<u>Principles of hip arthroplasty</u>

Total Hip Arthroplasty (TKA) aims to relief pain and restore function in patients with severe hip joint degeneration.

<u>Indications</u>	<u>Contraindications</u>
Pain and functional limitation of the hip due to osteoarthritis Failed conservative therapies Take-down of a fused hip sometimes performed to slow down progression of spine, knee, contralateral hip degeneration	Absolute: Active infection Medically unfit Relative: Neuropathic joint Class III Obesity

Surgical goals:

Reconstruct the hip articulation with prosthesis while:

- Not causing contamination / infection
- Restoring the soft tissue (abductor) tension
- Optimize forces affecting prosthetic articulation
- Maximising functional range of motion
- Ensure good fixation of prosthesis to bone

Strategies to achieve:

Strict aseptic technique, minimal soft tissue manipulation

Good visualization minimise injury to abductor mechanism, repair capsule & muscles

Restore offset and length – medialize cup, match femoral offset, equalize length

Optimal range of motion functional range without impingement of prosthesis or bone (consider spinopelvic motion)

Good initial stability in cementless implants set stage for osteointegration

Pre-op planning:

Radiographs:	Ensure adequate position, rotation, magnification	
See areas of disease (cartilage loss, consequent shortening)		
	Mark important landmarks	Determine CORA – cup / femur
Plan implant positioning, need for graft / augments		
Cup	True hip centre: floor osteophytes, uncoverage of cup	
Femur	Neck cut, offset, depth of stem Resultant lengthening after matching of CORA	

High risk patients (revision surgery, previous spine fusion, high demand, neuromuscular / cognition disorders, restriction compliance)

= sitting / stooping forward, standing pelvic lateral radiographs (assess spinopelvic mobility)

<u>Intraop:</u>

Approach: direct anterior, direct lateral, posterolateral approaches

Need to visualize whole of acetabulum, proximal femur

Challenges: protecting gluteus tendon, release to allow adequate access

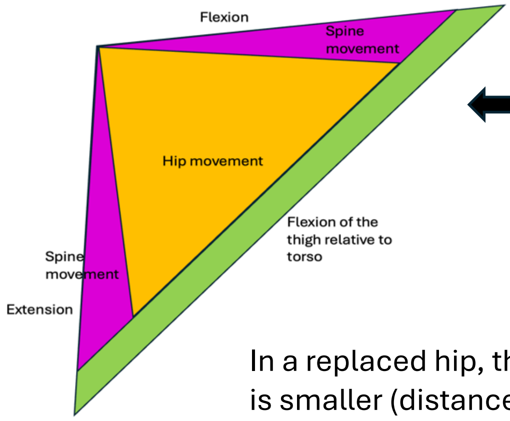
Cup positioning:

Ream all cartilage, sclerotic bone adequate: cementless, cancellous bone: cemented

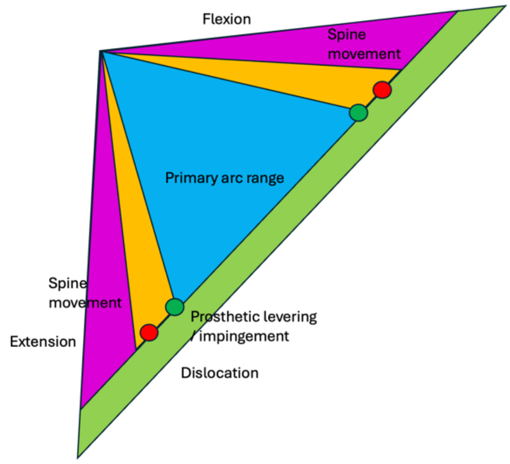
Identify true floor to ensure adequate medialization

Match abduction and anteversion to native acetabulum (use TAL as guide)

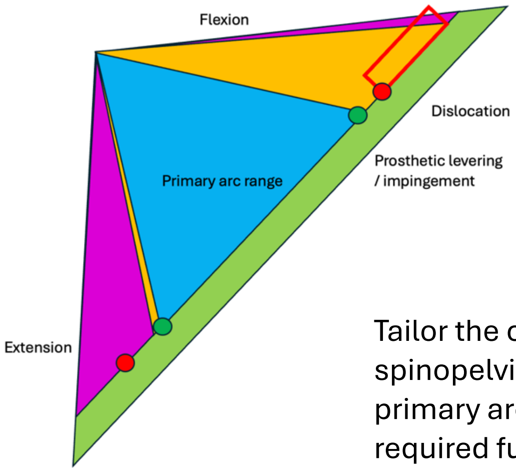
Transverse reamer must just brush the anterior and posterior walls



Resultant movement of a limb = movement of the lumbosacral spine + movement at the hip
e.g. standing to sitting = pelvis moves 20°, femur only flexes 55-70°

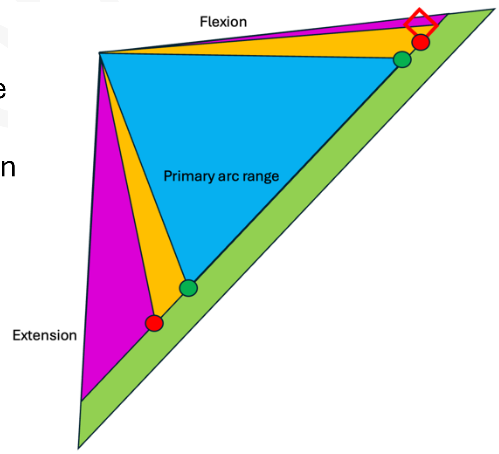


In a replaced hip, the primary arc range is smaller (distance to impingement less due to smaller head size)

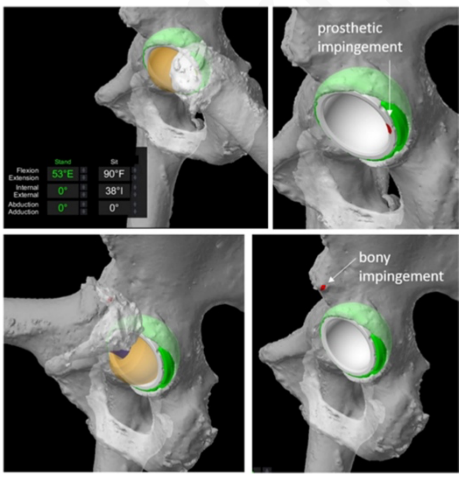


In a stiff spine, the hip needs to move a bigger quantum to achieve a desired position (e.g. sitting)
Placing cup in the usual spot limits the hip movement

Tailor the cup placement to the spinopelvic motion to optimize the primary arc range to allow the required functional range of motion



Planning of cup position = pelvic lateral view films at functional positions (sitting and standing).
Assess the quantum of change in pelvic tilt, sacral slope etc. If stiff, determine the position in which the pelvis spends most of it time in (standing or sitting)
Cup opening and version may be determined through this



Pre-operative planning
Using a robotic arm software, sites of impingement can be identified and cup positioning is adjusted

Femoral component
Cementless: follows the native anatomy to allow for optimal press-fit and maximal contact area between prosthesis and bone
Cemented: 10 degree allowance on the stem version possible

Combined version – initially described by Ranawat
Ideal sum of anteversion between femur and acetabulum, ♀: 45, ♂: 30
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5449346/

Intraop checks:
Impingement-free range of motion
Anterior stability: combined extension and external rotation
Posterior stability: combined flexion, internal rotation, and adduction

Soft tissue tension (recreation of offset, length)
Shuck tests: distraction axially and laterally, see if head stays in the cup or too easily disengaged
Drop-kick test: tests tightness of rectus femoris, flex the knee with a neutral hip

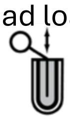
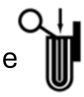
*** risk of dislocation can be reduced through increasing the jump distance (i.e. distance needed to lever out head before dislocation). Jump distance if half the diameter of the head. Use of a dual mobility allows for a larger head size to be used as the liner is not fixed to the shell

<u>Fixation methods:</u> cemented vs cementless
Femoral stems: overwhelming evidence of cemented superiority
Collarless, polished, tapered cemented stems allows dynamic loading of bone through controlled subsidence of the stem
Cement converts axial load to hoop tension and compressive stress to cement & bone
60-70% load to proximal femur, 30-40% distal femur

Cementless fixation: 2 phases of fixation, 1: primary rigid fixation 2: osteointegration

Surface	Porous metal – ingrowth Rough surface - ongrowth	Viable bone
Fit	Smallest gap possible optimal fit and minimal micromotion	Good cortical contact

∴1 is pre-requisite for 2.
Press-fit: bone prepped with broach, reamers. Implant that is slightly larger impacted
Risks: fractures
Intra-op fractures: (Vancouver classification), stable implant = limit weightbearing
Unstable – fix, still unstable after fixation – distal fixation stem

Modes of stem failure (causes stem loosening or breakage): basically occurs because there is an offset between femoral head loading to the bone interface
I: pistoning – a: stem within cement  b: stem and cement within bone 
II midstem pivot  III calcar pivot  IV cantilever bending 

Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. Clin Orthop Relat Res. 1979 Jun;(141):17-27. PMID: 477100 https://pubmed.ncbi.nlm.nih.gov/477100/

Reasons for THA failure
Infection: see prevention of PJI
Dislocation: stratify risk, determine spinal mobility, adjust approach, MDM
Restore soft tissue tension
Aseptic Loosening: optimize Joint forces, good fixation of prosthesis to bone
Wear: ceramic bearings, better PE
Fractures: stratify risk, careful instrumentation, if in doubt: cement
Nerve injury: careful placement of retractors, limit lengthening of femur

<u>Further reading:</u>
Edward J. McPherson, James A. Browne, and Stephen R. Thompson, *Adult Reconstruction, chapter 5* in Miller Review of Orthopaedics (2016), 403-481

Lawrence Dorr , Yohei Yukizawa, Principles of Total Hip Replacement, chapter 3
Lawrence Dorr, Dislocation, chapter 9
Lawrence Dorr*, Successful techniques for total hip replacement* (2014)