BASIC SCIENCE

Total Knee Arthroplasty

Technical goals of knee replacement surgery are:
- restoration of mechanical alignment
- preservation of joint line
- balanced soft tissue envelope

Biomechanical requirements:
- 15-20 degrees of rotation
- 5-10 degrees of medial/lateral translation
- flexion
  - 65 degrees → walking
  - 95 degrees → walking upstairs
  - 110 degrees → arise from chair

ALIGNMENT

Static:
- Vertical axis (VA) = line perpendicular to centre of gravity.
- Mechanical axis (MA) = centre of femoral head → centre of knee (medial tibial spine) → centre of ankle.
- Anatomical axis (AA) = I/M axis of the femur and tibia
- Weightbearing axis (WBA) = centre of femoral head → centre of ankle.

In the normal knee:
- MA = WBA
- MA = 3 degrees from VA
- Knee joint is perpendicular to VA

Femur:
- AA = 7 degrees valgus from MA & 10 degrees from VA
- MFC = ↑ size → valgus and internal rotation
- MComp = ball & socket motion
- LComp = flexion & extension + A/P translation
- Post Fem Condylar axis = base of trochlea groove to apex of intercondylar notch (= 3 degrees of IR to compensate for tibial varus)

Tibia:
- AA = MA & 3 degrees varus from VA
- 2-10 degree posterior slope (neutralised by menisci)

Dynamic:
- 60-75% force through medial compartment of knee
- 3 degrees of tibial varus → varus moment around knee → lateral “thrust” during gait resisted by lateral structures
- LCL
- Cruciate ligaments
- Ligamentum Patellae
- Iliotibial Band (ITB)
**DESIGN**

**General:**
- Uni-condylar / Bi-condylar / Total condylar
- Surface replacement / Structural (tumour) replacement
- Constrained / Semi-constrained / Unconstrained
- Modular / Non-modular
- PCL – retaining / sacrificing
- Cemented / Cementless
- Rotating platform / Fixed platform

**Geometry:**
- Flat / Conforming / Highly conforming
  → issues = contact area; contact stress; stability; interface stresses (i.e. ↑ conformity = ↑ stress transfer to bone interface)

**Modularity:**
- For = flexibility
  Against = cost; extra wear interface; locking mechanism failure
  Ranawat Clin Orth 2001 – using AGC with diff tibial trays
    - 96% survival – All Poly
    - 75% survival - Modular

**PCL:**
- Controversial
  - ? see-saw effect of femoral roll back on bone-implant interface
  - ? ↑ poly-wear with translational movement of femoral rollback
  Udomkiat Clin Orth 2000
    - No difference in clinical outcome
    - ↑ normal kinematics (fluoroscopy) in PS knees

**Absolute indications for PS knees:**
- patellectomy
- Inflammatory arthropathy
- Fixed varus/valgus
- Flexion contracture > 15 degrees

**Fixation:**
Controversial. Presently no problem with cemented fixation
Cementless = expensive; demanding surgical technique; poor on-growth to tibial components

**Patella:**
- Controversial.
  - Function = congruent surface against femur; fulcrum to augment quads power; strong linkage within quads tendon; protect knee from direct trauma.
  - PFJ forces > 1400N → exceeds yield strength of poly
  Barrack JBJS(A) 2001
    P, R, DB trial with 5-7yr f/u. Inconclusive but trend in favour of resurfacing.

**Modes of wear:**
- 2 x intended surfaces; 1 x intended + 1 x non-intended surface;
  2 x non-intended surfaces; third body wear.

**Wear issues:**
- Poly thickness - > 8mm to avoid delamination
- Congruency – compromise with congruent design
  (contact stress ‘v’ contact surface area)
- Unbalanced PCL function → femoral rollback
  (diskinetic/translational motion → sliding wear)
- Polyethylene sterilisation – air is bad – vacuum/inert is good