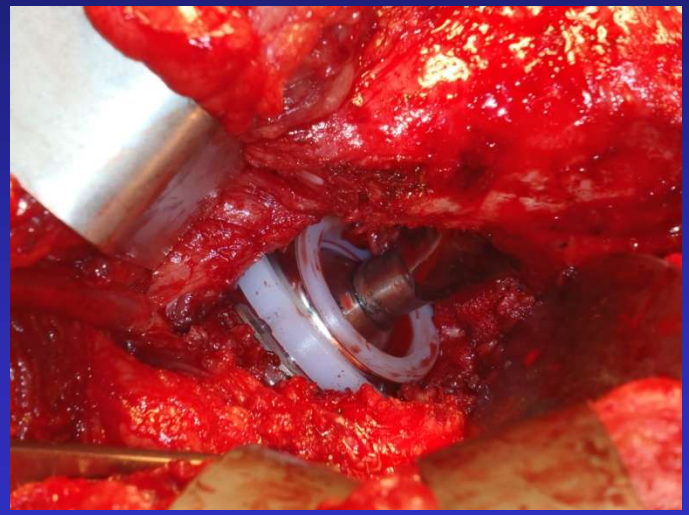
The Role and Concerns with Dual Mobility Components in Primary and Revision Hip Arthroplasty



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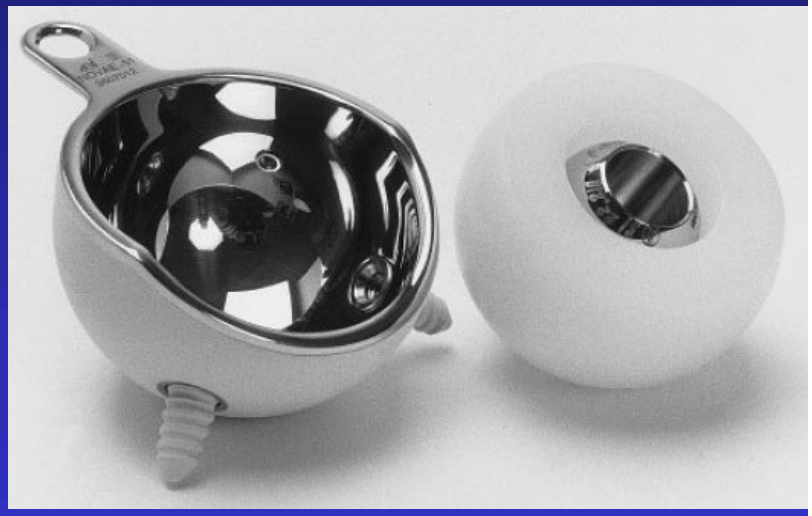
None related to dual mobility components

Dual Mobility Components

- Long history of designs, use in Europe
- Renewed interest in North America and release of new designs
- Alternative to constrained liners
- Alternative to large femoral heads

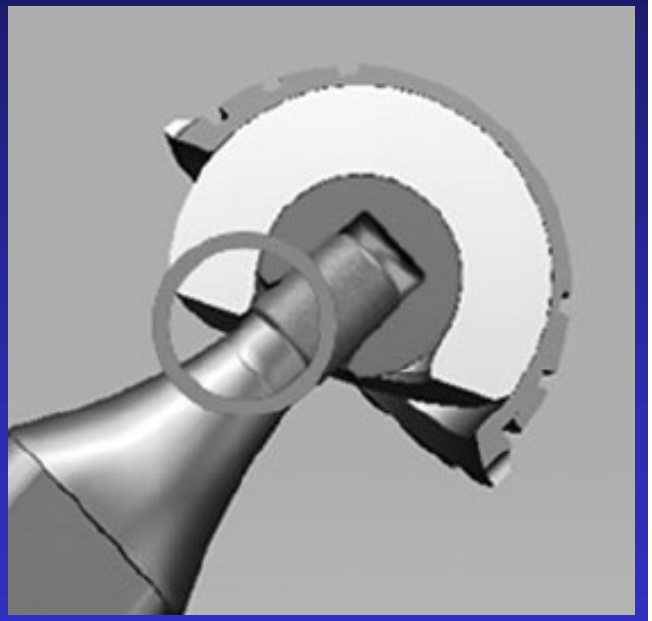
First Dual Mobility Hip

- Introduced by Bousquet for primary THA in 1970's
  - 22.2 mm metal inner head
  - 40-50 mm polyethylene head which articulated with a stainless steel acetabulum



Presumed Biomechanics Dual Mobility

- Greater range of motion with
  2 articulations ?
  "3rd articulation" neck-poly contact ?



- Increased jump distance
  large poly head, with 42-64 mm
- Little lab data on ROM (manufacturers)

- Retrievals: neck-poly contact in all (MDM)

Nebergall et al J Arthroplasty 2016
Adam et al Orthop Traum Surg Res 2014

Biomechanics of Tripolar
Range of Motion

- Mayo hip simulator
- Tripolar vs conventional hip
- Increased flexion, adduction, and external rotation
- Internal rotation increased 45º at 90 degrees flexion

Guyen et al Clin Orthop 2007

Biomechanics *in vitro*

- 3-D CT cadaver hip model:

  no difference in range of motion between

  36 mm head and ADM 50-56 mm (44-50) !!

Klingenstein et al J Arthroplasty 2013

Wear Data *in vitro*

- 2.5 million cycles in MTS hip simulator
- Gravimetric measurements converted into volumetric wear
- ADM 28 mm head, 48 mm X3 poly, 54 mm shell
  Fixed bearing 28 mm head, 48 mm poly
  Fixed bearing 48 mm head, 54 mm shell

- ADM 2.3 mm^3 $\pm$ 1.1
  Fixed 28 mm 3.8 mm^3 $\pm$ 1.2
  Fixed 48 mm 30.7 mm^3 $\pm$ 1.2

Loving et al J Arthroplasty 2013

Wear Data *in vitro*
Adverse Conditions

- MDM 28/ 42/ 54 mm and 22.2/ 36/ 48 mm
  Metal on poly 28/ 54 mm
- 2.5 million cycles
- Gravimetric wear analysis

- Component at 50^{o} and 65^{o} abduction angle
- No differences between DM and MoP except
  higher wear of MoP at 65^{o}, with eccentric wear

Loving et al J Orthop Res 2015

Available European Designs

- Serf Novae (Orthodynamics)
- Mobilite (Tournier)
- ADES (Didienne Sante)
- H-Max and M2 (Lima)
- Integra cup (Groupe Lepine)
- Versafit (Medacta)
- DMS cemented (SMS Paris)
- EVORA uncemented (SMS Paris)

Available USA Designs

Stryker ADM X3 poly

Stryker MDM X3 poly

Available USA Designs

Biomet Active Articulation
Vitamin E-1 poly (being discontinued)

Smith + Nephew PolarCup
stainless steel bearing

Available USA designs

Medacta Versafit DM

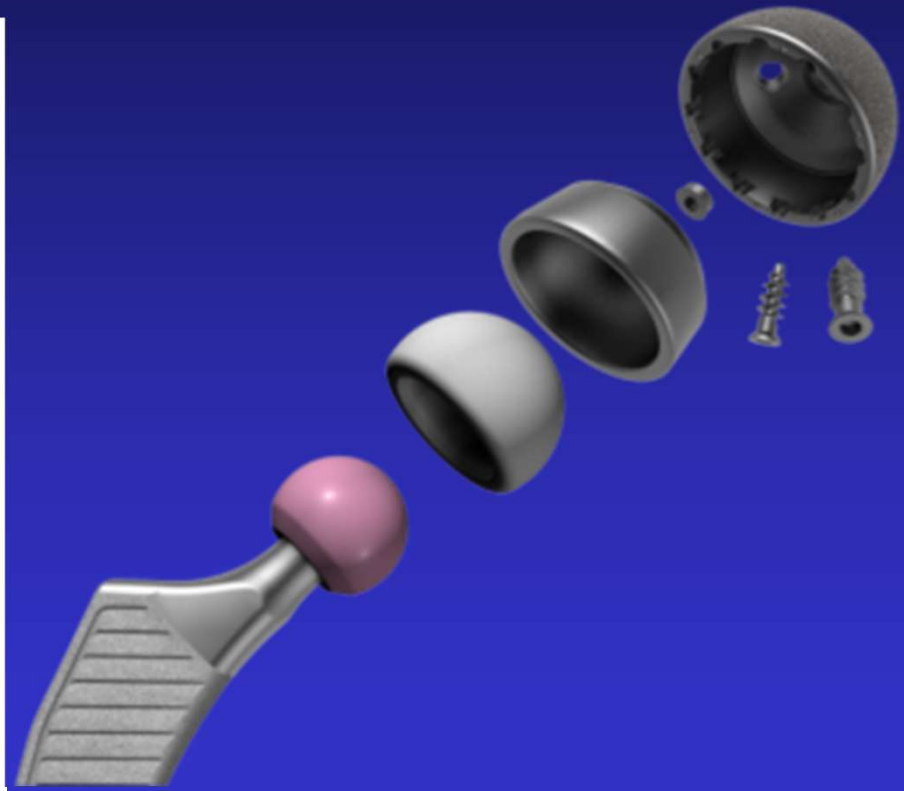
Medacta Mpact DM

Modular DM

ZimmerBiomet Vit E poly or Arcom XL
metal or ceramic head

New Revision Modular DM

Not available in USA



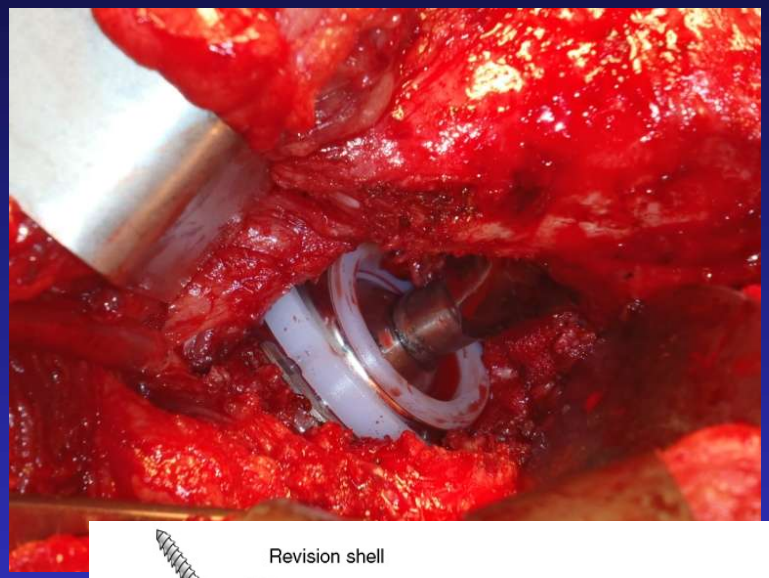
Surgeon-fabricated Tripolar

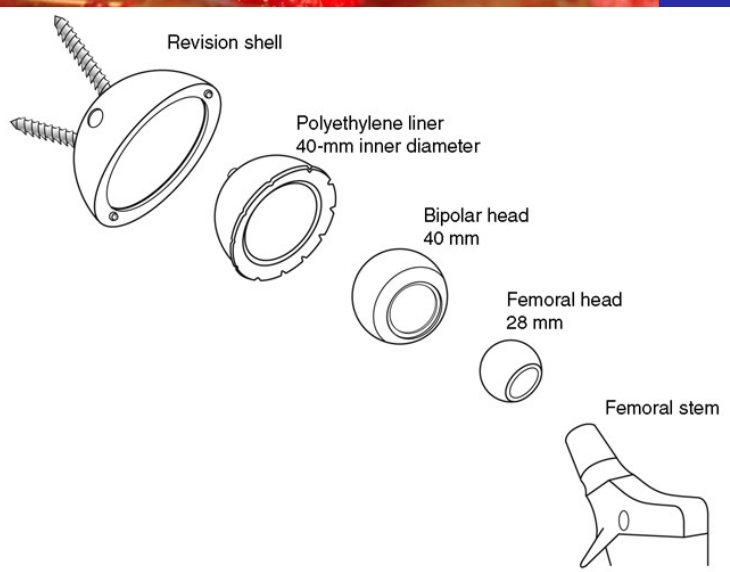
- Revision shell
- 40 XLP liner
- Standard bipolar
  with 40 OD

Caveats:

maximum size 40 mm

inner liner may not be XLP

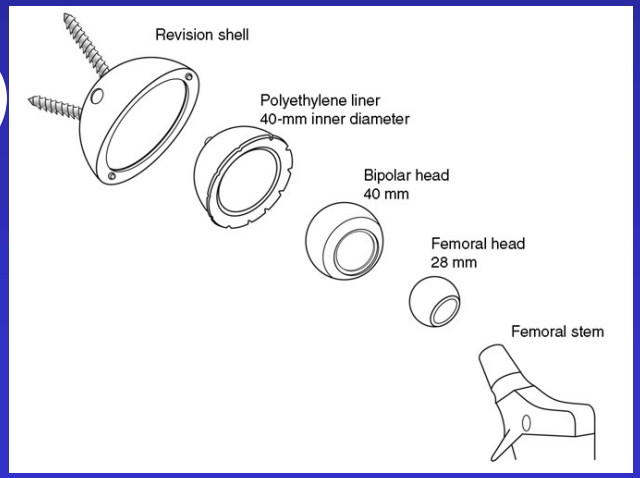




Loose cemented socket, but "modular" 26 mm femoral head unable to be removed !

Results of Surgeon-fabricated Tripolar

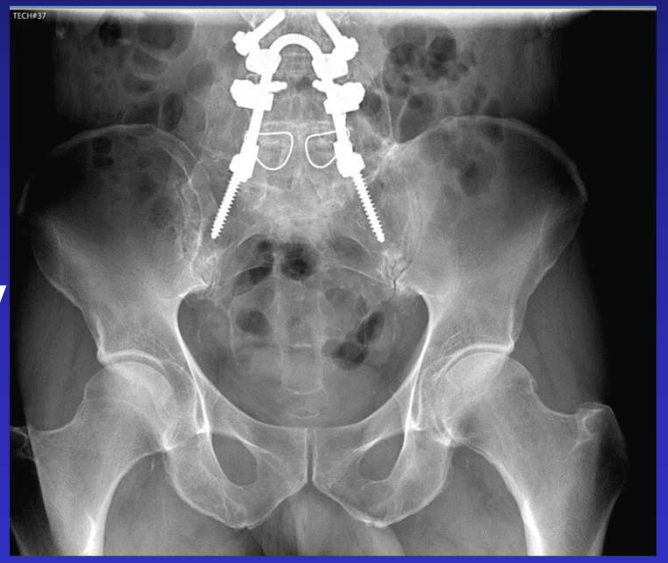
- 30 hips
- 47% revised for recurrent dislocation
- 2 to 4 year (mean 3) followup
- 3 dislocations (10%)
- Re-revised for dislocation (2)



Levine et al J Arthroplasty 2008

Possible Indications for DM Primary THA

- Femoral neck fracture
- Prior lumbar spine arthrodesis
- Concomitant lumbar spine deformity
- Concomitant neurological disorder
- Dislocation of contralateral THA
- Other “high-risk” patients



Possible Indications for DM Revision THA

- Recurrent dislocation, without obvious cause
- Revision of m-m resurfacing
- Revision of m-m large head THA
- Revision of hemiarthroplasty for dislocation
- 2nd -stage reimplantation for infection
- Alternative to constrained in “young” patient?
- Failure of constrained liner ?

Operative Techniques

Ream acetabulum

Press-fit shell; screw fixation

Trial reduction

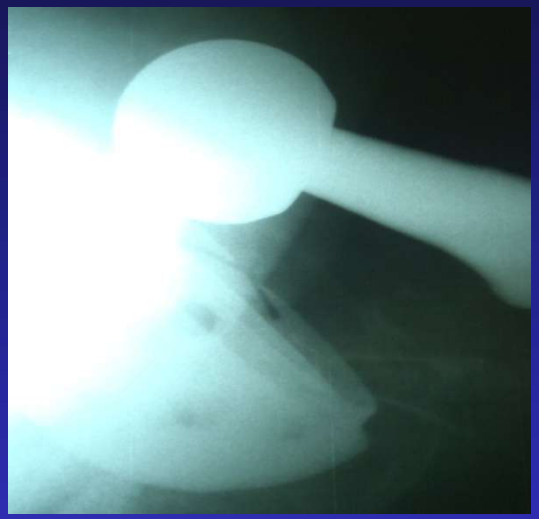
Impact metal articular surface

Place femoral head into poly
using press-clamp

Impact head/poly onto taper

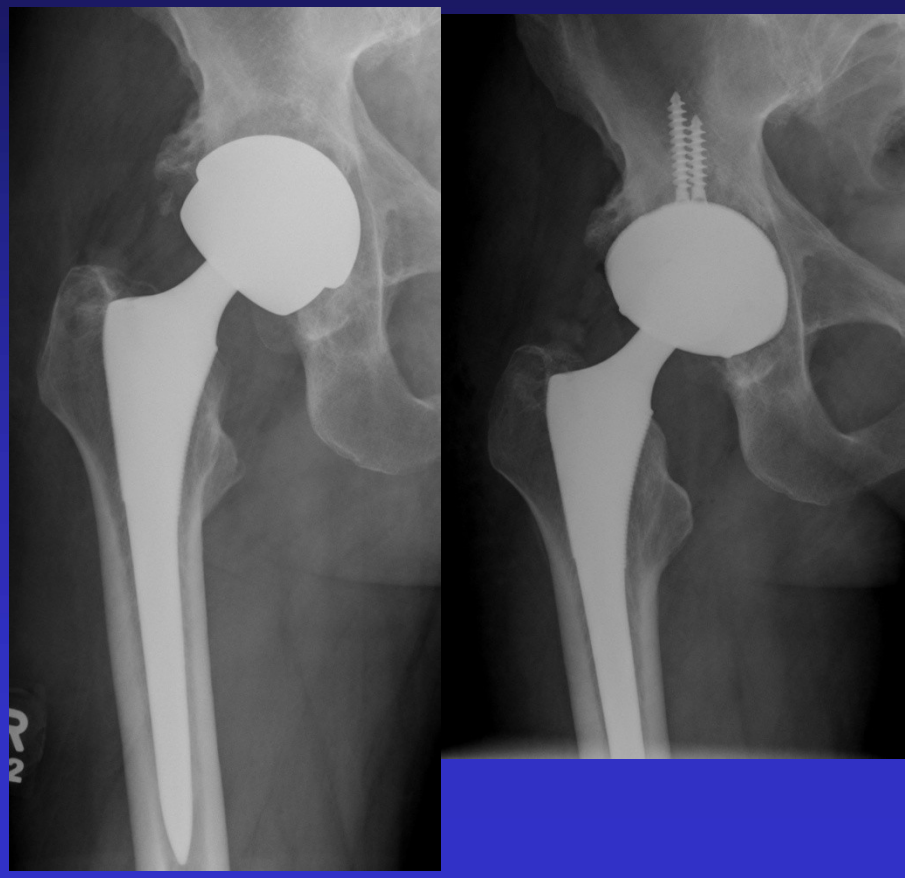
Reduce poly into shell liner

Revision for Recurrent Dislocation



Revision of large head metal-metal THA

- High risk for dislocation
- High risk abductor muscle-tendon necrosis



Dual mobility polyethylene placed against monobloc metal shell or hip resurfacing shell

- Off-label use
- Permits retention of a well-fixed, well-positioned shell
- No ASR shells (sharp inner edge)
- 2 papers

Studies of dual-mobility polyethylene against retained metal shell

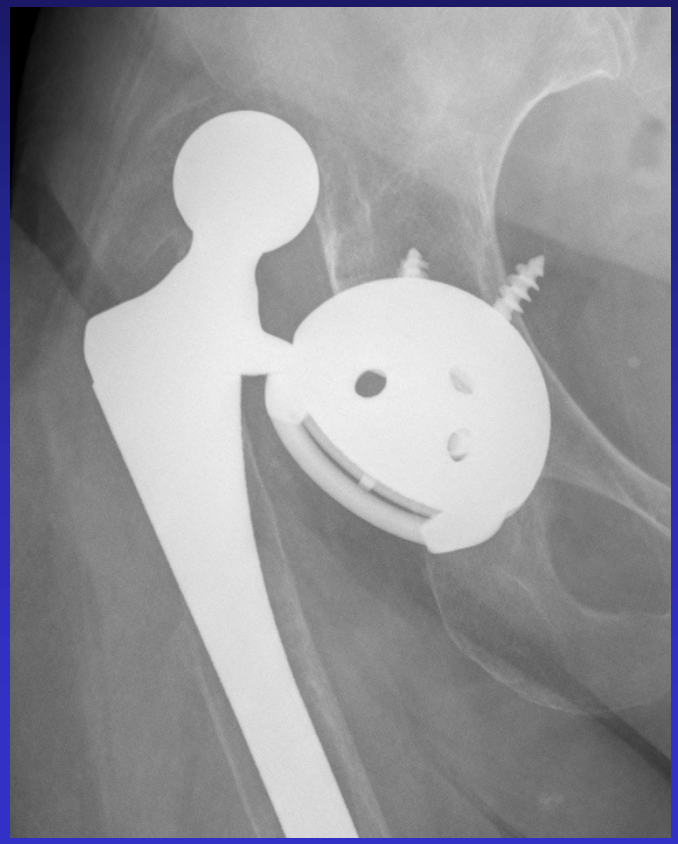
- **Multicenter** Plummer et al J Arthroplasty 2017
  - 25 revisions (14 THA, 11 resurfacings)
  - No ASR® shells 2 year follow-up
  - One failure: early, acute intra-prosthetic dislocation

- Fehring et al unpublished Hip Society 2015
  - 34 DM vs 114 formal acetabular revisions
  - one dislocation DM vs 20% complications revision

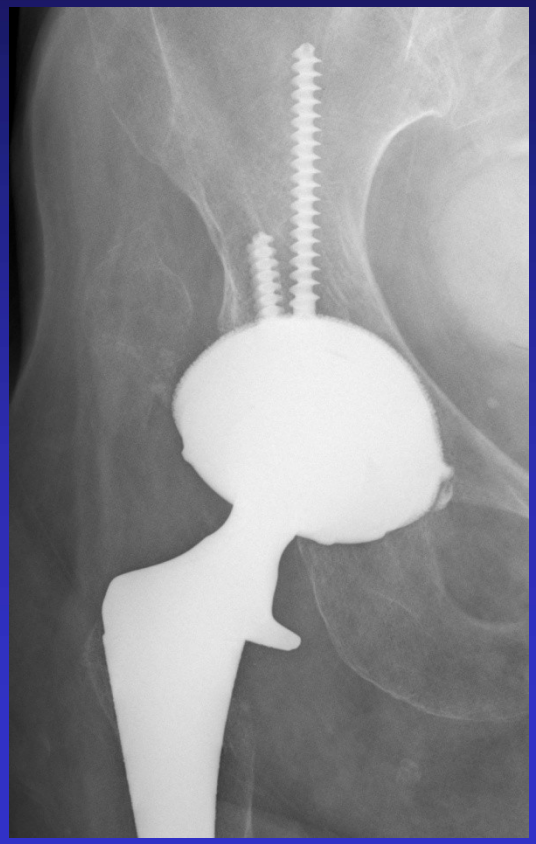
Revision of dislocated or failed constrained liner ?

(n=2; both successful)

1 year postop constrained



2 years postop DM



Revision of failed constrained liner with modular DM

- 14 patients with failed constrained liner
- Mean # surgeries 5; 50% > constrained liner
- 10 successful

  4 dislocated: 2 had closed reduction
  1 IP dislocation-open
  1 resection

- Reasonable salvage

Chalmers, Trousdale et al Clin Orthop 2018

Results of DM in Revision for recurrent dislocation

- Retrospective, level IV
- Follow-up mean 3-7 yrs
- Success 90-100%

Table 1

Results of Dual-mobility and Tripolar Components for Recurrent Dislocation Follow

Study	Implant Type	No. of Hips	No. Revised f Instability (%
Levine et al[6]	UTP	30	14 (47)
Guyen et al[15]	DM	51	51 (100)
Hamadouche et al[16]	DM	47	47 (100)
Leiber-Wackenheim et al[17]	DM	50	50 (100)
Langlais et al[13]	DM	85	5 (5.9)
Grigoris et al[18]	UTP	8	8 (100)
Philippot et al[14]	DM	156	26 (16)
Beaulé et al[19]	UTP	11	11 (100)

DM = dual mobility, UTP = unconstrained tripolar
[a] Hips followed for <2 years were excluded from this analysis.
[b] Infection, fracture, or loosening
[c] Denotes number of subset originally revised for instability in a larger series

Table 1 (continued)

Results of Dual-mobility and Tripolar Components for Recurrent Dislocation Following Total Hip Arthropl

Mean Follow-up in Years (range)	No. of Dislocations (%)	No. of Re-revisions for Dislocation (%)	No. of Other Revisi (%)
3 (2–4)	3 (10)	2 (6.7)	1 (3.3)
4 (2–7)	3 (5.9)	2 (3.9)	3 (5.9)
4 (2–6)	2 (4.3)	2 (4.3)	1 (2.1)
8 (6–11)	1 (2)	None	2 (4)
3 (2–5)	1 (1.2)	1 (1.2)	5 (5.9)
4 (2–6)	None	None	None
5 (2–9)	6 (3.8) None[c]	None None[c]	11 (7.1)
7 (3–12)	1 (10)	1 (10)	4 (40)

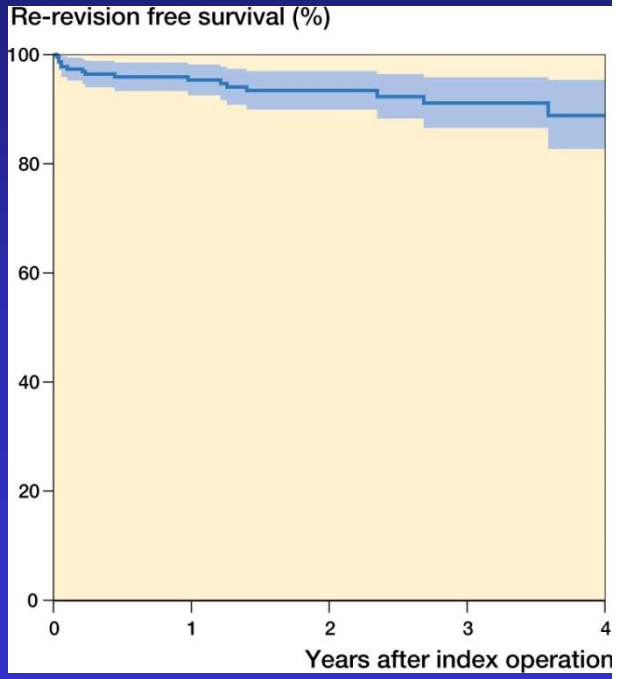
DM = dual mobility, UTP = unconstrained tripolar
[a] Hips followed for <2 years were excluded from this analysis.
[b] Infection, fracture, or loosening
[c] Denotes number of subset originally revised for instability in a larger series

Lachiewicz + Watters JAAOS 2012

DM Revision for Dislocation
Swedish Registry

- 228 hips revised for instability
- 25% had a previous revision
- 2 yr non-dislocation 99%
- Risk factors for failure
  - age 50-59
  - prior revision

Hailer et al Acta Orthopaedica 2012



DM Revision for Dislocation

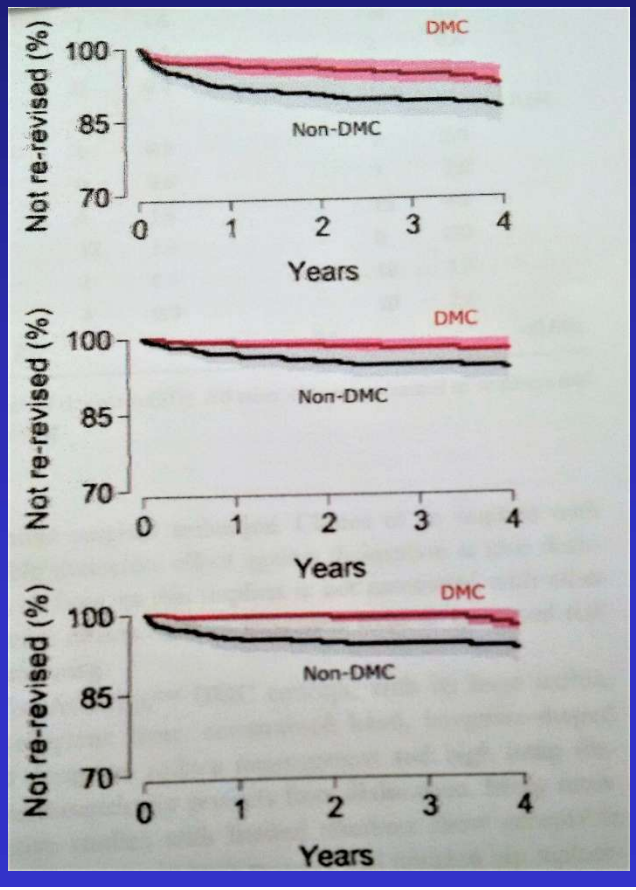
new Swedish Registry data

- 984 THAs revised for instability
- 436 cemented DM

  355 standard cup (28-36 mm)
- 4 yr survival (reop for dislocation)

  DM 96%

  Std 92% (p=0.001)



Mohaddes et al Intl Orthop 2017

"Double-mobility" acetabulum in revision THA: UK experience

- 149 patients 2005-2009 Saturne DM
- Mean f/u 42 mths (18-68)
- Indications: aseptic loosening 113
  recurrent dislocation 29
- 2% early dislocation (3, all with abductor deficiency)
- Literature review: 10 studies, 645 revisions
  3% re-dislocation rate (288 recurrent dislocations)

Vaskutty et al Bone and Joint J 2012

Results MDM®
Duke Orthopaedics series

- 64 hips (20 men, 43 female patients)
- Revision indications
  - Recurrent dislocation 42%
  - Metal-metal 25%
  - Reimplant infection 17%
  - Acetabular loosening, other 16%
- Two dislocations, reduced follow-up 3 yrs
- 14% infection; acetabular loosening 1.3%

Sutter et al J Arthroplasty 2017

Systematic reviews
Dual Mobility in revision THA

- DeMartino et al (HSS) BJJ 2017
  59 papers 5064 hips
  dislocation 3 %; intra-prosthetic 1.3%

- Darrith et al (Rush) BJJ 2018
  54 papers 3008 hips
  dislocation 2.2 %; intra-prosthetic 0.3%

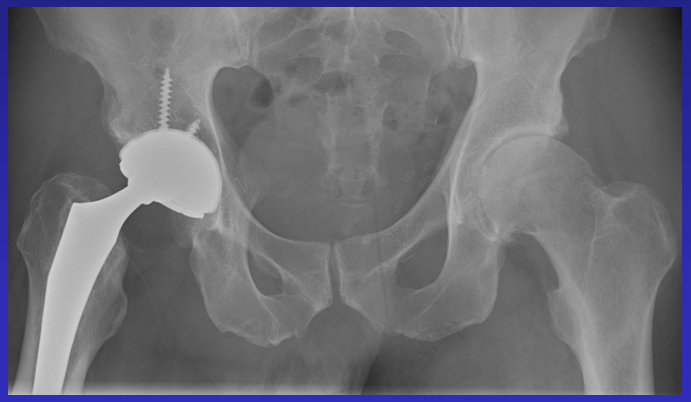
Systematic reviews
Dual Mobility in revision THA

- Levin et al J Arthroplasty 2018
  9 papers ("modern" DM)
  dislocation 2.2 % intra-prosthetic 0.3 %
  (meta-analysis: compared to fixed bearing OR 0.24)

- Reina et al (Mayo) J Arthroplasty 2019
  6 papers systematic review of DM
  compared to fixed bearing
  dislocation 2.2 % DM 7.1 % fixed (OR 3.59)

Dual Mobility will not “save you”

- Acetabular malposition
- Impingement due to skirted neck



- Massive loss of abductor muscle tissue

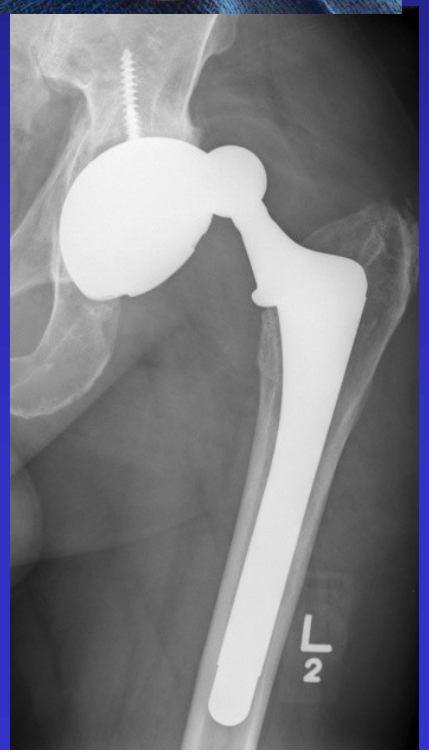
  (>50% loss of posterior abductors

  AAOS ICL 2018 Mr Stephen A Jones)

Mechanisms of failure of DM Components

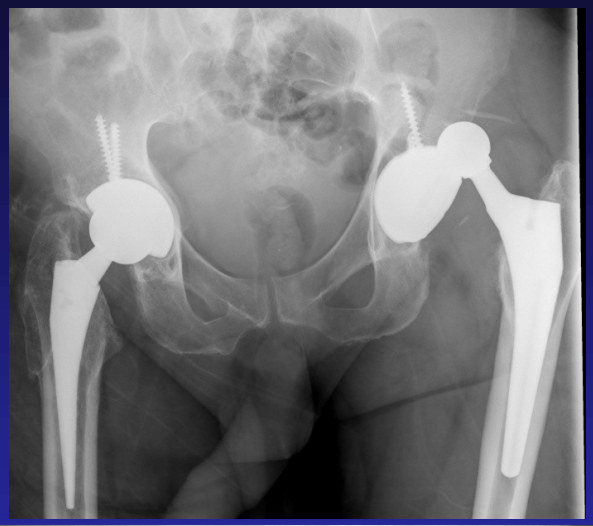
- Dislocation of polyethylene from metal shell
  (reduction possible)

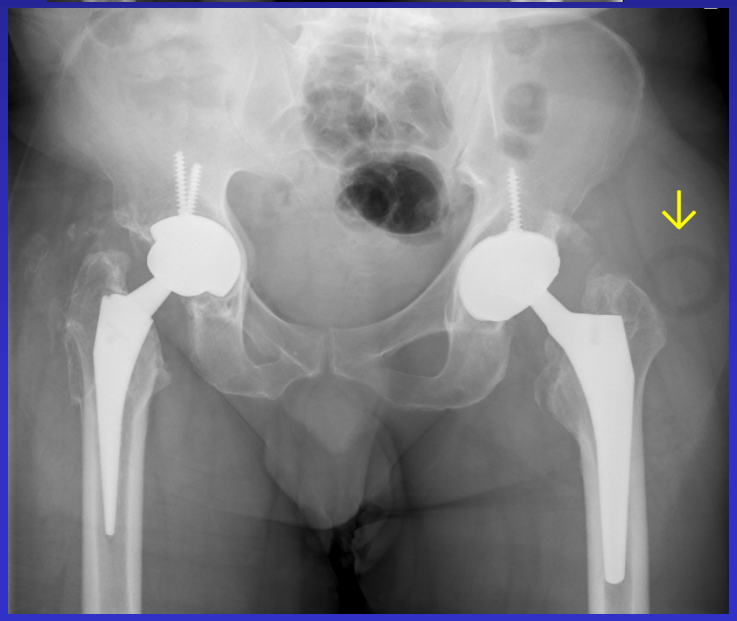
- Dislocation of metal or ceramic head from polyethylene
  (open reduction?)



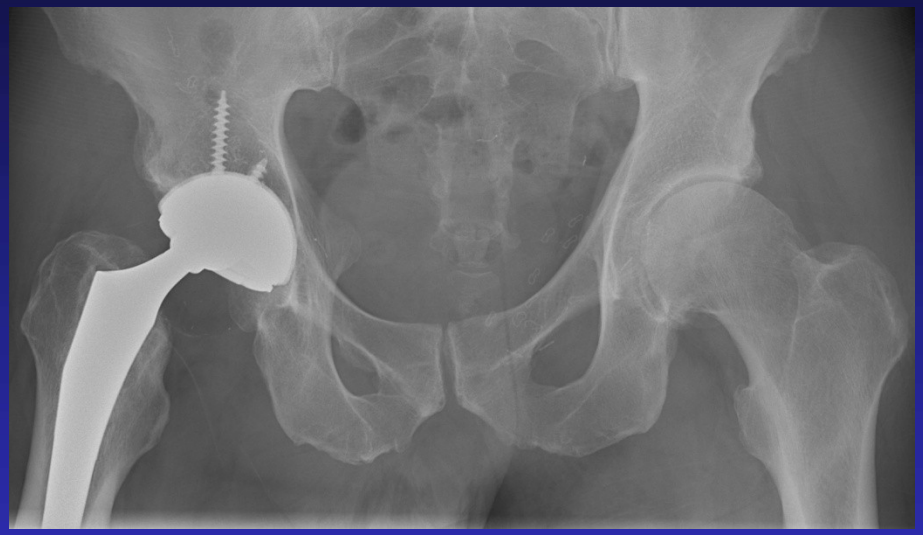
Acute Early Dissociation

- Pull out of femoral head from large polyethylene “ball”
- Case reports of 2 designs
- Causes:
  - Impingement of skirted head or taper ?
  - Closed reduction maneuver without GA





Salvage of
Acute Intra-prosthetic Dissociation

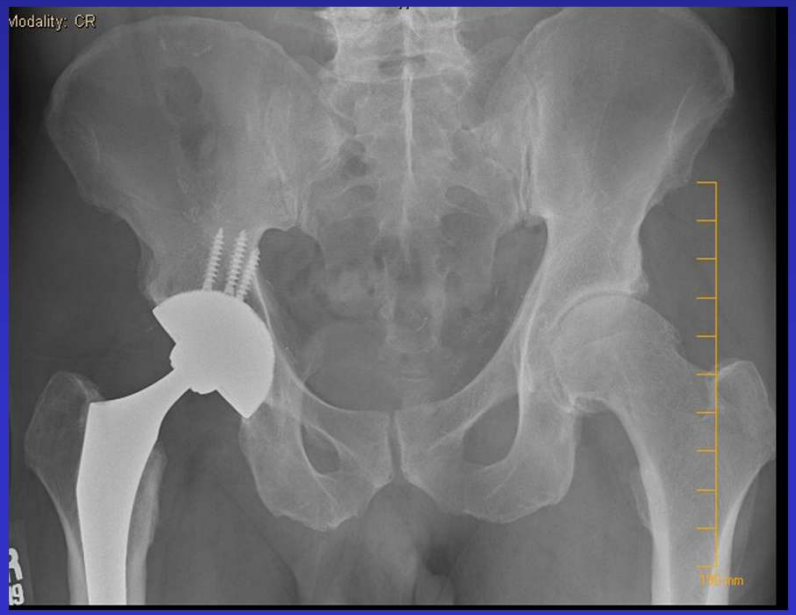


Generally recommended:

revise to constrained

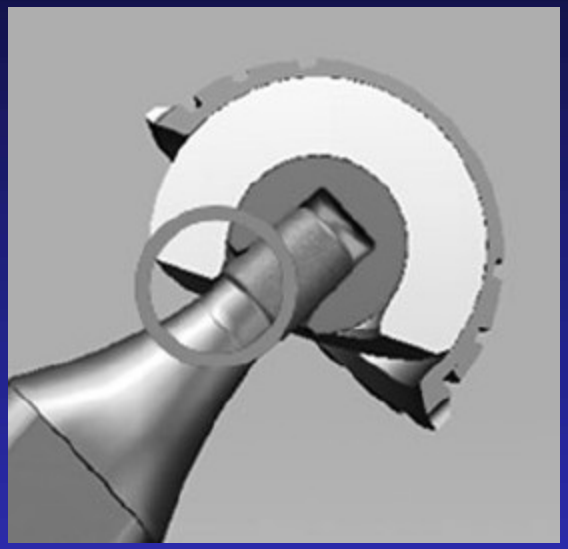
Another DM ?

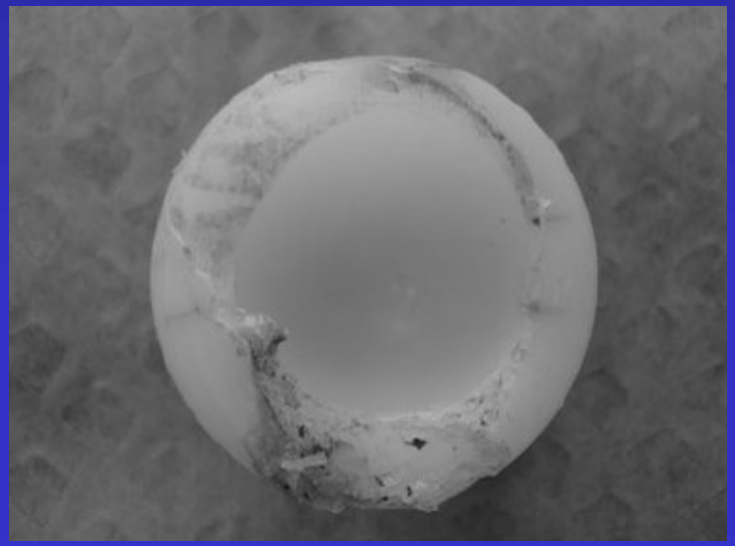
larger; no “skirt”



Chronic Intra-prosthetic Dislocation

late wear phenomenon





Polyethylene wear !

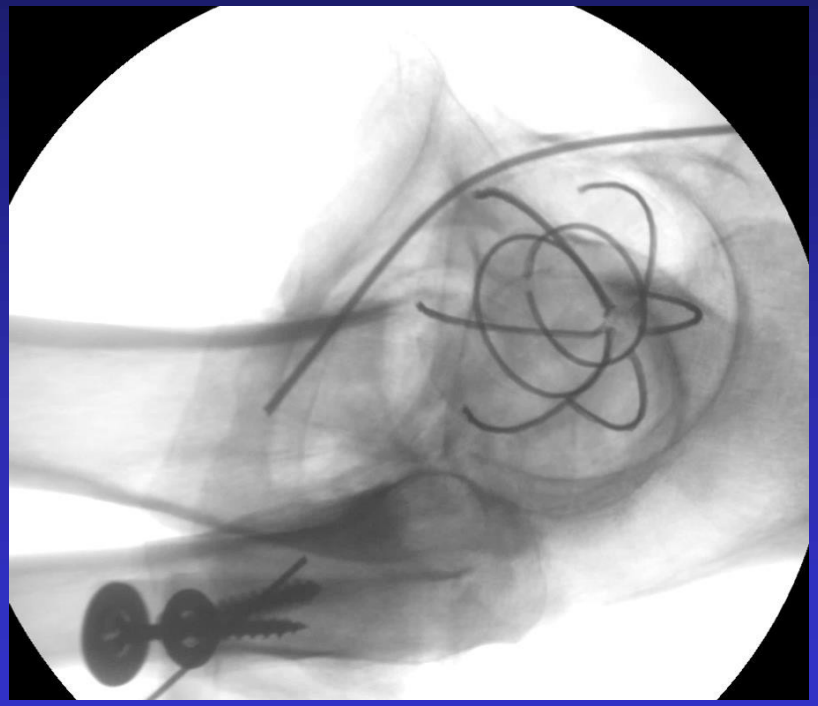
4 of 168 primary THA 5-7 yrs f/u

Hamadouche et al Clin Orthop 2012

Iliopsoas tendon impingement with DM components ?

- Cadaver + fluoroscopy
- Direct pressure on large poly head
- Cause of persistent groin pain ?
- Related to intraprosthetic dislocation ?

- Not clinically reported



Nebergall et al J Arthroplasty 2016

Photo: courtesy Muratoglu et al MGH lab

Elevated metal levels from modular MDM ® component ?

- 100 primary THA (90 pts) 2 yr f/u
- Most 22-mm metal head
- MARS MRI in 4 with pain, ↑ cobalt
  (ALTR in 2 !) Think from TMZF trunnion?
  Matsen Ko et al J Arthroplasty 2015

- 22 patients MDM (all ceramic heads)
- mean f/u 4 yrs
- mean Co 0.26 Chr 0.82
  Chalmers et al BJJ 2019

Conclusions
Dual Mobility for THA

- Theoretical advantages of increased ROM, and increased stability
- Indications in primary THA -- evolving
- Indications: revision for recurrent dislocation, alternative to constrained, all revisions?
- Will DM work when abductors deficient?

- More data and longer followup required !

Possible Concerns
Dual Mobility

- Elevated metal levels with modular metal;
  use ceramic head ?
- Acute early intraprosthetic dissociation:
  dislocation reduction manuever ?
- Chronic intraprosthetic dislocation:
  polyethylene wear + impingement

- Long-term success of newer designs ?