OSTEOLYSIS AND WEAR

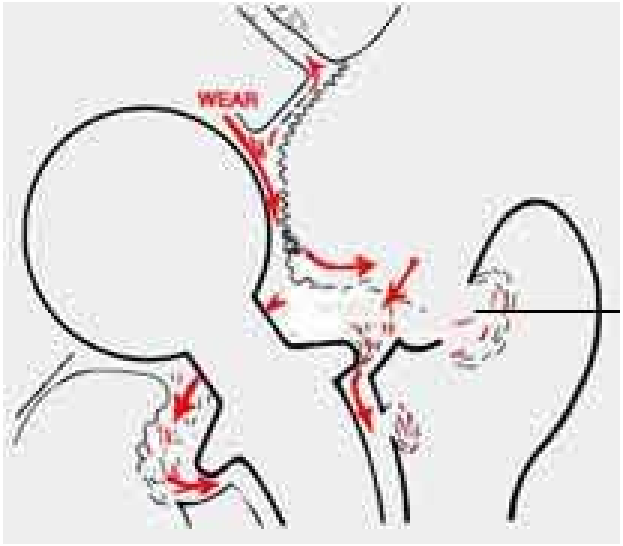
Osteolysis remains the most worrying problem in total hip arthroplasty. It represents histiocytic response to wear debris. The wear sources are:

I. Primary articulation: Adhesion
Abrasion

II. Secondary articulation

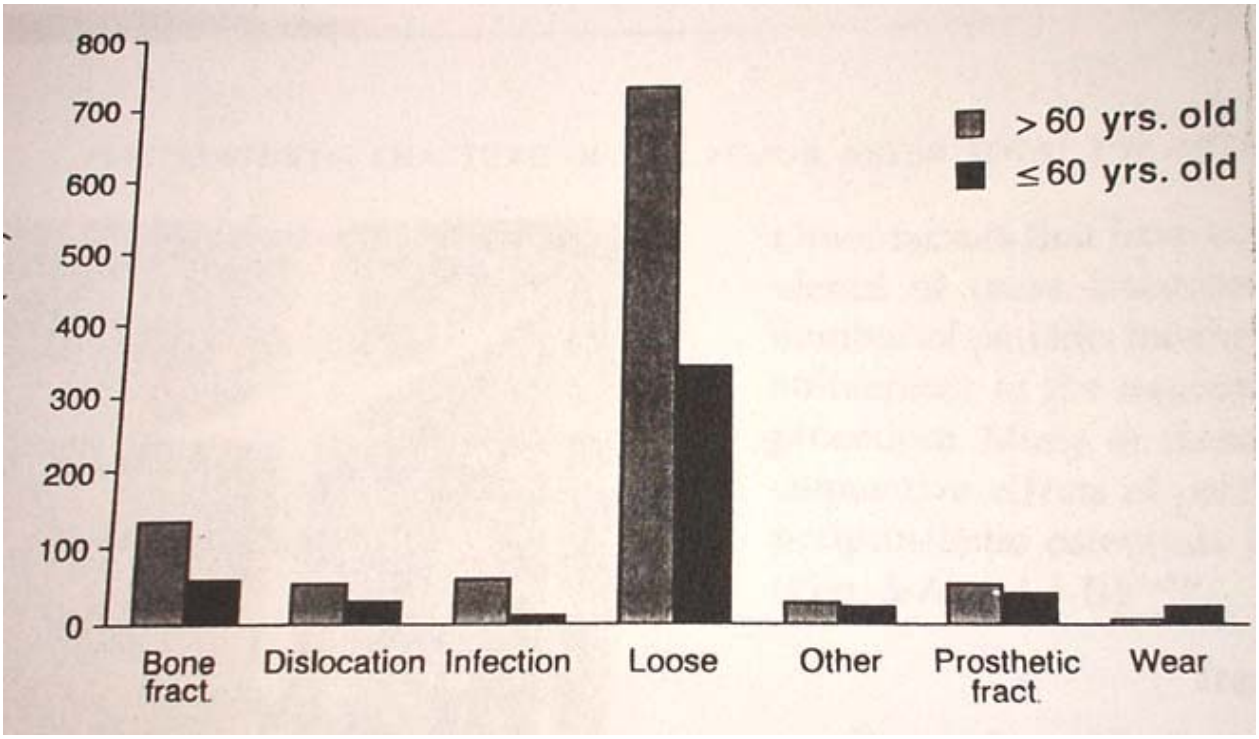
III. Third body wear

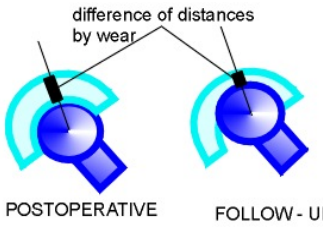
IV Cement/Bone or prosthesis/bone micromotion



Small wear particles [<5 u] cause activation of macrophages leading to Osteolytic reaction. The inflammatory response generated within the joint produces an increased hydrostatic pressure that allows for dissemination of particulate debris within the effective joint space. The effective joint space comprises the potential space where joint fluid can be pumped and there by allow particle debris to travel.

Loosening is the commonest cause for revision of total hip arthroplasty. Other causes for revision being periprosthetic fracture, infection, recurrent dislocation and wear.





Risk Factors for loosening

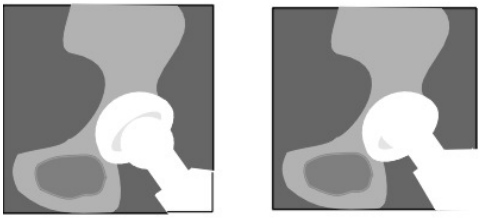
1. Age: Young, Active
2. Surgery technique

    Poor cement technique

    Alignment: Varus prosthesis increase in wearing

    Offset: increase in offset, increases wear
3. Type of bearing: Less wear with Ceramic, metal on metal and cross link poly

    More wear with traditional poly



X - RAY PICTURES

4. Size of the head: optimum 28.

    Bigger head, more sliding distance more volumetric wear

    Small head: More linear wear

5. Cementless hips more than cemented hips.

ASSESSMENT OF LOOSENING

1. Pain: Disability: work, recreation, walk, activities of daily

    With loosening there is more pain on getting out of a chair

    Site: Groin when cup is loose and over the femur when stem is loose

2. Previous surgical notes to learn type and size of prosthesis

3. Rule out possibility of exogenous source of pain ie., Back ache or Malignancy

4. Medical co-morbidities

5. Blood: Septic screen

6. Radiological: AP and Judet views

    Selective cases: CT to assess osteolysis

7. Bone scan

8. Hip aspiration to rule out infection

RADIOLOGICAL CRITERIA FOR A CEMENTED PROSTHESIS

Acetabulum

1 Good interdigitation of the cement into the underlying cancellous bone with no radiolucency

2 Thin radiolucent line less than 1 mm

3 Wide lucent line more than 1 mm

4 Migration

1-4 points are calculated in 3 zones of DeLee. Minimum point is 3 and maximum is 12

Stem [Barrack]

Category A Complete filling of medullary cavity by cement; whiteout at cement-bone interface

Category B Slight radiolucency at cement-bone interface

Category C Radiolucency involving 50%-99% of interface or incomplete cement mantle

Category D Radiolucency involving 100% in any projection, or tip of stem uncovered

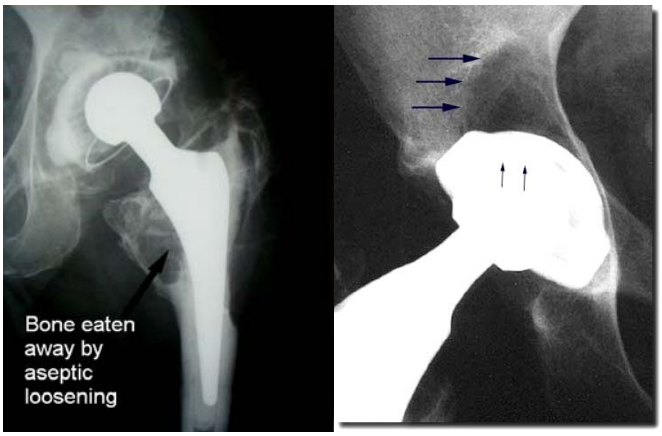
HARRIS LOOSENING

Definite loosening

1. Stem or cup migration (medial collar to calcar)
2. stem/cement mantle fracture

Probable loosening

Continuous radiolucent line surrounding entire cement mantle on any view



Possible loosening

Radiolucent zone involving 50%-99% of cement- bone interface

CT

25% of lesions is missed in regions on plain radiographs. These lesions are well seen on CT.

In the past, it has been impossible to use CT for examination of patients with total hip prostheses. The metal in the prosthesis caused so called scattering of X-rays, the image of the metal on the X-ray picture was surrounded by small lightning-like spikes that concealed the changes in the skeleton around the prosthesis.

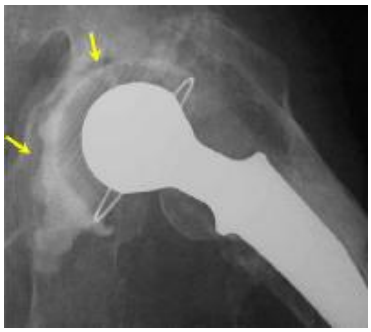
Development in the computer software now allows successful imaging of total the total joint prostheses and the soft tissues around them with CT (Eustace 1998).

So called "helical computed tomography" makes it now possible to detect areas of "silent" osteolysis, hidden behind the metal backed cup component of the total hip. Plain radiograms are not able to detect this form of osteolysis, which is frequent in young patients operated on with cementless acetabular cups.

The mean largest diameter of the bone destruction discovered on plain X-rays measured 17 mm, whereas the helical CT scan revealed that the diameter was 10 mm larger

AAOS CLASSIFICATION OF OSTEOLYSIS



FEMUR

Type I Segmental

a. Above lower part of lesser trochanter
b. Within 10 cm of Lesser trochanter
c. >10 cm of Lesser trochanter

Type II Cavitary: Cortex intact

a. With ectasia (expansion of the canal)
b. Without ectasia

Type III Combined segmental and cavitary

Type IV Rotational and angular malrotation

Type V Femoral stenosis

Type VI Discontinuity

CUP

Type 1 Segmental defect: loss of acetabular rim
[Superior, Anterior, Posterior, and Medial wall]

Type II Cavitary deficiencies
(Rim and medial wall intact); Superior, Anterior, Posterior, Medial

Type III Combined - Cavitary and segmental

Type IV Pelvic discontinuity

Type V Arthrodesis

Paprosky's classification [Radiological and intra-operative]

The four criteria for assessment of bone loss

1. Superior migration of the hip center
   Represents bone loss in the acetabular

2. Ischial Osteolysis: Bone loss from the posterior column

3. Teardrop Osteolysis: inferior aspect of the anterior column

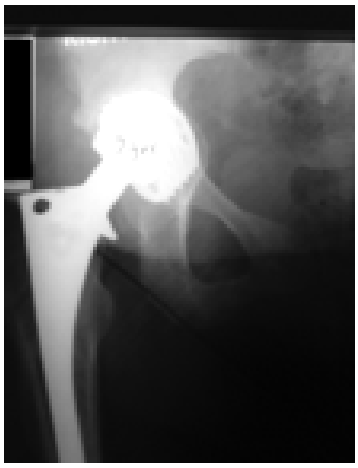
4. Implant relation to the Kohler line.
   - Grade I: Lateral to the Kohler line
   - Grade II: Migration to the Kohler line
   - Grade III: Medial to the line

PAPOROSKY CLASSIFICATION

Type-I A cementless implant completely supported by native bone

Type-II There is adequate host bone to support. At least 50% of the surface area is in contact with host bone. The anterior and posterior columns intact

The hip center is within 1.5 cm in relation to superior Obuturator line [OL]



IIIa **IIIb**

Type-III There is no adequate initial component stability

Type-IIIA Host bone contact 40-60
Superior migration <3 cm above the [OL]
Ischial lysis <15 mm inferior to the [OL]

IIIB Contact with <40%
Superior migration > 3cm above the [OL]
>15mm inferior to obturator line [OL]

GRUEN'S 4 MODES OF STEM FAILURE

IA. Subsidence of stem in the cement mantle

Radiolucency in Zone I and II

Cement fracture

IB. Subsidence of cement mantle and stem within bone

Radiolucency in all zones

II. Medial stem pivot

Lack of supero-medial and infero-lateral cement

Medial migration of proximal stem

III. Medial calcar pivot

Medial and lateral toggle of distal stem
Windshield wiper reaction at distal stem
Sclerosis and thickening of bone at stem tip
Radiolucency in zons 4 and 5

IV Cantilever bending

Distal strong fixation and loss of proximal support
Stem crack or fracture

PRINCIPLE OF MANAGEMENT

I. Single loose component: replace only single component

2. Cementless cup is preferred in revision

[As high failure with cemented revision: 20% at 5 yrs]

3. Femur: Old and frail with adequate bone Cemented

When bone loss: Impaction grafting technique or
Distal fixation PFM or ZMR or Wagner

When bone is adequate: AML

4. When cemented: Antibiotic with cement always used

5. Osteolytic lesion without loosening: Curette and bone graft and change the poly liner

6. Long stem: if perforation is present should by pass by 2 times the canal diameter

TYPES OF SURGERY

1. Cemented revision hip Good for elderly low demanding patients
High failure in active patients: 18% at 3 yrs and 40% at 10 years
May need acetabular reinforcement rings

2. Impaction Grafting Ling popularized revision with impaction technique.
Need expertise

IMPACTION GRAFTING

Patulous femur may be an indication

1. Graft Size

Femur:	3 and 5 mm in diameter
Acetabulum	8 to 10-mm-diameter chips

Larger particles are more porous and more permeable compacted graft. This is important for angiogenesis.

2. Rinsing

The results suggest that rinsing removes both beneficial and harmful factors.

The effect is negative for the autograft

The effect is positive for allograft as it washes out the fat and greater stability

3. Compaction

The graft compaction, which is achieved by repetitive vigorous impaction.

Plastic deformation and intergranular motion occur, leading to denser packing

Only following compaction the graft strong enough to carry the load

Inadequate compaction results in severe subsidence

Intra-operative fracture of the femur is most common during this process

For stem, impact with tapered reamer to create wedge shaped envelope of allograft

Long Exeter prosthesis with cement

Major Problem

Fracture femur

High incidence of dislocation

High incidence of subsidence

Technically demanding

Retrieval study

The histological evaluation showed that the allograft chips had been largely replaced with living cortical bone over 90% of the total surface area. Importantly, the cement-tissue interface resembled that seen after primary arthroplasty, with some direct Osteoid-cement contact and areas of foreign-body giant-cell reaction.

The main advantage of impaction grafting is long-term reconstitution of bone stock, with obvious implications for any subsequent surgery. Load transfer between the implant and bone is likely to be more physiological.

Procedure is technically demanding; time-consuming; and, like all revision surgery, is associated with a high complication rate. As such, it requires special equipment and training.

Outcome: 2/3 Excellent-good; 1/3rd Poor

3. Cementless fixation

Cup Rim or press fit

May need screw fixation

Biologic fixation [Uncemented] refers to any surgical option that requires direct contact with host bone and Osseo integration into the acetabular shell. This is a common type of acetabular fixation used these days.

1. Hemispherical cup at the anatomic hip center
2. High hip center (>2 cm superior to the native hip center),
3. Jumbo cup (66 to 80mm)
4. Oblong cup,
5. Hemispherical cup supported by structural allograft,
6. A modular cementless implant system

Reliable and durable fixation of cementless acetabular components

1. Requires intimate contact between the implant and viable bone
2. Mechanical stability (motion of less than 40 to 50 μm).
3. Host bone: 50% to 60% of acetabular cover is necessary.

Results

90 survival rate at 10 years [at least 50% host bone cover]

Radiological assessment of the acetabulum [Paporosky]

Paporosky: I and II Structural or morsellised graft

Cementless cup with or without screws

Paporosky: III Superior migration is more than 2 cm and Kohler's line is not intact means severe damage to both columns and options for acetabular fixations are

1. Total acetabular transplant graft
2. Metal reinforcing protrusion shell
3. G.A.P cup [osteonics]

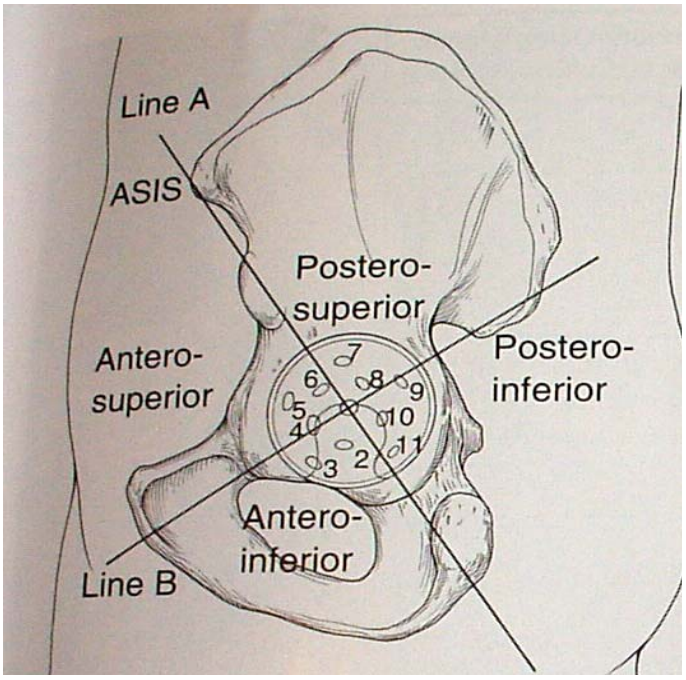
Screw placement for the cup [Wasilewski: 4 quadrants]

Posterosuperior Safe zone <35 mm
Sciatic nerve
Superior Gluteal vessels at risk

Posteroinferior Safe if < 20mm
Sciatic and Inferior gluteal at risk

Anteroinferior Avoid screws
Obturator N and artery at risk

Anterosuperior Zone of death
External Iliac Artery and vein at risk



STEM

1. Fully coated AML: Straight or curved
High incidence of intra-op fracture has been reported [up to 40%]
Stress shielding [Many believe: this is not progressive > 2 yrs]

2. Modular cementless stems: PFM, SRO, ZMR
Theoretical increases metallosis. This is not a clinical problem.
5 cm of distal diaphyseal contact is important for osteointegration

70% Good to excellent; 20% Fair and 10% poor results

3. Composite: allograft-prosthesis:

Long stemmed femur is cemented to allograft proximally
Now distal part of the prosthesis in to the diaphyses without cement
Cement should not come between the graft and the host
cortical onlay graft

TREATMENT OF ASYMPTOMATIC OSTEOLYSIS

1. Go through the series of X ray: look for any increase in size of the lesion

2. Observe and X ray: 6 wks and 3 months and then yearly follow up

3. All symptomatic

Change the liner

And curette and bone graft the Osteolytic lesion

Change the metal shell if it is loose

Dexa has been used assess bone loss following cementless prosthesis. With a tapered prosthesis, the BMD increased significantly in Gruen zones 2, 4 and 5 by 11%, 3% and 11% respectively, and decreased significantly in Gruen zones 1, 6 and 7 by 3%, 6% and 14% respectively, over the five-year period.