



ROTHMAN
INSTITUTE



Thomas
Jefferson
University

Ceramic on XLPE

My Choice

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Professor

Orthopedic Surgery

**Rothman Institute at Thomas
Jefferson University**

■ Research support:

- NIH
- OREF
- Stryker Orthopedics
- Depuy
- Zimmer
- Baxter
- 3M
- Biomemetics
- Ceramtec
- Smith and Nephew

■ Board Member/Adviser

- Journal of Arthroplasty
- Philadelphia Orthopaedic Soc
- Eastern Orthopedic Assoc.
- United Healthcare
- 3M
- JBJS-A
- Bone and Joint Journal (British)
- Muller Foundation

■ Consultant:

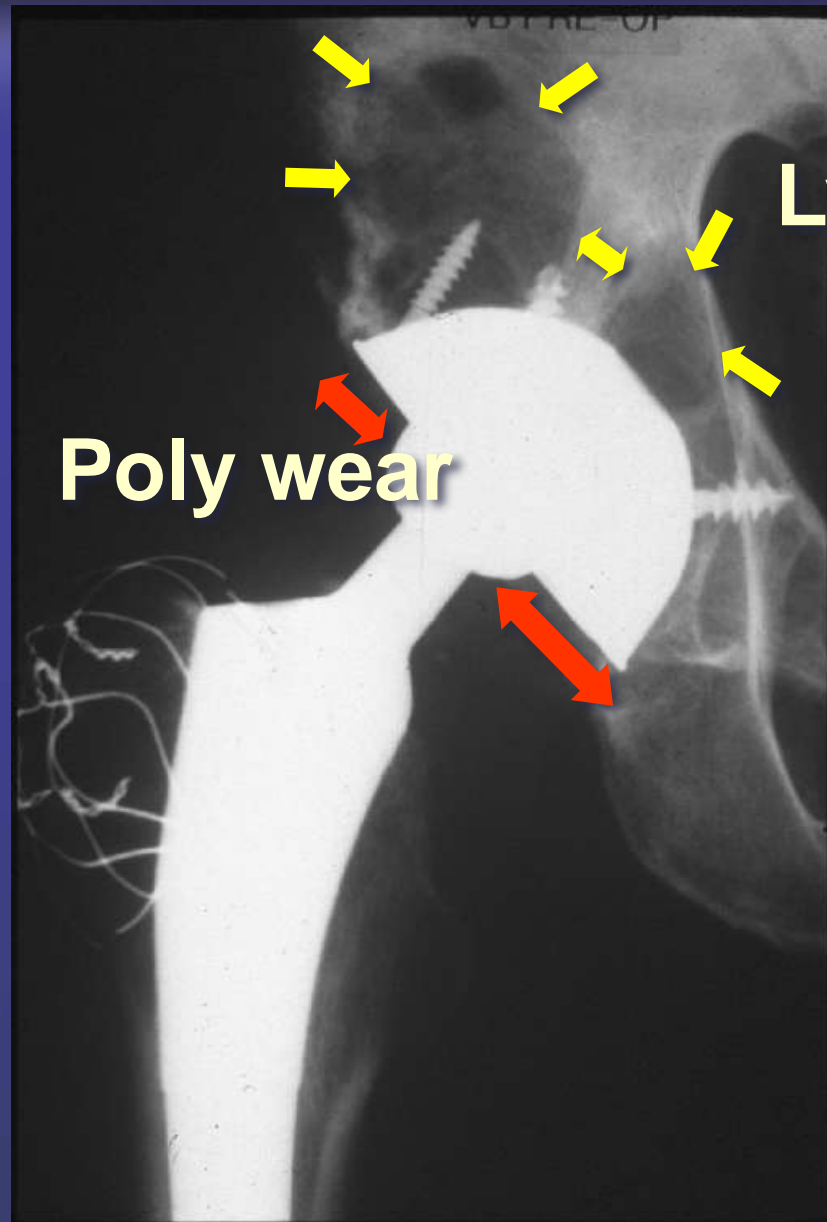
- Zimmer
- Smith and Nephew
- Convatech
- TissueGene
- Ceramtec
- 3M
- PRN
- Medtronic
- Pfizer

■ Intellectual

Property/Royalty:/Ownership

- Elsevier
- Wolters Kluwer
- Slack
- Hip Innovation Technology
- CD Diagnostics
- Jaypee publishers
- Datatrace
- ForMD

- PE wear # 1 cause of long term failure
- PE wear → Osteolysis



Lysis

Poly wear

Choices



Conventional Polyethylene



Cross Linked Polyethylene



Ceramic on Ceramic



Metal on Metal

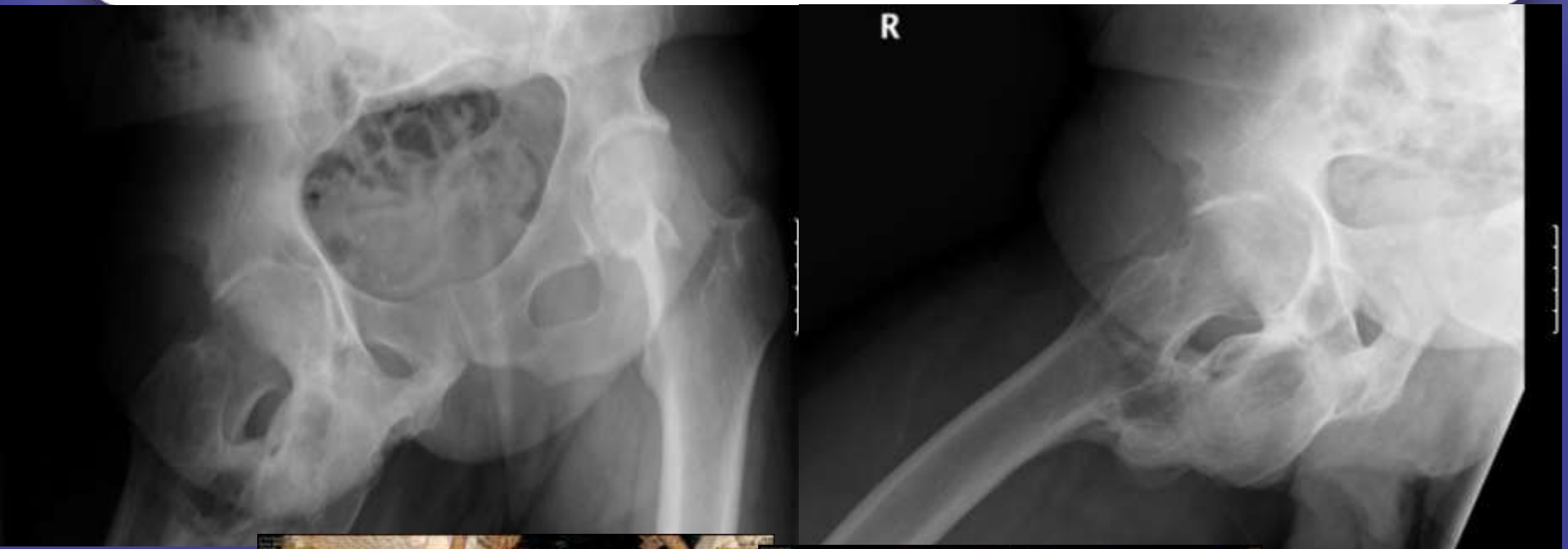
Metal on Metal



- Conventional poly---
not for the young
- Abandoned mostly

- Elderly/inactive---- Metal on poly
- Moderately active– metal or ceramic on XLP
- Hyperactive
 - Everyone ---- COC

22 YEAR OLD

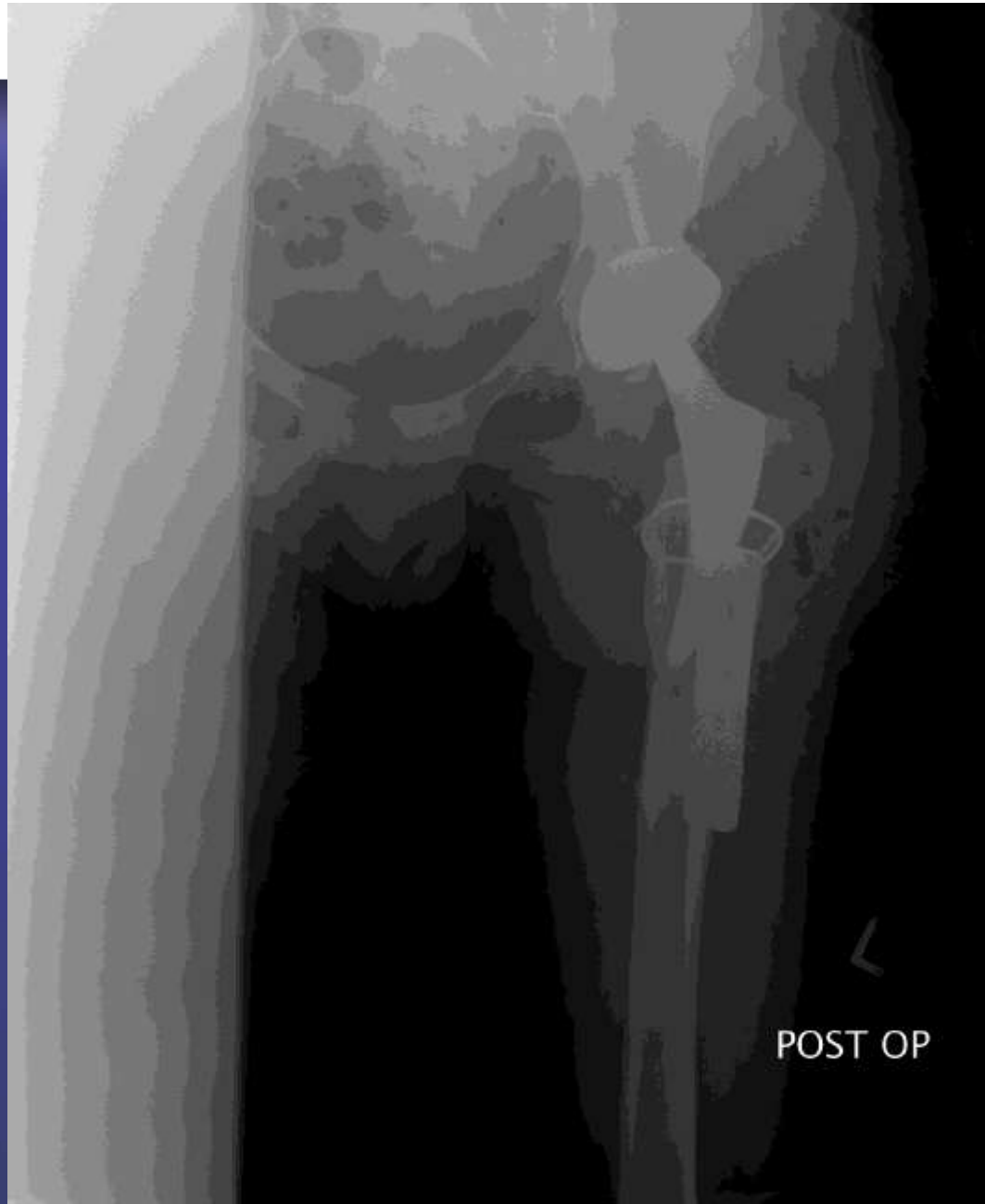






17 YEAR OLD (9 previous operations)





- Elderly/inactive---- Metal on poly
- Moderately active— metal or ceramic on XLP
- Hyperactive
- Everyone ---- COC



Rothman Institute Orthopaedics
Thomas Jefferson University

Wear Rate

(microns/year)



CoCr/Polyethylene¹

200 microns/year



CoCr/Crossfire™
Polyethylene²

20 microns/year



Metal/Metal³

4.2 microns/year



Alumina/Alumina⁴

less than
1 micron/year



Ceramic heads



More wettable → ↑ lubrication

Small grain size → improved surface finish

= reduced friction



Couple

Linear wear

(clinical data)*

Metal / UHMWPE

0.2mm/y

Alumina / UHMWPE

0.1mm/y

Zirconia / UHMWPE

0.1mm/y

Alumina / Alumina

0.005mm/y

Wear rate

Femoral head	2 - 165 $\mu\text{m}/\text{y}$
Cup	1 - 48 $\mu\text{m}/\text{y}$
Metal / UHMPE	100 - 200 $\mu\text{m}/\text{y}$

Risk factors

- Males
 - <50 years
 - >80 kgs

→ Using ceramic femoral heads against highly cross-linked polyethylene (HXLPE) reduces wear by ~30% when compared to metal against HXLPE.

- Four groups:
 - Metal vs. 1st generation HXLPE (Crossfire[®])
 - Ceramic vs. 1st generation HXLPE (Crossfire[®])
 - Metal vs. 2nd generation HXLPE (X3[®])
 - Ceramic vs. 2nd generation HXLPE (X3[®])
- **Crossfire[®] and X3[®] (Stryker Orthopaedics, Mahwah, NJ)
- Power analysis:
 - Crossfire[®] group: 150 patients
 - X3[®] group: 500 patients

- Patients matched according to age, gender, BMI, activity level (UCLA score), preoperative diagnosis, laterality, year of surgery.
- Serial follow-up x-rays used to quantitate wear.
 - Crossfire[®] follow-up → ~6 years post-op
 - X3[®] follow-up → ~4 years post-op



Hypothesis



→ Using ceramic femoral heads against highly cross-linked polyethylene (HXLPE) reduces wear by ~30% when compared to metal against HXLPE.

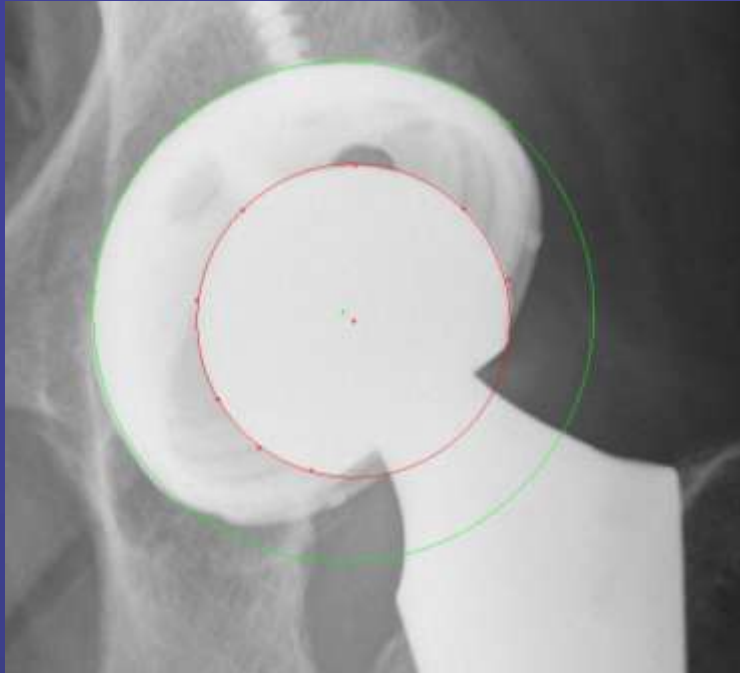
- We wanted to measure the in-vivo wear rates of metal vs. ceramic against X3
- Wear rate achieved by comparing serial xrays
- Power analysis: 250 patients/group → to show 30% difference in wear rate
- Data collected: age, gender, BMI, preoperative diagnosis, laterality and year of surgery.

- AP pelvis radiographs of THA patients
- First x-ray: postoperative (6 mos to 1yr)
→ to account for bedding in period
- Serial x-rays gathered with average 4 years follow up post THA

- Images anonymized and de-identified

	Metal	Ceramic
Patients	177	292
BMI	28.3	27.7
Age	70.1	59.8
Females	51.4%	52.1%

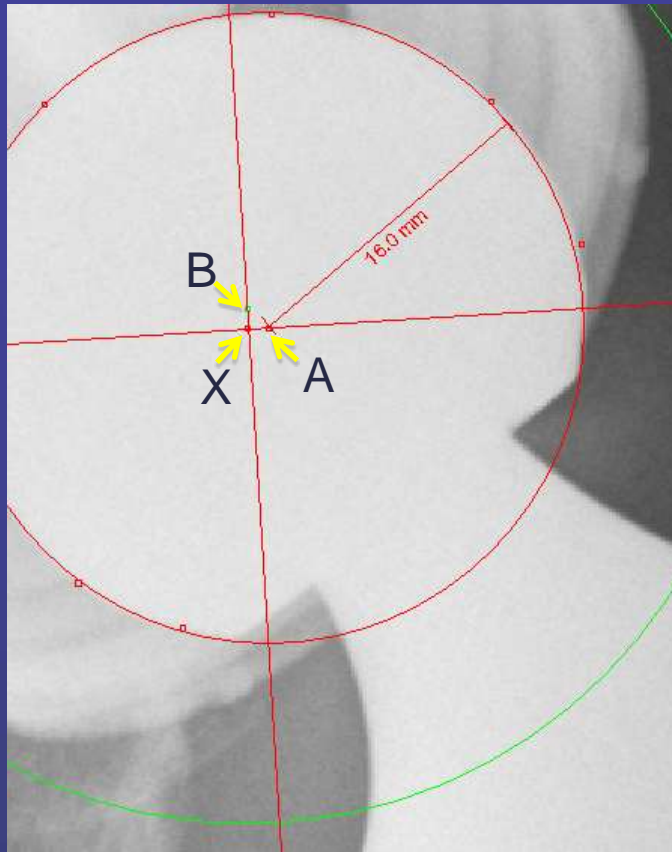
- Observers and statistician blinded to head material
- ROMAN method (ROntgenM onogrammetric ANalysis)



- Manually define acetabular cup and implant head edges
- Calibrate measurements according to known head size



- Draw a line joining ischial tuberosities (X)
- Draw perpendicular to (X) from center of cup
- Draw perpendicular to center of cup line from center head

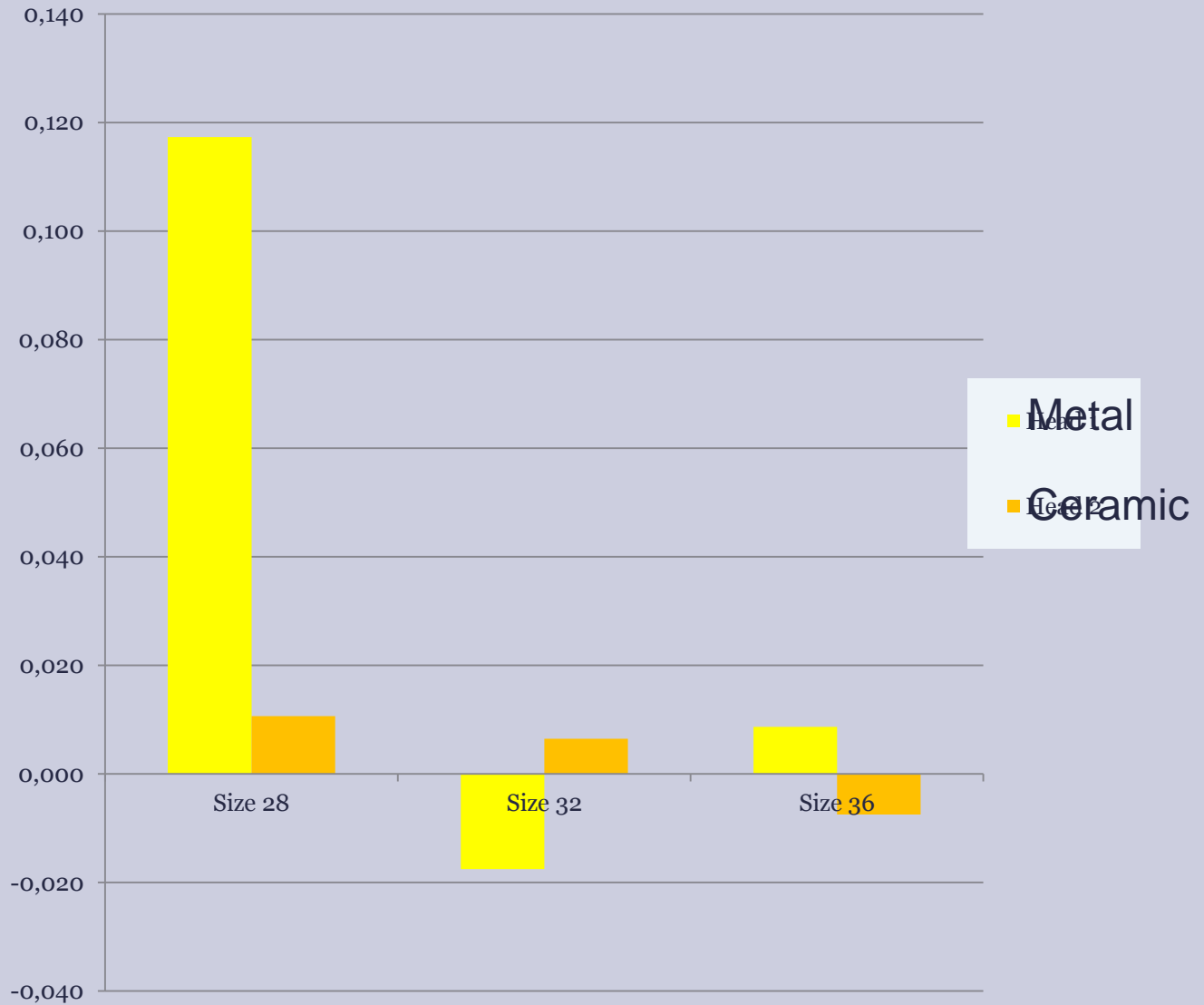


- Take intercept of the two lines (A and B)
- Measure distance X-A and X-B
- Determine resultant vector and angle of displacement

- XLPE Wear at 4 years
- Significantly higher with metal head

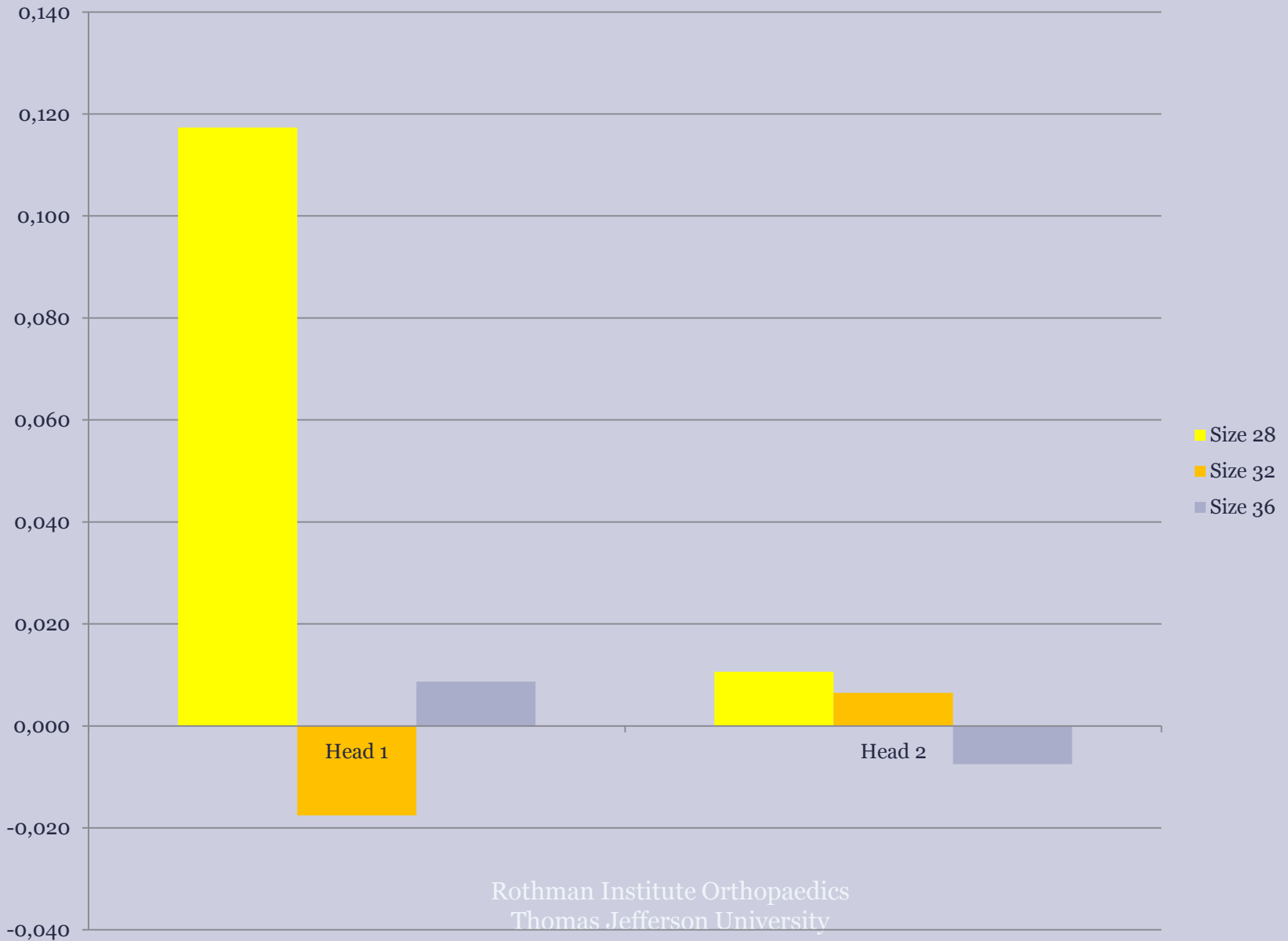
	Metal	Ceramic
28mm head	0.117 mm/yr	0.011 mm/yr
32mm head	-0.018 mm/yr	0.006 mm/yr
36mmhead	0.009 mm/yr	-0.008 mm/yr

Results





Results



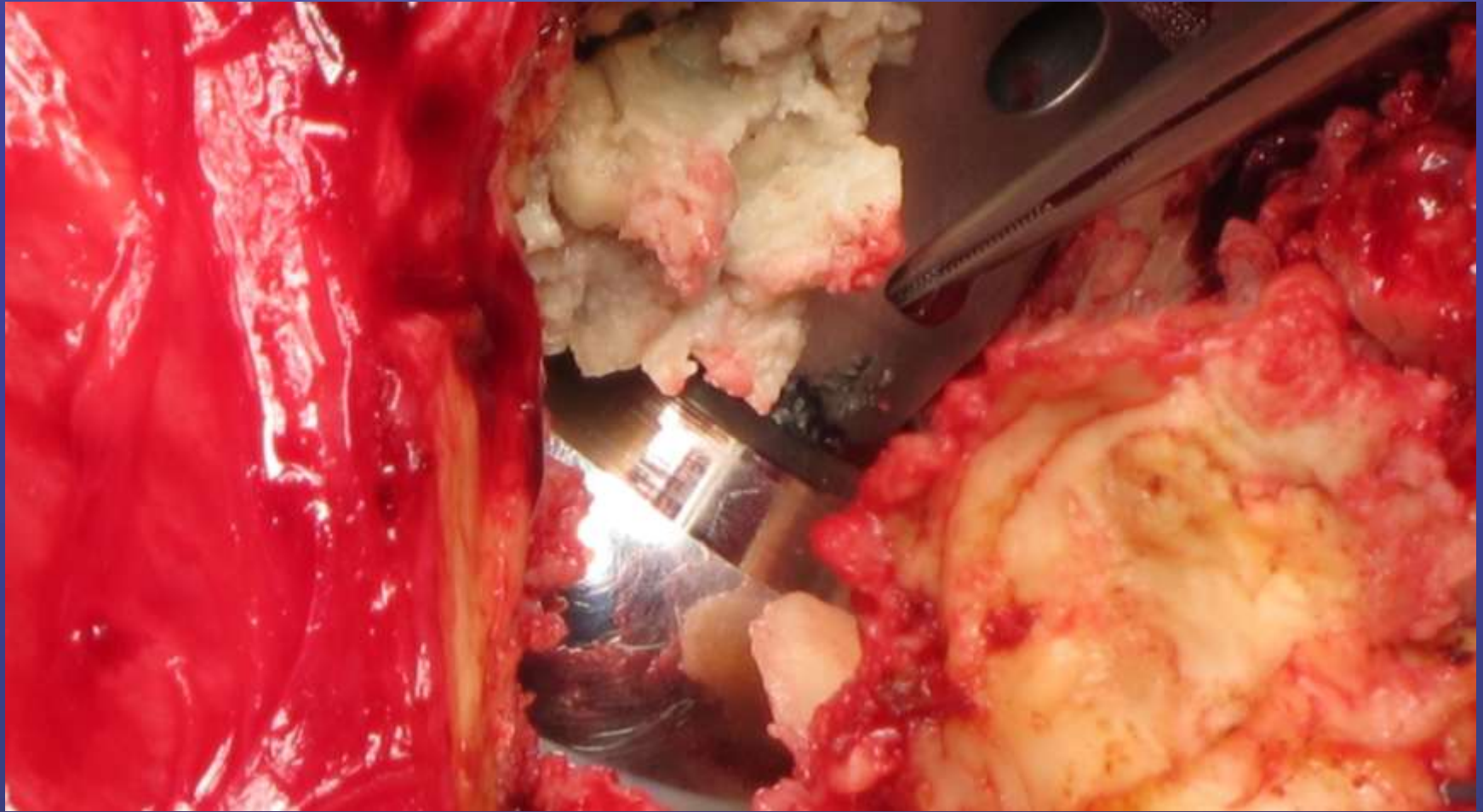
- No significant difference found between wear rates of metal vs. ceramic (32,36 and 40 mm)
 - Statistically indistinguishable from 0 wear
- Negative values may reflect measurement errors
- Intraclass correlation coefficient was low
0.06

- Ischial tuberosity delineated
- Head and shell edges manually defined
- Head and cup sizes manually entered
- Acetabular inclination and anteversion automatically detected



- True wear (excluding bedding in period)

	Metal	Ceramic
Mean Linear Wear Rate	0.277 ± 0.391 mm/yr	0.093 ± 0.206 mm/yr
Mean Volumetric Wear Rate	208.8 ± 245.4 mm ³ /yr	78.8 ± 65.9 mm ³ /yr





Metal on Poly Retrieval Study



- Taper corrosion
 - Higher with metal head compared to ceramic

Kurtz et al 2013



Ceramic against XLPE



- Great wear performance
- Biocompatible (no hypersensitivity)
- Excellent long term outcome
- Fracture risk– extremely small

