Total Hip Arthroplasty

Dr Suresh Annamalai

MBBS, MRCS(Edn), FRCS(Tr & Orth)(Edn), FEBOT(European Board), Young Hip and Knee Fellowship(Harrogate, UK)

Consultant Arthroplasty and Arthroscopic Surgeon

Manipal Hospital, Whitefield, Bangalore

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

History

- 1891:-
  - Dr. Gluck performs first reported attempt at a hip replacement with ivory used to replace the femoral head
- 1940:-
  - Austin Moore performs first metallic hip replacement surgery (hemiarthroplasty) with a proximal femoral replacement bolted to the femur

1952
Austin Moore prosthesis developed

1960:-Sir John Charnley

introduces concept of *low friction arthroplasty*

Concept: termed "low friction" as a small femoral head was used to reduce wear

components :metal femoral stem, polyethylene acetabular component,acrylic bone cement

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Indications

1. Debilitating pain affecting activities of daily living.
2. Pain not well controlled by conservative measures.
3. Medically fit for surgery
4. No active infection- anywhere

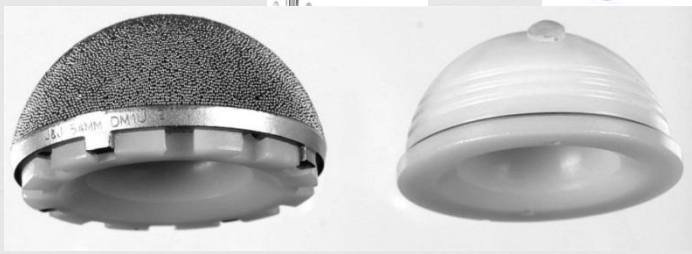
Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Prosthesis Design

- Designs include

- femoral component
  - cemented
  - press-fit (uncemented)
    - tapered stems
    - extensively porous coated stems
    - modular stems
- acetabular components
  - cemented
    - polyethylene
    - metal
  - press-fit (uncemented)
    - metal
- bearing surfaces
  - polyethylene
  - metal
  - ceramic



Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Implant Fixation

- cement fixation
  - polymethylmethacrylate (PMMA)
- biologic fixation (cementless fixation)
  - bone ingrowth
  - bone ongrowth

cement fixation

- Mechanism

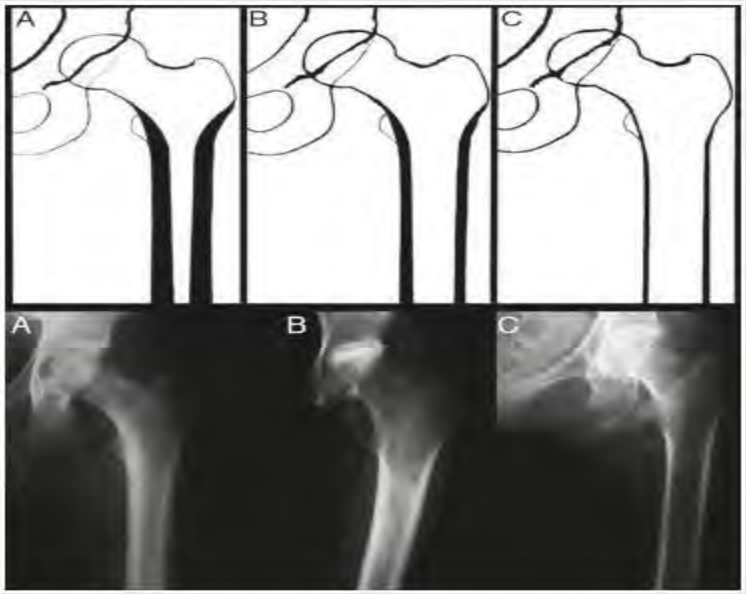
  acts as grout by producing interlocking fit between surfaces

- Indications:-

  Elderly Patients

  Irradiated Bone

  Stovepipe femur



cement fixation optimized by

- limited porosity of cement
  - leads to reduced stress points in cement
- cement mantle > 2mm
  - increased risk of mantle fractures if < 2mm mantle
- stiff femoral stem
  - flexible stems place stress on cement mantle
- stem centralization
  - avoid malpositioning of stem to decrease stress on cement mantle
- smooth femoral stem
  - sharp edges produce sites of stress concentration
- absence of mantle defects
  - defined as any area where the prosthesis touches cortical bone with no cement between
  - creates an area of higher concentrated stress and is associated with higher loosening rates
- proper component positioning within femoral canal
  - varus or valgus stem positioning increases stress on cement mantle

Biologic Fixation

- ingrowth
  - bone grows into porous structure of implant
- ongrowth
  - bone grows onto the microdivots in the grit blasted surface

Biological Fixation

- younger patients
- older patients with good bone stock
- revision total hip arthroplasty

- press fit technique
  - slightly larger implant than what was reamed/broached is wedged into position
- line-to-line technique
  - size of implant is the same as what was reamed/broached
  - screws often placed in acetabulum if reamed line-to-line

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

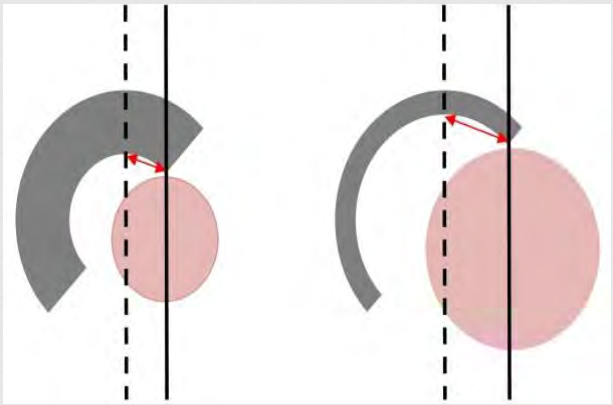
THA- Joint Stability techniques

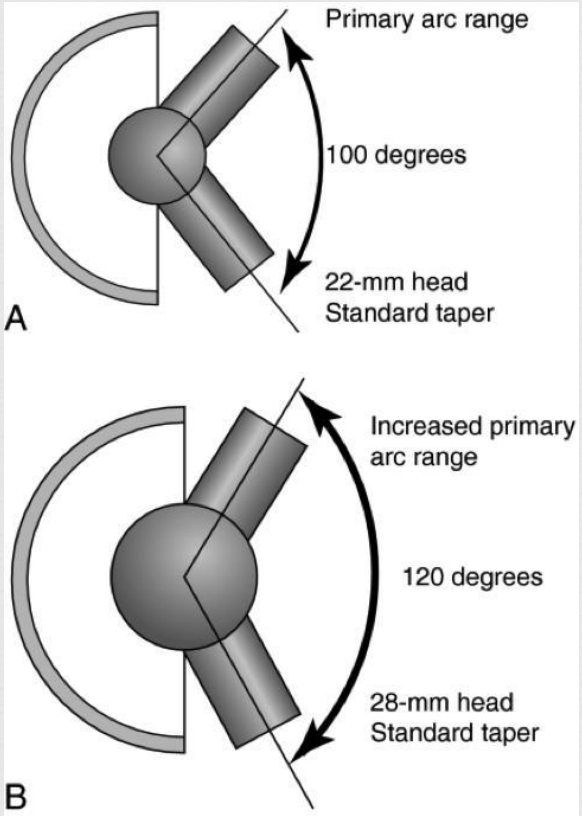
- component design
- component position
- soft-tissue tensioning
- soft tissue function

component design Femoral

large femoral heads:-

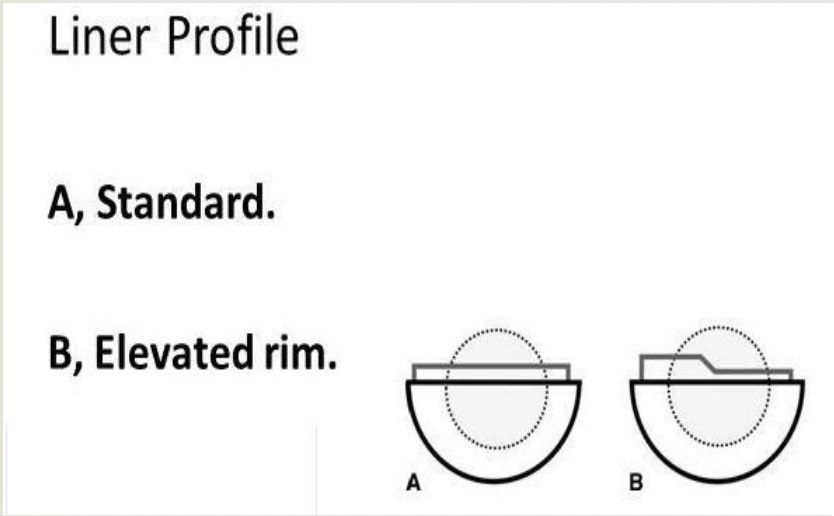
- Decreased dislocation rates
  - head neck ratio increase
  - Jump distance increases
- Femoral Offset

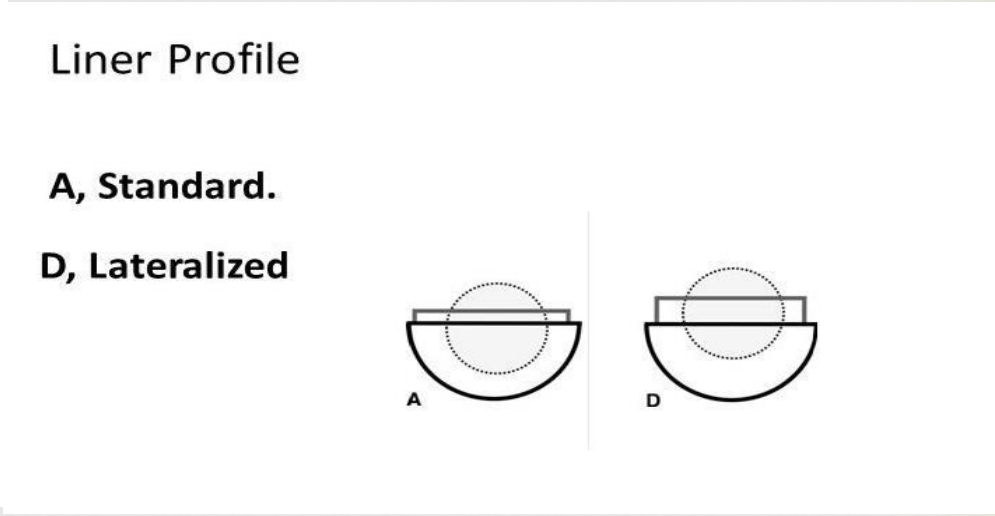




component design acetabulum

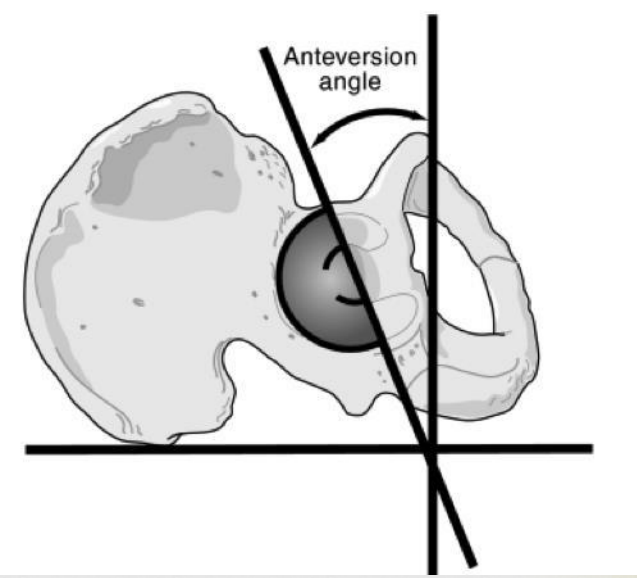
- elevated rim liner
- Lateralized liner





Component Position

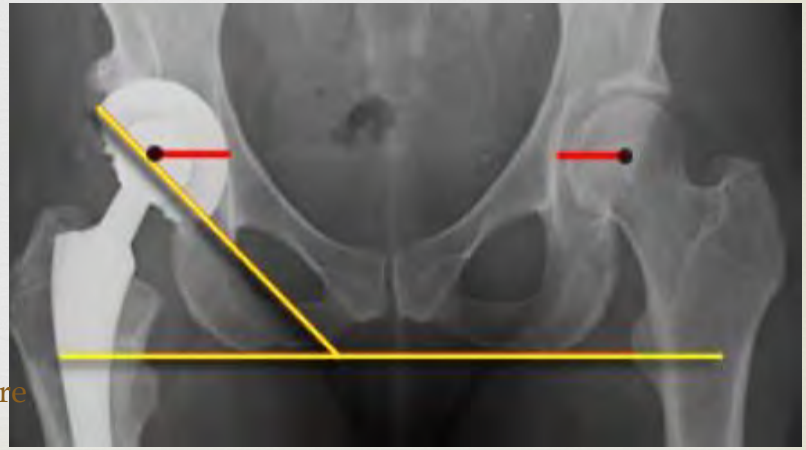
- Acetabular position
- anteversion 5° - 25°
- abduction 30° - 50°



Caveats

posterior approach should err towards more anteversion

anterior approach should err towards less anteversion



Component Position

- Femoral stem position

  Ideal : 10°- 15° of anteversion

  Caveats

  more difficult to adjust femoral component version in uncemented femoral components

Combined version:

37 degrees

soft-tissue tensioning

- Restoration of offset

increased offset leads

increased soft-tissue tension

decreased impingement

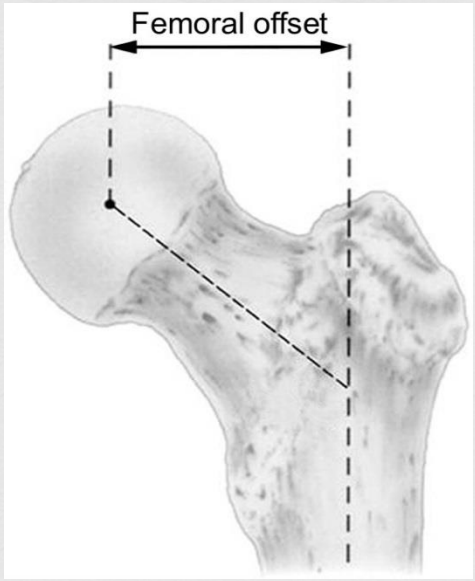
Increase joint Stability

decreased joint reaction force

Decreased offset leads

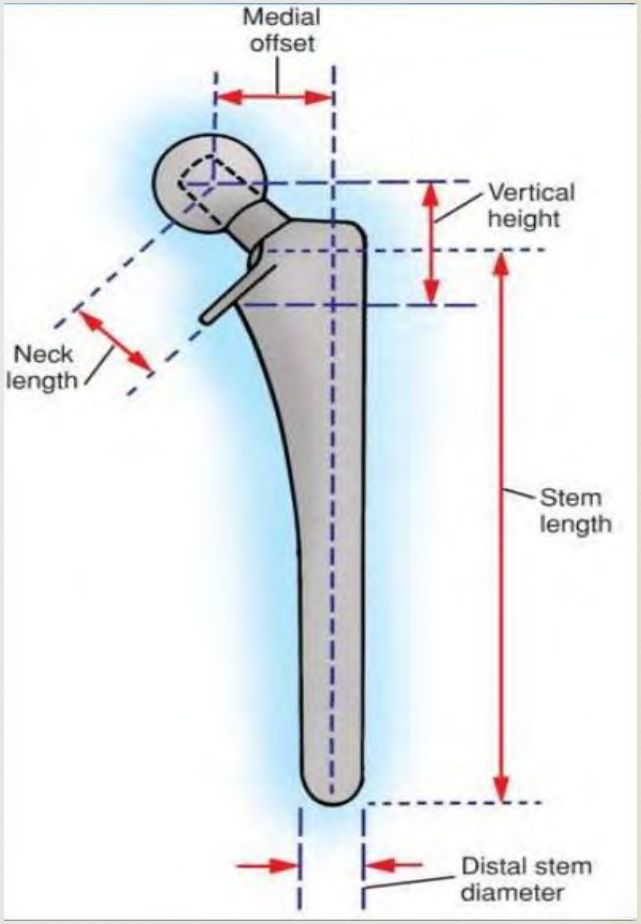
Instability, abductor weakness

Gluteus medius Lurch



Techniques to increase offset

- increasing length of femoral neck
- decreasing neck-shaft angle
- medializing the femoral neck
  while increasing femoral neck length
- trochanteric advancement
- alteration of the acetabular liner



Soft Tissue Function

- central nervous system
- peripheral nervous system
- local soft tissue integrity

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Articular Bearing Technology

- Metal-on-polyethylene
- Metal-on-metal
- Ceramic on Ceramic

Metal-on-polyethylene

metal (cobalt-chrome) femoral head on polyethylene acetabular liner

Benefits

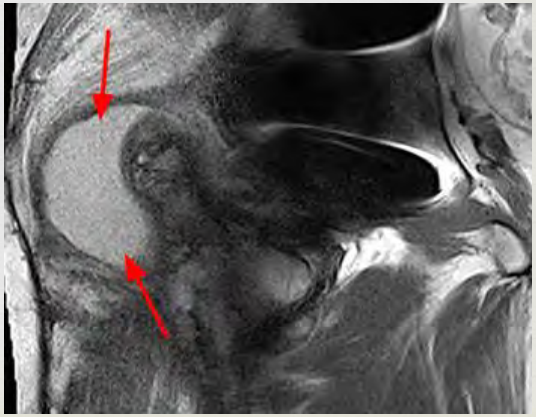
- longest track record of bearing surfaces
- lowest cost
- most modularity

disadvantages

- higher wear and osteolysis rates compared to metal-on-metal and ceramics
- smaller head (compared to metal-on-metal) leads to higher risk of impingement

Metal-on-metal

- Benefits
  - better wear properties than metal-on-polyethylene
  - larger head allows for increased ROM before impingement
- Disadvantages
  - more expensive than metal-on-polyethylene
  - Increased metal ions in serum and urine (5-10x normal)
  - may form pseudotumors
  - hypersensitivity (Type IV delayed type hypersensitvity)
- Contraindications
  - pregnant women
  - renal disease
  - metal hypersensitivity due to metal ions



Ceramic on Ceramic

- Benefits

best wear properties of all bearing surfaces

lowest coefficient of friction of all bearing surfaces

inert particles

- Disadvantages

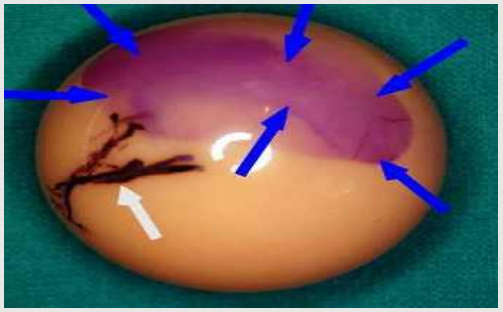
more expensive than metal-on-polyethylene

worst mechanical properties (alumina is brittle, low fracture toughness)

Squeaking

less modularity with fewer neck length options

stripe wear

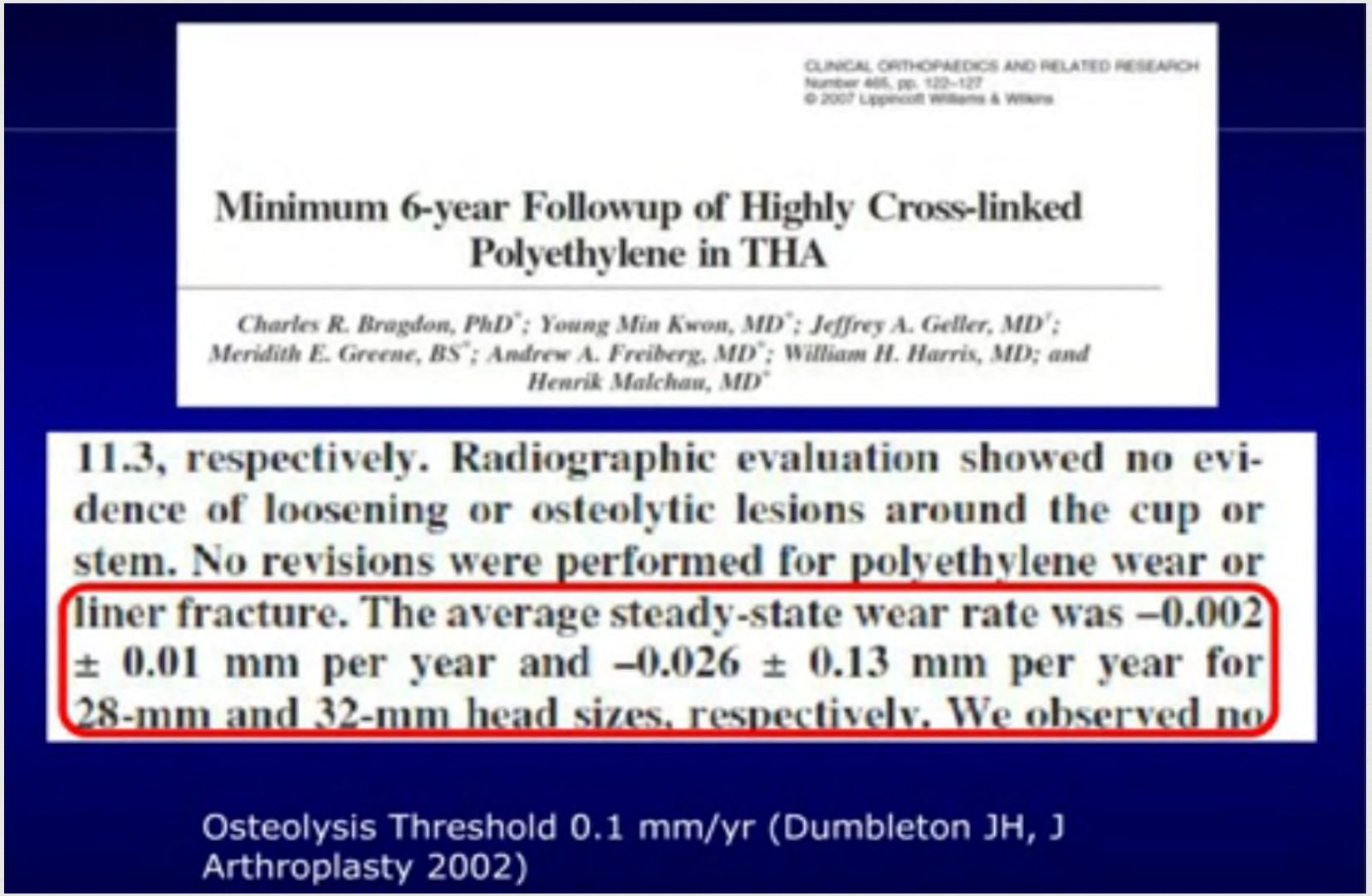


The Epidemiology of Revision Total Hip Arthroplasty in the United States

By Kevin J. Bozic, MD, MBA, Steven M. Kurtz, PhD, Edmund Lau, MS, Kevin Ong, PhD, Thomas P. Vail, MD, and Daniel J. Berry, MD

- Most common reasons for revision:
  - Instability/Dislocation : 22.5%
  - Mechanical Loosening: 19.7%
  - Infection: 14.8%

TREND TOWARDS USING LARGE HEADS


CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 465, pp. 122–127
© 2007 Lippincott Williams & Wilkins
Minimum 6-year Followup of Highly Cross-linked Polyethylene in THA
Charles R. Bragdon, PhD*; Young Min Kwon, MD*; Jeffrey A. Geller, MD†; Meridith E. Greene, BS*; Andrew A. Freiberg, MD*; William H. Harris, MD; and Henrik Malchau, MD*
11.3, respectively. Radiographic evaluation showed no evidence of loosening or osteolytic lesions around the cup or stem. No revisions were performed for polyethylene wear or liner fracture. The average steady-state wear rate was –0.002 ± 0.01 mm per year and –0.026 ± 0.13 mm per year for 28-mm and 32-mm head sizes, respectively. We observed no
Osteolysis Threshold 0.1 mm/yr (Dumbleton JH, J Arthroplasty 2002)

Clin Orthop Relat Res
DOI 10.1007/s11999-015-4319-5

Clinical Orthopaedics and Related Research®

SYMPOSIUM: 2015 HIP SOCIETY PROCEEDINGS

Wear and Osteolysis of Highly Crosslinked Polyethylene at 10 to 14 Years: The Effect of Femoral Head Size

Paul F. Lachiewicz MD, Elizabeth S. Soileau BSN, John M. Martell MD

Table 2. Volumetric wear rate by femoral head size

Head size (mm)	Number of hips	Median volumetric wear rate (mm^3/year) [95% confidence intervals]
26	10	3.1 [0.7–12.3]
28	31	12.3 [3.0–19.3]
32	30*	12.9 [6.6–16.8]
36/40	12	26.1 [11.3–47.1]

* One hip excluded as a result of missing value; $p = 0.020$.

Today's Patients

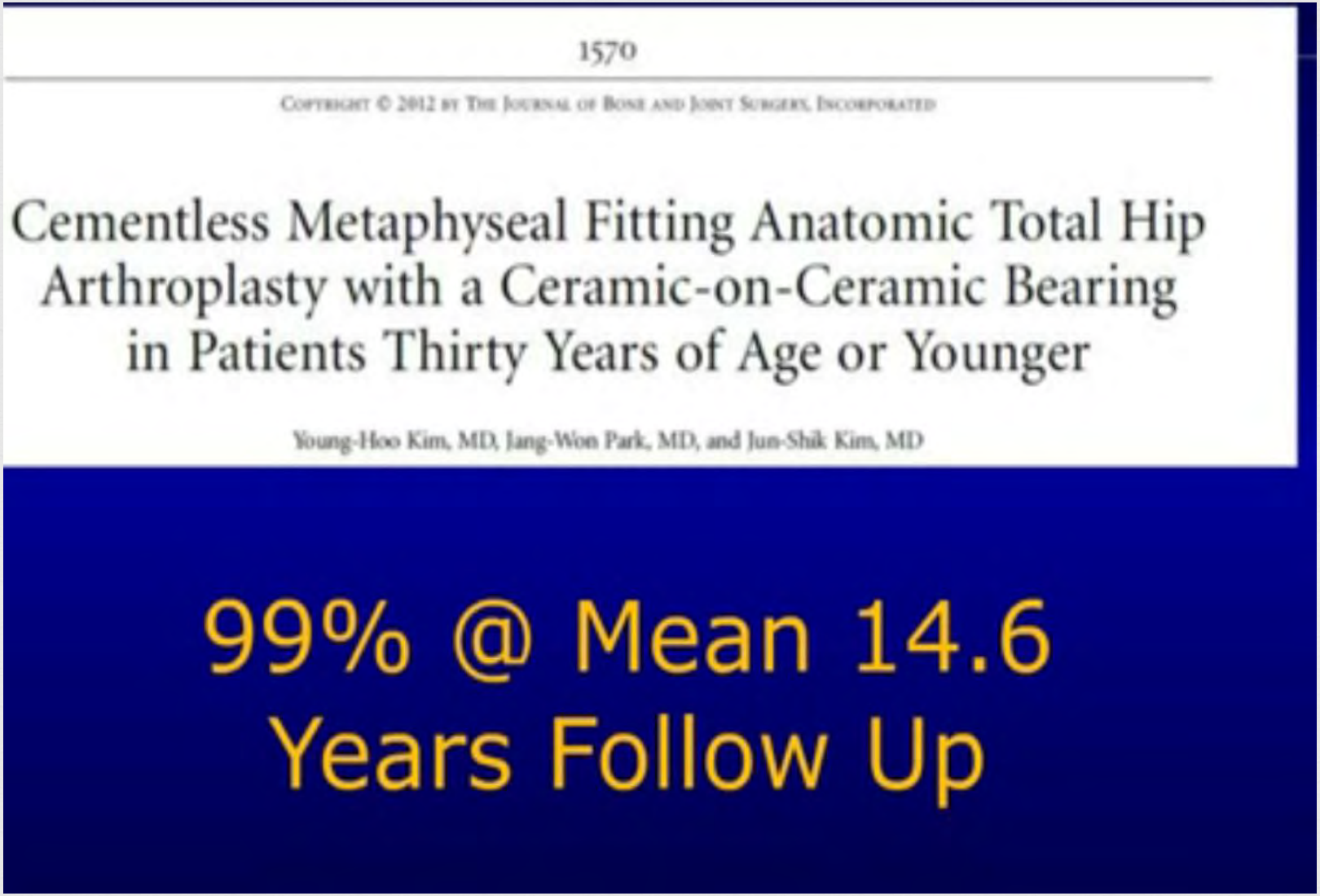
- Younger
- More Active
- Obese
- Life expectancy will increase

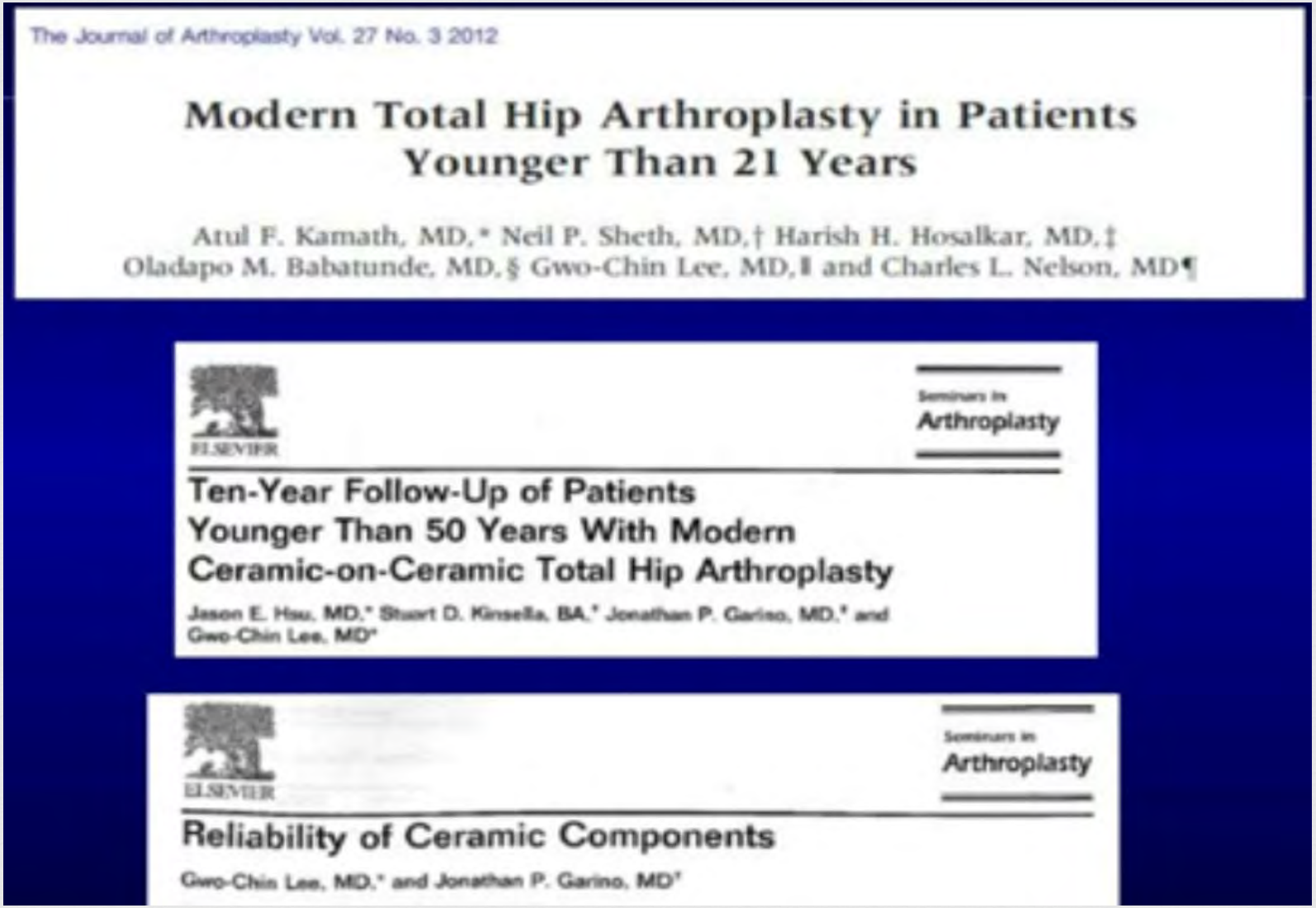
The Problem: Wear and Osteolysis

Resurgence of Ceramics

- Appetite for larger heads
- Increased number of head sizes, options, and reliability
- Trunionosis

Author	Journal	Year	F/U	Hips	Survivorship
Boyer	Orthop Traumatol Surg Res	2010	10.0y	83	92%
Capello	J Arthroplasty	2008	10.0y	380	95.9%
Mesko	J Arthroplasty	2011	8.3y	325	96.8%
Kim	Int Orthop	2010	11.1y	93	100%
Sugano	J Arthroplasty	2011	14.0y	100	97.9%
Solarino	J Orthop Traumatol	2012	13.0y	68	97%
Aldrian Silke	Hip Internat	2009	7.6y	229	98.2%
Lewis	J Arthroplasty	2010	8.1y	56	100%
Chevillotte	Int Orthop	2010	8.8y	100	96%
Park	Orthopedics	2010	9.6y	112	95%
Kress	Int Orthop	2011	10.5y	75	99%
Yeung	JBJS-A	2012	10.9	301	98%
D'Antonio	CORR	2012	10.1y	216	97.9%/95.2%


1570
Copyright © 2012 by The Journal of Bone and Joint Surgery, Incorporated
Cementless Metaphyseal Fitting Anatomic Total Hip Arthroplasty with a Ceramic-on-Ceramic Bearing in Patients Thirty Years of Age or Younger
Young-Hoo Kim, MD, Jang-Won Park, MD, and Jun-Shik Kim, MD
99% @ Mean 14.6 Years Follow Up



The Journal of Arthroplasty Vol. 27 No. 3 2012

Modern Total Hip Arthroplasty in Patients Younger Than 21 Years

Atul F. Kamath, MD,* Neil P. Sheth, MD,† Harish H. Hosalkar, MD,‡
Oladapo M. Babatunde, MD,§ Gwo-Chin Lee, MD,‖ and Charles L. Nelson, MD¶

ELSEVIER

Seminars in Arthroplasty

Ten-Year Follow-Up of Patients Younger Than 50 Years With Modern Ceramic-on-Ceramic Total Hip Arthroplasty

Jason E. Hsu, MD,* Stuart D. Kinsella, BA,* Jonathan P. Garino, MD,† and Gwo-Chin Lee, MD*

ELSEVIER

Seminars in Arthroplasty

Reliability of Ceramic Components

Gwo-Chin Lee, MD,* and Jonathan P. Garino, MD†

COC vs MOP

Author	Year	F/U	COC	MOP
Capello	2008	8.5y	95.9%	91.3%
Mesko	2011	10y	96.8%	92.1%
Yoon	2008	17y	81%	74.4%
D'Antonio	2012	10	97.9%	91.3%

Less Osteolysis and
Less Measurable Wear

Why not ceramics in everyone?

- Fewer options
- Risk of fracture
- Risk of squeaking
- Less forgiving
- Cost

Author	Year	Hips	Fractures	Rate	Squeaking
Boyer	2010	83	1 liner	1.2%	1 (1.2%)
Capello	2008	380	2 liners	0.5%	3 (0.8%)
Mesko	2011	325	2 liners 1 head	0.9%	9 (2.7%)
Kim	2010	93	0	0%	2 (2%)
Sugano	2011	100	1 liner	1%	0 (0%)
Solarino	2012	68	0	0%	NR
Aldrian Silke	2009	229	3 heads (extra long necks)	1.3%	NR
Lewis	2010	56	0	0%	0 (0%)
Chevillotte	2010	100	0	0%	6 (6%)
Park	2010	112	2 liners	1.7%	0 (0%)
Kress	2011	75	0	0%	NR
Yeung	2012	301	0	0%	1 (0.3%)
D'Antonio	2012	216	1	0.4%	2 (1%)

■ HIP

An estimation of the incidence of squeaking and revision surgery for squeaking in ceramic-on-ceramic total hip replacement

A META-ANALYSIS AND REPORT FROM THE AUSTRALIAN ORTHOPAEDIC ASSOCIATION NATIONAL JOINT REGISTRY

D. H. Owen,
N. C. Russell,
P. N. Smith,
W. L. Walter

From Trauma and Orthopaedic Research Unit, The Canberra Hospital, Woden, Australia

Squeaking arising from a ceramic-on-ceramic (CoC) total hip replacement (THR) may cause patient concern and in some cases causes patients to seek revision surgery. We performed a meta-analysis to determine the incidence of squeaking and the incidence of revision surgery for squeaking. A total of 43 studies including 16 828 CoC THR that reported squeaking, or revision for squeaking, were entered into the analysis. The incidence of squeaking was 4.2% and the incidence of revision for squeaking was 0.2%. The incidence of squeaking in patients receiving the Accolade femoral stem was 8.3%, and the incidence of revision for squeaking in these patients was 1.3%.

Cite this article: *Bone Joint J* 2014;96-B:181–7.

Concessions

- Hard bearings are less forgiving
  - Technically demanding
  - Component position critical
  - Liner insertion (chipping)

Choices and Decisions

- Patient specific
- Clinically sound
- Economically responsible

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Approaches pros and cons

- Surgical approach may be dictated by
  - -surgeon preference/Training
  - -prior incisions
  - -obesity
  - -risk for dislocation
  - -implant selection
  - -degree of deformity

Objectives

- History
- Indications
- Prosthesis design
- Implant fixation
- THA- Joint Stability techniques
- Articular Bearing Technology
- Approaches pros and cons
- complications

Complications

- Dislocation
- Periprosthetic Fracture
- Aseptic Loosening
- Sciatic Nerve Palsy
- Leg Length Discrepancy
- Iliopsoas Impingement
- General Complications