylaxis.
- Analgesia.
- Maintain blood pressure (BP) > 85mmHg (mean arterial pressure) and partial pressure of oxygen (PaO2) sats > 99%.

Post-reduction considerations

- Further imaging.
- Definitive surgical management.
- Reassess neurology and document findings.
- Transfer to dedicated unit.

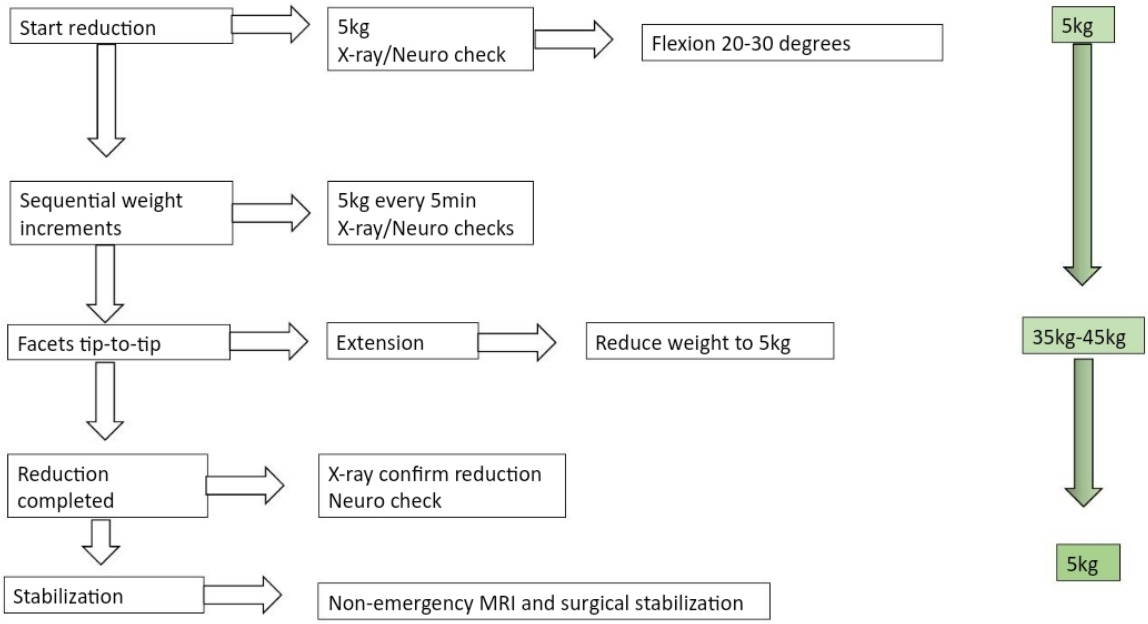


***Figure 11**: Visual summary of reduction process*

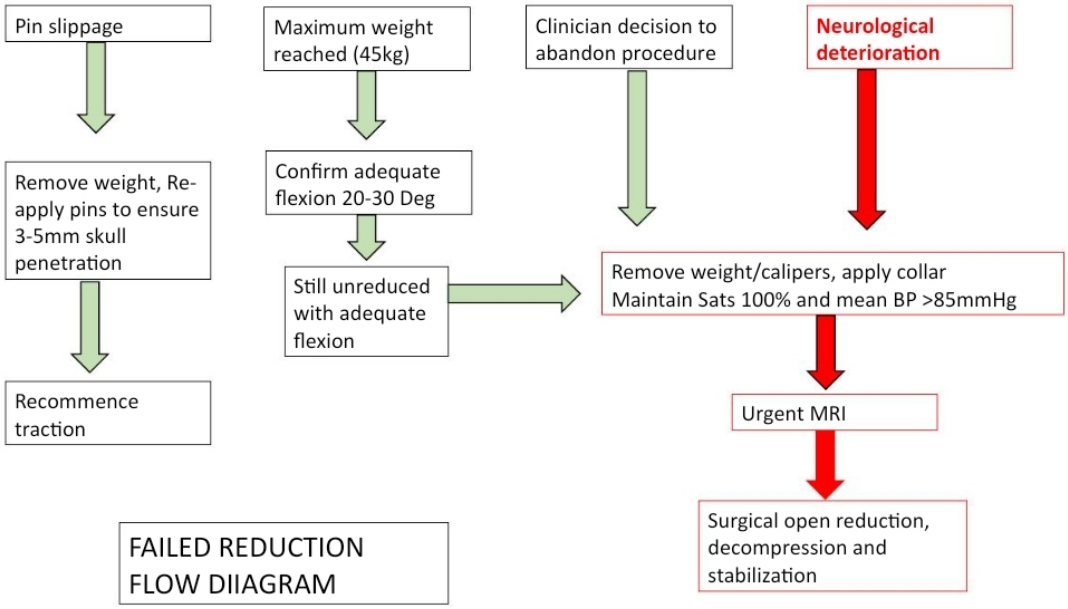


***Figure 12**: Visual representation of failed reduction flow*

Editor: Michael Held

Conceptualisation: Maritz Laubscher & Robert Dunn

Publishing Manager: Michelle Willmers

Cover design: Adapted from first edition cover design by Carlene Venter

Proofreading and page layout: Robyn Brown

ABOUT THE BOOK

This is the second volume of the *Orthopaedics for Primary Health Care* textbook edited by Michael Held, first published in 2021.

Most patients with orthopaedic pathology in low- and middle-income countries are tested by non-specialists. This book was based on a Delphi consensus study* with experts from Africa, Europe and North America to identify topics, skills and cases concerning orthopaedic trauma and infection that need to be prioritised in order to provide guidance to these health care workers.

The aim of this book is to be student-centred.

*Held et al. Topics, Skills, and Cases for an Undergraduate Musculoskeletal Curriculum in Southern Africa: A Consensus from Local and International Experts. JBJS. 2020 Feb 5;102(3):elO.

DISCLAIMER

Although the authors, editor and publisher of this book have made every effort to ensure that the information provided was correct at press time, they do not assume and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause.

This textbook is not intended as a substitute for the medical advice of physicians.

The information in this book is meant to supplement, not replace, orthopaedic primary care training.

The authors, editor and publisher advise readers to take full responsibility for their safety and know their limits. Before practicing the skills described in this book, be sure that your equipment is well maintained, and do not take risks beyond your experience, aptitude, training or comfort level.

The individual authors of each chapter are responsible for consent and rights to use and publish images in this book.

ACKNOWLEDGEMENTS

Thanks to the Orthopaedic Department in the Faculty of Health Sciences and the Centre for Innovation in Learning and Teaching in the Centre for Higher Education Development at the University of Cape Town for the support received in the development of this publication.