Wear

- **Modes of wear:**
  - 1 = between two primary bearing surfaces (intended)
  - 2 = between a primary bearing surface against a secondary surface (unintended)
  - 3 = two primary bearing surfaces interposed with a 3rd body
  - 4 = two non-bearing surfaces rubbing together

- **Mechanisms of wear:**
  - Abrasive wear = harder substances asperities cut into softer material
  - Adhesive wear = intermolecular bonds form between two opposing surfaces that are greater than cohesive force within one of the material resulting in shear fracture.
  - Fatigue wear (delamination) – subsurface fatigue failure resulting in cracks and delamination. Caused by macro-asperities on UHMWPE two orders greater than asperities on metal, which are plastically deformed by loading resulting in local stress concentrations above the yield point of UHMWPE. (e.g. in TKR)

- **Measurement of wear:**
  - Volumetric = volume of material detached from the surface of a material as result of wear (e.g. direct measurement of explanted cups)
  - Linear = loss of height of the bearing surface (e.g. cup penetration in vivo)

- **Law of wear:** volume of material (V) removed by wear is proportional to load (L) and sliding distance (x), but inversely proportional to the hardness of the softer material (H).

  \[ V \propto \frac{Lx}{H} \]

  explains why volumetric wear greater with larger femoral heads

- **Patient factors in wear:**
  - Weight (applied load)
  - Age and activity (rate of load, cycles)

- **Implant factors in wear:**
  - Reduced offset of prosthesis will reduce joint reaction force
  - Coefficient of friction of materials
  - Roughness (surface finish)
  - Toughness (ability to absorb energy and deform plastically before fracture)
  - Hardness (measure of resistance to permanent change)
  - Thickness of UHMWPE > 8mm (less creep, wear and contact stress)
  - Sliding distance
  - Endurance limit
  - Surface damage
  - Presence of 3rd bodies or modularity
Processing of UHHWPE – ram extrusion has greater linear wear than compression moulding (0.11 mm/yr vs. 0.05 mm/yr); gamma sterilisation in air or vacuum.

- Consequences of wear:
  - Synovitis
  - Osteolysis (loosening)
  - Systemic distribution
  - Immune reaction
  - Increased friction of joint
  - Misalignment and catastrophic failure

Reducing linear and volumetric wear, along with particle numbers and size.