TOTAL HIP REPLACEMENT.
Why does it fail?

Mr WN Bradley.
If I knew the answer!
MULTIFACTORIAL.
Summary

• What is failure?

• Early failure.

• Late failure.
WHAT IS FAILURE?

HOW CAN WE MEASURE IT?
Outcome measures.

**SURVIVAL ANALYSIS**
- ONLY SHOWS ONE ASPECT OF THR
- END POINT OFTEN REVISION

**HIP SCORE**
- CLINICAL
- RADIOLOGICAL
- BOTH.
Survival Analysis.

- DOBBS 1980
- 1st YEAR EQUALS THE TOTAL NO’S IN STUDY
- EACH YEAR CALC FAILURE RATE
- CUMULATE EACH YEAR

![Ten-year survival curve for the demonstration analysis.](image)
PROBLEMS

TAIL OF CURVE.

- Small numbers
- Unreliable
- Most important area for long term survival

![Graph showing survival rate over time. The curve indicates a significant drop in survival after a certain point.](image)

*Fig. 2*

The complete survival curve for the demonstration analysis.
PROBLEMS

Lost to follow up or died.

- Assume this group has same failure rate.
- Deaths Yes.
- Lost to follow up No
CONFIDENCE INTERVALS

- Different types
- New method
  Murray, Carr, Bulstrode
  JBJS 75-B 1993
PROBLEMS

DEFINITION OF FAILURE.

• 70% Use revision surgery
• this may be affected by --- resources
  --- pt fitness
• use multiple end points --- pain
  --- hip score
  --- recommendation of revision
HIP SCORES.

• Loads of different ones +/- modifications
• Aim to be objective
• Allow statistical analysis
• Descriptive (excellent / good / poor.)
• Encompass many different criteria, both clinical and radiological.
PROBLEMS

• Impossible to compare results with different scores
• Large inter observer errors (Thomas, Bannister 1991)
• Descriptive points are arbitrary
• Statistical analysis often misused
Merle d’Aubigné / Postel 1954

- PAIN
- MOBILITY
- ABILITY TO WALK
- ALL 1 → 6
- TOTAL 36

- Simple
- Reproducible
- Can use to compare to older studies
Merle d’Aubigne / Postel 1954

- Modified by Charnley 1972
- A  Unilateral
- B  Bilateral
- C  Rheumatoid
HARRIS HIP SCORE.  
(JBJS 51-A 1969)

- 0 → 100
- Pain 40
  - daily activity 14
  - gait 33
- Function 47
- ROM 5
- Deformity 8
<table>
<thead>
<tr>
<th>Grade</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>90 → 100</td>
</tr>
<tr>
<td>Good</td>
<td>80 → 90</td>
</tr>
<tr>
<td>Fair</td>
<td>70 → 80</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt;70</td>
</tr>
</tbody>
</table>
Johnstone 1990
Task force in outcome studies
AAOS

- Pain
- level of work and activities
- walking capacity
- satisfaction
- physical examination
- radiological assessment
Radiological assessment.

Gruen et al. Clin Orth 141, 1979

- cement fracture
- radiolucencies
- yearly comparisons
Radiological assessment.

Delee & Charnley
clin orth 121 1976

• radiolucent zones considered loose if >2mm in all zones.

• migration
Radiographic loosening
Harris & McGann JBJS 68-A

• **Definitely loose**: migration, cement or component fracture
• **Probably loose**: circumferential lucencies including the whole prosthesis
• **Possibly loose**: radiolucency of > 50% but <100%
PROBLEMS

• Standardise x-rays
• Failure is often a dynamic event
• Doesn’t account for all designs
  eg exeter loosening rate of 2% but nearly always subsides (70%)
Gruen modes of failure
clin orth 141: 17, 1979
EARLY FAILURE.

- DISLOCATION
- INFECTION
- NUEROLOGICAL DAMAGE
- HETEROTROPIC OSSIFICATION.
Dislocation

2 to 4 % Mostly occurs in first 2 years

CAUSES

• Surgical factors
• patient factors
SURGICAL FACTORS

- Orientation of prosthesis
- Prosthesis design
- Tissue tension
- Approach
- Experience of surgeon
PATIENT FACTORS

- Age > 80
- Decreased muscle tone
- Femoral neck fracture
- Acetabular dysplasia
- Cerebral palsy, Muscular dystrophy
- Intellectual impairment.
INFECTION

1 TO 2 %

Prophylaxis mandatory:

• clean air theatre
• prophylactic antibiotics
• antibiotic cement

current cost to NHS ~ £16 Million per annum
OTHER FACTORS

• Obesity
• Diabetes
• Sickle cell disease
• Osteonecrosis
• Alcoholism
• Rheumatoid
• Immunosuppressed
NEUROLOGICAL DAMAGE

- Minor temporary palsies ~ 5%
- Serious permanent palsies ~ 0.3 - 0.5%
- Sciatic > Femoral > Obturator
- Not associated with the approach
HETEROPTOPIC OSSIFICATION

7 to 50% (0.5% Symptomatic)

Those at risk:

- Young men with OA secondary to trauma
- Previous Hx of HO
- Ankylosing Spondylitis
- Diffuse idiopathic skeletal hyperostosis

Prophylaxis: 4 weeks of indomethacin preop

700 rads within 48hrs
Brooker classification
JBJS55-A :1629, 1973

• I   Bone Islands
• II  Spurs from pelvis or femur with > 1 cm gap
• III Spurs with < 1 cm gap
• IV  Radiological arthrodesis
LATE FAILURE

- Swedish Arthroplasty Register 1998
  138,830 primary THR,S

Reason for revision:

- Aseptic loosening 72.3 %
- Deep infection 7.2 %
- Dislocation 4.2 %
- Implant failure 1.7 %
Aseptic loosening & Osteolysis.

First noticed by Sir J Charnley in 1968.
Thought to be due to localised infection

1987 Hungerford  clin orth 225:192 -206
“Cement disease. “
Uncemented Implants

Prompted by failure due to “cement disease”

These also developed Aseptic loosening and Osteolysis.

Osteolysis also found in Thr’s known to be stable both cemented & Uncemented.
Histology

Similar granulomatous response in all cases of MØ, Giant cells containing particulate matter:

UHMWPE
Cement
CoCr
Ceramic
Ti alloy
Particulate Disease

- UHMWPE > 70 %
- 90 % Sub Micron in size
- 0.4 - 0.5 μm
- ? Poly Disease
Pathology

• Particles excite a local biological response

• Stimulate MØ proliferation & activation

• Cytokine & Intercellelar mediator release

• Stimulate Oseoclastic bone resorption.
How do the particles migrate to distant sites
How do the particles migrate to distant sites

- Effective joint space
  Schmalzreid JBJS 74-A

- Cracks in cement mantle

- Incomplete porous coating

- Along fibrous mantle
Early & Late movement

- Early micro motion is the engine that pushes fluid around the effective jt space
- Shown to stimulate fibrous layer at interface with bone
- This may progress onto Osteolysis
- Leading onto Late gross movement
- Cement fractures
- 3rd body wear
HDP Guilty or Innocent?

Which came first the chicken or the egg!

Does HDP cause the loosening or is it an opportunistic pathogen

BIOLOGICAL Versus MECHANICAL
Eftekhar "Osteolysis caused by HDP particles is the ultimate cause of failure of THR’S"

- Predominant particle found in lesions
- Howie Rat knee model -- Osteolysis
- Some advocate this as primary cause leading onto Osteolysis
Mechanical

Invitro & invivo lesions packed with HDP have been shown to heal and calcify

Early motion:
Poor surgical technique
cement technique

heat injury to cancellous bone

Cement
Rasp
Mechanical

Late motion:
- Wolff’s Law / Pauwel’s (function / elastic)
- THR alters the normal pattern of loading
- Stress shielding (bone density reduced by 10 - 45 % after THR)
- Ageing
- Increased intramedullary pressure
• Although there is still much disagreement

• Most agree that impeccable surgical technique should be followed to give best possible interfaces and that the potential for wear particles must be minimised.
Which approach

Scandinavian Hip Registries show
- Posterior approach has least risk of revision
- Independent of prosthesis used

Reasons?
- Better implant position
- Better cement mantle
Cement technique

Sir Charnley’s finger packing. (30-40% increase in femoral failure rate)

2nd Generation technique (each reduces risk by 20%)

Canal plugging
Curettage of canal
Lavage & drying of canal
Retrograde filling
Cement technique

Only 25% of Orthopaedic surgeons in England use 2nd generation cementing techniques

Goddard 1994 Annals RCS 76
Cement technique

3rd generation cement technique

Roughened surface

Precoating with PMMA

Porosity reduction of cement

Centralizers
Roughened surface

Jury is still out!

Worse:
- Crawford, Ling JBJS 1998 79-B (Exeter)
- Dall et al JBJS 75-B (Charnley)

No Worse:
- Swedish Hip Registry
- Wroblewski JBJS 1998 80-B
Porosity reduction of cement.

Can increase strength of cement by 50 - 90%

Achieved by vacuum mixing or centrifuging

However Swedish Registry has shown no benefit from this.
Cement Mantle

Ebranzadeh JBJS 76-A 77 - 87

- “Areas of thin cement or complete perforation of the mantle plays a central role in initiation of implant loosening.”
- 96 % of #’s occur in areas where the cement mantle is < 2mm
- 78 % adjacent to corners of the implant
Cement Mantle

Commonest areas for deficiency:

- Proximally as femur often less curved than the implant
- Distally → Varus / Valgus
due to anterior starting point
Centralizers

Femoral: (Schellur)

No centralizer: 35% Inadequate prox
49% Inadequate dist
37% bone impingement

Distal centralizer: 19% Inadequate prox
3% Inadequate dist
0% bone impingement

(Centralizers themselves create voids !)
Centralizers

Acetabulum.

Introduced as lag in improvement on acetabular side compared to femoral side.

Problem as they bottom out and lose pressurization.
Cement type

Boneloc cement:
loosening in 65% at 3-38 months

Swedish Hip Registry:
Palacos > Simplex
Sulfix worse
Surgeon

Large study in Florida:
More experienced surgeon → better results.

Wrobleweski:
Consultants had better results than trainees
also less dislocations
Implant positioning

Acetabulum:
↑ antero/retro version leads to dislocation
Too open leads to ↑ wear
Too high leads to increased failure

Femoral:
Varus leads to ↑ loosening & ↑ stem #
Implant design

Type of articulation:

Metal on HDP (Ti→metallosis) (10x less wear)
Ceramic on HDP 10x less wear
Metal on Metal 40 - 100x less wear
Size of head

Livermore, JBJS 1990 72-A, 518:

• least amount of linear wear 28mm
• greatest amount of linear wear 22mm
• greatest amount of volumetric wear 32mm (also associated with increased acetabular lucency zone I )
• Both 32 & 22 associated with increased proximal femoral lysis.
Modularity

Modular implants cause wear particles from morse taper.

Also they can impinge on edge of cup.

This leads to an increase in wear particles.
Cup thickness

If < 5mm Brakedrum phenomenon

Metal backed gives a more even distribution of forces to acetabulum

Caused increased failure

Ideal at least 8mm with 0.4-0.6mm of play
Patient causes of failure

Young
Active
Heavy

Underlying pathology: CDH
Rh
2ndry to fracture
After arthrodesis
? Paget, ? Avn, ?protrusio
MULTIFACTORIAL.
Survival of THR is in the hands of the surgeon

- Good patient selection
- Good operative technique
- Scientifically based choice of implant
- Long term follow up
Thank You.