Ceramic on XLPE
My Choice

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Disclosures

- ## 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**

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Choices
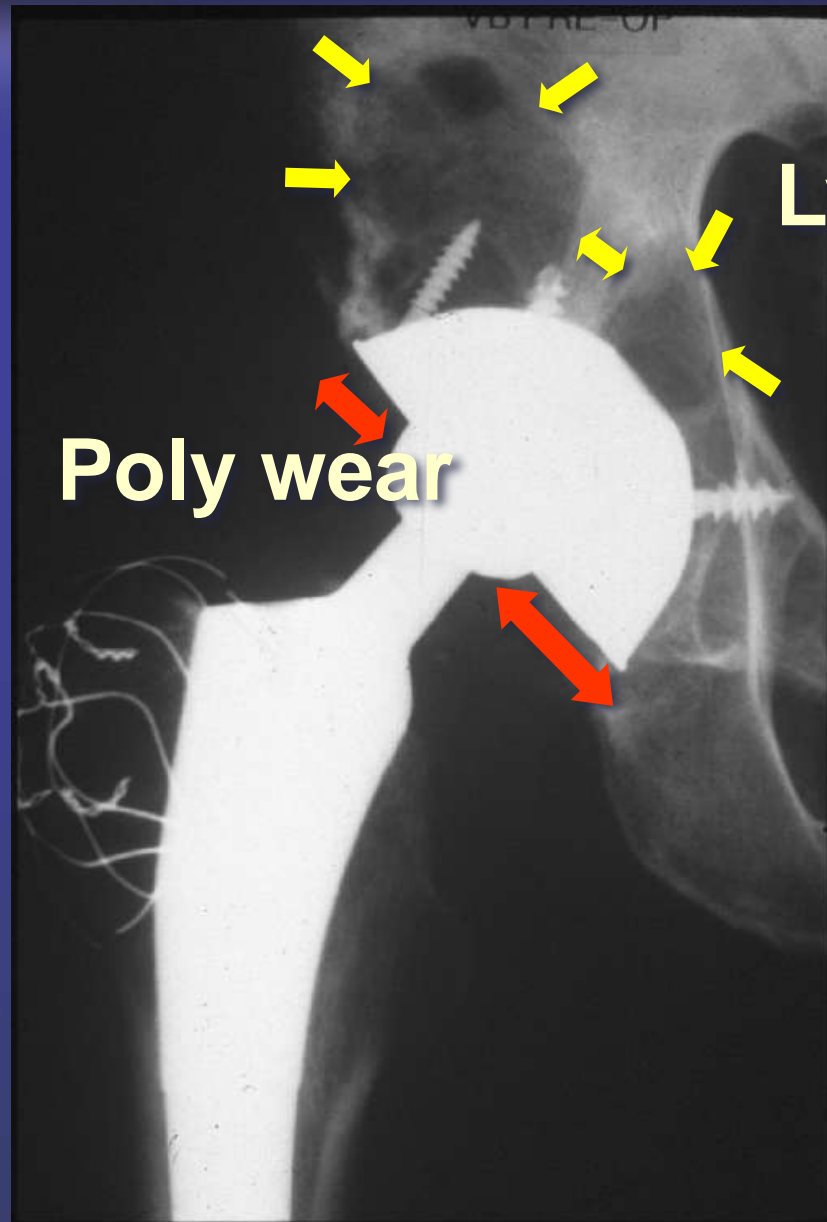
Conventional Polyethylene

Cross Linked Polyethylene

Ceramic on Ceramic

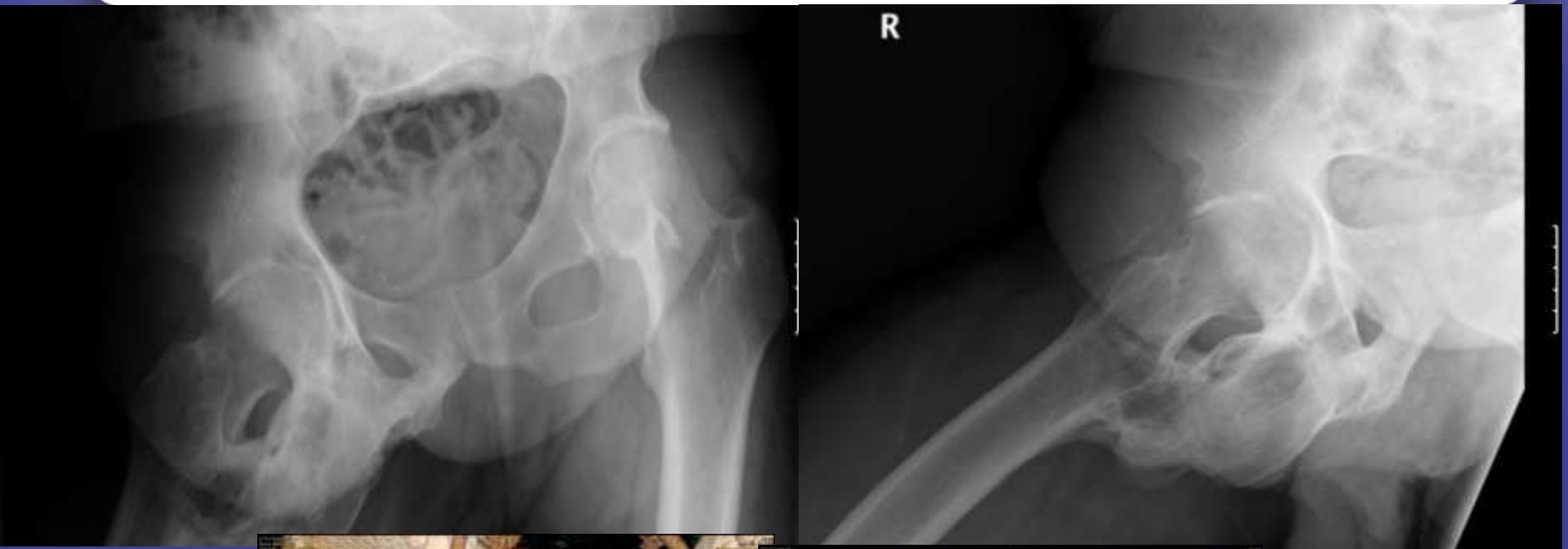Metal on Metal

Metal on Metal

■Conventional poly--- not for the young

■Abandoned mostly

My Choices

- Elderly/inactive---- Metal on poly

- Moderately active– metal or ceramic on XLP

- Hyperactive
    - Everyone ---- COC

POST OP

- Elderly/inactive---- Metal on poly

- Moderately active– metal or ceramic on XLP

- Hyperactive
  - Everyone ---- COC

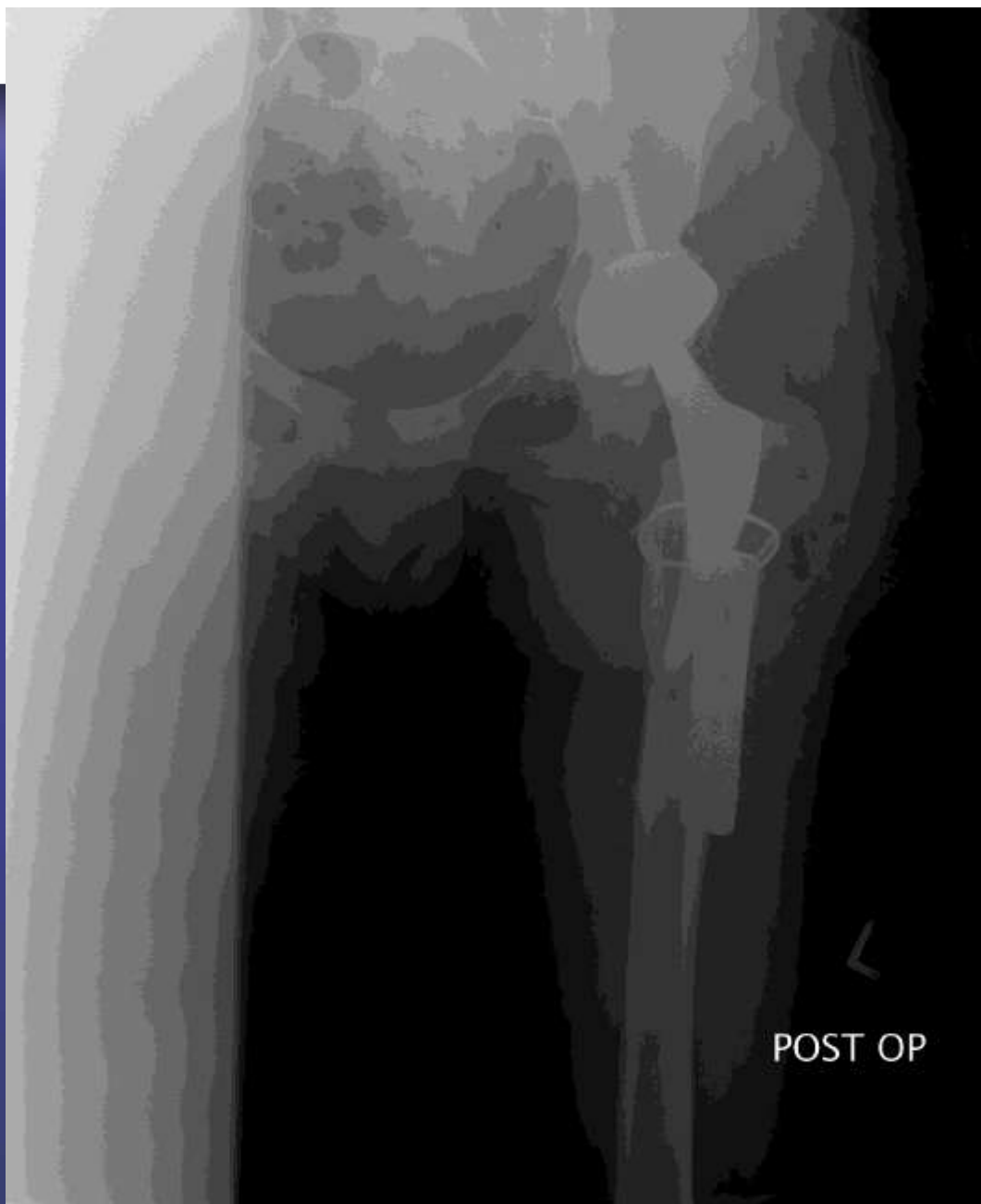Rothman Institute Orthopaedics
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Wear Rate (microns/year)

CoCr/Polyethylene[1]	CoCr/Crossfire™ Polyethylene[2]	Metal/Metal[3]	Alumina/Alumina[4]
200 microns/year	20 microns/year	4.2 microns/year	less than 1 micron/year

Ceramic heads

More wettable → ↑ **lubrication**

Small grain size → **improved surface finish**

= reduced friction

Standard CoCr Head

Ceramic Head

Wear Rate

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

Retrievals (Sedel)

Wear rate

Femoral head	2 - 165 µm/y
Cup	1 - 48 µm/y
Metal / UHMPE	100 - 200 µm/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

Study Design

- 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.

Study design

- 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.

Parameters

- 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

Parameters

- Images anonymized and de-identified

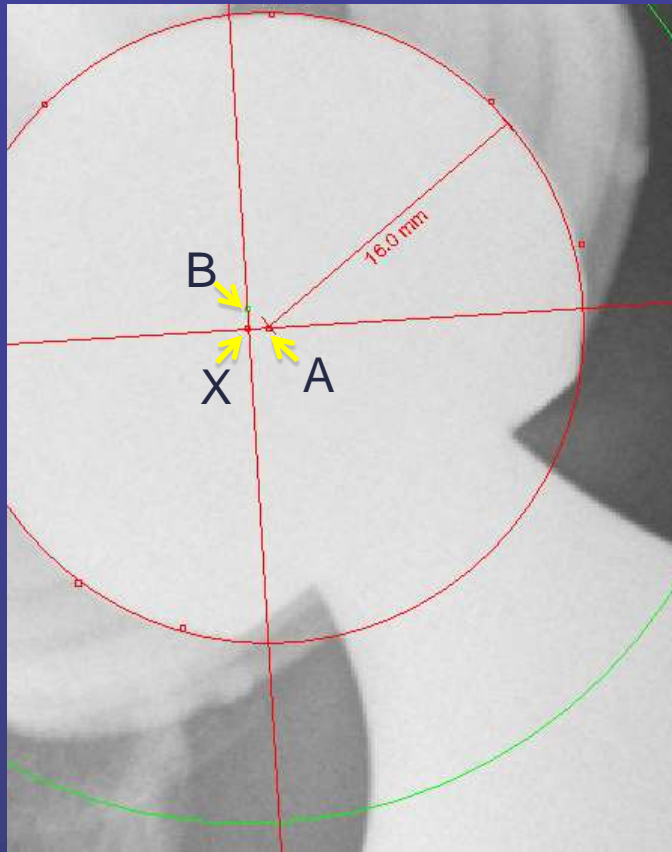|	Metal	Ceramic
Patients	177	292
BMI	28.3	27.7
Age	70.1	59.8
Females	51.4%	52.1%

- Observers and statistician blinded to head material

- ROMAN method (ROntgenMonogrammetric ANalysis)

Measurement method
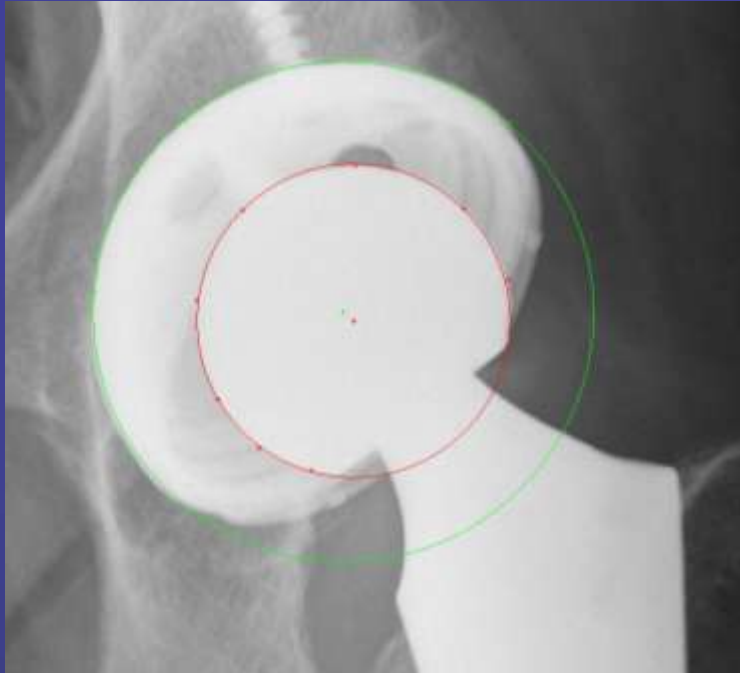
- Manually define acetabular cup and implant head edges

- Calibrate measurements according to known head size

Measurement method

- 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

Measurement method

- Take intercept of the two lines (A and B)

- Measure distance X-A and X-B

- Determine resultant vector and angle of displacement

Results

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

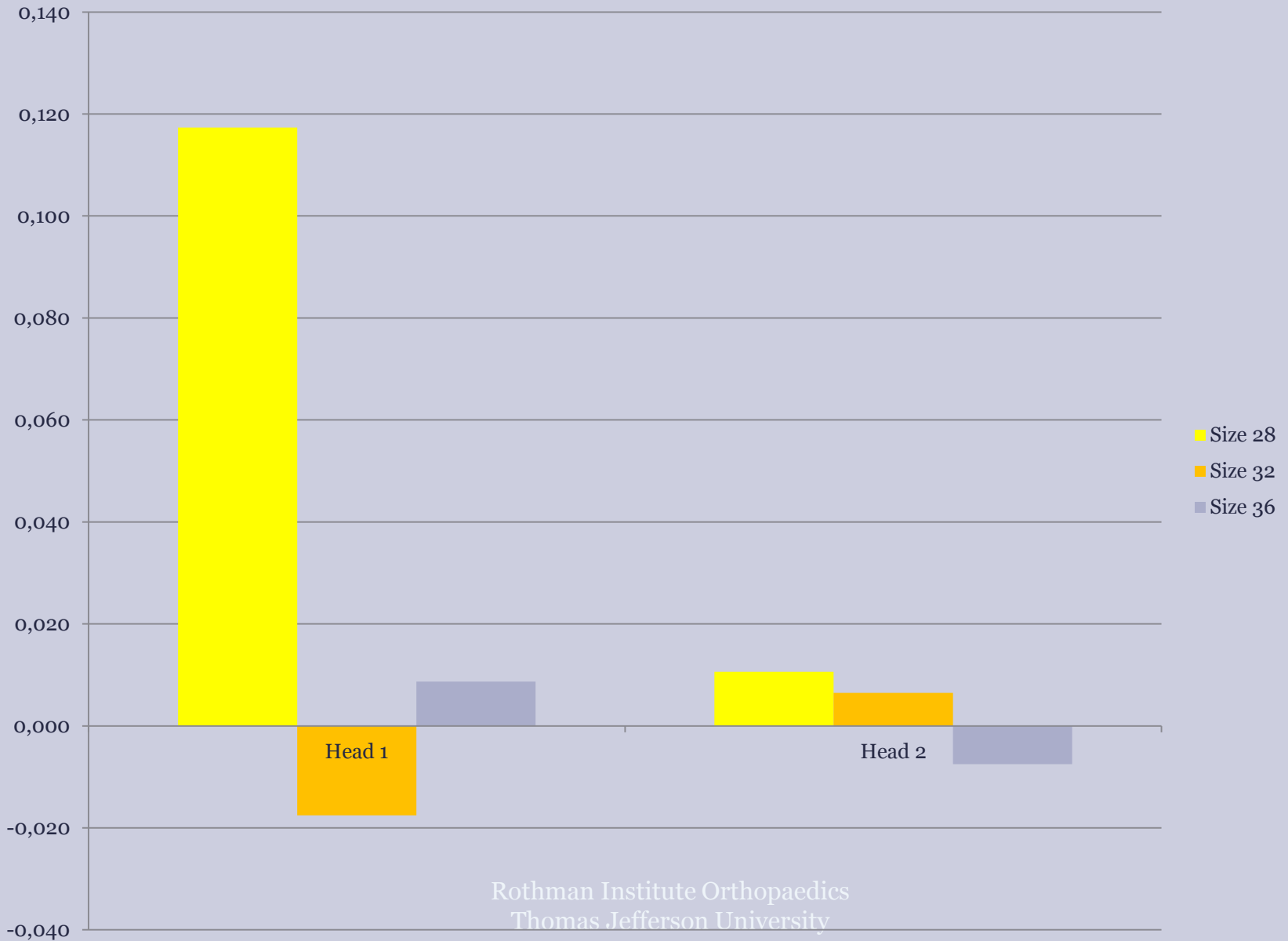|	Metal	Ceramic
28mm head	0.117 mm/yr	0.011 mm/yr
32mm head	-0.018 mm/yr	0.006 mm/yr
36mmhead	0.009 mm/yr	-0.008 mm/yr

Results
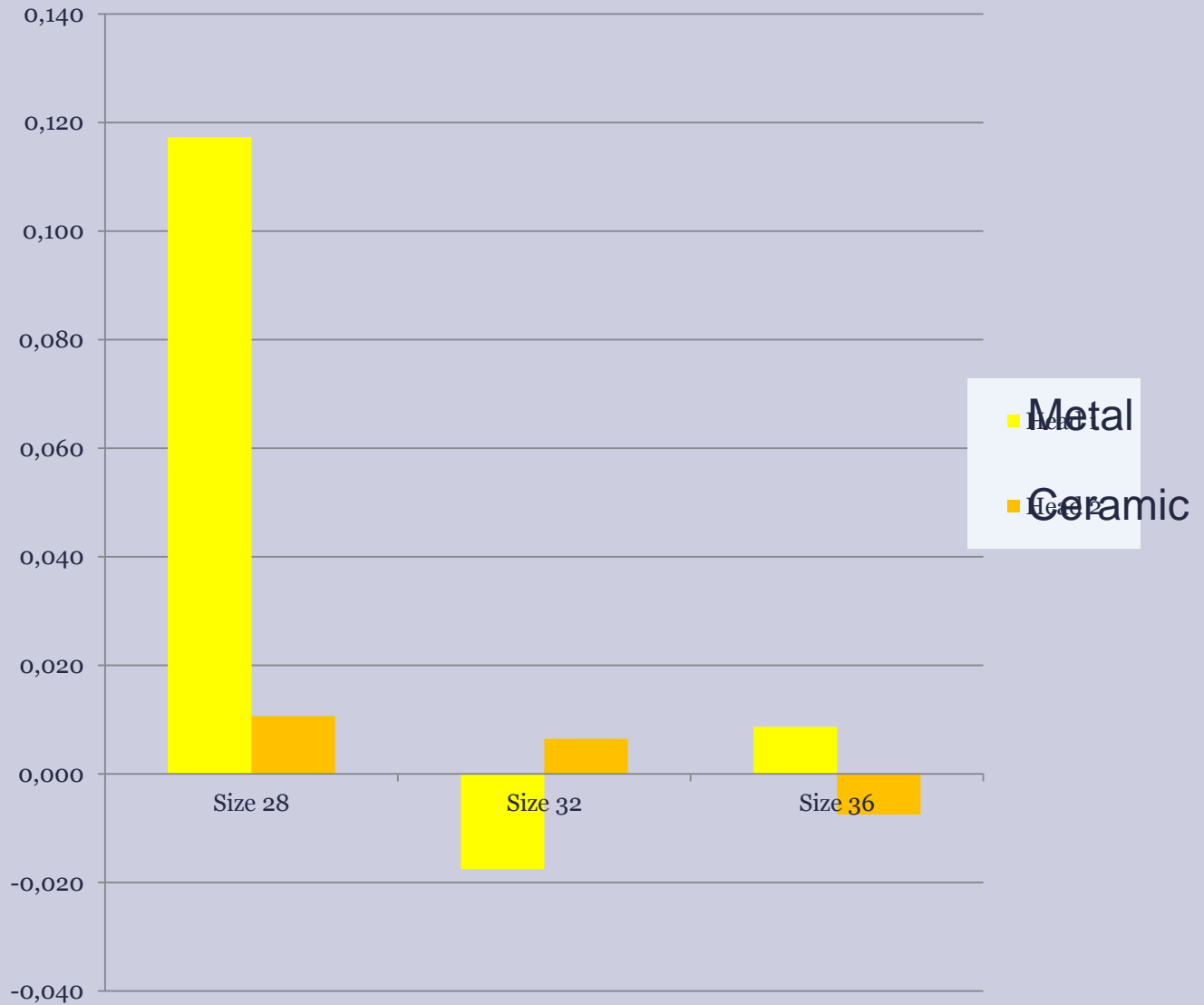
Results

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

Wear Analysis

- Ischial tuberosity delineated

- Head and shell edges manually defined

- Head and cup sizes manually entered

- Acetabular inclination and anteversion automatically detected

Findings

- 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 mm³/yr	78.8±65.9 mm³/yr

Metal on Poly
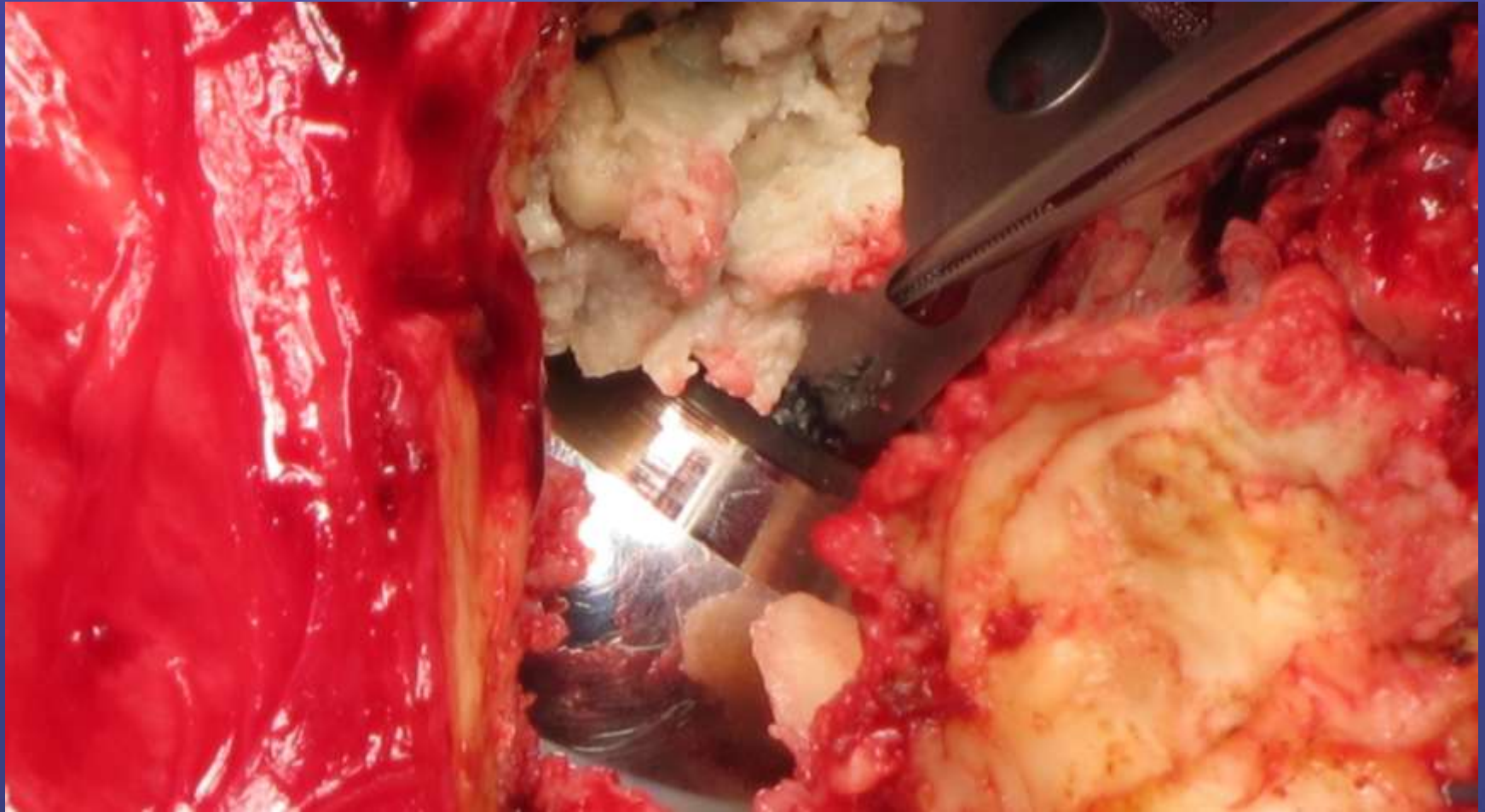
- Taper corrosion

- Higher with metal head compared to ceramic

Kurtz et al 2013

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Ceramic against XLPE

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