TOTAL HIP ARTHROPLASTY

CURRENT ASPECTS
DESIGN, FIXATION AND BEARING SURFACES

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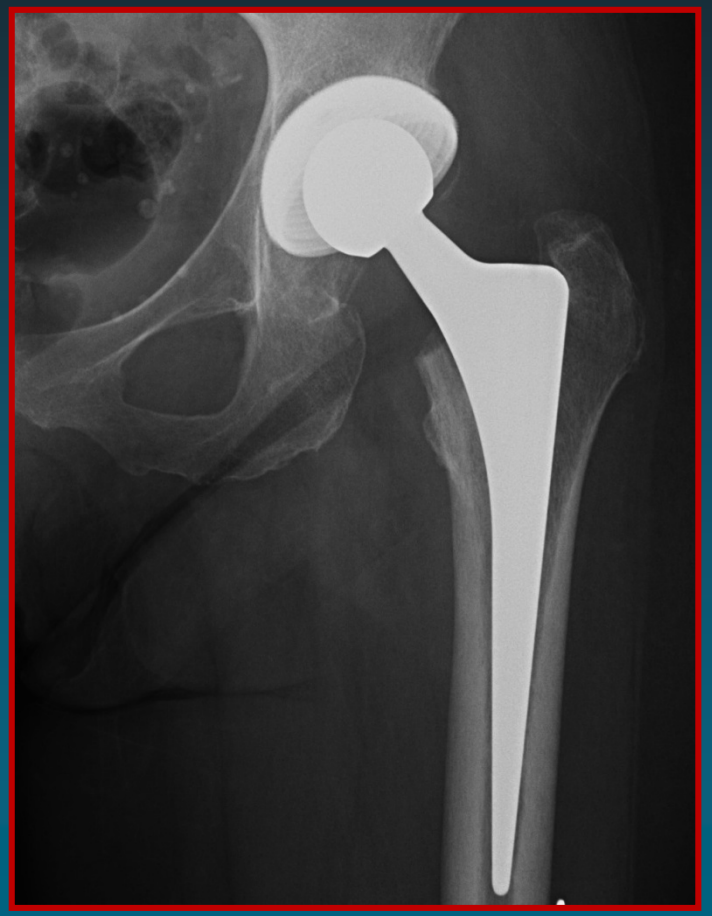
TOTAL JOINT ARTHROPLASTY

- FROM THE BEGINNING OF 60's
- EXCELLENT CLINICAL RESULTS AT 15-20 YEARS
  - INCIDENCE OF ASEPTIC LOOSENING 2-20%
  - TECHNIQUE
  - BASIC PRINCIPLES
  - VARIATIONS
  - ERRORS

Με τσιμέντο-Χωρίς Τσιμέντο



TOTAL JOINT ARTHROPLASTY SURVIVAL

PATIENT

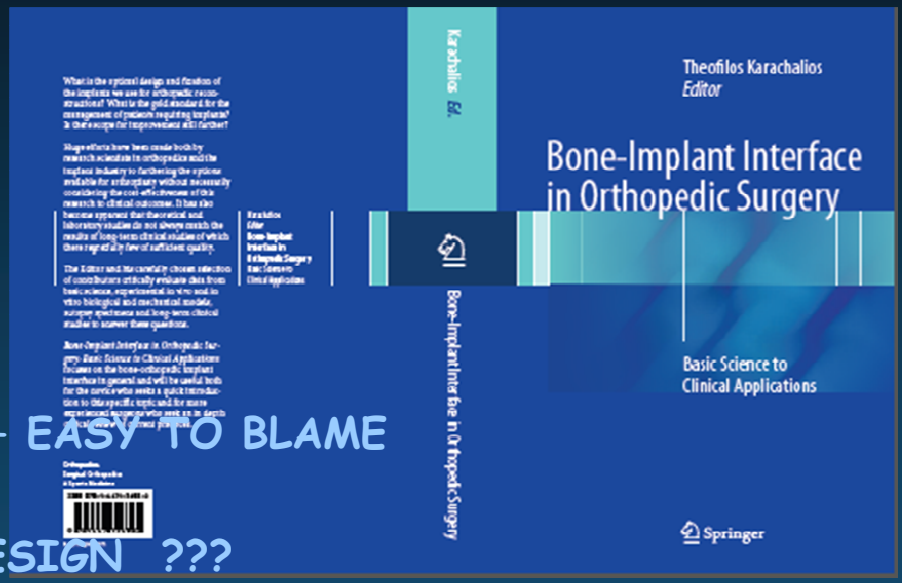
SURGEON

SURGICAL TECHNIQUE

DIAGNOSIS

MATERIALS ???
IMPLANT DESIGN ??
FIXATION ???

TOTAL JOINT ARTHROPLASTY



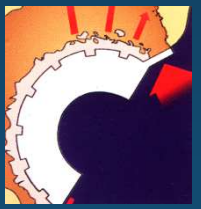
- IMPLANT DESIGN – EASY TO BLAME
- OPTIMAL DESIGN ???
- BAD RECIPIES !!!!
- PRINCIPLES V/S GIVEN DESIGN
- GOOD AND BAD DESIGNS
- FOR EITHER CEMENTED OR CEMENTLESS USE
- CURRENT TREND TO MODIFY OLDER GOOD RECIPIES

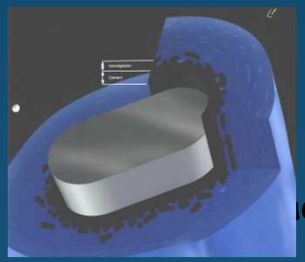
ΟΛΙΚΗ ΑΡΘΡΟΠΛΑΣΤΙΚΗ ΙΣΧΙΟΥ ΜΕ ΤΣΙΜΕΝΤΟ

- **ΚΥΠΕΛΙΟ**
  - ΜΑΝΔΥΑΣ ΤΣΙΜΕΝΤΟΥ
  - 8mm ΠΑΧΟΣ
  - <50 -22mm ΚΕΦΑΛΗ
  - 50-60mm -28mm ΚΕΦΑΛΗ
  - > 60mm – 32mm ΚΕΦΑΛΗ
- **ΜΗΡΙΑΙΑ ΠΡΟΘΕΣΗ**
  - ΜΑΝΔΥΑΣ ΤΣΙΜΕΝΤΟΥ
  - 2mm, 3-4mm ΠΑΧΟΣ
  - ΕΓΚΑΡΣΙΑ ΔΙΑΤΟΜΗ ΧΩΡΙΣ ΣΗΜΕΙΑ ΣΥΓΚΕΝΤΡΩΣΗΣ ΦΟΡΤΙΩΝ
  - ΣΤΡΟΦΙΚΗ ΣΤΑΘΕΡΟΤΗΤΑ ΜΕ ΕΠΙΠΕΔΗ ΠΡΟΣΘΙΑ ΚΑΙ ΟΠΙΣΘΙΑ ΕΠΙΦΑΝΕΙΑ ΚΑΙ ΟΜΑΛΗ ΕΣΩ
  - COBALT-CHROME
  - ΛΕΙΑ -ΠΡΟΕΠΙΚΑΛΥΨΗ
- **ΤΕΧΝΙΚΗ ΤΣΙΜΕΝΤΟΥ**
  - ΠΡΟΕΤΟΙΜΑΣΙΑ ΟΣΤΙΚΗΣ ΚΟΙΤΗΣ
  - ΓΕΝΕΕΣ ΤΣΙΜΕΝΤΟΥ
  - ΣΥΜΠΙΕΣΗ
  - ΘΕΡΜΟΚΡΑΣΙΑ
  - ΧΡΟΝΟΣ

ΣΥΓΧΡΟΝΕΣ ΤΕΧΝΙΚΕΣ ΣΥΝΔΕΣΗΣ ΤΣΙΜΕΝΤΟΥ

ΟΣΤΟΥΝ	ΠΑΡΑΣΚΕΥΗ ΕΠΙΦΑΝΕΙΑΣ	ΑΦΑΙΡΕΣΗ ΧΑΛΑΡΩΝ ΟΣΤΙΚΩΝ ΤΕΜΑΧΙΩΝ ΒΟΥΡΤΣΑ ΕΚΠΛΥΣΗ ΚΑΤΑ ΩΣΕΙΣ
	ΑΙΜΟΣΤΑΣΗ	ΕΝΔΟΜΥΕΛΙΚΗ ΤΟΠΟΘΕΤΗΣΗ ΓΑΖΩΝ ΤΟΠΙΚΟΙ ΑΙΜΟΣΤΑΤΙΚΟΙ ΠΑΡΑΓΟΝΤΕΣ ΤΕΧΝΙΚΗ ΑΝΑΙΣΘΗΣΙΑΣ
	ΑΠΟΦΡΑΞΗ ΑΥΛΟΥ	ΟΣΤΙΚΟ ΤΕΜΑΧΙΟ ΤΕΜΑΧΙΟ ΤΣΙΜΕΝΤΟΥ ΠΛΑΣΤΙΚΟ ΤΕΜΑΧΙΟ
ΤΣΙΜΕΝΤΟ	ΣΥΣΤΑΣΗ	Δομή Πολυμερούς Χαμηλό ιξώδες Μειωμένο ιξώδες Χαμηλή θερμοκρασία πολυμερισμού
	ΠΑΡΑΣΚΕΥΗ	Κενό Φυγοκέντρηση
ΤΟΠΟΘΕΤΗΣΗ ΤΣΙΜΕΝΤΟΥ		
	ΕΙΣΑΓΩΓΗ	Ανάστροφη Μηχανικό πιστόλι Συμπίεση Διατήρηση συμπίεσης -μηχανική -δάκτυλα
	ΤΟΠΟΘΕΤΗΣΗ ΠΡΟΘΕΣΗΣ	Ακριβής τοποθέτηση Καθυστέρηση σύμφωνα με τις ιδιότητες του τσιμέντου Περαιτέρω συμπίεση





ΕΠΙΦΑΝΕΙΑ ΕΠΑΦΗΣ ΤΣΙΜΕΝΤΟΥ - ΟΣΤΟΥ

ο μηχανισμος συνδεσης του τσιμεντου εξαρταται απο την ικανοτητα του πολυμερους να σχηματιζει ενα δικτυο συνδεσης μεταξυ ανωμαλιων του οστου και της επιφανειας της προθεσης

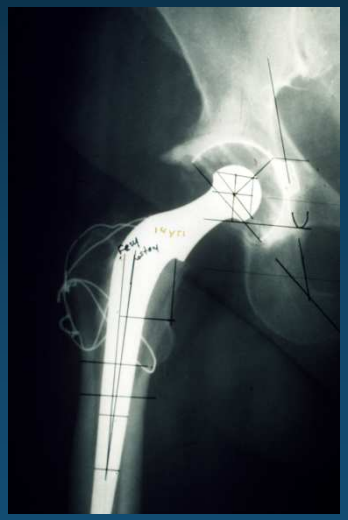
ΑΡΧΙΚΗ ΟΣΤΙΚΗ ΚΑΚΩΣΗ

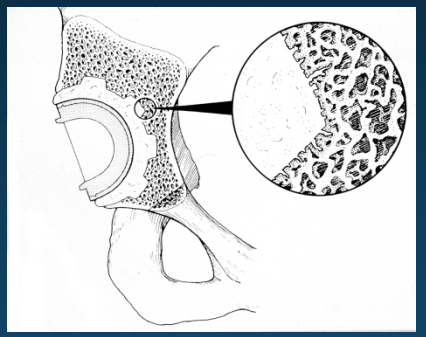
- ΑΦΑΙΡΕΣΗ ΟΣΤΟΥ
- ΝΕΚΡΩΣΗ ΟΣΤΟΥ
- ΘΕΡΜΙΚΗ ΚΑΚΩΣΗ ΤΣΙΜΕΝΤΟΥ

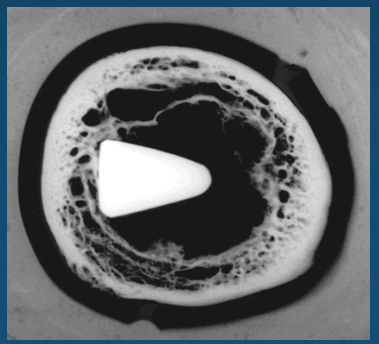
ΝΕΚΡΟΤΟΜΙΚΕΣ ΜΕΛΕΤΕΣ ΣΕ ΑΣΘΕΝΕΙΣ ΜΕ ΣΤΑΘΕΡΕΣ ΠΡΟΘΕΣΕΙΣ

- ΣΤΕΝΗ ΣΥΝΔΕΣΗ ΤΣΙΜΕΝΤΟΥ ΚΑΙ ΕΝΔΟΣΤΙΚΗΣ ΕΠΙΦΑΝΕΙΑΣ ΤΟΥ ΟΣΤΟΥ
- ΙΝΩΔΗΣ ΙΣΤΟΣ ΣΤΑ ΠΡΩΤΑ 2 cm ΤΗΣ ΖΩΝΗΣ 7
- ΟΣΤΙΚΗ ΑΝΑΚΑΤΑΣΚΕΥΗ ΜΕΤΑΞΥ ΕΝΔΟΣΤΕΟΥ ΚΑΙ ΦΛΟΙΟΥ

Jasty JBJS 1986, 1990
Kwong JBJS 1992
Maloney JBJS 1995



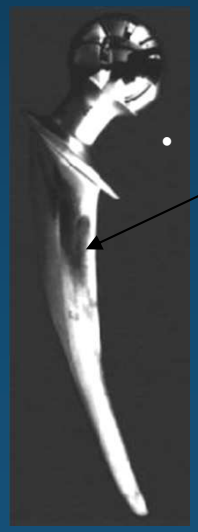


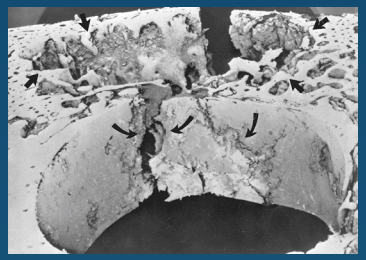


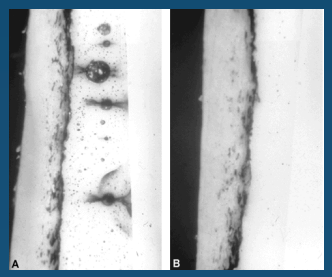
BONE-CEMENT INTERFACE

EARLY AND LATE STABLE FIXATION

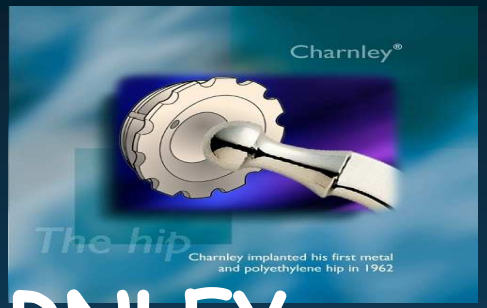
- BONE - CEMENT INTERFACE
- IMPLANT CEMENT INTERFACE
- 1992 -2000 213 HYBRID ELITE THA

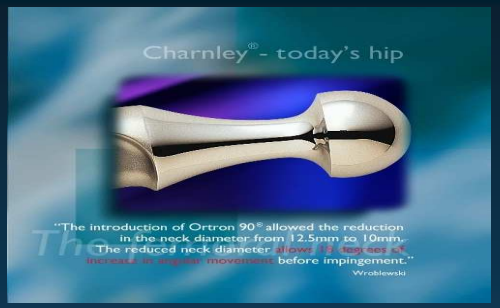






LFA - CHARNLEY
EVOLUTION OF STAINLESS - STEEL





- CHARNLEY
  - STAINLESS - STEEL
  - ORTRON 90
- ELITE
- ELITE PLUS
- C-STEM

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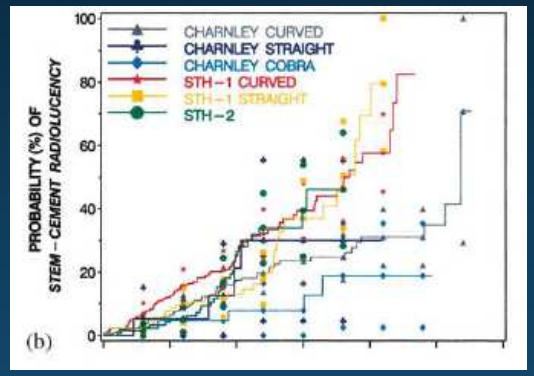
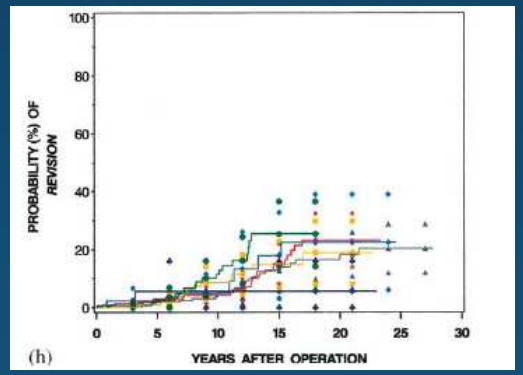
THE EFFECT OF ALLOY AND DESIGN

- FEMORAL STEMS
  MADE OF TITANIUM
  - WERE AT GREATER RISK
    - OF DEVELOPING
      - RADIOLUCENT LINES
      - ENDOSTEAL SCALLOPING
      - ASEPTIC LOOSENING…..
    - AT 25 YEARS FUP

Ebramzadeh Biomaterials 2004





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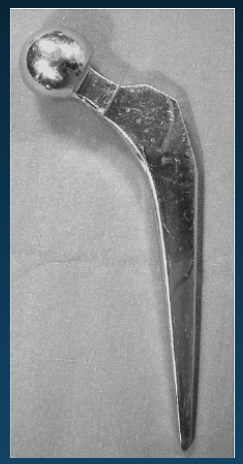
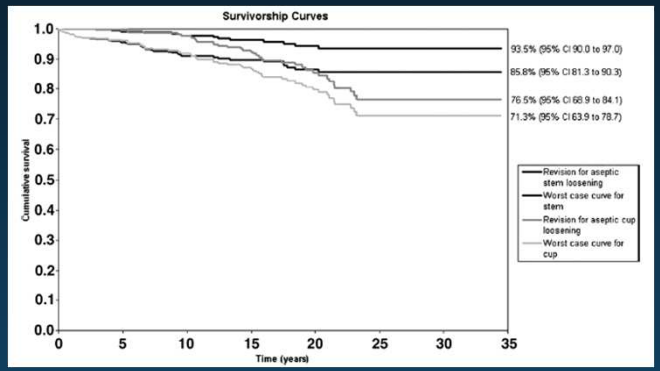
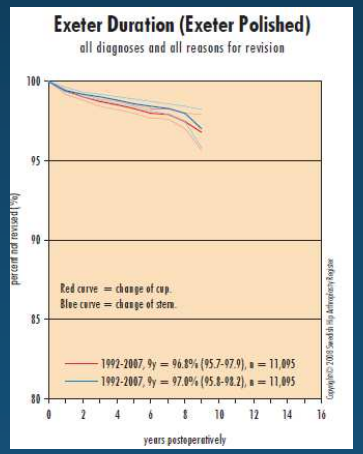
THE EXETER HIP







- UNIQUE EXAMPLE
  - SURVIVAL FEMORAL STEM RATE OF 93.5% AT 33 YEARS
    - 3.23% REVISION RATE
  - SURVIVAL ACETABULAR CUP RATE OF 76.5 AT 33 YEARS
  - END POINT – REVISION FOR ASEPTIC LOOSENING

Ling J Arthroplasty 2009

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BONE IMPLANT INTERFACE INCORPORATION

IMPLANTATION

INITIAL BONE REACTION
BONE INTERFACE NECROSIS
REVASCULARIZATION

REPARATIVE PHASE

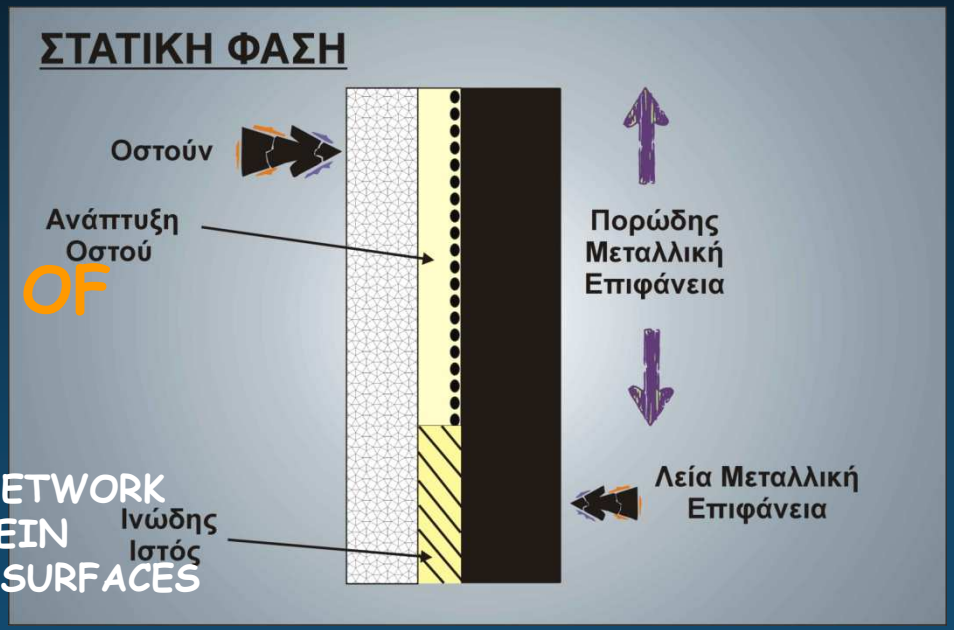
- HAEMORRAGE
- INCREASED BLOOD SUPPLY
- INFLAMMATION (24 H)
- LINING CELLS – FIBROBLASTS (3RD D)
- CHODROCYTES, OSTEOBLASTS (1ST W)
- WOOVEN BONE (2ND WEEK)
- PRIMARY STABLE MEMBRANE (4-6 W)
- STABLE INTERFACE (4 M)

- FRACTURE HEALING LIKE PROCESS

Draenert The Hip 1981

STABLE BONE-IMPLANT INTERFACE

BONE FORMATION ON POROUS SURFACES OF STABLE IMPANTS



- BONE MATRIX WITHOUT COLLAGEN NETWORK
  - OSTEOPONTIN-BONE CIELOPROTEIN
- DIRECT BONE FORMATION ON POROUS SURFACES (70%)
- FIBROUS TISSUE ON POROUS SURFACES (30%)
  - FIBROUS TISSUE ON SMOOTH SURFACE (WELL ORGANISED DENCE COLLAGEN NETWORK)

Davies Anat Rec 1996

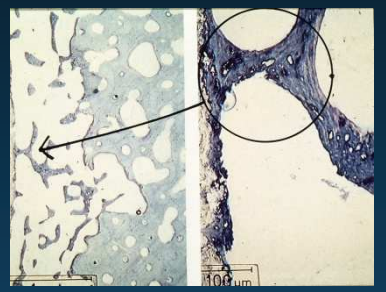
Davies Anat Rec 1996 Engh JBJS 1995

HA - BONE INTERFACE

BIOACTIVE MATERIALS -HA

- OSTEOINDUCTIVE-OSTEOCONDUCTIVE PROPERTIES
- NO FIBTOUS TISSUE IN THE INTERFACE
- INSTABILITY
- TITANIUM ALLOY, HIGH CRYSTALLINITY HA, 50-75µm THICKNESS, PLASMA SPRAY TECHNIQUE
- THIRD BODY WEAR WHEN THICKNESS HA >75µm

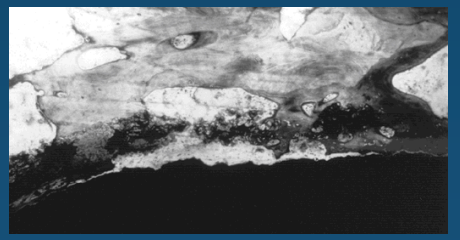
Duchene Clin Orth RR 1992
Dalton JBJS 1995
Klein J Biom Mat Res 1994



- TEN YEARS FOLLOW-UP
- 1.5% LOOSENING OF FEMORAL STEM
- 20% LOOSENING OF ACETABULAR CUP

- DESIGN PROBLEMS - ACETABULAR CUP???

D'Antonio JBJS 2002

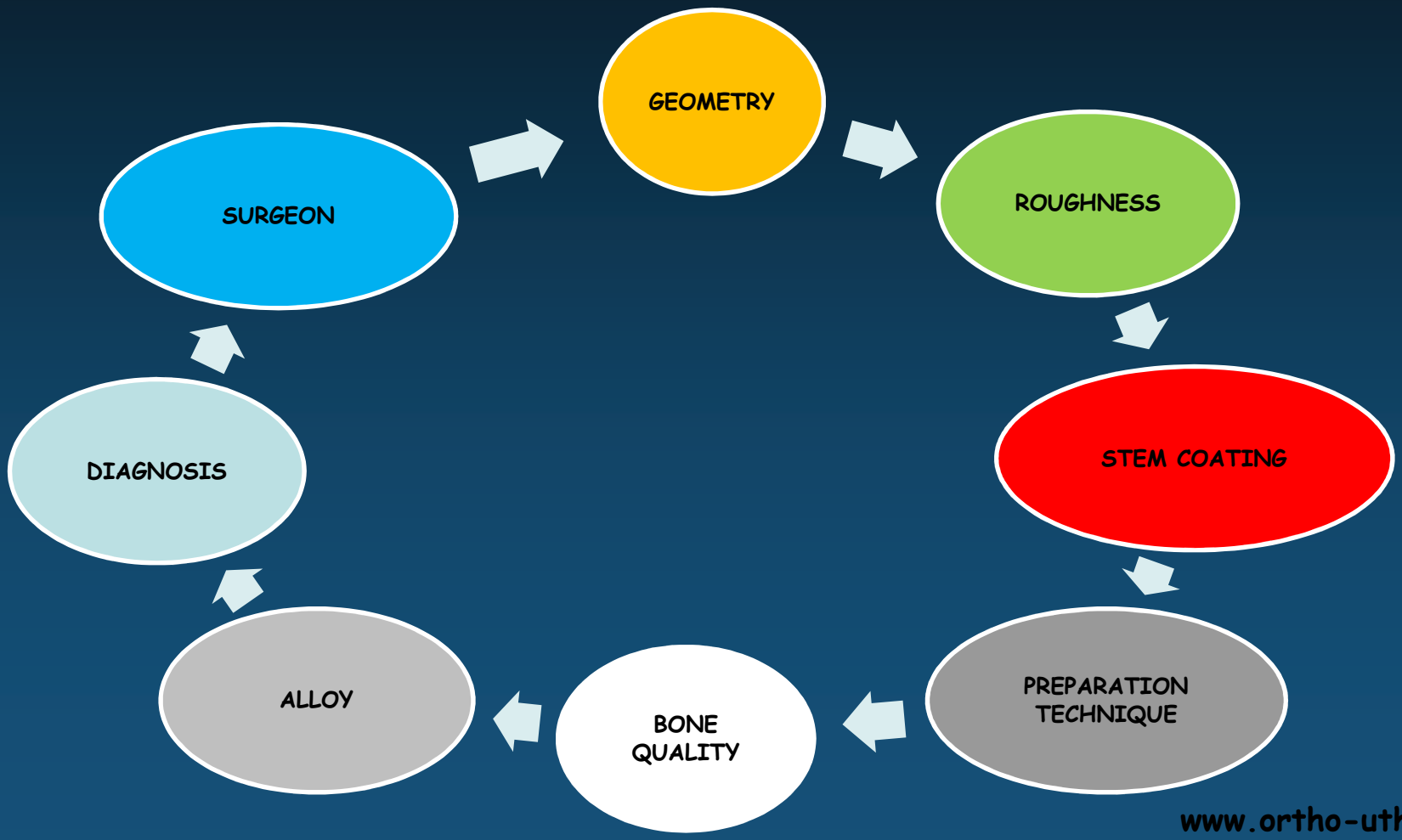


AMOUNT OF POROUS COATING

- EXTEND OF COATING DEPENDS ON
  - STEM PHILOSOPHY
  - TYPE OF COATING
  - STEM MATERIAL

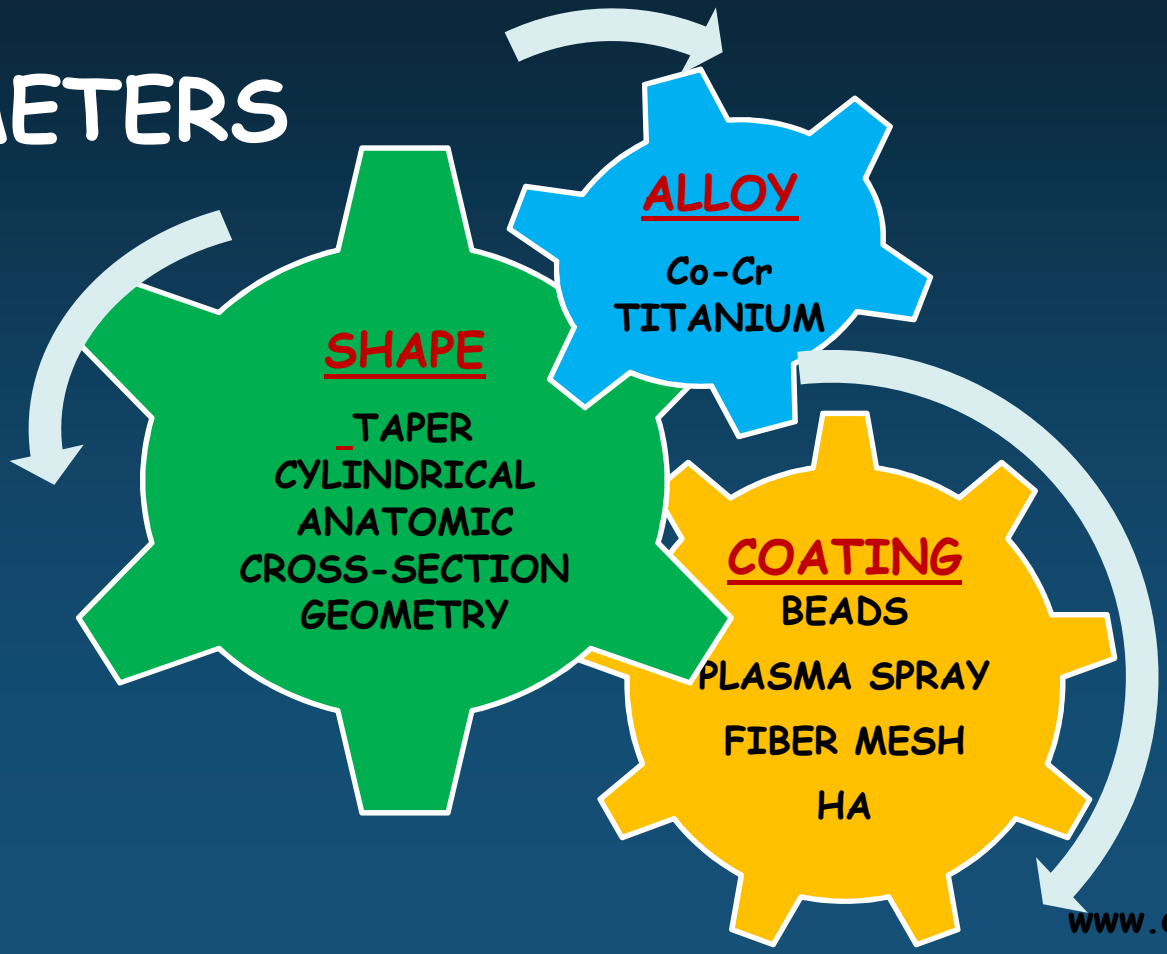
- TAPERED TITANIUM STEM
  - PROXIMAL PRESS FIT
  - PROXIMAL COATING
    - LOADED AREA IS COATED
  - "NOTCH SENSITIVE"
- CYLINDRICAL CoCr STEM
  - MORE EXTENSIVELY COATED
  - NO ALTERED STRENGTH

VARIABLES
CEMENTLESS LONG TERM FIXATION



DESIGN PRINCIPLES CEMENTLESS FEMORAL STEMS

- PARAMETERS



COBALT - CROMIUM ALLOYS

- COMPOSITIONS MANUFACTURED BY
  - CASTING (ASTM F17 ALLOY)
  - FORGING (ASTM F799 ALLOY)
    - SUPERIOR MECHANICAL PROPERTIES
  - COLD WORKING (ASTM F90 AND F562)
    - SUBSTANTIAL MECHANICAL PROPERTIES
- CHROMIUM - CORROSION RESISTANCE LAYER
- RANGE OF MECHANICAL PROPERTIES
- QUALITY CONTROL PROBLEMS
  - CASTING PROCESS
- DISADVANTAGES
  - CREVICE CORROSION AND STRESS CORROSION
- FIXATION DEVICES AND ARTHROPLASTIES
  - STEMS - HEADS -ARTICULATING SURFACES

Typical Mechanical Properties of Implant Metals

Material	ASTM Designation	Condition	Elastic Modulus (GPa)	Yield Strength (MPa)	Ultimate Strength (MPa)	Endurance Limit (MPa)
Stainless steels	F55, F56, F138, F139	Annealed	190	331	586	241–276
		30% Cold-worked	190	792	930	310–448
		Cold forged	190	1213	1351	820
Cobalt alloys	F75	As cast/annealed	210	448–517	655–889	207–310
		Hip*	253	841	1277	725–950
	F799	Hot forged	210	896–1200	1399–1586	600–896
	F90	Annealed	210	448–648		951–1220
		40% Cold-worked	210	1606	1896	586
	F562	Hot forged	232	965–1000	1206	500
		Cold-forged/aged	232	1500	1795	689–793
Titanium alloy	F67	30% Cold-worked	110	485	760	300
	F136	Forged annealed	116	896	965	620
		Forged/heat treated	116	1034	1103	620–689

* HIP = hot isostatically pressed; ASTM = American Society for Testing and Materials. (Reproduced with permission from Ratner BD, Hoffman AS, Schoen FJ, Lemons JE (eds): *Biomaterials Science: An Introduction to Materials in Medicine*. San Diego, CA, Academic Press, 1996.)

TITANIUM ALLOYS

- Ti-6Al-4V (ASTM F136)
  - TITANIUM-ALUMINIUM-VANADIUM ALLOY
    - AEROSPACE TECHNOLOGY
    - HIGH STRENGTH TO WEIGHT RATIO MATERIAL
    - LOW OXYGEN MANUFACTURING PROCESS
    - 2-PHASE FINE GRAINS
    - OPTIMAL ??? MECHANICAL PROPERTIES FOR ORTHOPAEDIC APPLICATIONS – LOW ELASTIC MODULUS
  - DISADVANTAGES
    - NOTCH OR SCRATCH SENSITIVITY-NOT FOR ARTICULATING SURFACES
    - SHARP ENDS-STRESS RISERS
    - LOW HARDNESS
      - MICROMOTION – SIGNIFICANT WEAR
      - TITANIUM AND VANADIUM IONS
      - NIOBIUM

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		Cold worked	90	1213	1351	820
Cobalt alloys	F75	As cast/annealed	210	448–517	655–889	207–310
		Hip*	253	841	1277	725–950
	F799	Hot forged	210	896–1200	1399–1586	600–896
	F90	Annealed	210	448–648		951–1220
		44% Cold-worked	210	1606	1896	586
	F562	Hot forged	232	965–1000	1206	500
		Cold-forged/aged	232	1500	1795	689–793
Titanium alloy	F67	25% Cold-worked	110	485	760	300
	F136	Forged annealed	116	896	965	620
		Forged/heat treated	116	1034	1103	620–689

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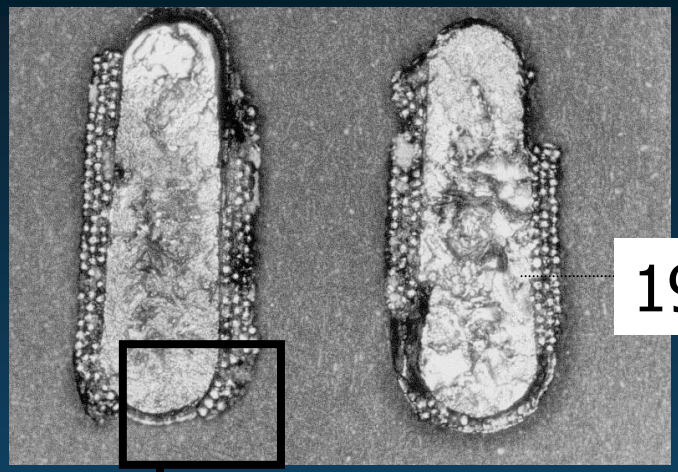
TITANIUM FEMORAL STEMS

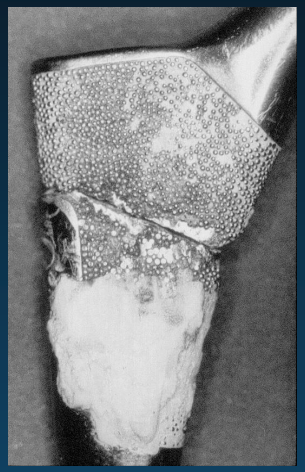
FAILURE AT 2 YEARS

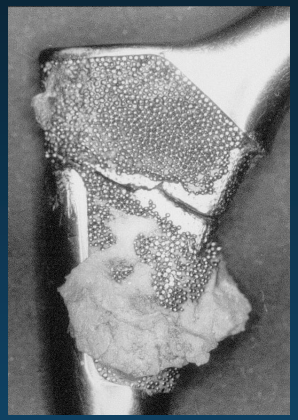
Magnisalis, Karachalios, Hartofilakidis

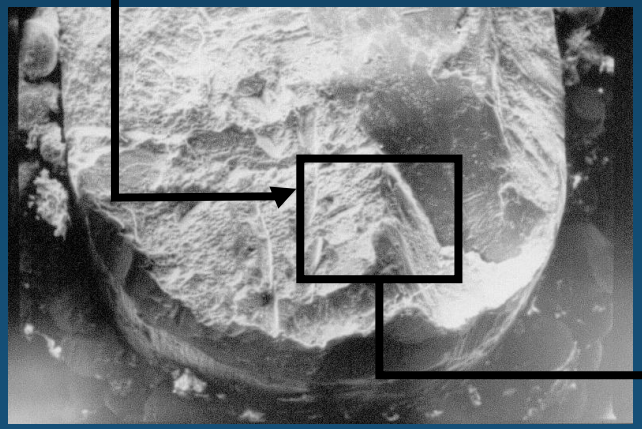
J Biomat Res 2003

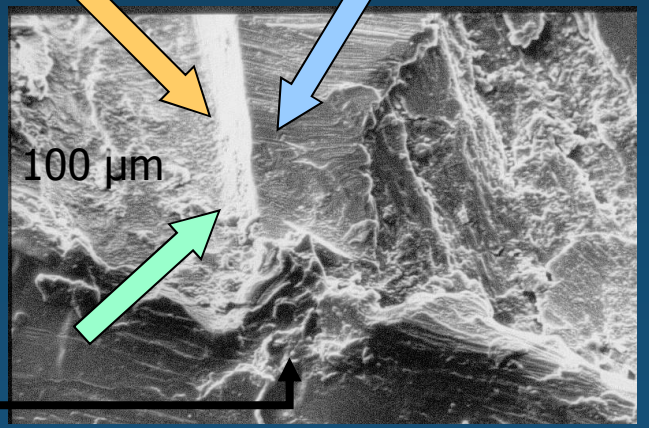


19 mm









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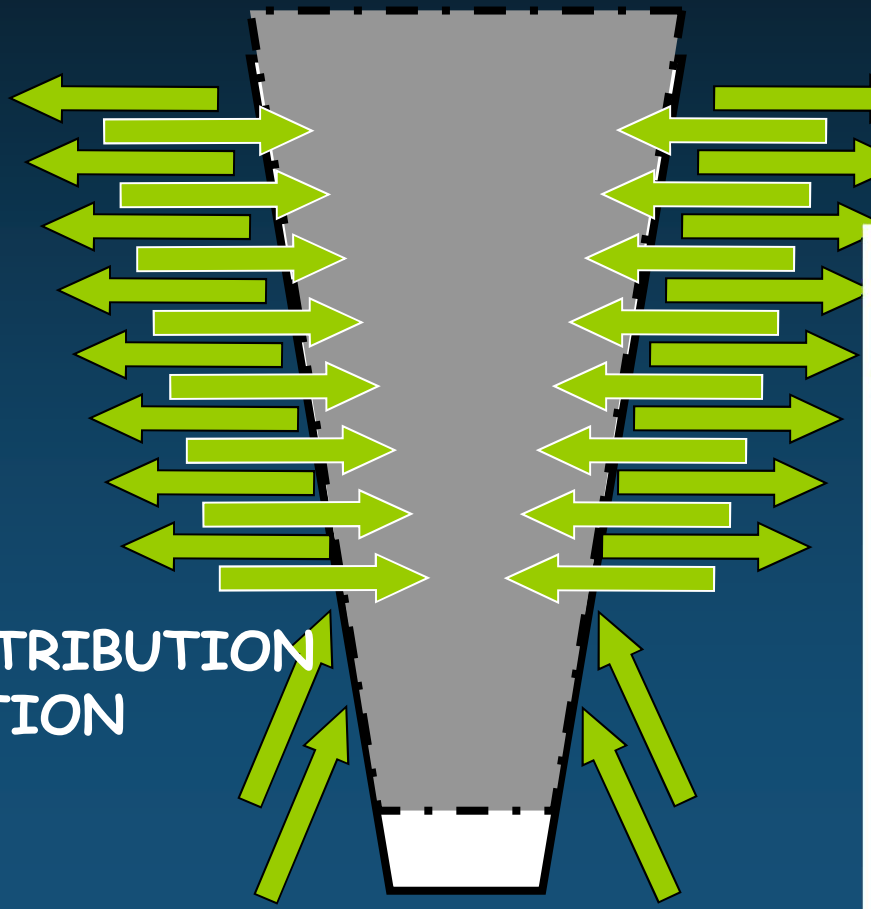
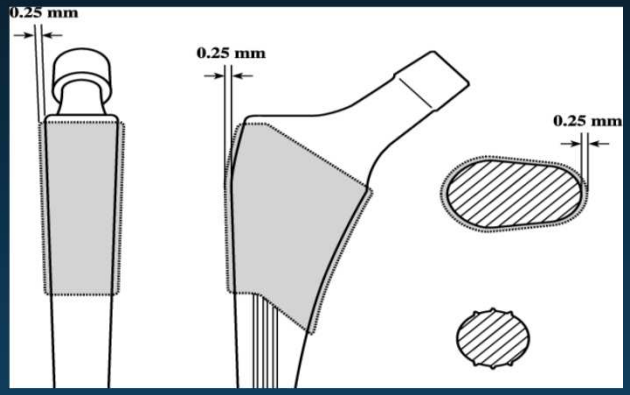
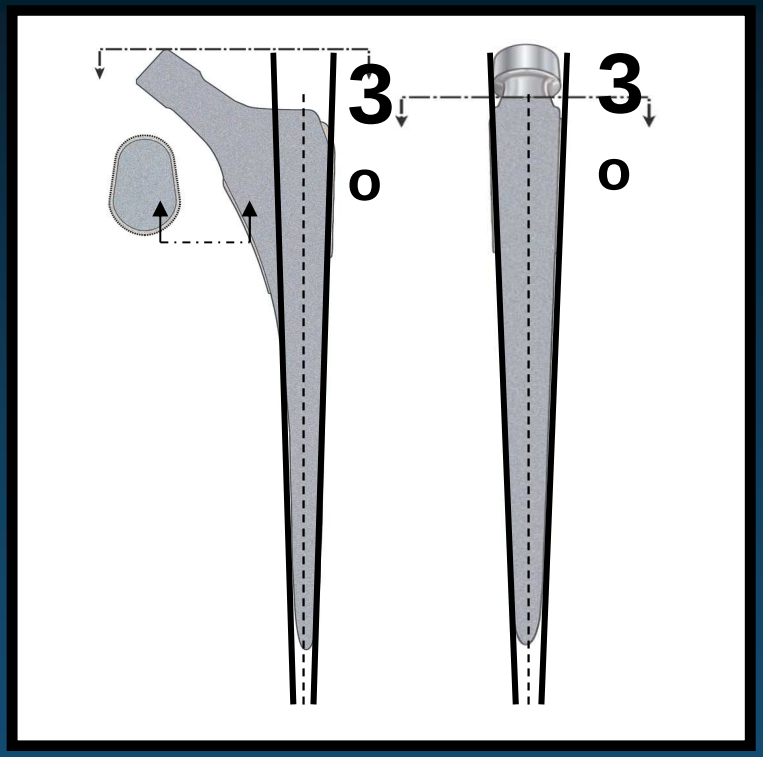
WEDGE SHAPE



- INITIAL STABILITY
- IMPROVED STRESS DISTRIBUTION
- IMPROVED INCORPORATION

SHAPE

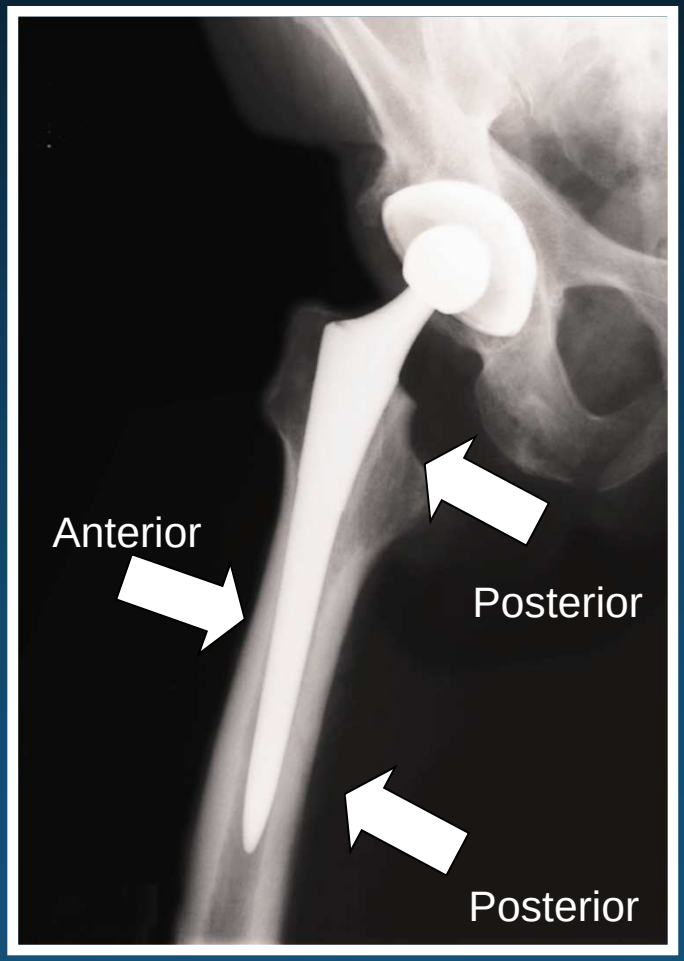




- 3 DEGREES WEDGE
  IN THE FRONTAL AND SAGGITAL PLANE
- THE SHAPE OF THE TRANSVERSE SECTION ???

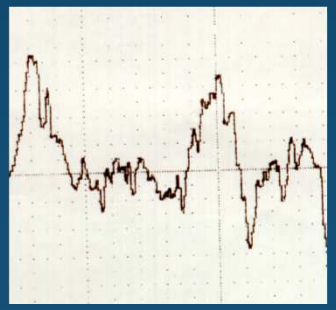
FIXATION

PROXIMAL LOAD TRANSFER
3X POINT FIXATION
·MAXIMISES RIGIDITY
·PROVIDES LONG-TERM STABILITY

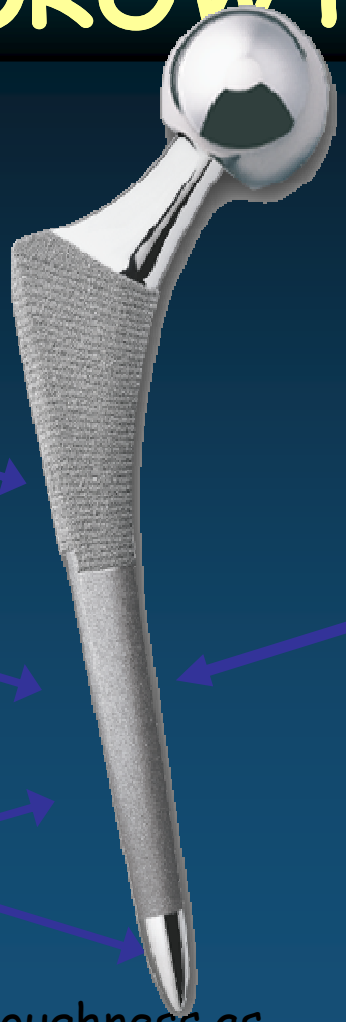


TRANSITION OF COATINGS IN AND ON-GROWTH

- In-growth
- On-growth
- No-growth



Grit blasted surface roughness as measured by profilometry



Grit-blasting for on-growth

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PLASMA SPRAY

- ROUGH COATING
- WEAKER MECHANICAL BOND
- ABRASION AND INCREASED WEAR
- TITANIUM ALLOY SURFACES ONLY
  - STRENGTH OF LONG REVISION STEMS
- LOW MANUFACTURING COST

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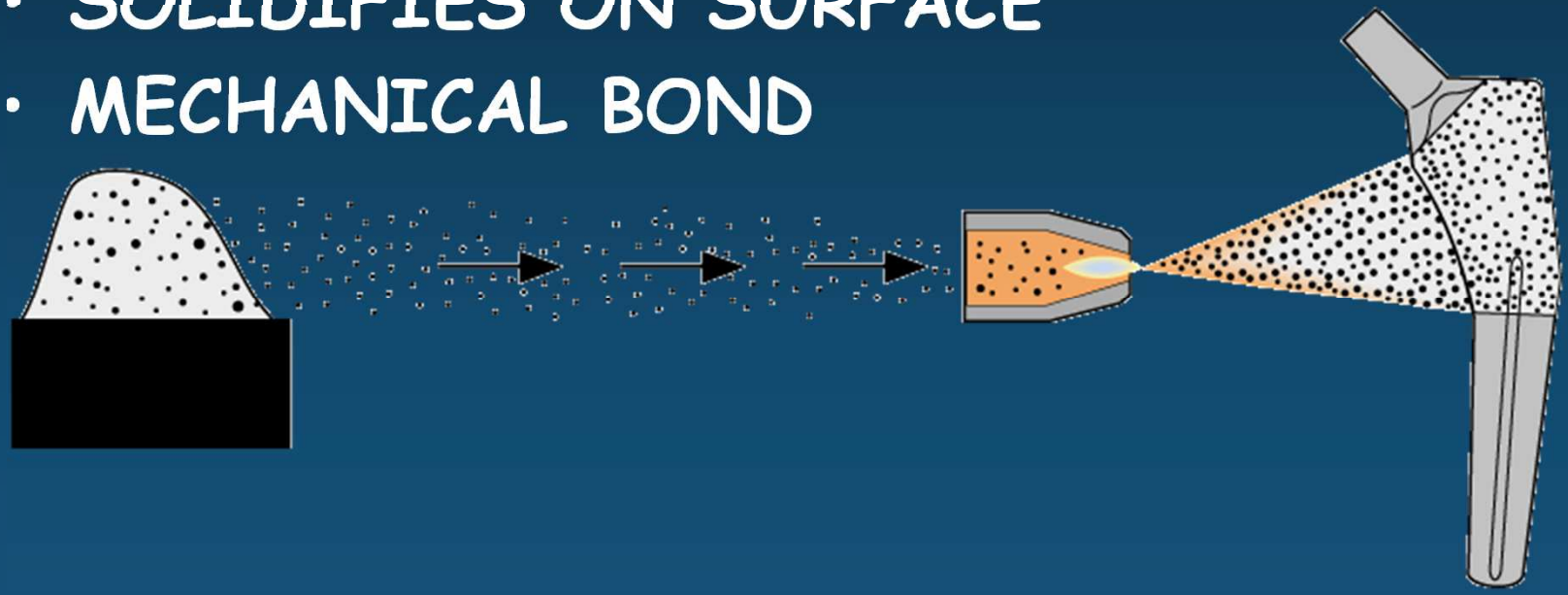
MANUFACTURING OF PLASMA SPRAY

- HEAT Ti POWDER TO MOLTEN STATE
- SPRAYED ON STEM IN INERT GAS
- SOLIDIFIES ON SURFACE
- MECHANICAL BOND

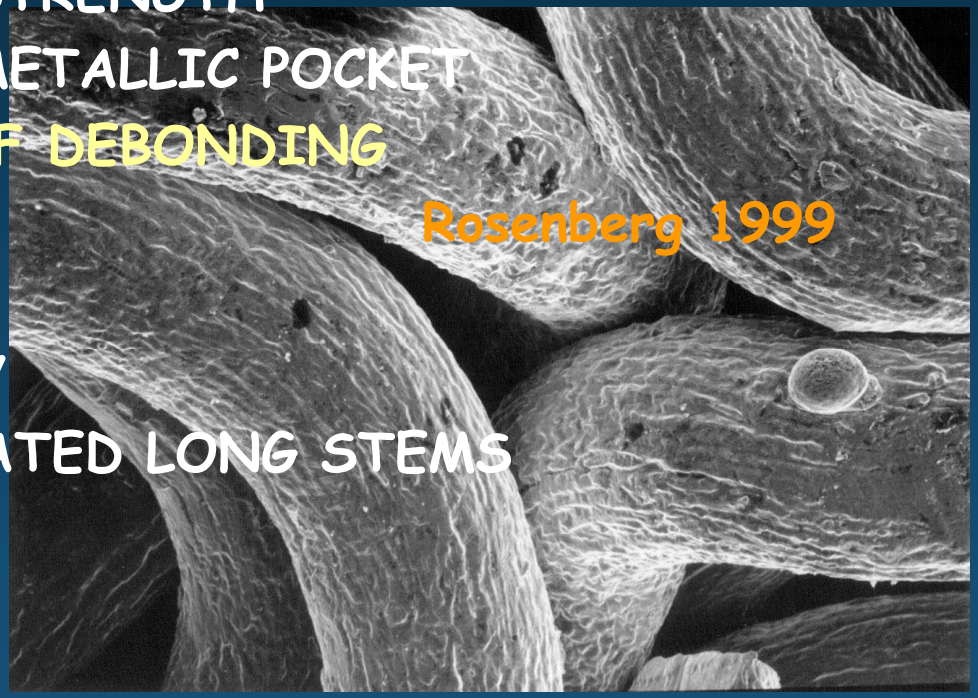


DIFFUSION BONDED WIRES

- BONE-COATING INTERLOCKING
  - INGROWTH vs ONGROWTH
- LOWEST ATTACHMENT STRENGTH
- ALWAYS APPLIED IN A METALLIC POCKET
  - INCIDENCE (12.2%) OF DEBONDING

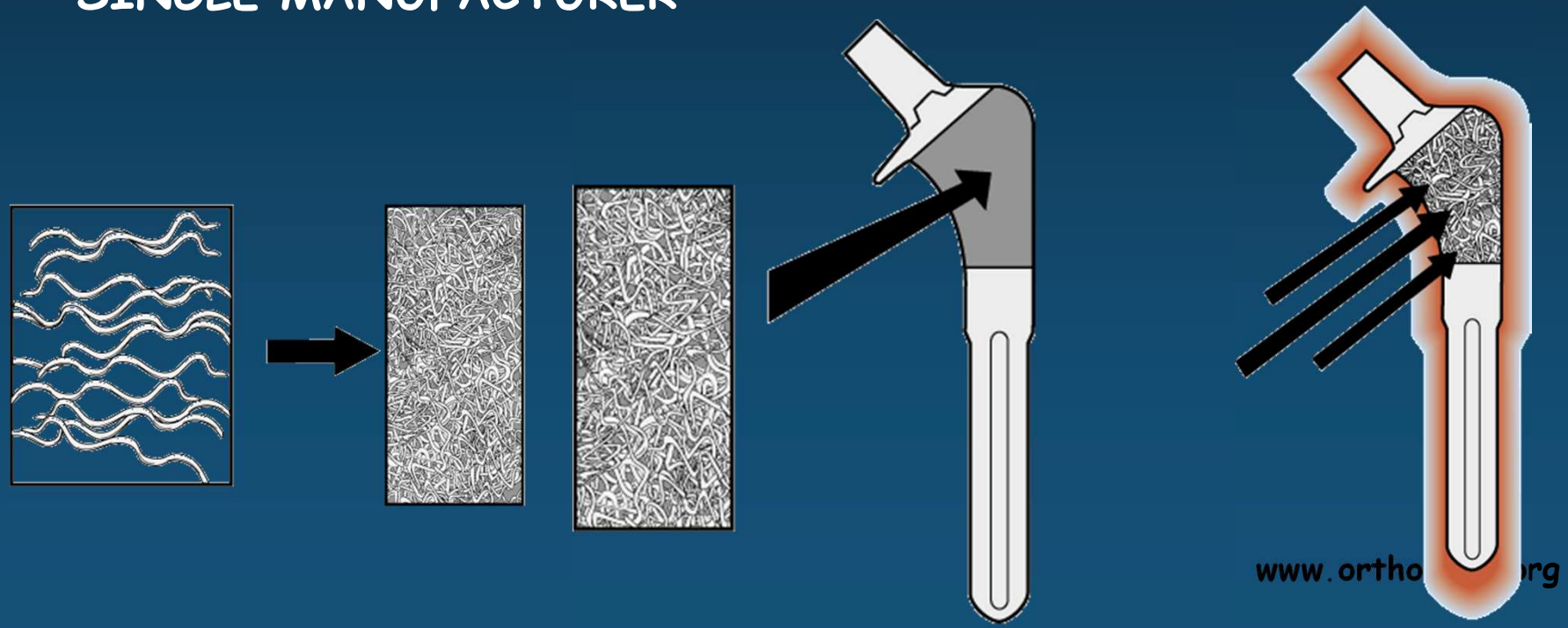
Rosenberg 1999

- NOT A ROUGH COATING
- TITANIUM ALLOYS ONLY
  - NO EXTENSIVELY COATED LONG STEMS



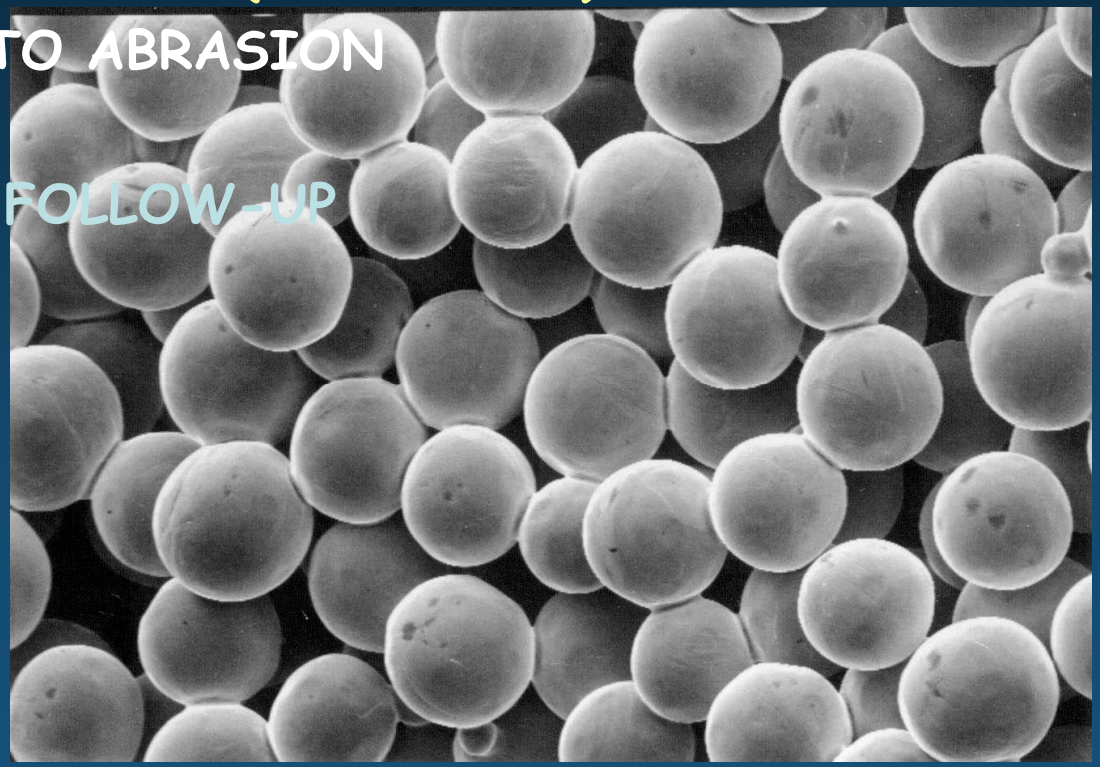
MANUFACTURING OF FIBER MESH PAD

- PRESSING METAL FIBERS INTO A MESH
- PAD APPLIED ON STEM WITH HEAT AND PRESSURE
- LOWER TEMPERATURE THAN SINTERING
- NO NEED FOR SUBSEQUENT HEAT TREATMENT
- SINGLE MANUFACTURER



SINTERED BEADS

- WIDEST CLINICAL USE
- EXCELLENT BOND STRENGTH
- BONE-COATING INTERLOCK (INGROWTH)
- HIGH RESISTANCE TO ABRASION
- Ti AND CoCr
- LONGEST CLINICAL FOLLOW-UP



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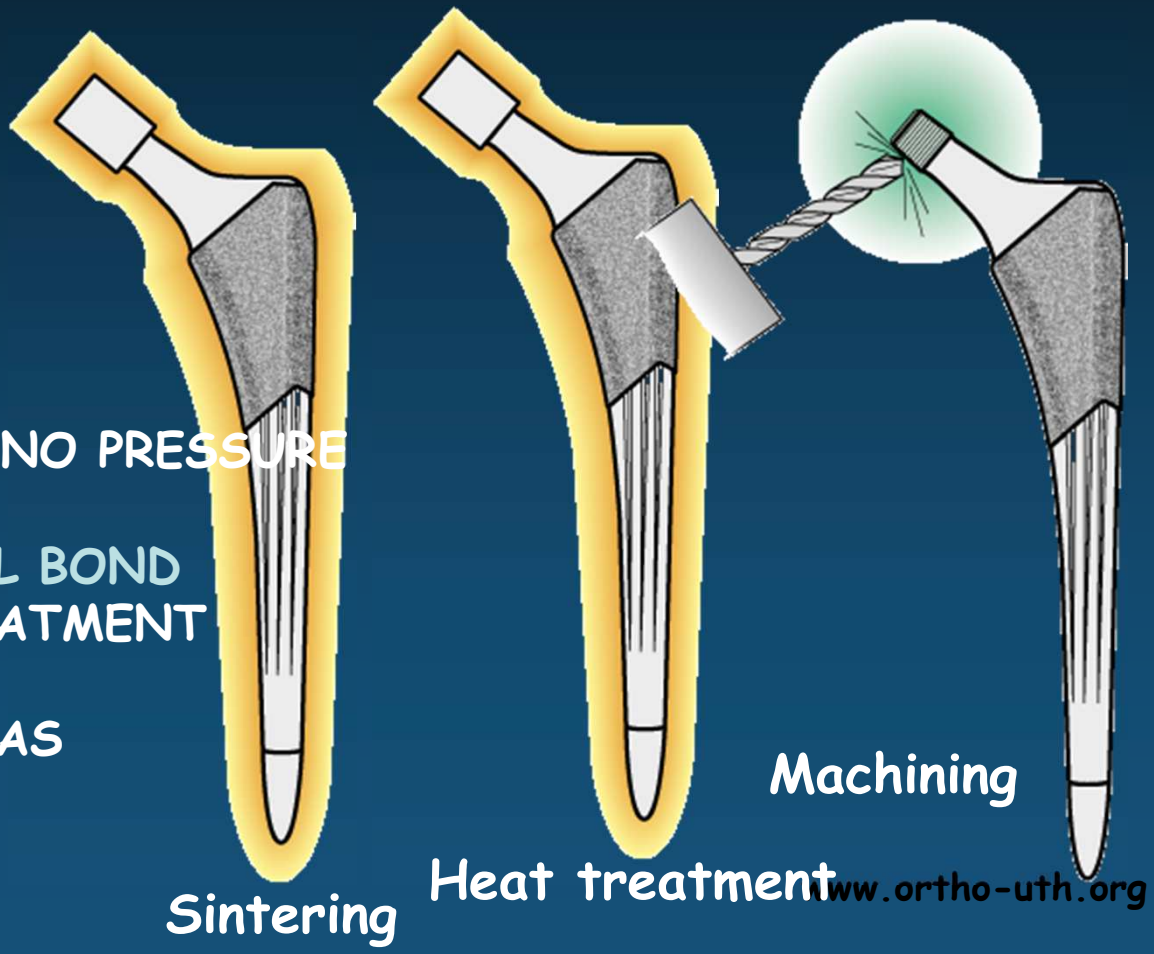
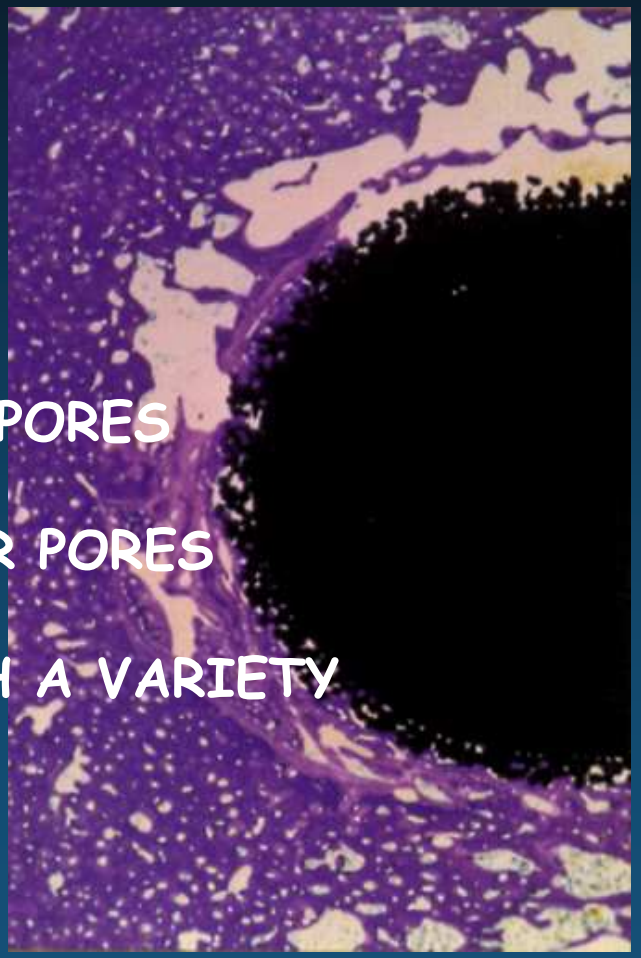
SINTERED BEAD MANUFACTURING

- APPLIED WITH BINDER
- HIGH TEMPERATURE AT NO PRESSURE
- BINDER DISSIPATES
- STRONG METALLURGICAL BOND
- SUBSEQUENT HEAT TREATMENT NECESSARY
- MACHINE CRITICAL AREAS



OPTIMUM PORE SIZE RANGE

- OPTIMUM RANGE 100-400μ
- BONE CAN NOT GROW IN SMALLER PORES
- TAKES LONGER TO GROW IN LARGER PORES
- PORE SIZE CAN BE MEASURED WITH A VARIETY OF METHODS



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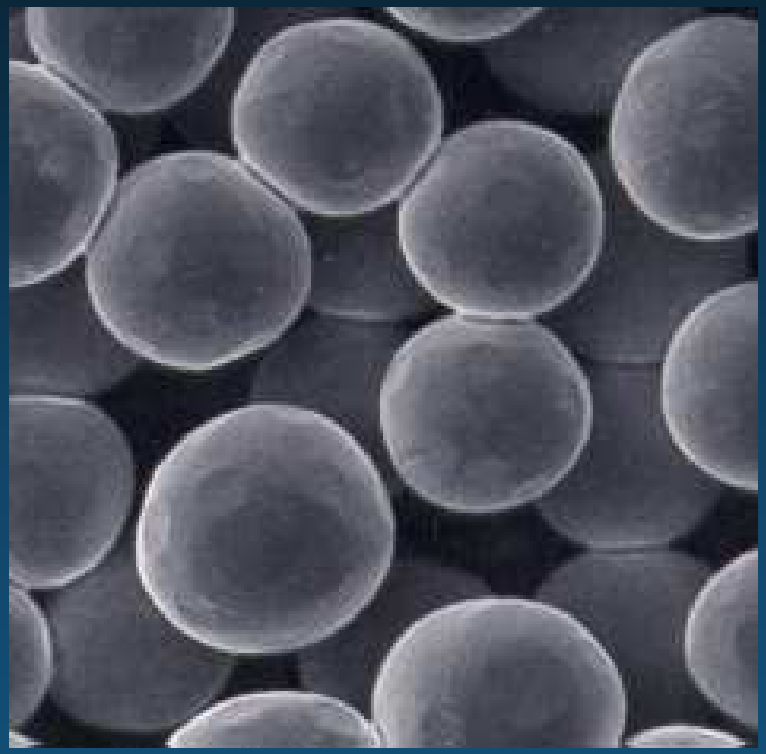
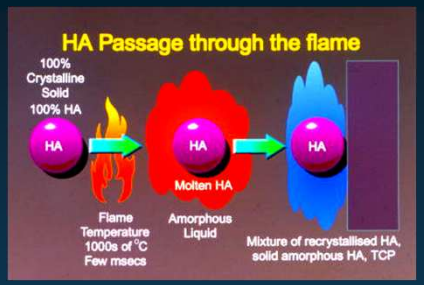
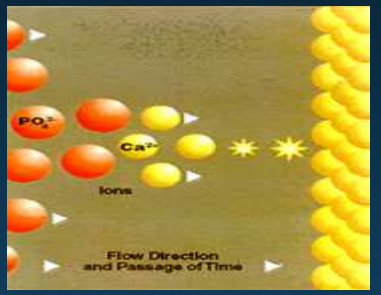
VOLUME PERCENT POROSITY

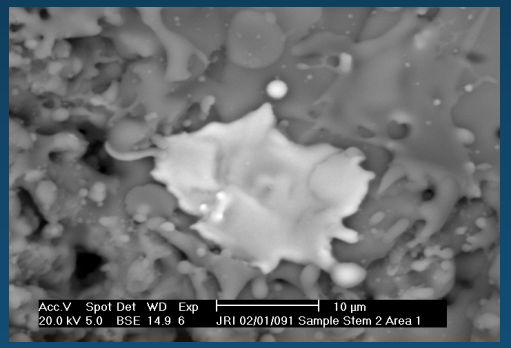
- VOLUME OF VOID SPACE
- BONE GROWS IN VOID
- RANGE STUDIED IS 30-40%
  - 80-90%???



HA COATING
IMPLANT – HA INTERFACE







- FLAME - SPRAYING
- PLASMA - SPRAYING
  - 75µ THICKNESS

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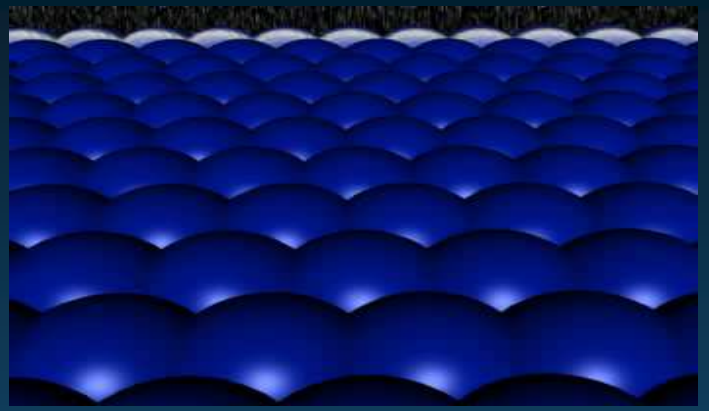
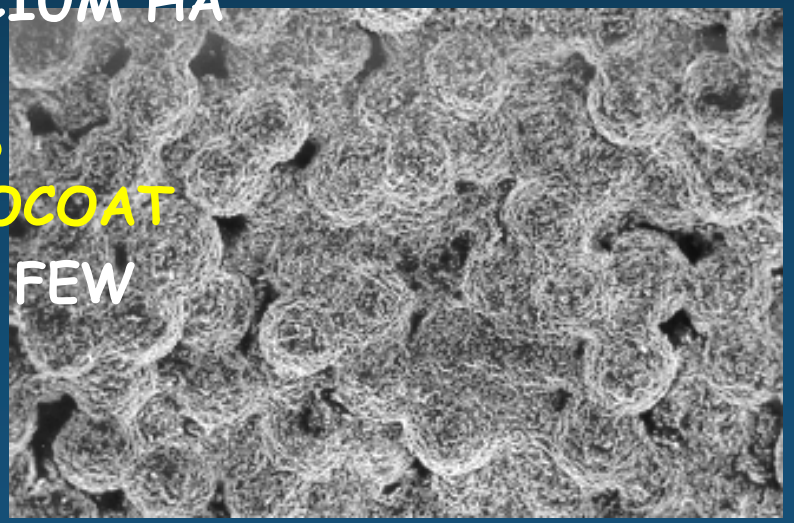
DUOFIX HA COATING



- PRECISION CONTROLED THERMAL PROJECTION PLASMA SPRAY APPLICATION OF CERAMIC CALCIUM HA OVER POROCOAT
- OPTIMUM COATING THICKNESS MAINTAINS POROSITY OF POROCOAT
- HA COATING DISPPEARS AFTER FEW WEEKS (35 micron)

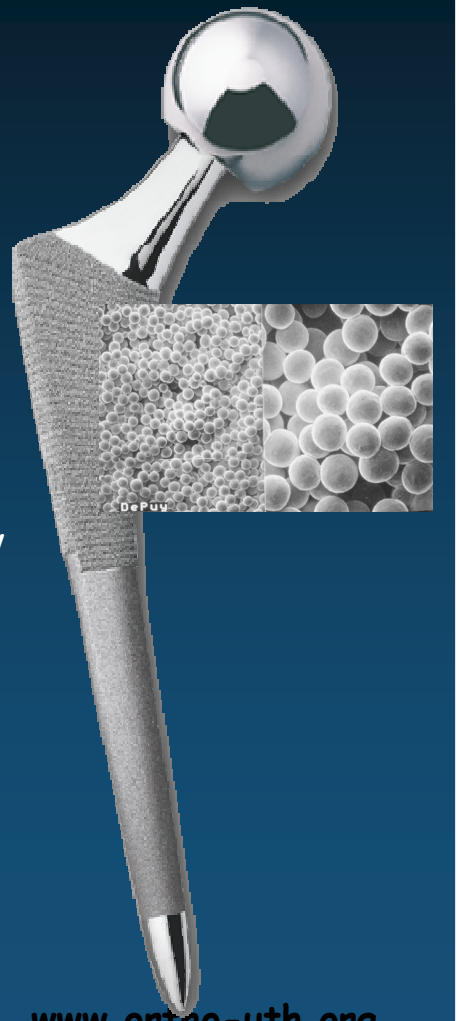


SUMMIT

- TITANIUM ALLOY Ti 6Al-4V (3-DEGREE TAPERED STEM)
- PROXIMAL FIXATION
- POROCOAT POROUS COATING
  - Pore size of 250 microns:
  - "…a pore size range of approximately 50 to 400 µm

"The Optimum Pore Size for the Fixation of Porous-Surfaced Metal Implants by the Ingrowth of Bone" J.D. Bobyn, Ph.D., R. M. Pillar, Ph.D., , H. U. Cameron, M.D. and G. C. Weatherly, Ph.D. Basic Science and Pathology Section III October 1979

- RADIAL ZTT STEPS
- DUOFIX HYDROXYAPATITE COATING
- DISTAL GRIT-BLASTED SURFACE



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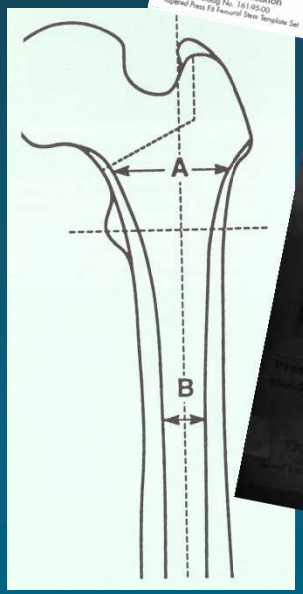
PROXIMAL COATING

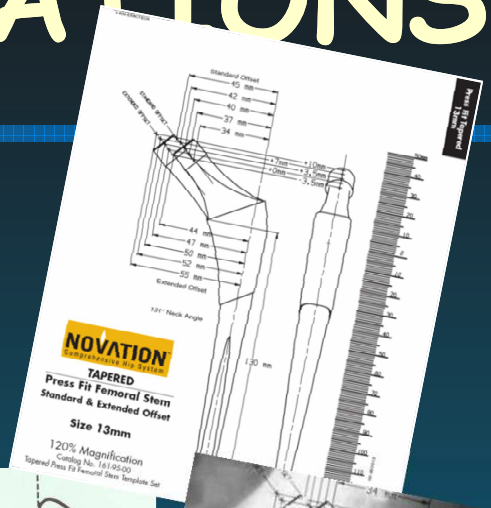
- ZTT RADIAL STEPS
- STEPPED TRANSITION
- LOAD TRANSFER
- INCREASE SUMMIT POROUS SURFACE AREA BY 13%
- ROUGH, 20-GRIT BLAST SURFACE - DISTAL STEM Ra 125 TO 150 MICRO-INCH-BONE ONGROWTH
- POLISHED DISTAL END

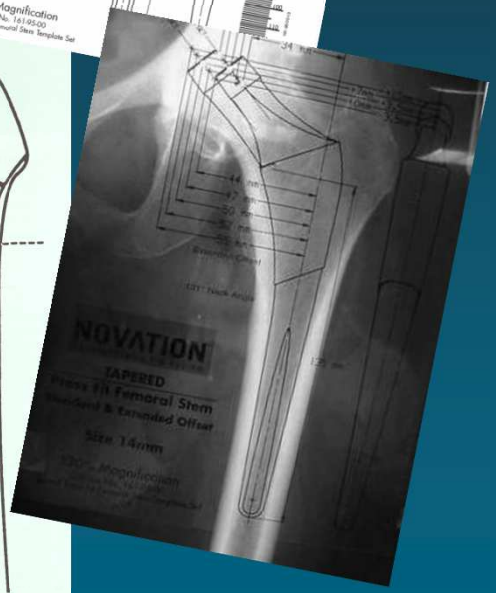
ANATOMICAL VARIATIONS

- HIP MORPHOLOGY

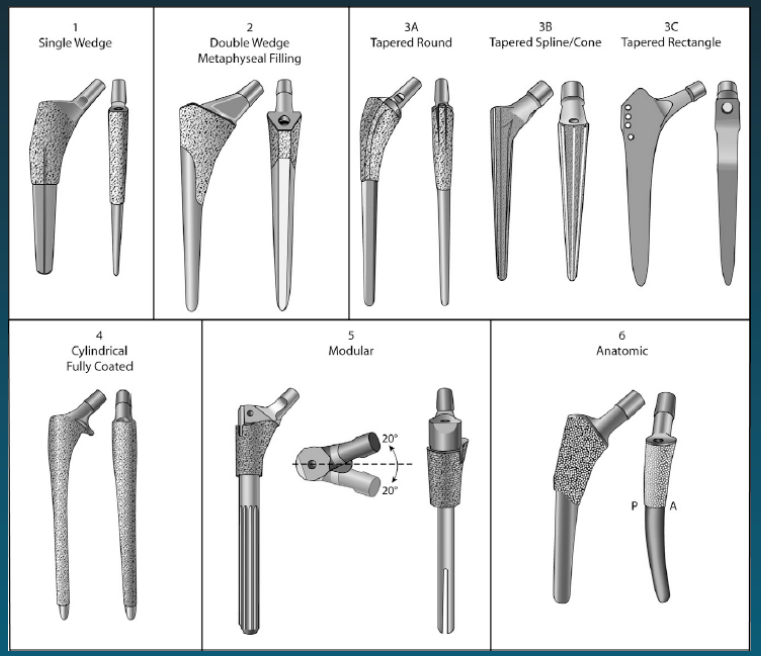
Dorr Bone 1993







CEMENTLESS FEMORAL STEM DESIGNS



Khanuja JBJS 2011 Berry AAOS 2000

- A CLASSIFICATION SYSTEM
- BASED ON
  SHAPE AND ALLOY PARAMETERS
- SURFACE TYPE PARAMETERS ????
- A MODIFICATION…..

TYPE 1A SINGLE WEDGE

TAPERED PROXIMAL FIXATION

- NUMEROUS REPORTS
- FIRST GENERATION ROUGH GRIT BLASTED SURFA
  - SURVIVAL RATE AT 17 YRS 98.8%
  - THIGH PAIN 25%
  - STRESS SHIELDING 84%

Muller Arch Orthop Trauma Surg 2009

  - YOUNG PATIENTS
  - SURVIVAL RATE AT 20 YRS 90%
  - NO THIGH PAIN

Aldinger JBJS 2009

TYPE 1B SINGLE WEDGE

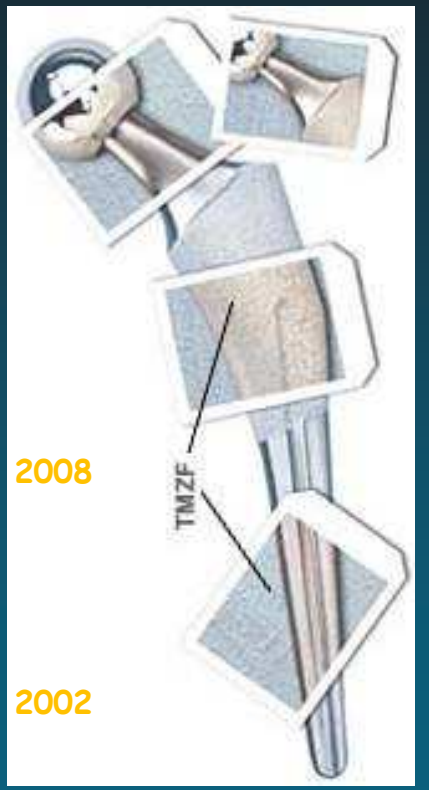
TAPERED PROXIMAL FIXATION

- NUMEROUS REPORTS
- FIRST GENERATION PLASMA SPRAY
- SECOND GENERATION POROUS COATED (SINTERED BEADS)
  - SURVIVAL RATE AT 22 YRS 99%
  - THIGH PAIN 3%

  - YOUNG PATIENTS
  - DORR A AND B
  - SURVIVAL RATE AT A MINIMUM 10 YRS 94%
  - THIGH PAIN 4%

  - EXPANDED INDICATIONS
  - RA ARTHRITIS, DORR TYPE C
  - SURVIVAL RATE AT 10 TO 15 YRS ~100%
  - MILD THIGH PAIN

McLaughlin JBJS 2008



Teloken JBJS 2002

Burt JBJS 1998
Purtil Clin Orthop 2001
Keisu JBJS 2001

TYPE 2A DOUBLE WEDGE

METAPHYSEAL FILLING - TAPERED PROXIMAL FIXATION

- EXCELLENT MEDIUM AND LONG TERM RESULTS
- GRIT-BLASTED AND HA COATED
- SURVIVAL RATE AT 17-24 YRS 99.2 TO 99.5%

Capello JBJS 2003

Epinette Hip Int 2008

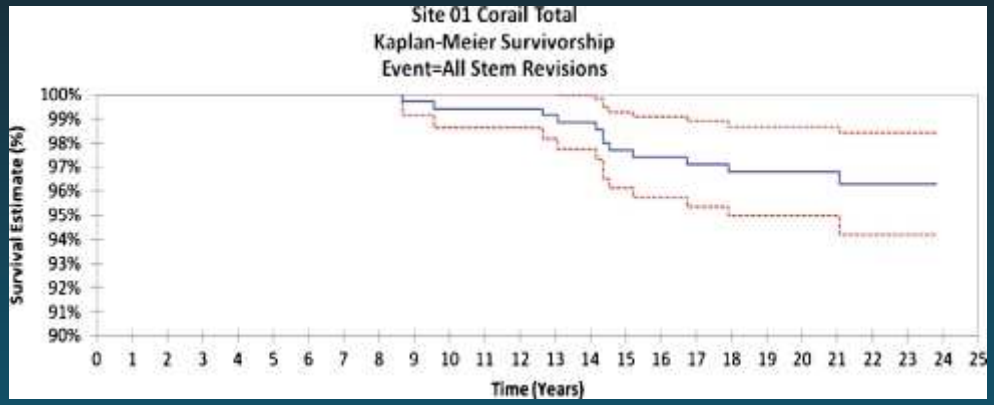
- YOUNG PATIENTS
- SURVIVAL RATE AT 15 YRS 95-100%
- THIGH PAIN 7-15%

Capello JBJS 2003

Lee JBJS 2003

TYPE 2B DOUBLE WEDGE

METAPHYSEAL FILLING - TAPERED PROXIMAL FIXATION



- EXCELLENT LONG TERM RESULTS
- SURVIVAL RATE AT 20 YRS 97%
- CUP FAILURES
- STRONG DATA FOR OSTEOPOROTIC BONE
  - HEMI-ARTROPLASTIES

Vidalain Int Orthop 2011

TOTAL HIP ARTHROPLASTY
HA-COATED

- 180 CORAIL IMPLANTS
- 15-25 YEARS OF FOLLOW-UP
- 5 CUP REVISIONS
- NO MIGRATION AND ASEPTIC LOOSENING OF THE FEMORAL STEM

Karachalios, Diakomopoulos
Karachalios J Arthroplasty 2004

www.ortho-uth.org

TYPE 3C TAPERED RECTANGLE

TAPERED DISTAL FIXATION

- UNIQUE DESIGN
- WIDELY USED IN EUROPE – EXCELLENT LONG TERM RESULTS
- NO MODIFICATIONS
- DORR C
- SURVIVAL RATE AT 15-20 YRS 95-98%
- THIGH PAIN 2-4%
- STRESS-SHIELDING 15-30%

Carcia –Cimberelo JBJS 2003

Grubl JBJS 2006

Reigstad Acta Orthop Scand 2008

Suckel J Arthoplasty 2009

TYPE 4 CYLINDRICAL

FULLY COATED – DISTALLY FIXED

- A NUMBER OF LONG TERM CLINICAL STUDIES
- EXCELLENT CLINICAL RESULTS - NORTH AM
- FIRST GENERATION
- COBALT CHROMIUM 80% PROX COATED
  - SURVIVAL RATES AT 22 YRS 98%
  - YOUNG PATIENTS
  - SURVIVAL RATE AT 10- 15 YRS 96-99%

Engh Clin Orthop 2001
Belmont JBJS 2008
McAuley Clin Orthop 2004
Moyer Clin Orthop 2010

  - STRESS SHIELDING
  - THIGH PAIN 4-8%

Nourbash Clin Orthop 1998
Engh Clin Orthop 1998
Engh Clin Orthop 1988

  - LARGER STEMS INFERIOR RESULTS

Engh J Arthoplasty 2009

METALS AND ALLOYS
COST - EFFECTIVENESS

SUPER-ALLOYS AND DESIGNS IN ORTHOPAEDICS

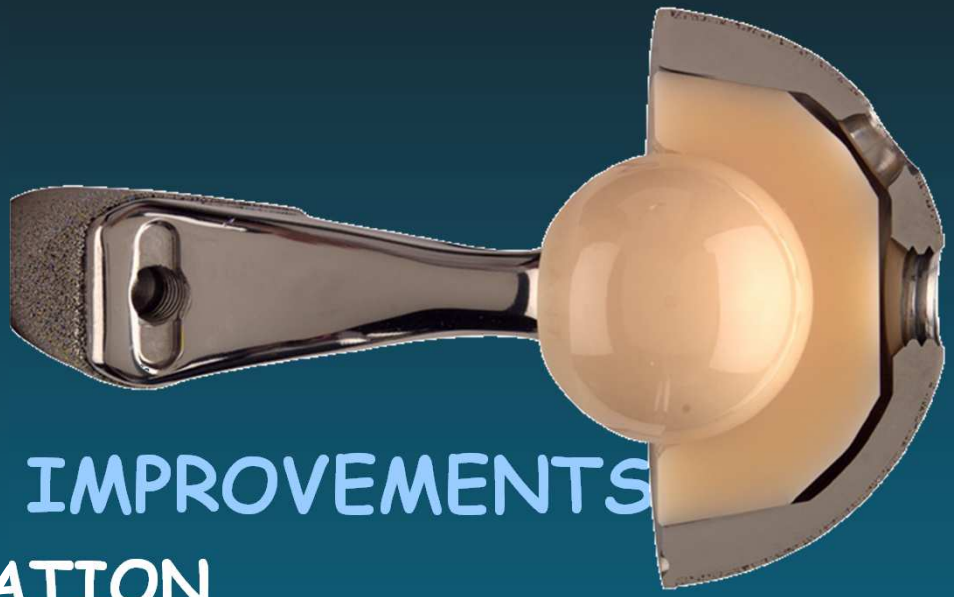
??????

…AS A SINGLE FACTOR…

….15 YEARS SURVIVORSHIP - 1.5% ASEPTIC LOOSENING…

…BEARING SURFACES DO MATTER…

MODERN THA

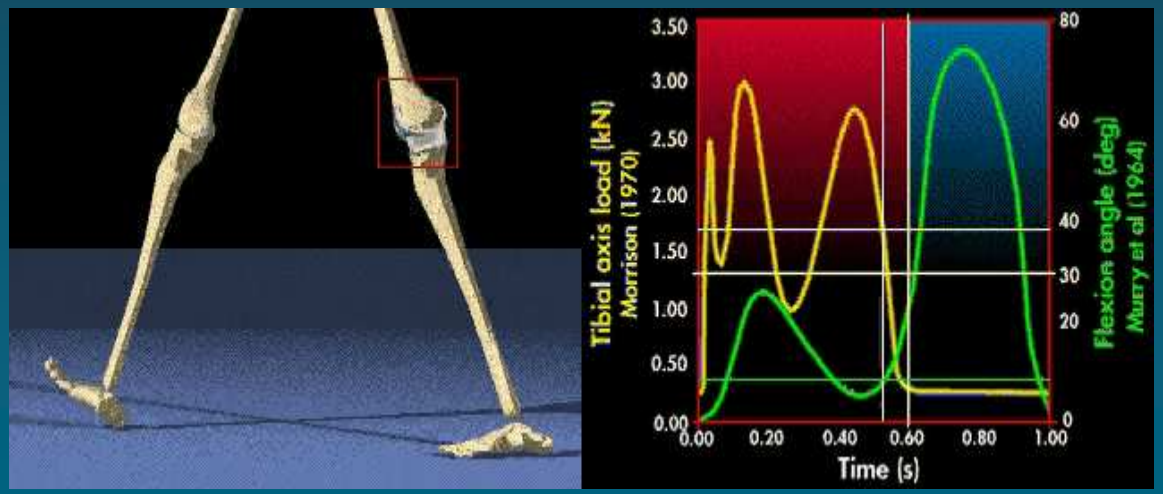


- COMBINATION OF IMPROVEMENTS
  - IMPLANT INTERGRATION
  - BEARING SURFACES
  - STRATEGIES TO TARGET THE CELLULAR COMPONENTS

Abu-Amer Arthritis Research & Therapy 2007

PERTICLES GENERATION

- TENS OF THOUSANDS OF PARTICLES (<5µm)
  - EVERY GAIT CYCLE

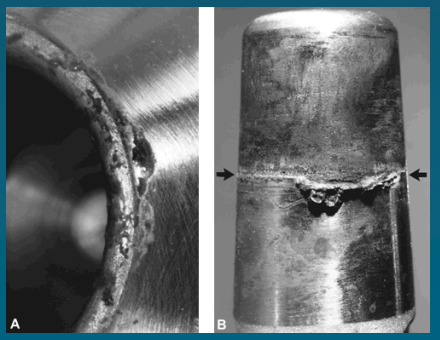


ASEPTIC LOOSENING

AETIOLOGY, PATHOGENESIS, CELLULAR RESPONCE

- AETIOLOGY
  - WEAR DEBRIS FROM
    - PROSTHETIC JOINT ARTICULATION
    - MODULAR INTERFACES
    - NONARTICULATING INTERFACES
    - IMPINGEMENT AREAS

Harris Clin Orthop 1995
Goldring JBJS 1993
Abu-Amer Arthritis Research & Therapy 2007

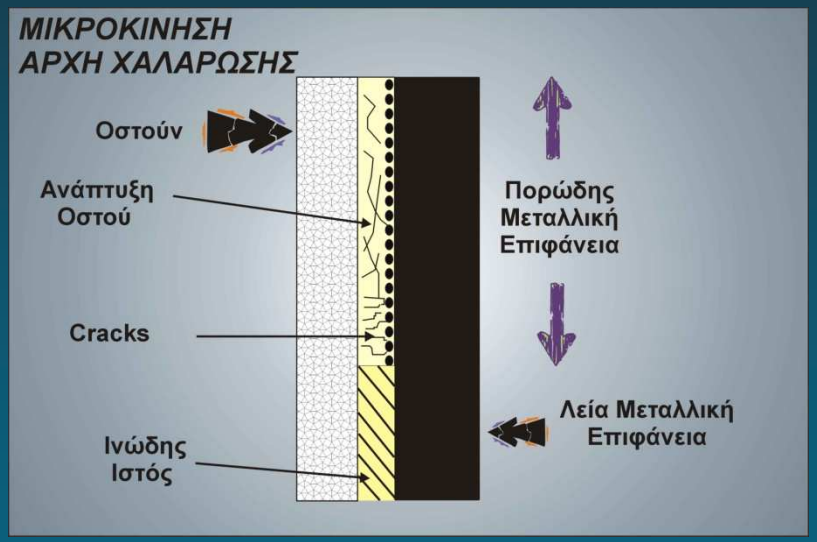


UNSTABLE BONE-IMPLANT INTERFACE

FAILURE - ASEPTIC LOOSENING

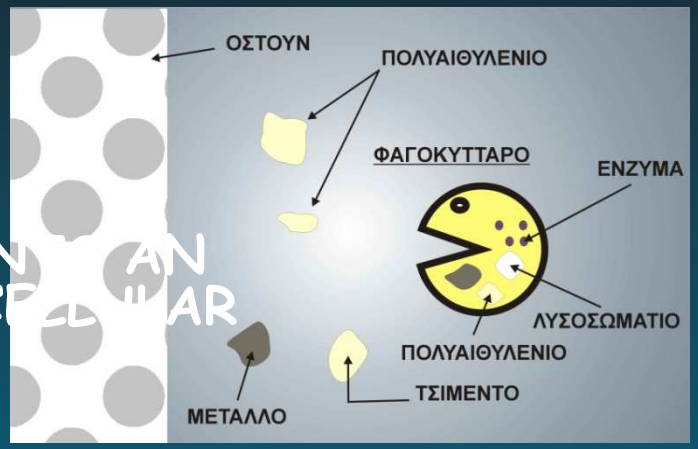
- ADAPTATION - TIME FACTOR
- CYCLIC LOADING - MICROMOTION
- FATIQUE TISSUE DAMAGE - REMODELING
- MICROFRACTURES – MICROCRAKS
- PUMBING - HYDRODYNAMIC EFFECT

- WEAR PARTICLESS



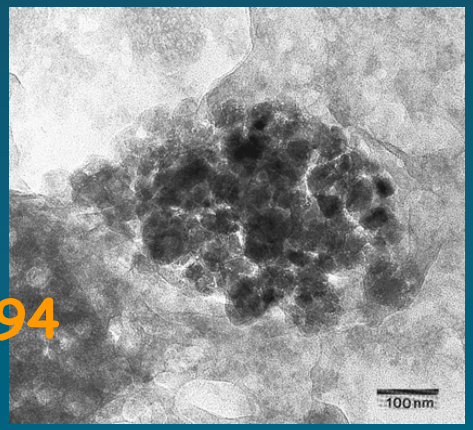
ASEPTIC LOOSENING

AETIOLOGY, PATHOGENESIS, CELLULAR RESPONCE



- PARTICLE PHAGOCYTOSIS REPRESEN[illegible]AN IMPORTANT COMPONENT OF THE C[illegible]AR RESPONSE
  - THE SIZE OF THE PARTICLES
  - PARTICLES RANGING FROM 0.2μm TO 10μm UNDERGO PHAGOCYTOSIS BY MACROPHAGES

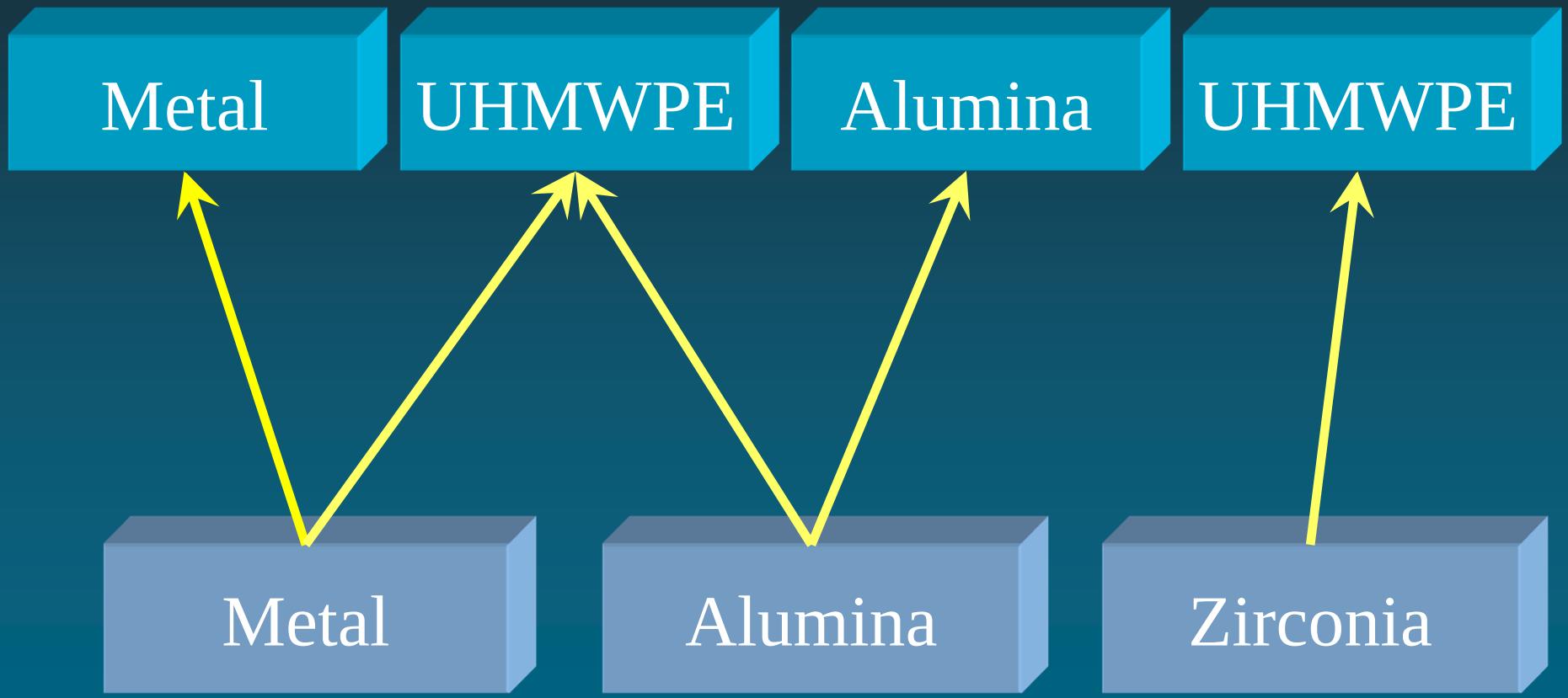
Gelb J Orthop Res 1994



TOTAL JOINT REPLACEMENT

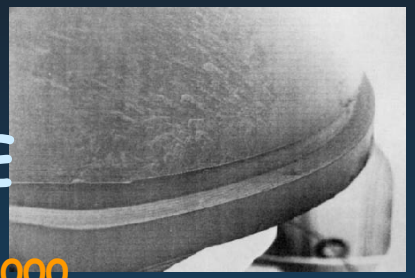
- ASEPTIC LOOSENING OF IMPLANTS
  - DISABLING CONDITION
  - AFFECTS PATIENTS 10 TO 20 YEARS AFTER JOINT REPLACEMENT SURGERY

BEARING OPTIONS IN TOTAL HIP ARTHROPLASTY



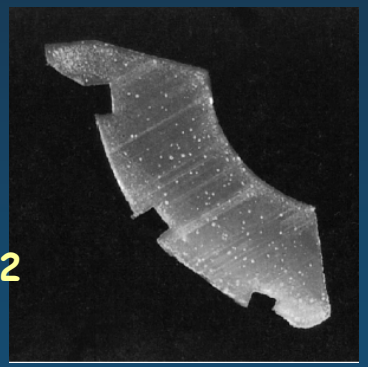
POLYETHYLENE

- RELIABLE LONG TERM PERFORMANCE
  - 20 YEARS FOLLOW UP



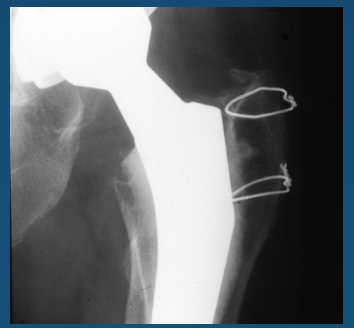
Wroblevski JBJS 2000

- OLD POLYETHYLENE
  - VOLUMETRIC WEAR RATE (50-100mm^3) 0.1-0.2mm /y
  - OSTEOLYSIS
  - ATTEMPT TO IMPROVE PERFORMANCE (eg HYLAMER) ????



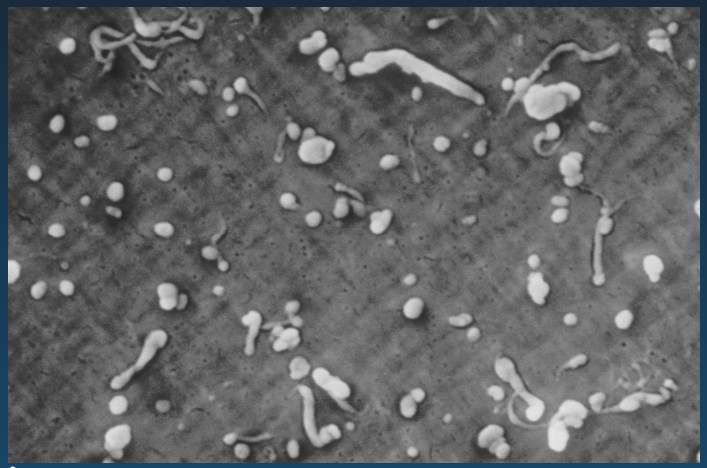
Pryor JBJS 1992

- CONVENTIONAL POLYETHYLENE
  - AVOIDANCE OF OXIDATIVE DEGRADATION
    - GAMMA IRRADIATION IN AIR
    - GAMMA IRRADIATION IN INERT
    - GAS STERILIZATION



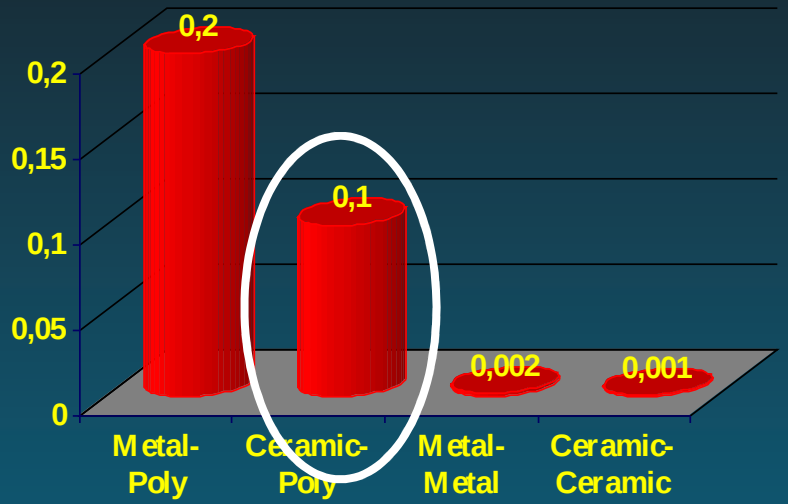
Jacobs JBJS 2007

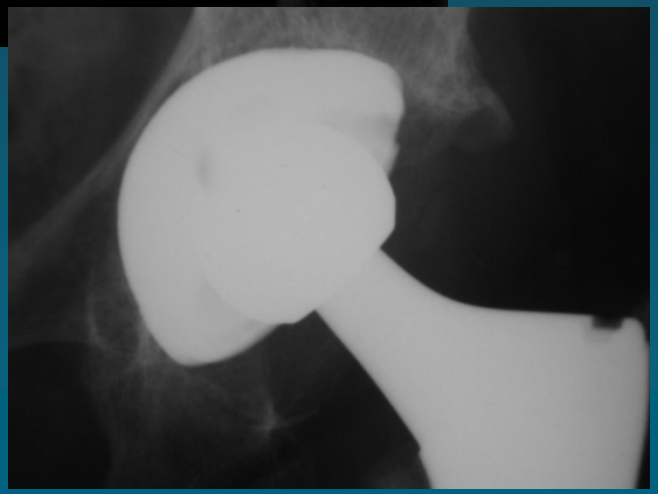
BASIC SCIENCE
WEAR PARTICLES



- CONVENTIONAL PE
  - SPHERICAL IN SHAPE
    - SIZE 0.1 TO 1μm (MEAN 0.5μm)
    - FIBRILS OF PARTICLES (W:0.3-1 μm, L:10-23μm)
  - CUP SCREW HOLES
    - SLIGHTLY BIGGER PARTICLES
  - SIZE PLAYS A ROLE IN BIOLOGICAL ACTIVITY

IMPROVEMENT ??





- THE LINER
- THE HEAD

POLYETHYLENE COMPARISON

Trade Name	Company	X-link Protocol	Annealing Step	Sterilization Method	Quoted Volumetric Wear Reduction	Wear Reduction vs. Standard Poly
Reflection XLPE	**Smith and Nephew**	**Gamma 10 Mrad (room temp)**	**melt**	**Gas (VHP or EtO)**	98%	98%
Longevity	**Zimmer**	E-beam **10 Mrad (~40 ° C)**	**melt**	**Gas (VHP Gas Plasma)**	**89%**	**94%**
Durasul	**Centerpulse**	E-beam **9.5 Mrad (~125 ° C)**	**melt**	**Gas (EtO)**	100%[a]	**No correlation possible**
Marathon	**Depuy / J & J**	**Gamma** 5 Mrad **(room temp)**	**melt**	**Gas (VHP Gas Plasma)**	86%	87%
Crossfire	**SHO**	**Gamma 7.5 Mrad (room temp)**	Below melt	Gamma (N_2) 2.5 Mrad	**90%**	**94%**
ArCom	**Biomet**	**none**	**none**	Gamma (N_2) 3.3 Mrad	**40%**	**45%**

CROSS LINKED PE
CLINICAL PERFORMANCE

- ACETABULAR COMPONENT DESIGN
  - MINIMAL DAMAGE TO PE
  - CLOSE PE LINER AND SHELL CONFORMITY
  - EVEN DISTRIBUTION OF STRESSES
  - REDUCED BACKSIDE WEAR
  - FEW SCREW HOLES
  - LINERSHELL LOCKING MECHANISM
  - PE THICKNESS
- TECHNIQUE
  - COMPONENT POSITIONING AND SOFT TISSUE TENSION

…. CONFOUNDING FACTORS….

FACTS
METAL ON METAL

- RETRIAVAL STUDIES
  - FIRST GENERATION METAL-METAL BEARINGS WITH LONG IN-VIVO SERVICE DEMONSTRATE LOW WEAR OF THE BEARING WITHOUT EVIDENCE OF ADVERSE LOCAL OR DISTANT TISSUE REACTIONS

    Schmalzried J Arthroplasty 1996
    McKellop Clin Orthop 1996
    Howie J Arthroplasty 2005
  - WHEN THE DESIRED TRIBOLOGICAL CONDITIONS ARE MET, METAL-METAL WELL-TOLERATED AND CAN FUNCTION FOR THREE DECADES WITH LITTLE WEAR

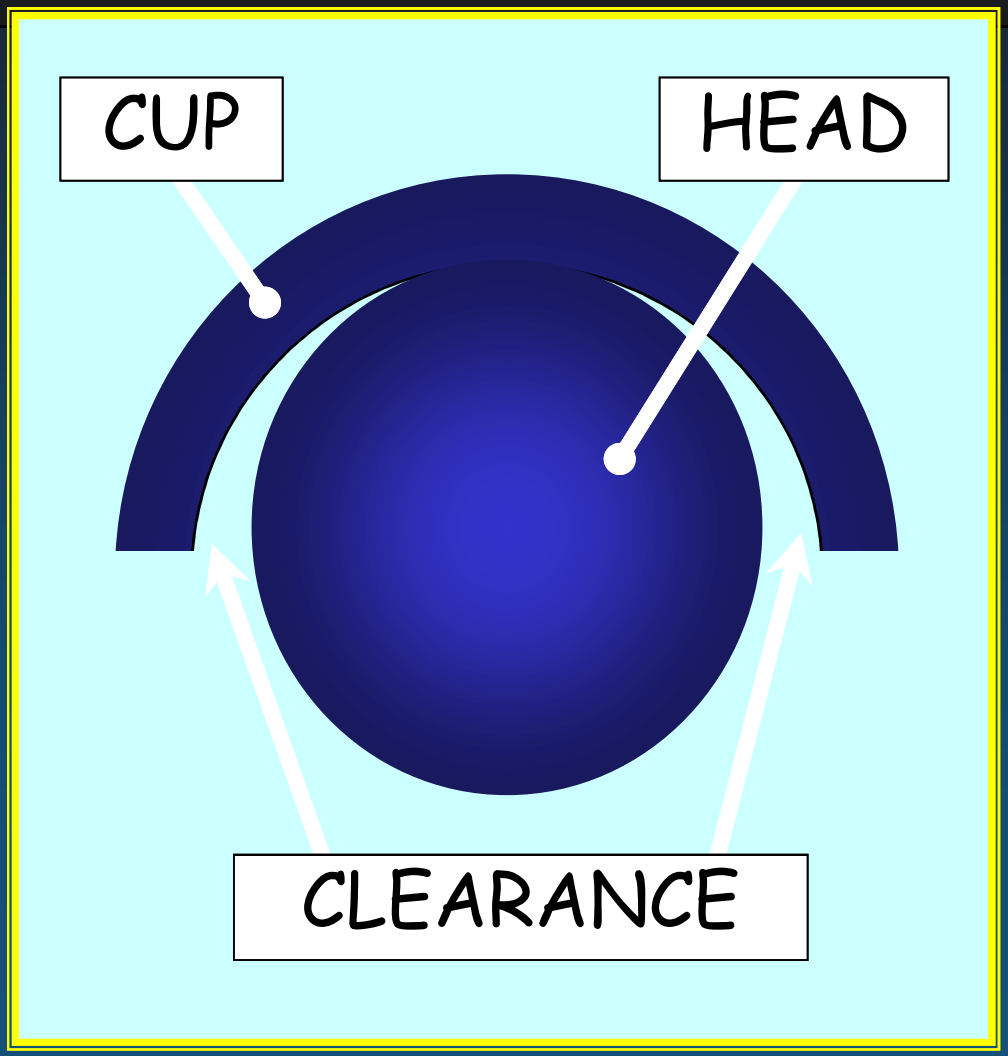
    Campbell JBJS 2003
    Clarke J Arthroplasty 2005

METAL ON METAL

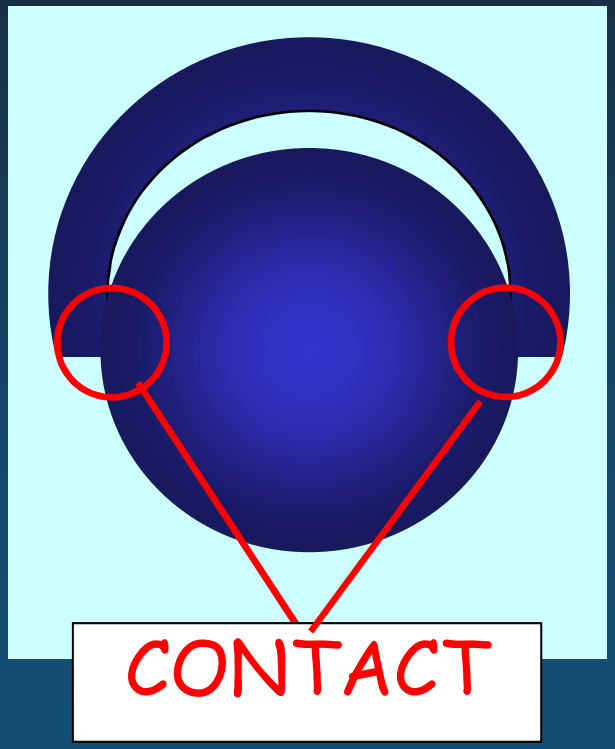
- MATERIALS
  - HARDNESS Co, Cr
  - CARBON RICH COMPOUNDS OF Co, Cr, Mo
- MACROGEOMETRY
  - DIAMETER
  - CLEARANCE (LOWER LIMIT OF 20µm)
- MICROGEOMETRY
  - SURFACE TOPOGRAPHY
- LUBRICATION
  - FLUID FILM LUBRICATION

Schmidt Clin Orthop 1996

CLEARANCE



CONTACT



METAL ON METAL

- CLEARANCE
  - SMALL CLEARANCE LEADS TO EQUATORIAL CONTACT
    - HIGH FRICTION AND HIGH TORQUE
    - IMPLANT LOOSENING
  - LARGE CLEARANCE LEADS TO REDUCED CONTACT AREA
    - LOSS OF EFFECTIVE LUBRICATION
    - RAPID WEAR

Schey Clin Orthop 1996

METAL ON METAL

- RELATIVE POLAR CONTACT IS PREFFERED

Lothari Clin Orthop 1996

Schmalzried J Arthroplasty 1996

METAL ON METAL

- LUBRICATION
  - λ RATIO
    - FILM THICKNESS TO SURFACE ROUGHNESS RATIO
  - IT IS ENHANCED BY THE USE OF
    - THE LARGER POSSIBLE HEAD
    - THE SMALLER CLEARANCE

Dowson J Eng Med 2006

Jacobs JBJS 1992

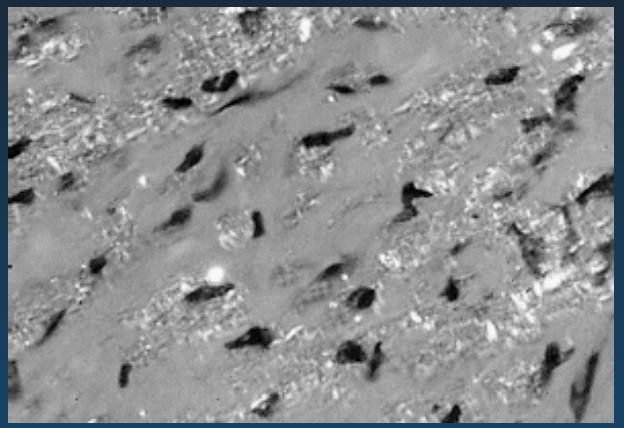
BASIC SCIENCE
METAL PARTICLES

- SMALLER THAN PE PARTICLES
- NANOMETERS IN LINEAR DIMENSION
  - SIZE RANGES FROM 0.01 TO 5μm
  - THE MOST SMALLER THAN 50nm
- LARGE AGGREGATE SURFACE AREA
  - LOCAL EFECTS
  - SYSTEMIC EFFECTS

Doorn J Biomed Mater Res 1998
Doorn Clin Orthop 1996
McDonald Clin Orthop 2003 Level 1

ASEPTIC LOOSENING

AETIOLOGY, PATHOGENESIS, CELLULAR RESPONCE



- AETIOLOGY
  - CELLULAR RESPONSE VARIES
    - NUMBER, CHARGE, COMPOSITION, SURFACE
    - SIZE AND SHAPE OF PARTICLES
      - THE MAJORITY ARE LESS THAN 5μm
      - RANDOM SHAPE

Gonzalez J Biomed Mater Res 1996
Sabokbar J Mater Sci Mater Med 2003

ASEPTIC LOOSENING

AETIOLOGY, PATHOGENESIS, CELLULAR RESPONCE

- PARTICLE CONCENTRATION AND SURFACE AREA (ESPECIALLY METALLIC PARTICLES)
  - SECRETIONS BY VARIOUS TYPES OF CELLS
    - MONOCYTES – CYTOKINES, PGE2, HEXOSAMINIDASE
    - MACROPHAGE CELL LINES – APOPTOSIS
    - COBALT AND VANADIUM TOXIC EFFECT ON FIBROBLASTS AND CHONDROCYTES

Jacobs JBJS 2006
Hirakawa Clin Orthop 2004
Shanbhag J Biomed Mater Res 2000
Shanbhag Clin orthop 1997
Shanbhag J Arthroplasty 1995
Shanbhag JBJS 1994

BASIC SCIENCE
METAL PARTICLES

- LOCAL EFFECTS
  - LOCAL TISSUE REACTION
    - No OF HISTIOCYTES ONE GRADE LOWER THAN METAL ON PE
    - HISTIOCYTES STORE LARGER NUMBER OF METAL PARTICLES
    - PINOCYTOSIS ISTEAD OF PHAGOCYTOSIS
      - REDUCED CELLULAR RESPONSE
    - CYTOTOXICITY

BASIC SCIENCE
METAL PARTICLES

- IN VITRO STUDIES
  - LOW INCIDENSE OF OSTEOLYSIS
  - DOSE RELATED RESPONSE TO METAL PARTICLES
    - LOW TO MODERATE CONCETRATIONS STIMULATE RELEASE OF CYTOKINES
    - HIGHER CONCETRATIONS (Co,Cr) CYTOTOXIC
      - APOPTOSIS- CELL DEATH

Catelas Biomaterials 2003

Zhiri J Arthroplasty 1999

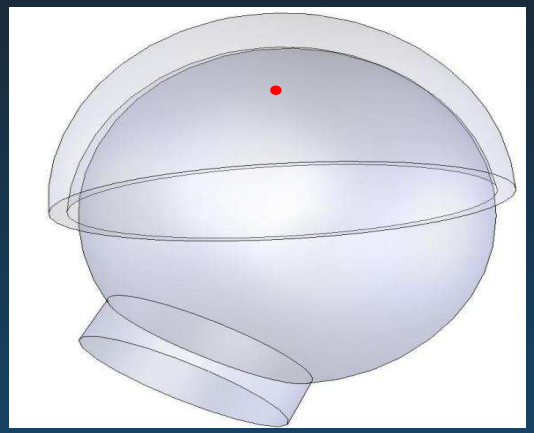
METAL ON METAL

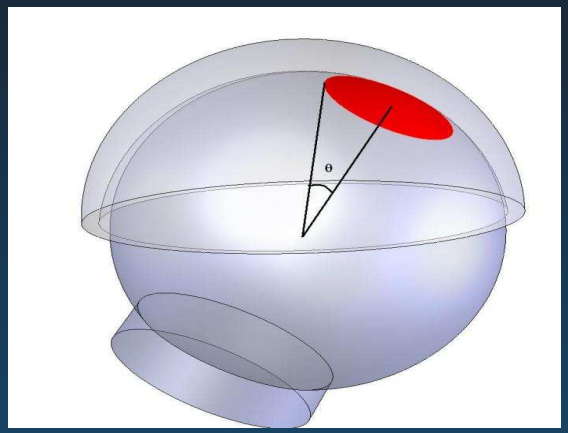
- WEAR RATES
  - IN VITRO
    - VOLUMETRIC WEAR 0.09 TO 61nm^3 PER MILLION CYCLES
    - LINEAR 1.3 TO 100µM PER MILLION CYCLES
    - AFTER 0.1-0.5 MILLION CYCLES WEAR IS REDUCED

Medley Clin Orthop 1996

Isaac Proc Inst Mech Eng H 2006

RUNNING-IN WEAR





- INITIAL RUNNING-IN WEAR DECREASES AS THE BEARING DIAMETER INCREASES AND/OR THE DIAMETRICAL CLEARANCE DECREASES

- SUBSEQUENT STEADY-STATE WEAR RATE IS MUCH LESS, RUNNING-IN WEAR CONTRIBUTES SIGNIFICANTLY TO THE TOTAL VOLUME OF METAL WEAR EVEN OVER VERY LONG PERIODS OF TIME

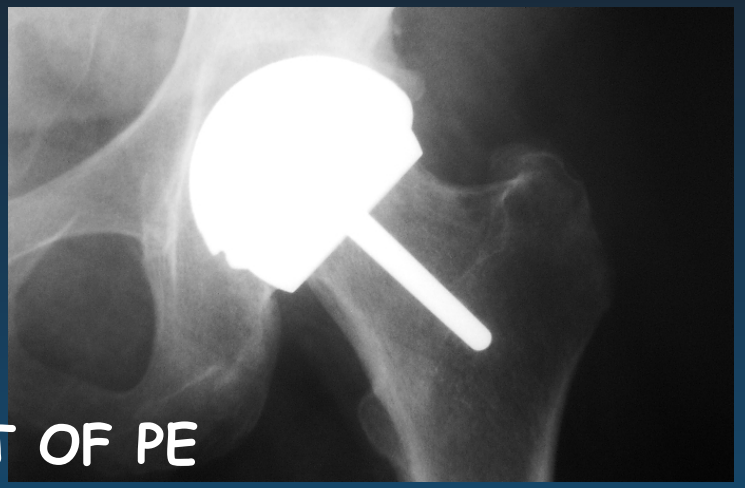
BLOOD AND SERUM ION LEVELS

- WELL FUNCTIONING ARTHROPLASTY
  - WHOLE BLOOD AND SERUM ION LEVELS DECREASE AFTER 6 MONTHS
    - THE CLINICAL RUNNING-IN PHASE
    - FEW PARTS PER BILLION
- PATIENT ACTIVITY DOES NOT INFLUENCE ION LEVELS OVER TIME

Heisel JBJS 2005

Bitsch JBJS 2007

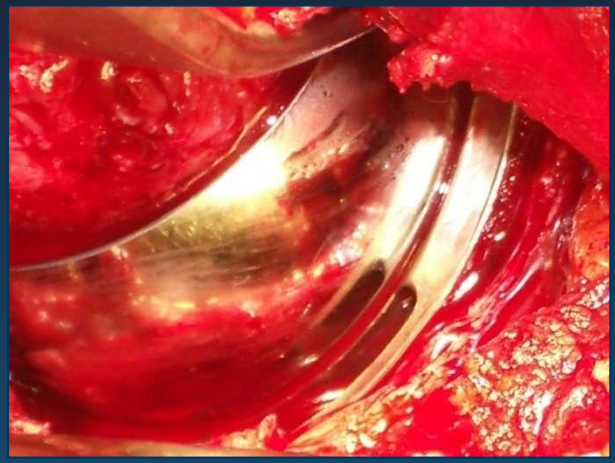
METAL ON METAL



- RETRIEVAL STUDIES
  - WEAR RATE SMALLER THAT OF PE
  - 25 TIMES LESS – 4.2µm PER YEAR
  - THE LARGEST THE HEAD THE SMALLER THE WEAR (TWO TIMES)

Willert Clin Orthop 1998

METAL ON METAL



- SENSITIVE TO CUP MAL-POSITIONING
- SPECIFIC DESIGNS SHOW EXCESSIVE WEAR WHEN CUP IS LEFT OPEN

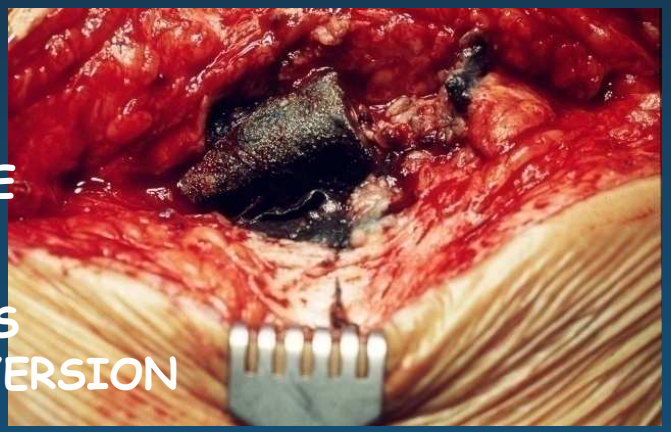
Grammatopoulos JBJS 2010

LOCAL EFFECTS

- ALTR IN PROSTHESES MADE OF (COCR) ALLOYS

Svensson JBJS 1988
Hallab JBJS 2001

- METAL REACTIVITY
  - HIGH WEAR OF THE BEARING
  - PREDOMINANTLY FOREIGN-BODY INFLAMMATORY RESPONSE

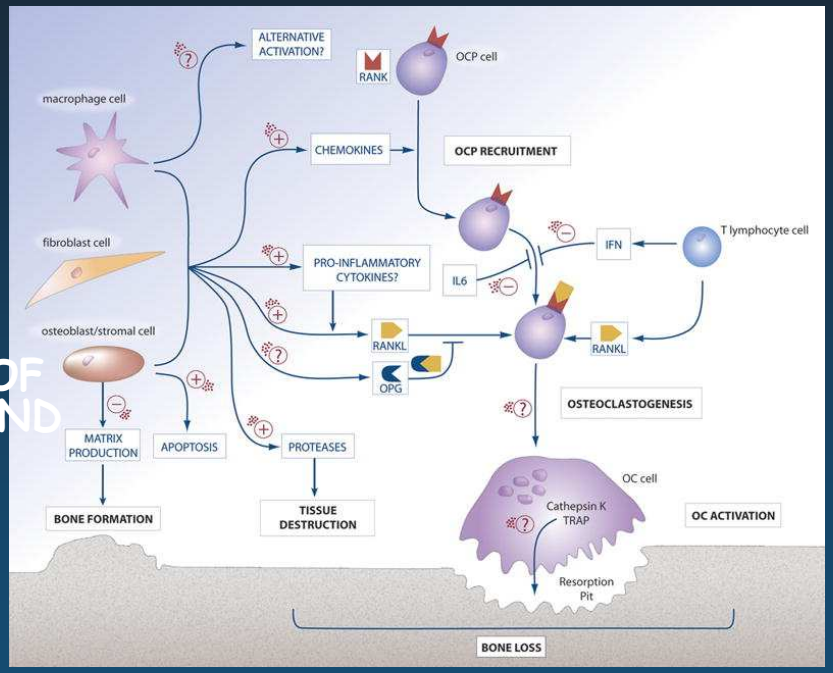


- LATERAL OPENING ANGLE >55 DEGREES
- AND/OR EXCESSIVE COMBINED ANTEVERSION
- EDGE LOADING AND HIGH WEAR
- RELATIVELY LARGE METAL PARTICLES
- CIRCULATING CO AND CR ION LEVELS GREATER THAN 10 PPB

Langton JBJS 2008
De Hann JBJS 2008
De Hann JBJS 2010

IMMUNE SYSTEM

- HOST DEFENCE CELLS (LYMPHOCYTES)
  - RECOGNITION OF PARTICLES
    - RELEASE OF LARGE QUANTITIES OF PROINFLAMMATORY CYTOKINES AND FACTORS
      - TNF,
      - IL1a, IL1b, IL6
      - RANKL
      - PGE2
  - HYPERSENSITIVITY



Looney Curr Opin Rheumatol 2006
Hallab J Orthop Res 2005
Ritchlin J Musculoskelet Neuronal Interact 2004

LOCAL EFFECTS

- METAL SENSITIVITY
  - PREDOMINANTLY LYMPHOCYTIC (IMMUNE) RESPONSE
  - OR ALVAL
    - (ASEPTIC LYMPHOCYTE-DOMINATED VASCULITIS-ASSOCIATED LESION)
  - WITH OR WITHOUT EXCESSIVE METAL-METAL BEARING WEAR

Willert JBJS 2005

Jacobs JBJS 2006

LOCAL EFFECTS

- EFFUSION OR A CYCTIC/SOLID MASS
- SO-CALLED PSEUDOTUMOR

Pandit JBJS 2008

- SUCH REACTIONS ARE NOT NEW OR UNIQUE TO METAL-METAL BEARINGS AND HAVE BEEN PREVIOUSLY REPORTED IN ASSOCIATION WITH COCR CORROSION

Svensson J Arthroplasty 2008

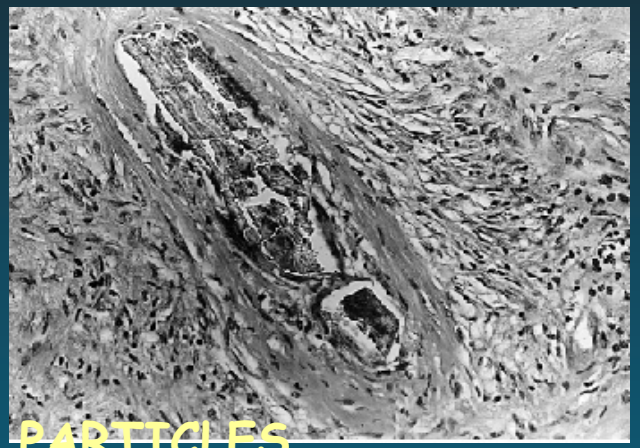
LOCAL EFFECTS

- A WIDE RANGE OF OCCURRENCE
  - FROM 1 IN 100 TO LESS THAN 1 IN 1,000
- VARIABLES ARE UNDER INVESTIGATION
  - PATIENT-RELATED FACTORS
    - GENDER, ETIOLOGY OF ARTHRITIS, BILATERAL IMPLANTS,GENETIC OR ENVIRONMENTAL SENSITIZATION
  - SURGICAL TECHNIQUE
    - COMPONENT ORIENTATION AND FIXATION
  - IMPLANT FACTORS
    - BEARING DIAMETER, FORM AND FINISH

METAL ON METAL BEARING SURFACES

- SYSTEMIC EFFECTS
  - LONG TERM EFFECTS
    - ELEVATED SERUM METAL ION LEVELS
    - PROTEIN BINDING
    - REMOTE SITE DEPOSITION OF METAL PARTICLES
      - LYMPHORETINACULAR SYSTEM DISSEMINATION
      - LIVER, SPLEEN, ABDOMINAL, PELVIC AND AXILLARY LYMPH NODES CHAINS
      - KIDNEY FUNCTION ???
      - PLACENTA CIRCULATION ???

Jacobs JBJS 2007



METAL PARTICLES
LOCAL AND SYSTEMIC EFFECTS

- CARCINOGENESIS
  - Co AND Cr METAL PARTICLES INDUCE CARCINOMA IN ANIMAL MODELS

    Freeman Ann Rheum Dis 1969
    Heath Lancet 1971

  - HUMAN TISSUES ???

METAL PARTICLES

- IMPLANT SITE TUMORS
  - CLINICAL EVIDENCE ???
    - 19 CASES OF PERIPROSTHETIC TUMORS
      - MAJORITY MALIGNANT FIBROUS HISTIOCYTOMA

      Jacobs JBJS 1992
    - FOUR CASES OF SOFT TISSUE SARCOMA

      Langhamer J Arthroplasty 1997

CARCINOGENESIS

- THERE IS LIMITED DATA ON PATIENTS
  - WITH METAL-METAL BEARINGS FOR MORE THAN 20 YEARS

Tharani JBJS 2001

  - THE RISK OF CANCER WAS SIGNIFICANTLY LOWER IN PATIENTS WITH A HIP RESURFACING COMPARED TO THE GENERAL POPULATION

Ostwestry report 2008

METAL PARTICLES

- REMOTE SITE MALIGNACIES
  - EPIDEMIOLOGICAL STUDIES
    - LYMPHOMA, LEUKEMIA
      - OLDER METAL ON METAL DESIGNS (BEFORE 1973)
      - SMALL NUMBER OF PATIENTS / LESS THAN 10 YEARS F-UP

Black The adult hip 1998

Gillespie Clin Orthop 1996

    - TUMOR DEVELOPMENT LATENT PERIOD IS MORE THAN 20 YEARS
      - LONGER F-UP STUDIES ARE NEEDED

Tharani JBJS 2001

CERAMIC ON CERAMIC

- EXCELLENT WEAR CHARACTERISTICS
- BOTH IN THE LABORATORY AND CLINICAL SETTING

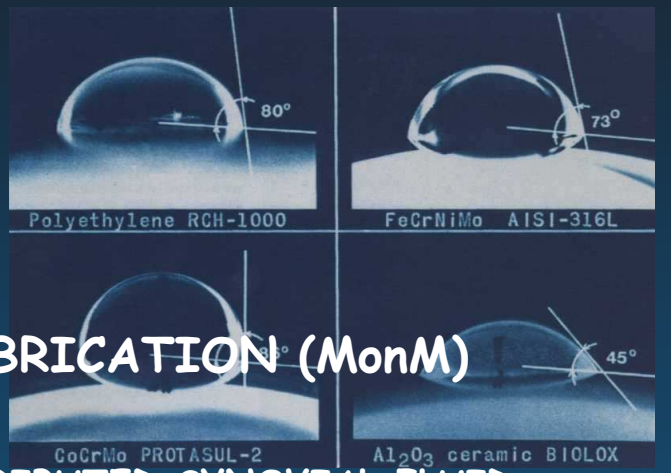
Lee JBJS 2010

Petsatodis JBJS 2010

….A CERAMIC BEARING MAY NOT WEAR OUT IN THE PATIENT'S LIFETIME…..

www. ortho-uth.org

CERAMIC ON CERAMIC



- THE LOWEST IN VIVO WEAR RATES
- SAME PRINCIPLES OF FRICTION AND LUBRICATION (MonM)
- TWO MORE PROPERTIES
  - WETABILITY - HYDROPHILIC-UNIFORMLY DISTRIBUTED SYNOVIAL FLUID
  - GREATER HARDNESS
- CAN BE POLISHED TO A MUCH LOWER SURFACE ROUGHNESS
- λ RATIO IS HIGHER – REDUCED COEFFICIENT OF FRICTION
- TRUE FLUID-FILM LUBRICATION

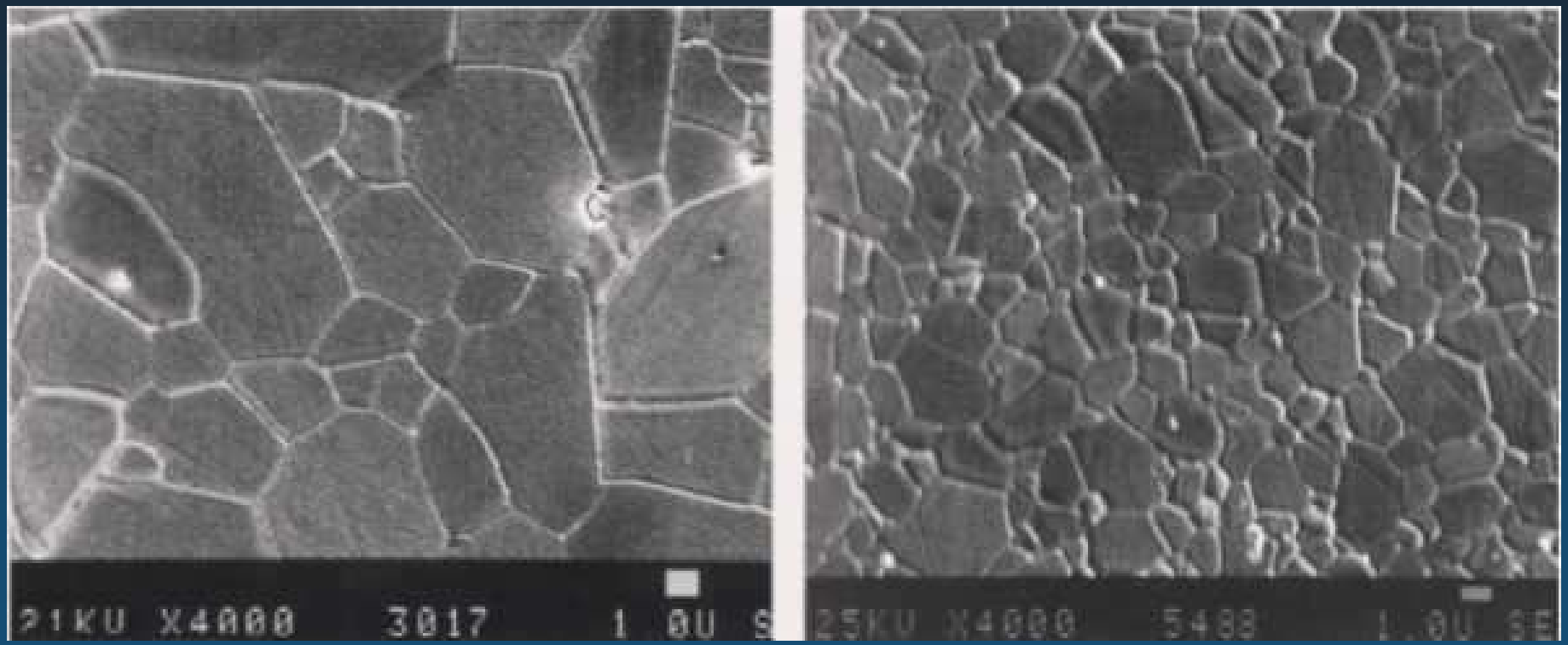
Walter Clin Orthop 1992

Clarke Proc Inst Mech Eng 2000

CERAMIC ON CERAMIC

- CERAMIC BEARINGS HAVE A LOW CO-EFFICIENT OF FRICTION DUE TO A COMBINATION OF THE SMALL GRAIN SIZE AND LOW SURFACE ROUGHNESS
- HARDNESS AND RESISTANCE TO SCRATCHING THIRD BODY PARTICLES

GRAIN SIZE



Large grains Small grains

CERAMIC ON CERAMIC

- LOW REACTIVITY OF THE CERAMIC PARTICLES
  - LOWER RISK OF OSTEOLYSIS
- NO SYSTEMIC RELEASE OF CERAMIC DEBRIS THROUGHOUT THE BODY

Lerouge JBJS 1997
Catelas JBJS 1999
Hozack ICL 341 Technology 2011

CERAMIC PARTICLES

- RETRIEVAL STUDY
  - DOUBLE SIZE RANGE OF CERAMIC WEAR DEBRIS
    - NORMAL ARTICULATING CONDITIONS
      - SMALLEST 5-90nm (MEAN 24nm)
    - MICROSEPARATION CONDITIONS – STRIP WEAR
      - LARGEST 50-3200nm (MEAN 430nm)

Kothari Clin Orthop 1996
Stewart J Arthroplasty 2003

MICROSEPARATION IN VIVO AND IN VITRO

- IN VIVO MICRO SEPARATION OF HEAD AND INSERT DURING THE SWING PHASE OF WALKING DETERMINED BY FLUOROSCOPY
  DENNIS AND KOMISTEK AAOS 1999, ESB 2000

- CONTACT OF THE HEAD ON THE RIM OF THE INSERT AT HEEL STRIKE REPRODUCES CLINICAL WEAR MECHANISMS.

  NEVELOS AND FISHER ORS 2000, J ARTHROPLASTY

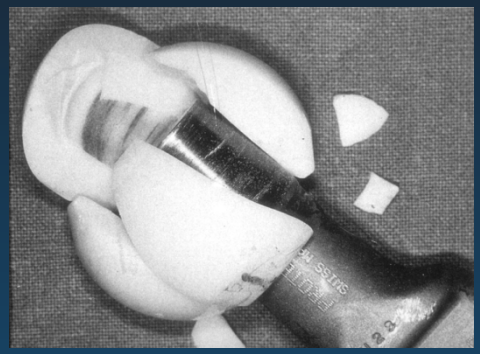
Swing phase. Heel strike. Stance phase.

Microseparation ~0.2 mm Rim contact. Re-location.

CERAMIC DISADVANTAGES

- POTENTIAL DISADVANTAGES OF COC
  - COST
  - FRACTURE RISK
  - REDUCED INTRA-OPERATIVE FLEXIBILITY RELATED TO NECK LENGTH AND LINER
  - POTENTIAL FOR ACTIVITY RELATED NOISE

CERAMIC DISADVANTAGES

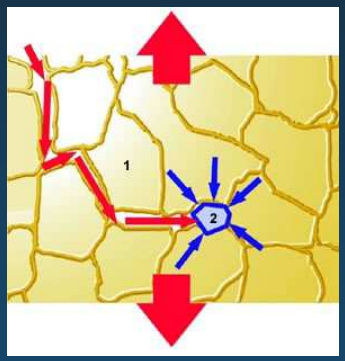


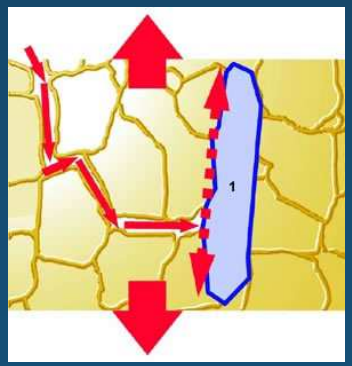
- CERAMICS CAN FRACTURE
  - HARD TO DEFINE THE EXACT RISK
  - IMPROVED CERAMIC MATERIAL AND STRUCTURAL PROPERTIES
    - DELTA CERAMICS
    - QUALITY CONTROL
  - ESTIMATED RISK OF FRACTURE IS 0.014% (1 IN 7000)
    - RAPID REVISION WHICH DOES NOT COMPROMISE RESULTS

Sharma J Arthroplasty 2010

MATERIAL PROPERTIES

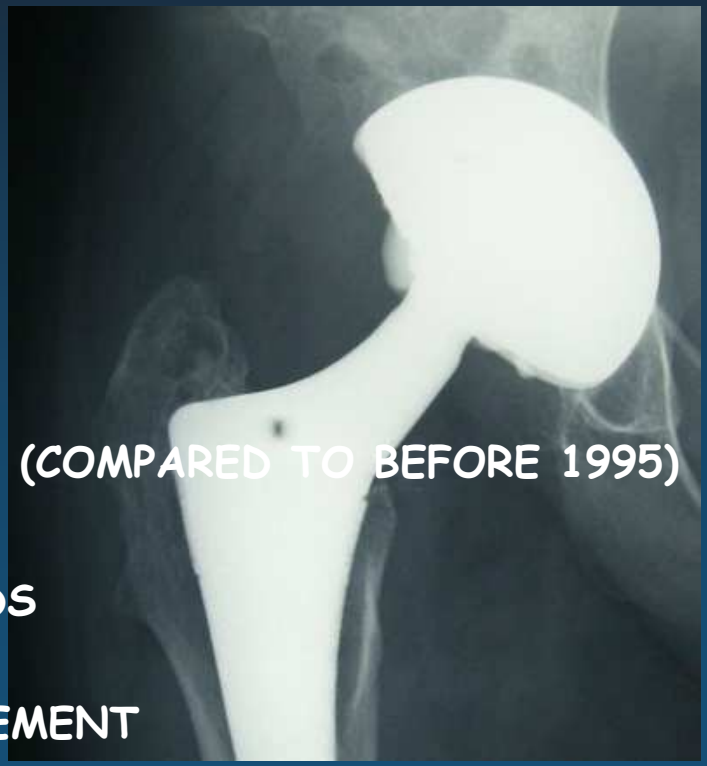
- FOUR GENERATIONS
  - FIRST
    - ALUMINA 1970's
      - 99.5% HIGH PURITY AL2O3
  - SECOND
    - ZIRCONIA 1980's
      - 99.0% YTTRIA-STABILIZED TETRAGONAL ZRO2
  - THIRD
    - BIOLOX FORTE
  - FOURTH
    - BIOLOX DELTA
    - GRAIN SIZE REDUCTION TO ONE MICRON





CERAMIC ON CERAMIC

- MODERN ERA
  - BIOLOX FORTE
    - HIGH QUALITY
    - DECREASED GRAIN SIZE
    - DECREASED INCLUSIONS
    - GRAIN BOUNDARIES
    - FAR GREATER BURST STRENGTH (COMPARED TO BEFORE 1995)
  - MATED IMPLANTS
    - EXCELLENT FIXATION RECORDS
    - HIGH TAPER TOLERANCE
    - NO RISK FOR CERAMIC IMPINGEMENT



Hamilton CORR 2010

CERAMIC DISADVANDAGES

- NOISES ARE CREATED WITH ALL BEARINGS
  - CLICKING IS THE MOST COMMON SYMPTOM
- HARD BEARINGS-THE HIGHEST POTENTIAL
  - MOM BEARINGS CLICK AND SQUEAK
    - 3.9% SQUEAKING
    - EARLY AND TRANSIENT
    - SELF POLISHING

Back JBJS 2005

AETIOLOGY

- CAUSE OF COC SQUEAK
  - EDGE LOADING OF THE CERAMIC HEAD ON THE CERAMIC LINER
  - IMPINGEMENT – COMPONENT PLACEMENT
  - BONE AND SOFT TISSUE IMPINGEMENT
  - SEPARATION OF THE FEMORAL HEAD FROM THE LINER
  - LOCALIZED FLUID-FILM BREAK DOWN
  - INCREASED WEAR AND FRICTION OF THE CERAMIC HEAD (A WEAR SCAR OR STRIPE)
  - VIBRATION – SQUEAKING

Walters JBJS 2008
Restrepo JOA 2008

AETIOLOGY

- PATIENT CHARACTERISTICS
  - YOUNGER, TALLER, HEAVIER AND MORE FLEXIBLE PATIENTS
- MAYO CLINIC
  - TITANIUM DEPOSITION WITHIN THE BEARING SURFACE
- TITANIUM DEBRIS NOT LOCATED IN THE AREA OF STRIPE WEAR

Hozack ICL 341 Technology 2011

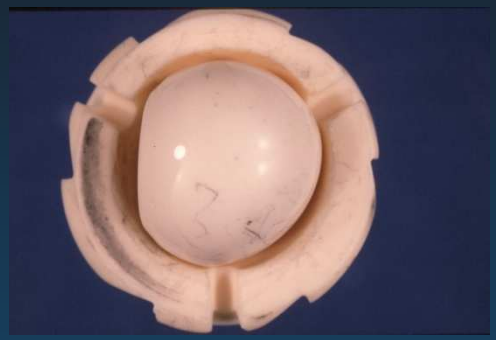
Chevillotte Clin Orthop 2010

IMPLANT
SPECIFIC ISSUE

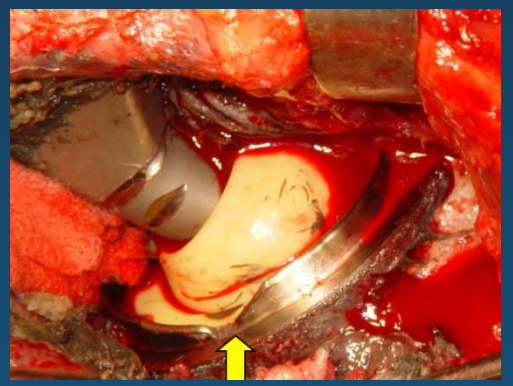
- FEMORAL IMPLANT SPECIFIC PROBLEM
  - TMZF FEMORAL COMPONENT WITH A V-40 NECK DIAMETER (8.6%)
  - TAV FEMORAL COMPONENT WITH A C-TAPER NECK DIAMETER (0.7%)
- CUPS WITH ELEVATED RIM CERAMIC INSERT

Restrepo JBJS 2010

CERAMIC ON CERAMIC

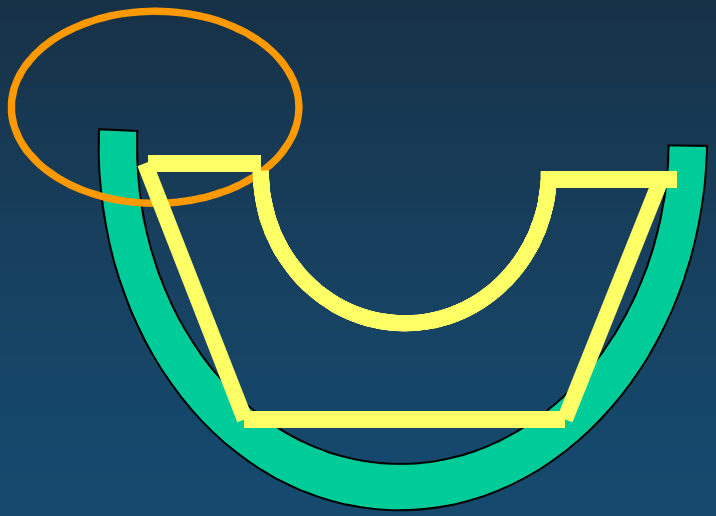


- PROPER IMPLANT PLACEMENT
  - RISK OF NECK/SOCKET IMPINGEMENT
    - LATERAL OPENING OF LESS THAN 30°
    - LATERAL OPENING GREATER THAN 55°
    - HIGH NECK/SHAFT ANGLE (>140°)
    - HIGH WEAR RATE

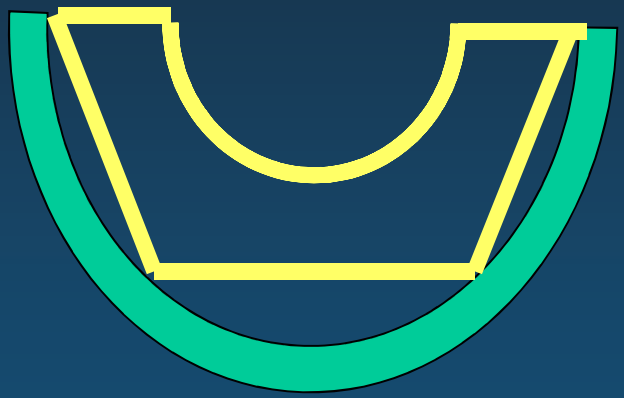


  - AVOID LINER/HEAD CHIPPING DURING INSERTION

CERAMIC CUP DESIGN

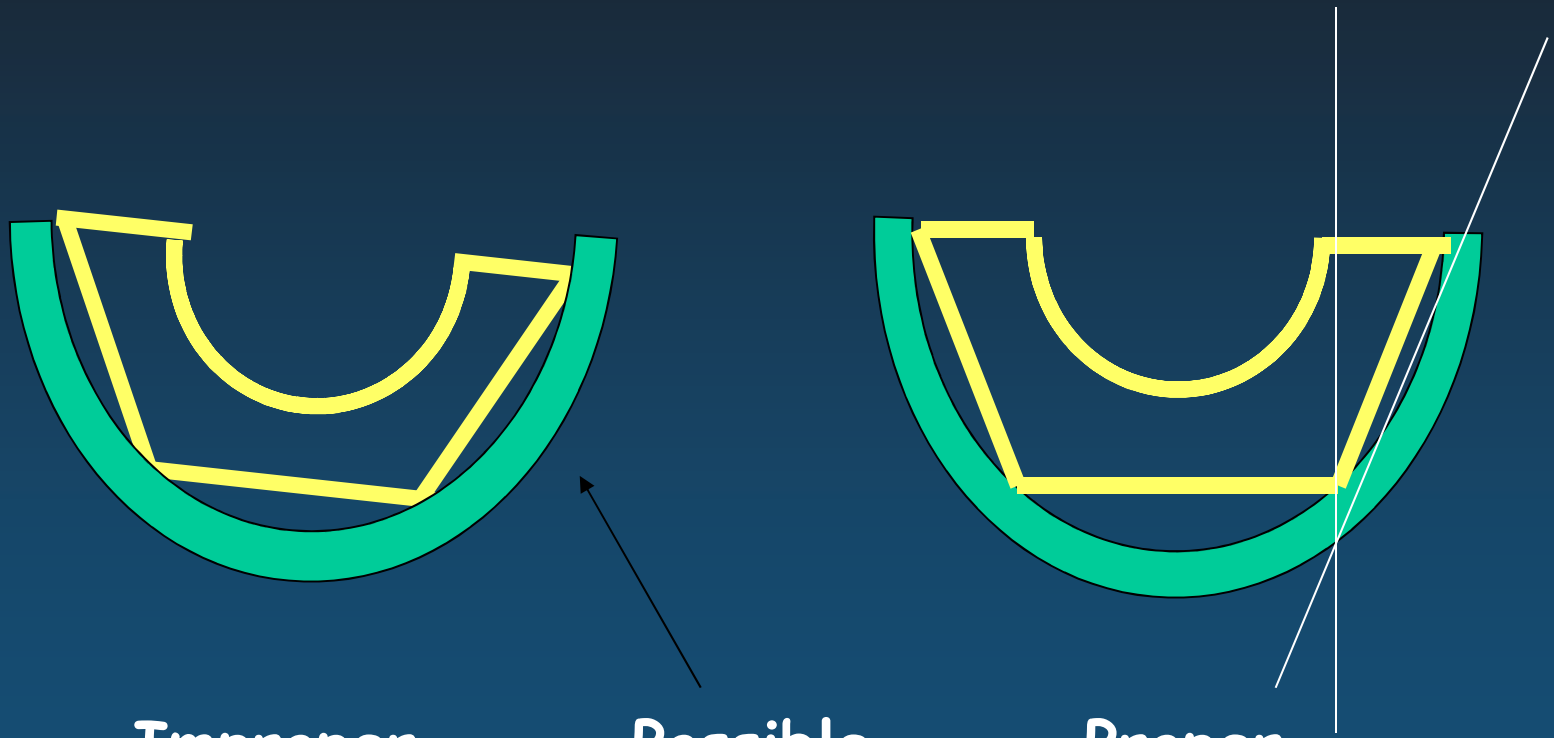


Extended lip



Preferred Design

CERAMIC LINER ASSEMBLY



Improper Position

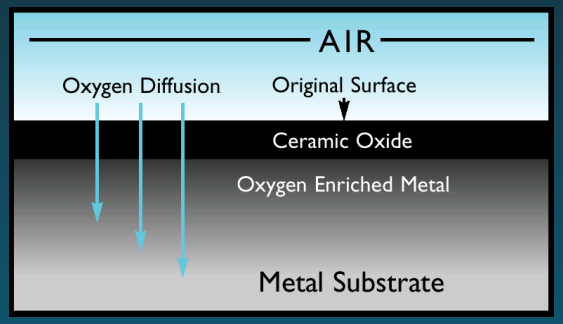
Possible Fracture

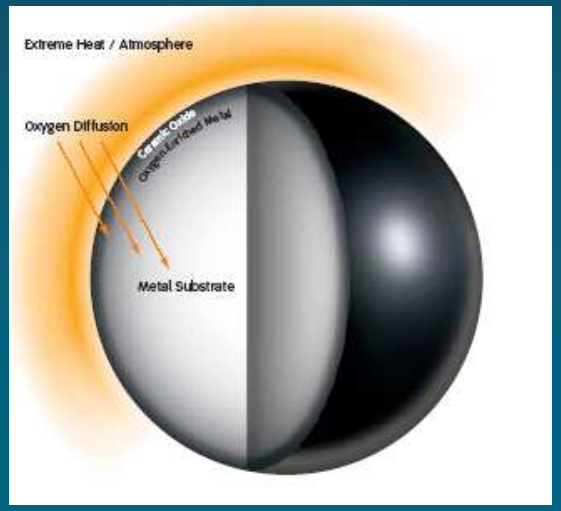
Proper position

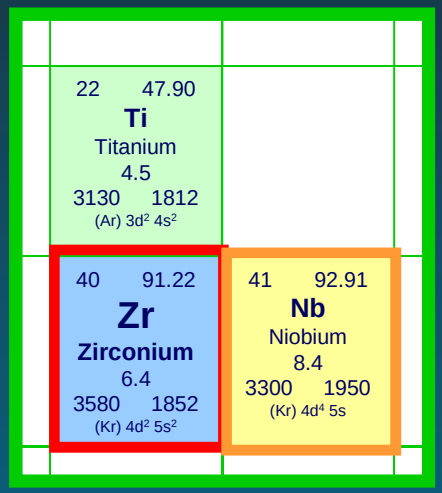
WHAT IS OXINIUM? -

METAL IN WHICH THE SURFACE HAS BEEN TRANSFORMED INTO CERAMIC

STARTS WITH A METAL ALLOY OF 2 OF THE 4 MOST BIOCOMPATIBLE ELEMENTS.







97.5% ZIRCONIUM

\+ 2.5% NIOBIUM

\+ OXYGEN + HEAT

=Oxinium

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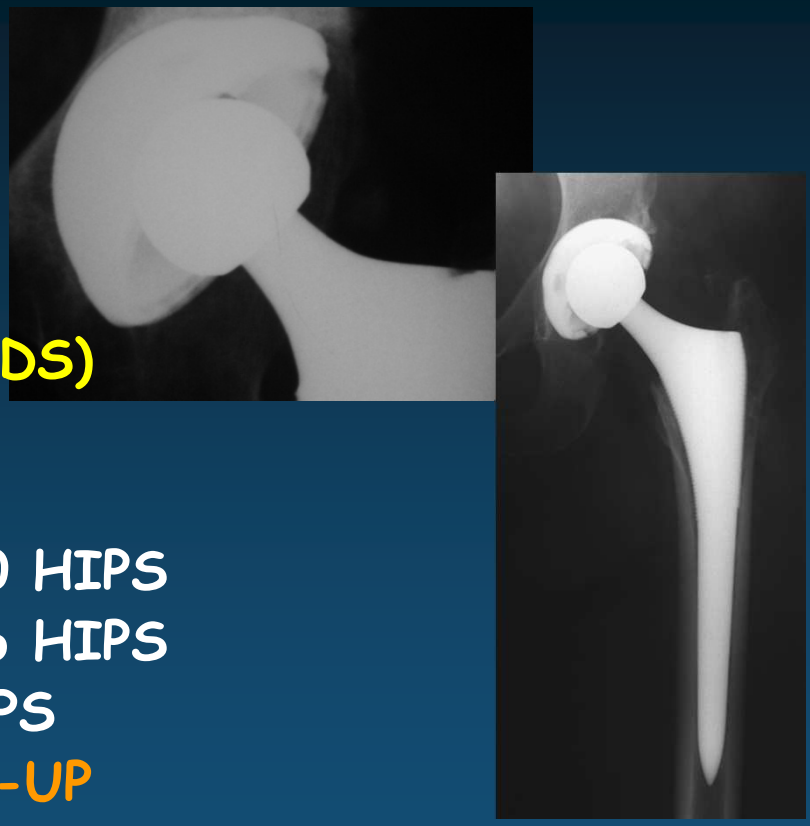
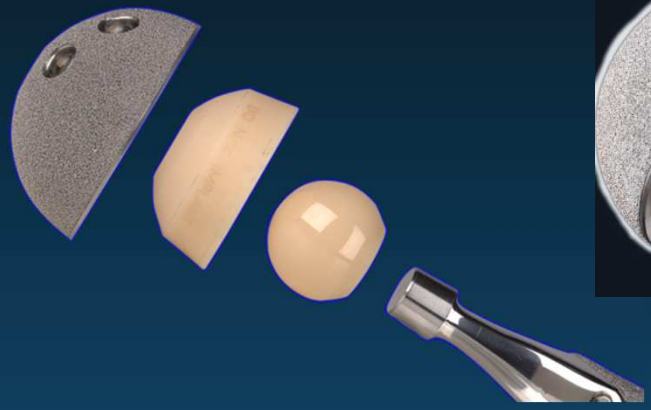
CLINICAL PRACTICE IN VIVO WEAR STUDY



- PROSPECTIVE THA TRIAL
- POLYWARE STUDY (2003 INWARDS)
  - CERAMIC ON PE 48 HIPS
  - CERAMIC ON XLPE 50 HIPS
  - OXINIUM (28mm) ON XLPE 50 HIPS
  - OXINIUM (32mm) ON XLPE 46 HIPS
  - CERAMIC ON CERAMIC 50 HIPS
  - UP TO 12-15 YEARS FOLLOW-UP
  - BRIEF PRELIMINARY REPORT

Harris Clin Orthop 2005
Bragdon Trans AAHKS 2002
Karrholm Clin Orthop 1997
www. ortho-uth.org

MATERIAL & METHODS



- 1/2003 – 5/2007: 221 PTS, 244 THA
- ONE SURGEON
- ♀:159, ♂:85
- STEM: SYNERGY
- CUP: REFLECTION INTERFIT
- HEAD: 28, 32 MM (SMITH&NEPHEW)
- GROUPS MATCHED FOR AGE SEX AND BMI
- TWO FAILURES

MATERIAL & METHODS

- Standard A-P & true lateral pelvis radiographs
  - 3 weeks, 6 weeks, 3 months, 6 months, 1 year and every year thereafter time intervals.
- Digitization by scanner
- Computer processed by PolyWare™ Auto 3D Digital, ver. 6.01 (Devane, Clin Orthop Relat Res, 1995 & Draftware Developers Inc.)

3D VOLUMETRIC WEAR

- BOTH OXINIUM FEMORAL HEADS PERFORMED WELL (SS DIF P= 0.03)
- INITIAL 2 YEARS BEDDING IN - THEN STABLE
- CERAMIC ON XL-PE ???
- CERAMIC ON PE COMPARABLE TO HISTORICAL CONTROLS

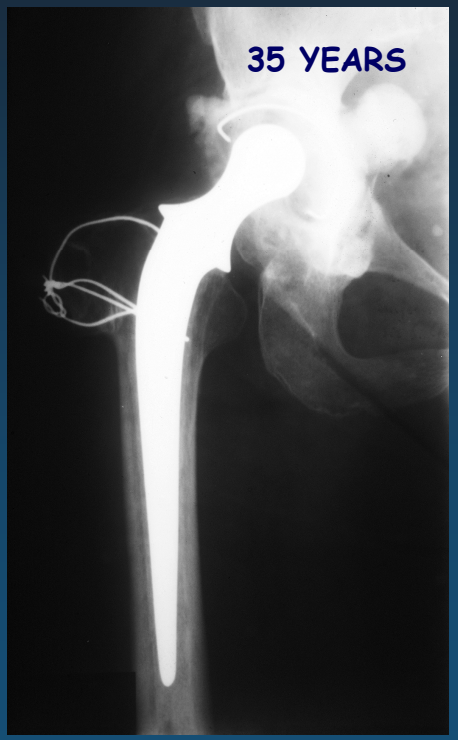
COST-EFFECTIVENESS

- NO COST EFFECTIVENESS DATA

- THE DIFFERENTIAL IN COST FOR COC FROM THE OTHER BEARINGS IS NEGLIGIBLE
  - XLP OR MOM
- RESURFACING HIP IS MORE COSTLY

TAKE HOME MESSAGE

- AT LEAST FOR THE FEMORAL STEM….
- BOTH CEMENTLESS AND CEMENTED FIXATION PRINCIPLE
  - 1.5-2.5% ASEPTIC LOOSENING AT 15 TO 20 YRS
- GOOD AND BAD RECIPES
- CAN WE DO BETTER ???
- THE COST OF SUCH AN EXCERSISE ????
- THE ROLE OF BEARING SURFACES



TAKE HOME MESSAGES

- SATISFACTORY BEARING SURFACES FOR THE YOUNG AND ACTIVE PATIENT
- DEMANDING SURGICAL TECHNIQUE
- LONG TERM CLINICAL DATA IS LACKING
  - THE UNIQUE CASE OF COC
- NEW BIOLOGICAL EFFECTS ???
- COST EFFECTIVENESS ????