UNCEMENTED THR
AN OVERVIEW

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History

- Initial THRs uncemented
  - McKee / Farrar (1956-1960)
  - Hybrid cemented Thompson - uncemented cup

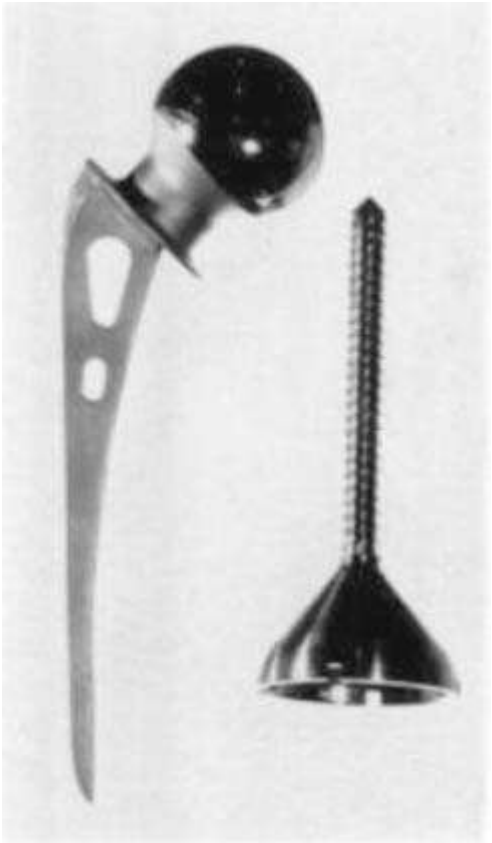
McKee

Cont…

- Initial cemented THRs failing
  - ‘Cement disease’ - Charnley- Muller

Cont…

- Ring type (late 1960's)
  - Metal on metal
  - Large femoral heads
  - Cup fixation with screw



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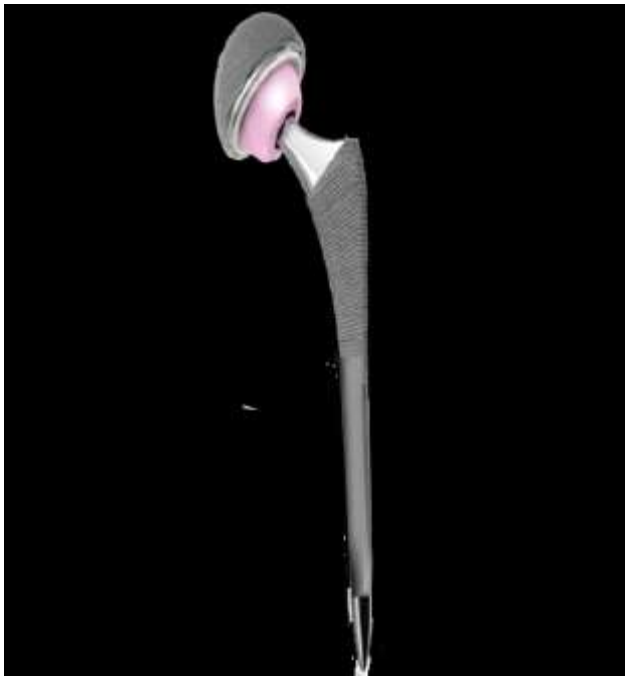
- Smooth surface implants (1970's)
  - Strong adherence to bone not present
  - Locking of implant with window / fins
- Bony ingrowth
  - Pore size for maximum ingrowth
  - Pore size 100 to 200µm

Biologic Interdigitation

- Dynamic interface
- Bone remodelling
- Long lasting bond



Categories

- Porous coated metal surface
- Grit blast metal
- Hydroxyapatite

Porous coated surface

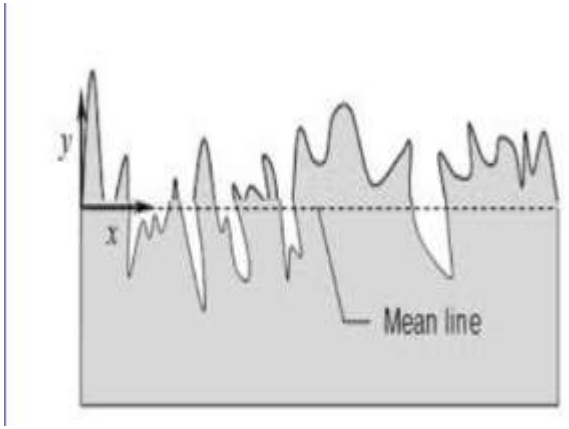
- Allowing bony ingrowth
  - Proximal coating
    - Less stress shielding
  - Extensive coated stem
    - Stress shielding of proximal bone

Optimal characteristics

- Pore size
  - 50 to 150µm
- Porosity
  - 50% - above this can cause shearing of metal
- Optimal gap
  - <50 µm - (space between implant and host bone)
- Acceptable micro motion
  - <150µm - more leads to fibrous in growth

Grit blasted metal

- Creates rough surface
  - Allowing bony ongrowth
- Surface roughness
  - Directly proportional to interface strength
  - Roughness - distance from peak to valley
  - Requires larger area



Hydroxyapatite

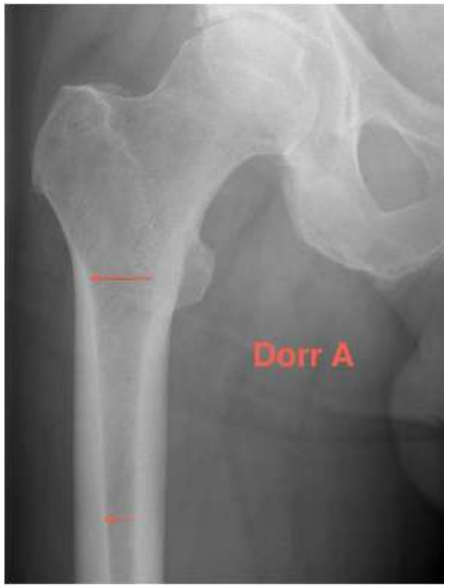
- Osteoconductive agent
  - Adjuvant to porous coated / grit blasted
  - More rapid closure of gaps
  - Shorter time to biological fixation
  - Disadvantage - delamination

Biological fixation techniques

- Rigid fixation (micro motion 50 to 150µm)
  - Press fit
    - Implant slightly larger than surrounding bone
    - Hoop stress around implant to reduce micromotion
  - Line to line
    - Bone size same as implant
    - Additional stabilisation (screws)
    - Femoral stem extensive coating
- Implant / bony contact
  - Cup - cortical rim
  - Femur - seated onto cortical bone

Dorr - Calcar to canal ratio

- Measure canal at LT and 10 cm below
- Inner diameter at midportion LT / inner diameter 10 cm distal
- Must be less than 75% to consider uncemented THR
- Ratio
  - Type A - ratio < 0.5
  - Type B – ratio .5 to .75
  - Type C –ratio > 0.75



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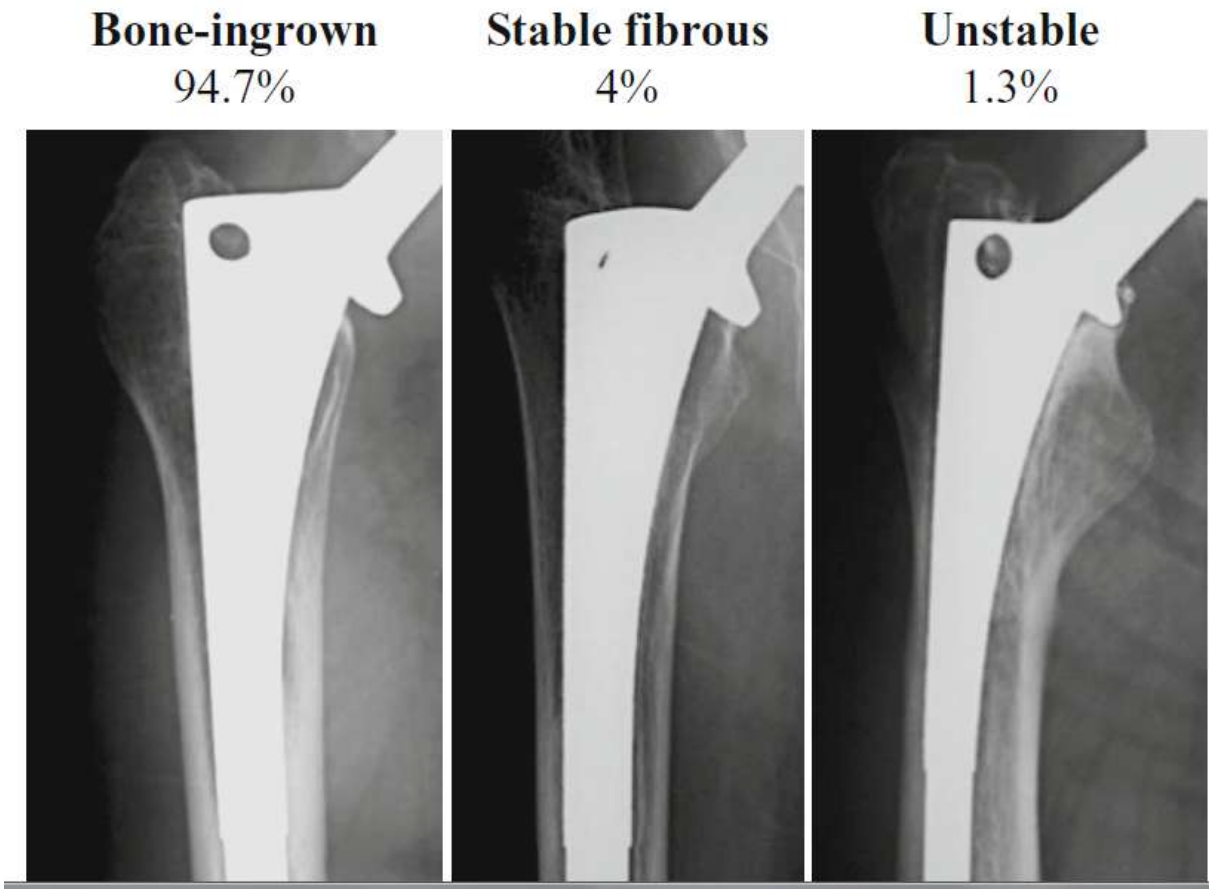

Signs of osteo-integration

- Spot welds
  - densification of endosteal bone
  - usually in the region of termination of the porous coating on the implant

Cont…

- Absence of any radiodense reactive lines
  - may occur around the smooth portion of the implant
  - this is where bone ingrowth is not expected to occur
  - they should not be present adjacent to the porous coating
- Calcar atrophy
  - this change is sometimes subtle
- Increased cancellous density / cortical hypertrophy distal to the coated region

Failed bone ingrowth / stabilization by fibrous tissue

- Parallel Sclerotic lines
  - remodelling signs around the porous surface
- Less atrophy of the medial femoral neck
- No progressive migration
- No local cortical hypertrophy / spot welding

Signs of frank implant instability

- Component migration
  - usually by subsidence and varus tilt
- Progressive luceny on serial radiographs
- Development of inferior pedestal

Uncemented THR failures

Failures of cementless cup after operation

Ope.

5y

10y

15y

20y

- Disruption of locking mechanism

- Osteolysis
  - thin polyethylene linear
  - back side wear
  - osteolysis through screw hole

- Loosening

Cont…

Failures of cementless stem after operation

Ope

5y

10y

15y

20y

- Intra-operative fracture
- Stress shielding
- Fracture due to stress shielding
- Osteolysis
- Loosening

Stress shielding

- Common in proximal femur
- Larger diameter stem
- Stiffer stem (radius, young's modulus, geometry)
- Extensive porous coated stem
- Preoperative osteopenia

NJR data 2014

Fixation	Number (%)	Bearing surface within fixation group	Number (%)
All cases	620,400 (100.0%)		620,400 (100.0%)
All cemented	228,196 (36.8%)	MoP	201,246 (88.2%*)
		MoM	1,277 (0.6%)
		CoP	20,317 (8.9%)
		Others/unsure	5,356 (2.4%)
All uncemented	240,087 (38.7%)	MoP	88,994 (37.1%)
		MoM	28,658 (11.9%)
		CoP	34,619 (14.4%)
		CoC	81,205 (33.8%)
		CoM	2,074 (0.9%)
		Others/unsure	4,537 (1.9%)
All hybrid	100,940 (16.3%)	MoP	65,554 (64.9%)
		MoM	2,400 (2.4%)
		CoP	13,556 (13.4%)
		CoC	17,448 (17.3%)
		Others/unsure	1,982 (2.0%)
All reverse hybrid	14,675 (2.4%)	MoP	9,982 (68.0%)
		CoP	4,603 (31.4%)
		Others/unsure	90 (0.6%)
All resurfacing	36,462 (5.9%)	(MoM)	36,462 (100%)
Unsure	40 (<0.1%)	Unsure	40 (not applicable)

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Figure 3.1

Temporal changes in percentages of each fixation method used in primary hip replacements.

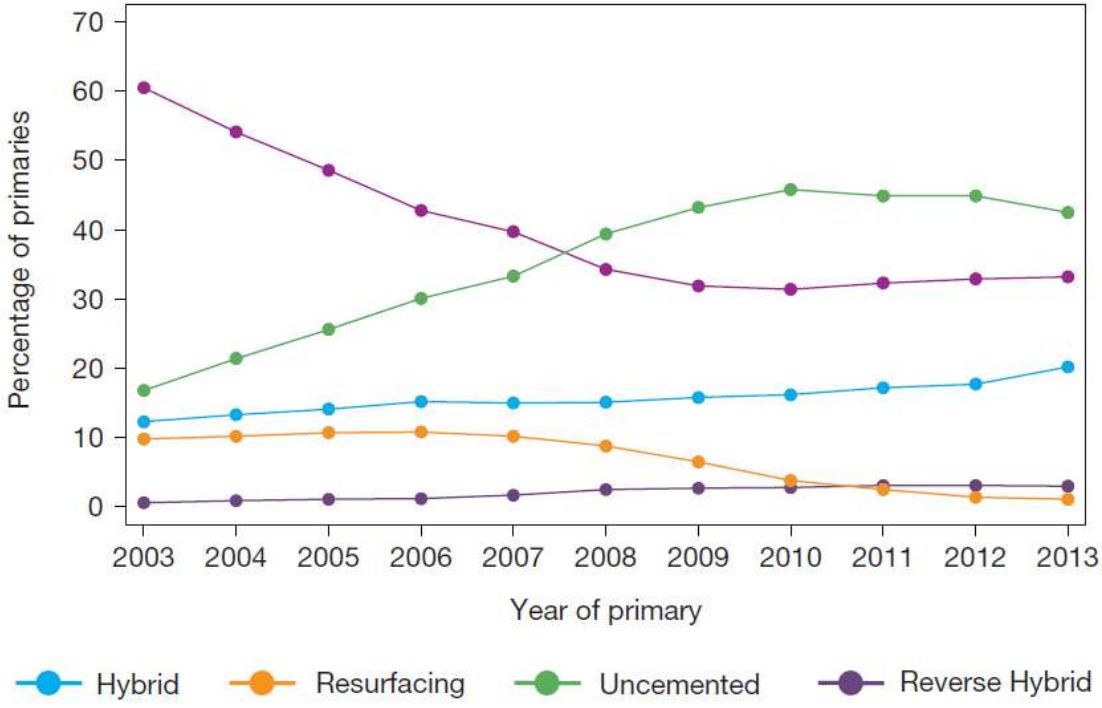

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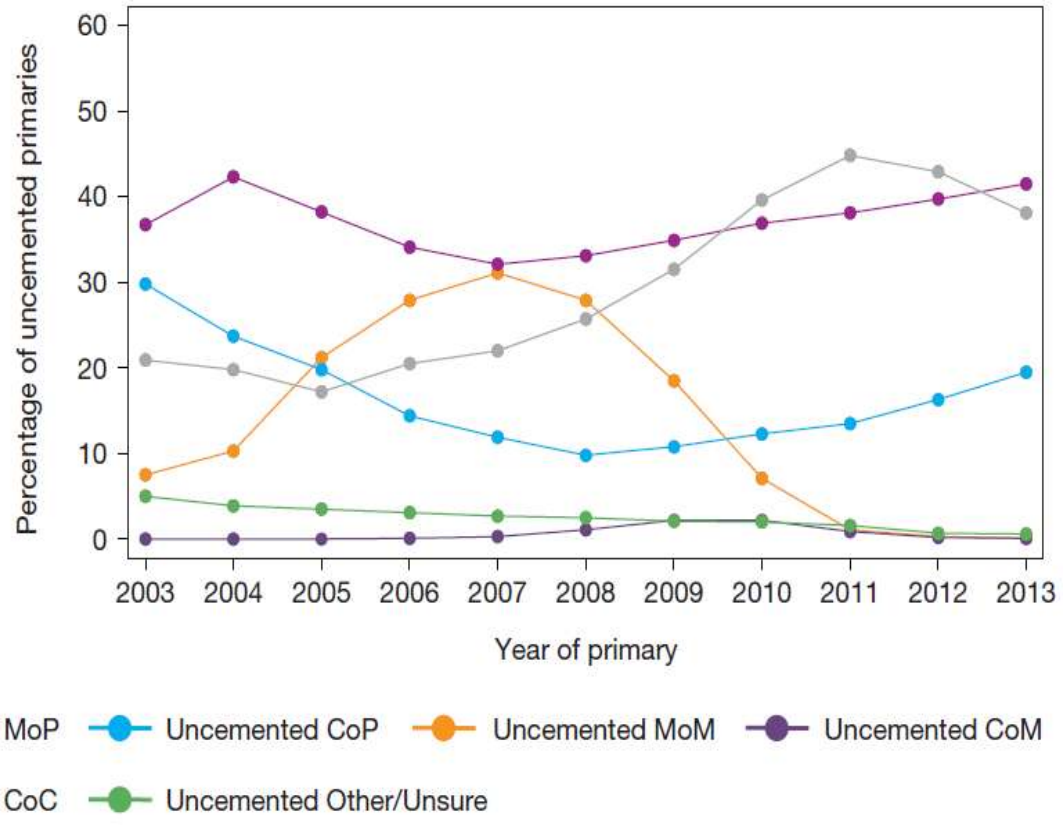
Figure 3.2 (b)

Temporal changes in percentages of each bearing surface used in **uncemented** primary hip replacements.



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All uncemented	240,087	1.00 (0.96-1.04)	1.55 (1.50-1.60)	2.13 (2.07-2.20)	2.80 (2.72-2.88)	3.65 (3.55-3.76)	4.67 (4.54-4.80)	5.50 (5.35-5.66)	6.42 (6.22-6.62)	7.05 (6.81-7.31)	7.68 (7.34-8.03)
Uncemented by bearing surface:											
MoP	88,994	1.07 (1.00-1.14)	1.52 (1.43-1.60)	1.89 (1.80-2.00)	2.15 (2.04-2.26)	2.44 (2.31-2.57)	2.80 (2.66-2.96)	3.09 (2.92-3.27)	3.57 (3.34-3.81)	3.92 (3.64-4.23)	3.98 (3.67-4.31)
MoM	28,658	1.03 (0.92-1.16)	2.02 (1.86-2.19)	3.38 (3.18-3.60)	5.31 (5.05-5.58)	7.87 (7.35-8.00)	10.58 (10.18-11.00)	13.11 (12.61-13.64)	16.01 (15.31-16.73)	18.50 (17.47-19.59)	21.92 (19.81-24.22)
CoP	34,619	0.84 (0.74-0.94)	1.20 (1.08-1.33)	1.58 (1.44-1.74)	1.88 (1.72-2.06)	2.17 (1.99-2.38)	2.41 (2.20-2.64)	2.64 (2.40-2.90)	2.93 (2.65-3.24)	3.17 (2.84-3.54)	3.73 (3.22-4.33)
CoC	81,205	0.96 (0.89-1.03)	1.49 (1.40-1.58)	1.89 (1.79-2.00)	2.24 (2.12-2.36)	2.61 (2.46-2.76)	2.98 (2.81-3.17)	3.33 (3.11-3.56)	3.73 (3.45-4.04)	4.06 (3.70-4.46)	4.75 (4.11-5.47)
CoM	2,074	0.68 (0.40-1.14)	1.53 (1.08-2.16)	2.85 (2.19-3.70)	3.96 (3.12-5.02)	5.03 (3.87-6.51)	*5.03 (3.87-6.51)*	*5.03 (3.87-6.51)*	-	-	-
Others/unsure	4,537	1.25 (0.96-1.62)	1.74 (1.39-2.17)	2.24 (1.83-2.73)	2.70 (2.24-3.26)	3.22 (2.69-3.86)	3.93 (3.30-4.69)	4.39 (3.67-5.24)	5.20 (4.27-6.31)	6.11 (4.89-7.62)	*6.11 (4.89-7.62)*

Cont…

Fixation/ bearing types	Age at primary (years)	Males						Females					
		n	Years from primary operation					n	Years from primary operation				
			1 year	3 years	5 years	7 years	10 years		1 year	3 years	5 years	7 years	10 years
All uncemented													
	<55	18,615	0.90 (0.77-1.05)	2.75 (2.49-3.04)	4.89 (4.47-5.33)	7.10 (6.49-7.75)	*10.41 (9.04-11.96)*	20,948	0.95 (0.83-1.10)	2.62 (2.38-2.88)	5.13 (4.74-5.57)	8.15 (7.53-8.83)	*10.66 (9.62-11.81)*
	55-64	32,236	0.92 (0.82-1.03)	2.26 (2.09-2.45)	3.96 (3.69-4.25)	6.11 (5.68-6.56)	8.15 (7.24-9.16)	39,357	0.88 (0.79-0.98)	2.11 (1.96-2.27)	3.96 (3.73-4.24)	6.18 (5.80-6.58)	8.95 (8.10-9.89)
	65-74	36,055	1.03 (0.93-1.14)	2.05 (1.89-2.22)	3.16 (2.94-3.40)	4.64 (4.30-5.02)	6.39 (5.72-7.13)	47,134	0.91 (0.83-1.00)	1.82 (1.69-1.96)	3.22 (3.01-3.44)	4.97 (4.65-5.33)	6.86 (6.21-7.58)
	75+	17,628	1.26 (1.10-1.44)	2.04 (1.82-2.29)	2.82 (2.52-3.16)	3.35 (2.96-3.82)	*4.36 (3.51-5.41)*	27,987	1.27 (1.14-1.41)	1.88 (1.72-2.06)	2.56 (2.34-2.81)	3.38 (3.05-3.75)	*4.58 (3.66-5.72)*

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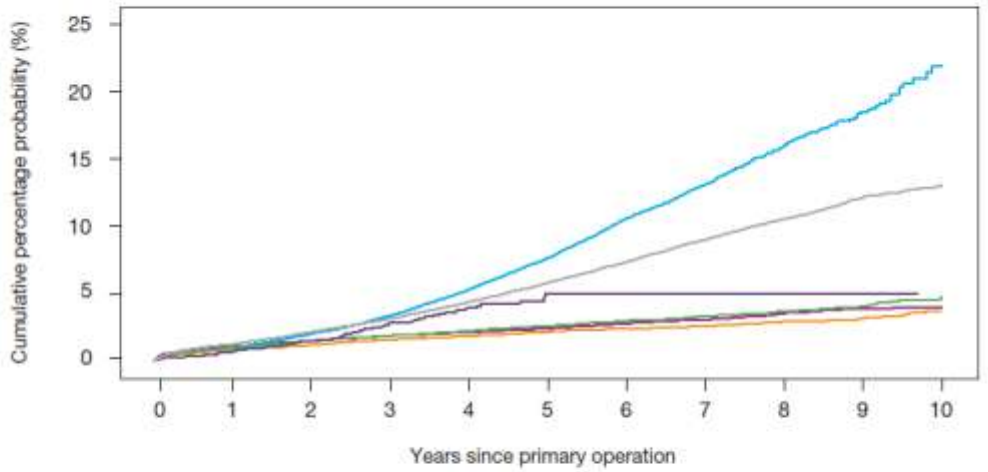
Figure 3.5

Comparison of cumulative probability of revision (Kaplan-Meier estimates) for **uncemented** hips with different bearing surfaces.



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Numbers at risk

Uncemented MoP	88,994	73,559	58,934	45,872	33,890	23,938	15,803	9,971	5,763	2,578	644
Uncemented MoM	28,658	28,030	27,389	26,323	23,367	17,793	11,034	5,637	2,342	624	131
Uncemented CoP	34,619	27,801	21,960	17,380	13,346	10,200	7,681	5,401	3,506	1,770	586
Uncemented CoC	81,205	67,690	52,636	37,920	25,412	16,466	10,013	5,821	3090	1,492	431
Uncemented CoM	2,074	2,017	1,932	1600	910	316	58	12	2	1	0
Resurfacing	36,462	35,092	33,638	31,417	28,370	23,619	18,093	12,235	7573	3,773	1250

Summary

- Concept of biological fixation
  - Optimal surface property
  - Optimal micro movement
  - Optimal pore size
  - Optimal fixation
  - Optimal implant size / contour

Thank you