

# 04 Principles of Fracture Reduction and Fixation – adult + paediatric

## PRO TIPS

- FRCS (T+O) Exam – Make sure you are fluent using the AO Glossary ([How to Describe + Fix Fractures](#))
- Systematically interpret your imaging.
  - **Understand the fracture** – make sure you identify all components, watch out for subtle articular impaction and in kids, plastic deformation.
  - **Extrapolate the mechanism**
    - Metaphyseal ‘spikes’ (pointing towards the diaphysis) indicate the direction the energy left the bone. Applying pressure in-line with this spike will reduce the fracture.
    - Tension and compression sides, nb bone starts to fail in one place, it may then propagate in multiple directions to create ‘extrusion wedges’.
  - **Extrapolate the soft tissue disruption** – Systematically review all soft tissues, periosteum, ligaments, intraosseous membranes and muscle attachments. If you understand the soft tissues you will have a good idea of how to position the patient, how the fracture will behave with traction and which approach to use to avoid further de-vitalisation.
- Emergency ex-fix should be completed without dependency on II.
- Before placing an emergency ex-fix you should plan how the definitive surgery is going to be performed. Don’t mess up the next surgeon’s operation....chances are you will be the next surgeon!
- Every strategy is a compromise, you need to find the one with the lowest risk / benefit ratio for the patient in front of you.
- If you only have one strategy for each fracture, it is unlikely it will be 100% successful.
- Gravity is the only assistant that will never let you down – [Reduction \(escalating levels of violence\) Ladder](#).
- A plate can be used in one of 6 modes and during reduction and fixation you may use one plate in several modes eg anti-glide then compression then neutralisation. Please note ‘locking’ is a method of fixation not a ‘mode’.
  - **Compression** – using eccentric screw placement.
  - **Neutralisation** – compression is achieved using a lag screw.
  - **Bridging** – length, alignment and soft tissues are maintained without anatomical reduction of the fragments. The decision to use this technique needs to be made before you expose the fracture. Not after failing to achieve anatomic reduction!
  - **Tension band** – any plate applied on a tension surface will help convert forces across the fracture into compression.
  - **Anti-glide\***- resisting/applying force in the mechanical axis.
  - **Buttress\***- resisting/applying force perpendicular to the mechanical axis.

*\*The distinction of how you are using the plate is important, although in reality there are no situations in which the plate is acting purely in anti-glide or buttress.*
- Putting metal in the body can often be easier than taking it out – [Removal of Metalwork](#)
- If you start a case and you need kit that nobody knows how to use or is not available – IT IS YOUR RESPONSIBILITY!

Please find below, resources that cover the [ISCP syllabus](#) objectives.

## DISCUSSION SLIDES

McMaster – [How to Describe + Fix Fractures a Practical Guide](#)

OTA Resident Lectures – [Biomechanics of Fractures + Fixation](#)

OTA Resident Lectures – [Basic Principles and Techniques of Internal Fixation of Fractures](#)

OTA Resident Lectures – [Locked Plating](#)

OTA Resident Lectures – [MIPO Technique](#)

**RECOMMENDED KNOWLEDGE REVIEW RESOURCES**

**FRACTURE CLASSIFICATION**

- Rockwood + Green Chapter 5a: Classification of Fractures p104-122
- [AO/OTA Classification](#)
- [OTA Resident Lecture – Fracture Classification](#)

**INTERNAL FIXATION**

- Rockwood + Green Chapter 11a: Principles and Biomechanics of Internal Fixation p362-390

**EXTERNAL FIXATION**

- Rockwood + Green Chapter 10a: Principles of External Fixation p296-361

**RECOMMENDED TECHNICAL REVIEW RESOURCES**

**PRE OP PLANNING**

- Example of plan for subtrochanteric IM nailing

PROCEDURE	EQUIPMENT	POTENTIAL PROBLEMS
Antibiotics	Operating table	Bleeding
<b>Patient position</b>	(Traction)	Neurologic damage
Pre-wash, prep + drape	II (positioning ?)	Vascular damage
<b>(Reduce)</b>	Drapes	Reduction
Mark skin	<b>Surgical adjuncts</b>	Access
Approaches	Ortho basic	Entry point
<b>(Reduce)</b>	Cephalo-medullary nail	Canal preparation
Entry point	Skin closure	Blow out prox femur
Prepare proximal canal	Dressings	Fracture
<b>(Reduce)</b>		<b>Guidewire bending, nail backing out, weakening nail</b>
Pass guidewire		Rotational malalignment
Measure (length / diameter)		Length
Insert nail		Implant failure
<b>(Reduce)</b>		Infection
Insert hip screw		DVT/PE
Distal locking		Symptomatic metalware
Wound closure		Delayed / Non union (Pathologic fracture)
		.....
		Zombie apocalypse

**REDUCTION ‘ESCALATING LEVELS OF VIOLENCE’ LADDER**

Levels		Concept	Examples
1	<b>Gravity</b>	Constant, never tires, unlike an assistant. Try and always to get it to work for you, not against you.	Classic technique for tibial fracture casting described by Charnley + Sarmiento
			Oxford Chair for shoulder dislocation
			Finger trap traction for distal radius
2	<b>Positioning</b>	Reducing effect of muscle	Flexing knee to defunction gastrocnemius in distal femur fractures
			Flexing hip in subtrochanteric femur fractures
			Talar body reduction
3	<b>Axial Manual Traction</b>	'Stretches' residual soft tissues by squeezing out interstitial fluid making them more compliant. To do properly it will take 3-5 minutes. Be patient you will get this time back and more.	Every displaced fracture

4	<b>Non Axial Manual Traction</b>	This either is a standalone manoeuvre or follows on from Axial Manual Traction. Used to create a traction vector that better aligns proximal and distal parts.	Restoration of distal radius volar tilt
			90-90 traction used to reduce hip dislocation
5	<b>Limb/skin Traction</b>	Non invasive traction applied to whole limb. Limited pull due to hold on foot or skin tolerance (max 10lb / 4 kg)	Traction table with boot
			Skin traction for paediatric femoral fracture
6	<b>Non Invasive Push</b>	External pressure can be added to in line traction to try and control an additional displacement that is not being resolved by the intact soft tissues	'Bump / drape pack' under distal femur
			Crutch under intertrochanteric fracture to counteract sag
			Hammer to push on long bone fragments
7	<b>Percutaneous Clamp</b>	Very effective in isolation if correct application and vector can be achieved. Will not hold reduction if further limb movement is required.	Oblique tibial shaft
8	<b>Percutaneous pins / wires</b>	Pins and wires can be used for traction. Pins are effective for 'pulling'	Wire in distal femur and traction
9	<b>Skeletal Traction (whole limb)</b>	Consistent traction for large forces	<ul style="list-style-type: none"> <li>o Femur fractures: 10 to 15 % of the patient's body weight</li> <li>o Pelvis fractures: 15 to 20 % of body weight for longitudinal traction, 5 – 7 kg for lateral traction</li> <li>o Humerus fractures: 2.5 kg initially and then increase until scapula is just lifted off the bed</li> <li>o Tibia fractures: 3-5 kg</li> </ul>
10	<b>Skeletal Traction (regional)</b>	Most effective traction technique that can correct non axial displacements	Femoral Distractor
			External fixation - temporary to allow ORIF
			External fixation - temporary to allow soft tissues to settle
			External fixation - definitive
11	<b>Mini Open</b>	Risk of morbidity low but not negligible	Quadriceps split for simple fracture pattern distal femur
12	<b>Implant Facilitated Reduction</b>	Using the implant to reduce the fracture. Requires skill.	Anti-glide plate
			Fixing plate to one fragment and then reducing by applying plate to other fragment.
			Blocking bolts
			Incomplete reduction using 'Defeatable fixation' - mini plates, recon plates, 1.6mm k-wires
13	<b>Maxi Open</b>	The only reliable way of reducing sufficiently to achieve absolute stability.	ORIF

## INTERNAL FIXATION

- Rockwood + Green Chapter 12a: Templating and Technical Tricks in Internal Fixation p391-433

## INTRAMEDULLARY FIXATION

- McMaster – [IM Nailing Subtrochanteric Femur Technical Tips](#)

## EXTRAMEDULLARY FIXATION

- MacLeod – [Pre-operative planning for fracture fixation using locking plates: device configuration and other considerations](#), Inj 2018 [Free text]

## EXTERNAL FIXATION

- Harding – [Tips for Definitive Ex Fix: Standard and Ring Fixators](#), VuMedi 2022 (16 mins)

## TENSION BAND WIRING

- Appleton – [Tension Band Wiring Techniques](#), VuMedi 2020 (23 mins)
- Spinnikie – [Olecranon and Patella Fractures Similarities in Anatomy and Treatment: Basic Concepts of Tension Band Fixation. How to Avoid Potential Pitfalls and Complications?](#), VuMedi 2021 (16 mins)

## REDUCTIONS + FIXATION ADJUNCTS

- Wiater – Staples ([Nitinol: The Minimax Applications in Trauma Surgery](#)), VuMedi 2018 (31 mins)
- Learned – [Reduction Tools](#), Orthobullets 2021 (10 mins)
- VuMedi – [The Sling & Cinch: A Method for Using a Sailing Knot to Stabilize Fractures & Dislocations](#)

## REMOVAL OF METALWORK

- [How to remove stripped screws – 7 different ways](#) – For DIY fans!
- McMaster – [Removal of Metalwork](#)

## THE FUTURE?

- Bottlang – [Far cortical locking can improve healing of fractures stabilized with locking plates](#), JBJSa 2020 [Full text]
- Henschel – [Comparison of 4 Methods for Dynamization of Locking Plates: Differences in the Amount and Type of Fracture Motion](#), JOT 2017 [Full text]
- Panagiotopoulou – [Adhesives for treatment of bone fractures: A review of the state-of-the art](#), Inj 2021 [Full text]

## SMITH + NEPHEW

- [Trauma Education](#)
- [Trauma Products + Guides](#)

## STRYKER

- [Surgeon Education](#)
- [Trauma Products + Guides](#)
- [Easyclip Staples](#)
- [Linear Reduction Clamp](#)

## DEPUY SYNTHES

- [Educational Material](#)
- [Trauma Products + Guides](#)

## UK ISCP TRAUMA + ORTHOPAEDIC SYLLABUS

### Knowledge

0 = No experience expected / 1 = Has observed or knows of / 2 = Can manage with assistance / 3 = Can manage whole but may need assistance / 4 = Able to manage without assistance including potential common complications

Green text = Oxford Trauma Service suggestions

Topic	CORE	ST3-ST8	>ST8
<b>Biomechanics &amp; Biomaterials</b>			
Biomechanics of fracture fixation	2	4	4
<b>Biomechanics &amp; Biomaterials</b>			
Principles of open reduction and internal fixation/external fixation of fractures	2	4	4
Classification			

## Technical

0 = No experience expected / 1= Has observed or knows of / 2= Can manage with assistance / 3 = Can manage whole but may need assistance / 4= Able to manage without assistance including potential common complications

Green text = Oxford Trauma Service suggestions

Topic	CORE	ST3-ST8	>ST8
Pre-op planning			
Staged fixation concept			
Reduction techniques			
Removal of metalwork			

## ABSTRACTS + FULL TEXT PAPERS

### GENERAL

- Augat – [Evolution of fracture treatment with bone plates](#), Inj 2018
- Ahmad – [Essential concepts in the treatment of common joint fractures: A narrative review](#), Inj 2022
- Russell – [Intramedullary nailing: evolutions of femoral intramedullary nailing: first to fourth generations](#), JOT 2011

### EXTERNAL FIXATION

- Caputo – [Novel method for sealing ex-fix pins with NPWT](#), JOT 19

### BASIC SCIENCE

- Yuasa – [The Size of Intramedullary Fixation Affects Endochondral Mediated Angiogenesis During Fracture Repair](#), JOT 2019
- Frank – [Variable Fixation Technology Provides Rigid as Well as Progressive Dynamic Fixation: A Biomechanical Investigation](#), JBJSa 2020

### TECHNIQUE

- Lim – [Surgical outcomes of minimally invasive cerclage clamping technique using a pointed reduction clamp for reduction of nonisthmal femoral shaft fractures](#), Inj 2021
- Hussain – [Effectiveness of the Taut-Line Hitch Knot in Reducing and Splinting Lower Extremity Fractures](#), J Orthop Trauma, 2019 Jan;33(1):e31-e35