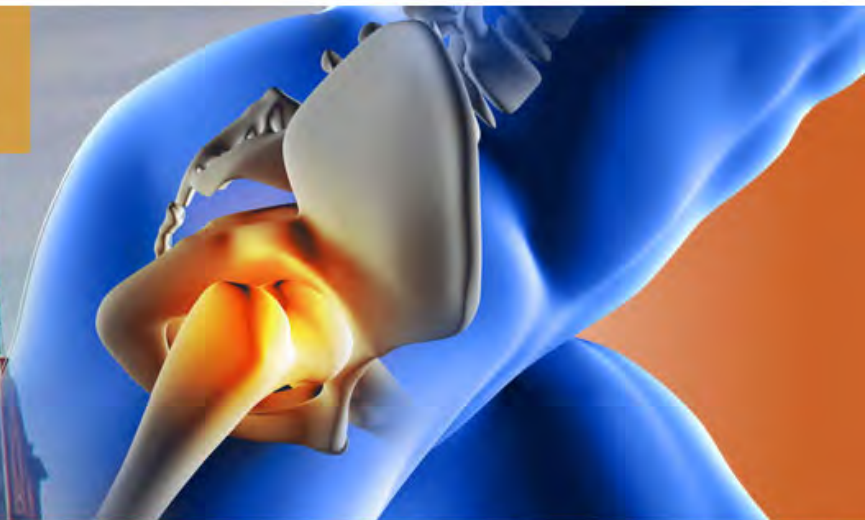




**Monza, 23-24 Novembre 2017**



**COMPLICANZE: PREVENZIONE E TRATTAMENTO NELLA CHIRURGIA DELL'ANCA DALL'ARTROSCOPIA ALLA PROTESI**

## **PRIMO IMPIANTO: COMPLICANZE CERAMICA CERAMICA**

Moderatori: **Sandro Giannini** (*Bologna*), **Bruno Marelli** (*Milano*)

**Aldo Toni** (*Bologna*) DESCRIZIONE DEL PROBLEMA

**Giuseppe Solarino** (*Bari*) PREVENZIONE

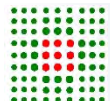
**Luigi Zagra** (*Milano*) TRATTAMENTO

# **DESCRIZIONE DEL PROBLEMA**

**Aldo Toni**

**Istituto Ortopedico Rizzoli**

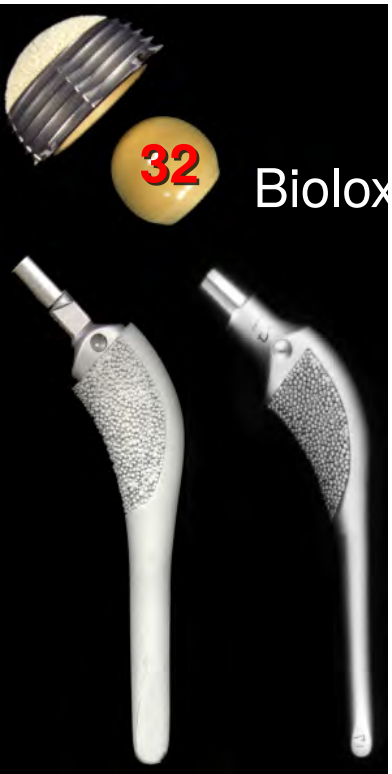
**Bologna**



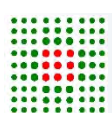
# Esperienza personale Cotili 1986-2017

AnCA

Cremascoli

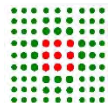
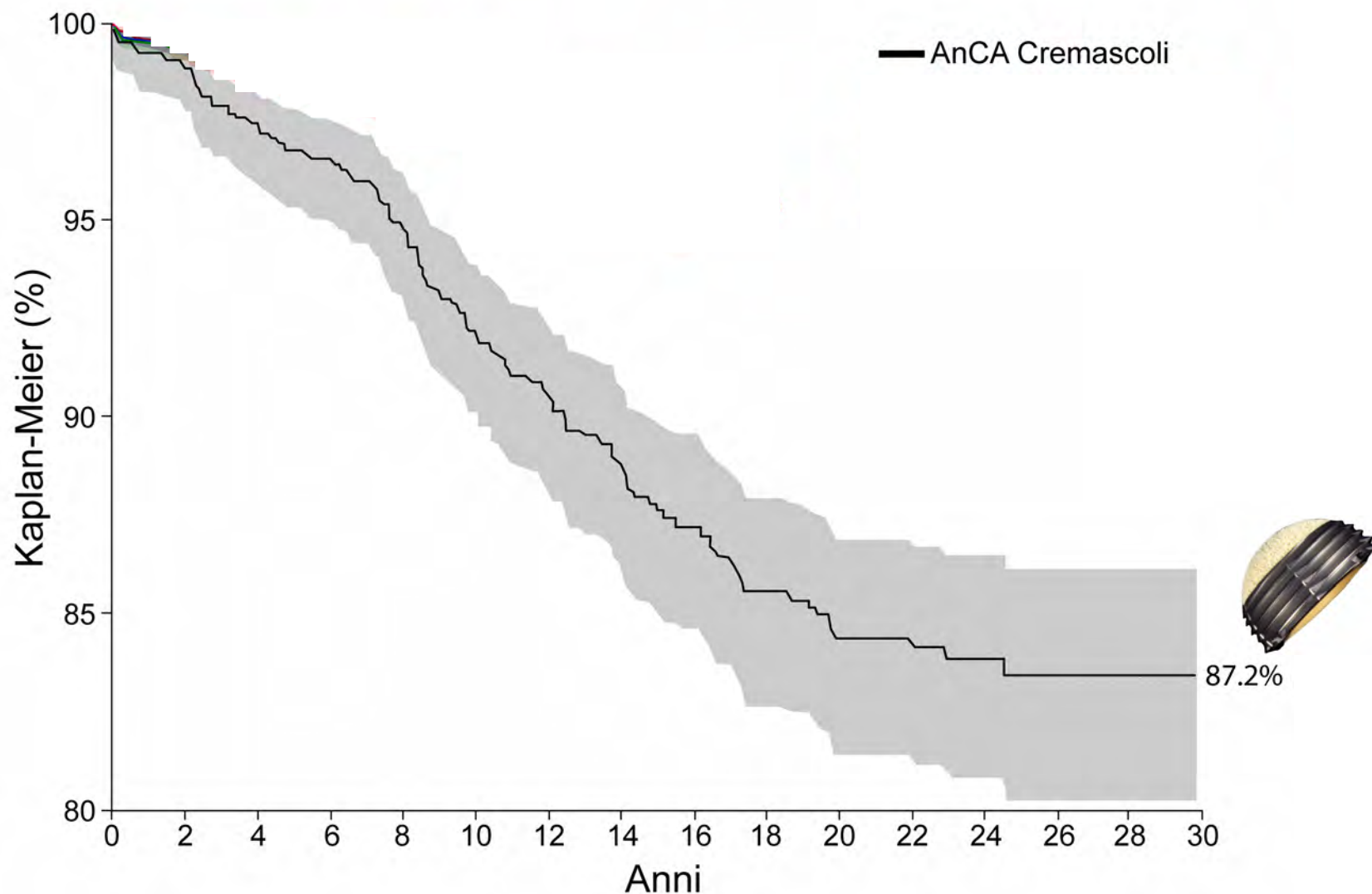


1986-1994





# Sopravvivenza cotili AnCA 1986-2015



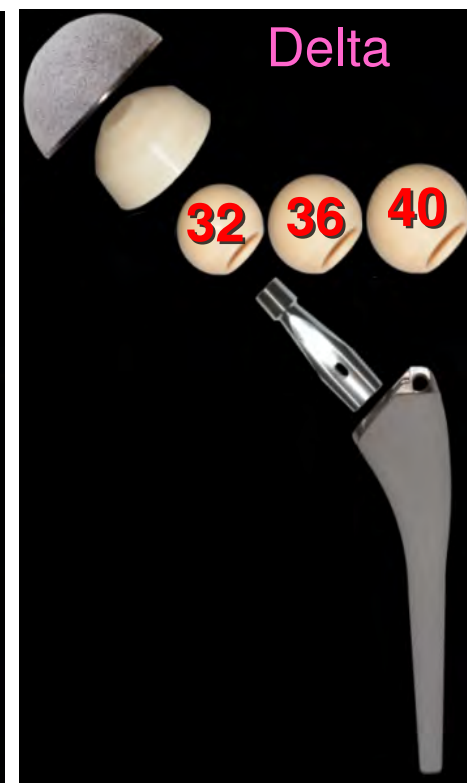
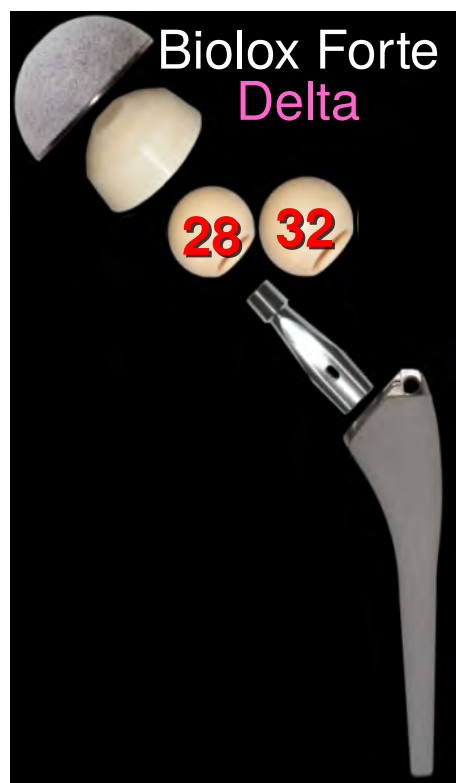
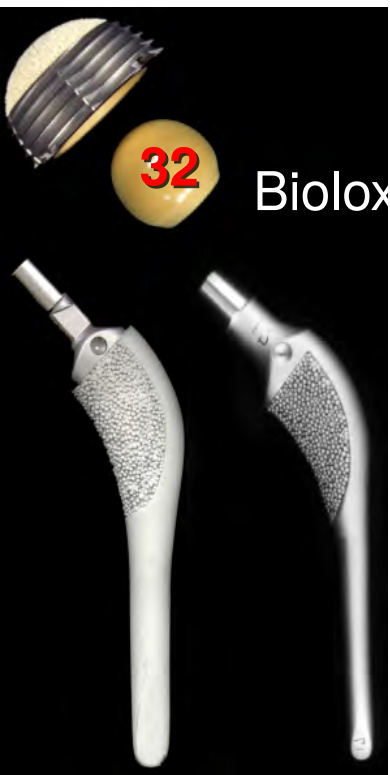
# Esperienza personale Cer-Cer 1986-2017

AnCA  
Cremascoli

AnCA Fit  
Cremascoli/  
Wright

ADLER FIXA

ADLER TIPOR

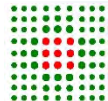


1986-1994

1994-2004

2004-2007

2007-2017





# RIPO (Registro degli Impianti Ortopedici)

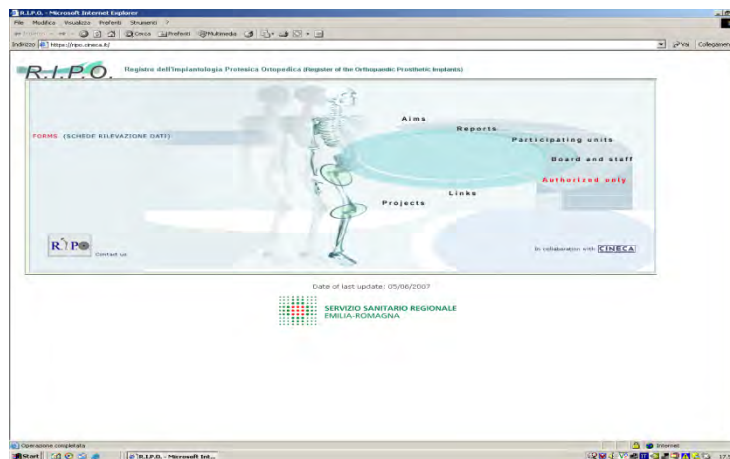
Emilia-Romagna



4,5 milioni

- iniziato nel 2000
- Protesi anca, ginocchio e spalla
- 119,000 protesi d'anca
- adesione >97%

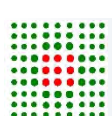
<https://ripo.cineca.it/>



# DATA – BASE ANCA

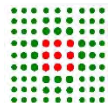
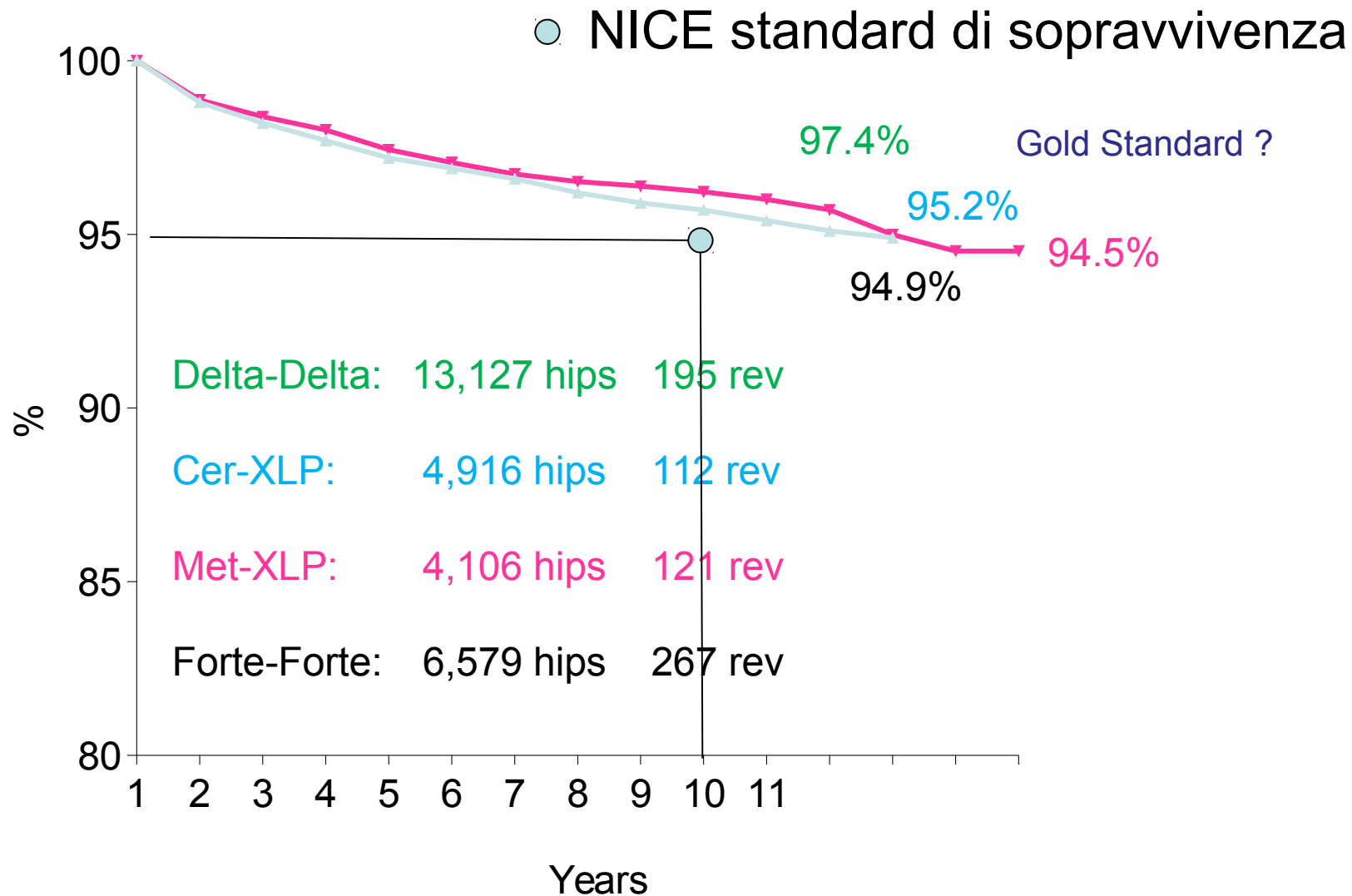
Protesi totali	88.000	
Protesi parziali	34.000	
Protesi di rivestimento	2.200	
Revisioni	13.600	
Espianti	1.000	
Altri interventi	600	

140.000

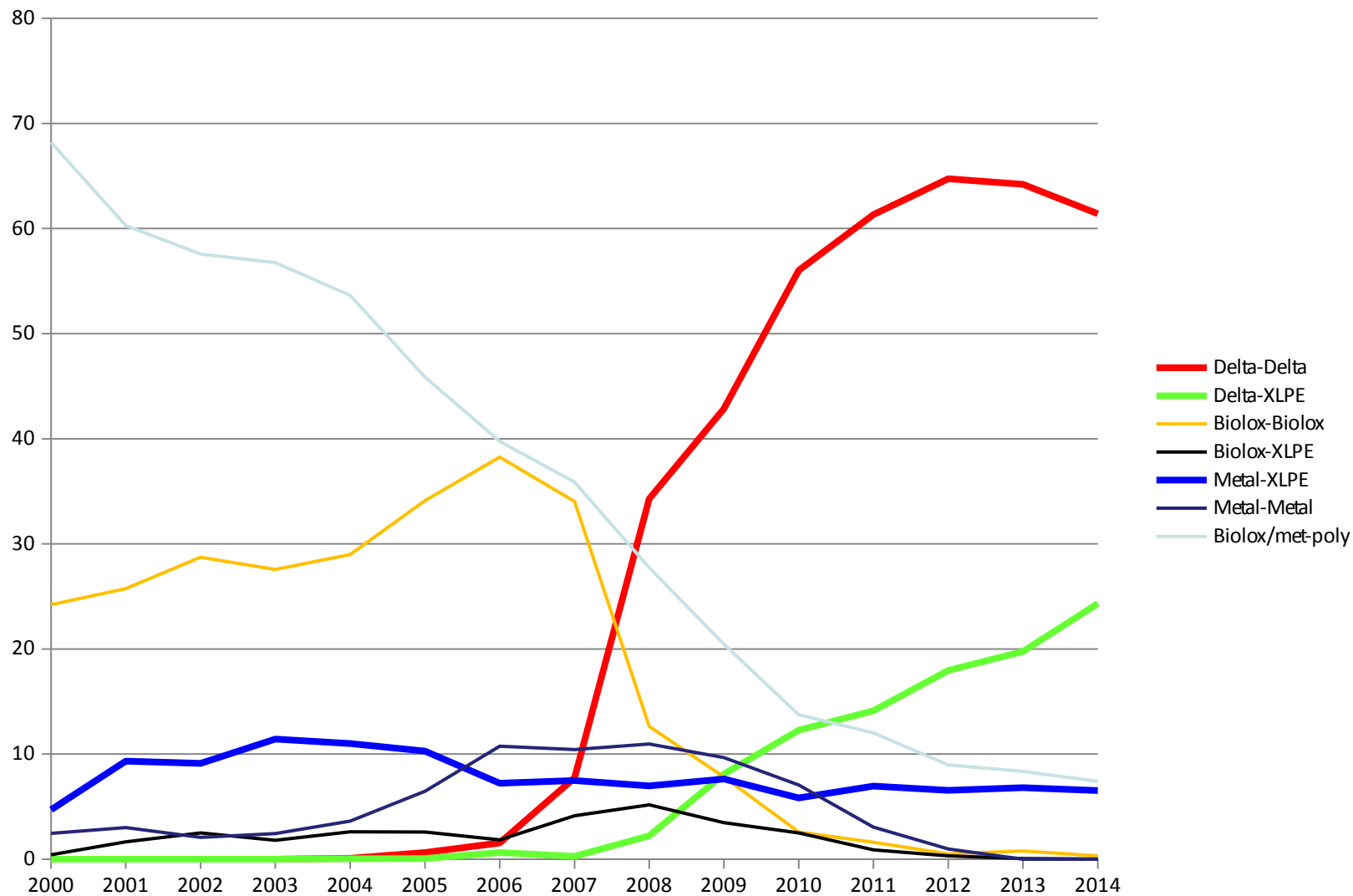




# Sopravvivenza vs Materiale Articolare



# THA: materiali usati in Emilia-Romagna



# COMPLICANZE

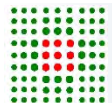
CER-CER



ROTTURA

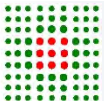
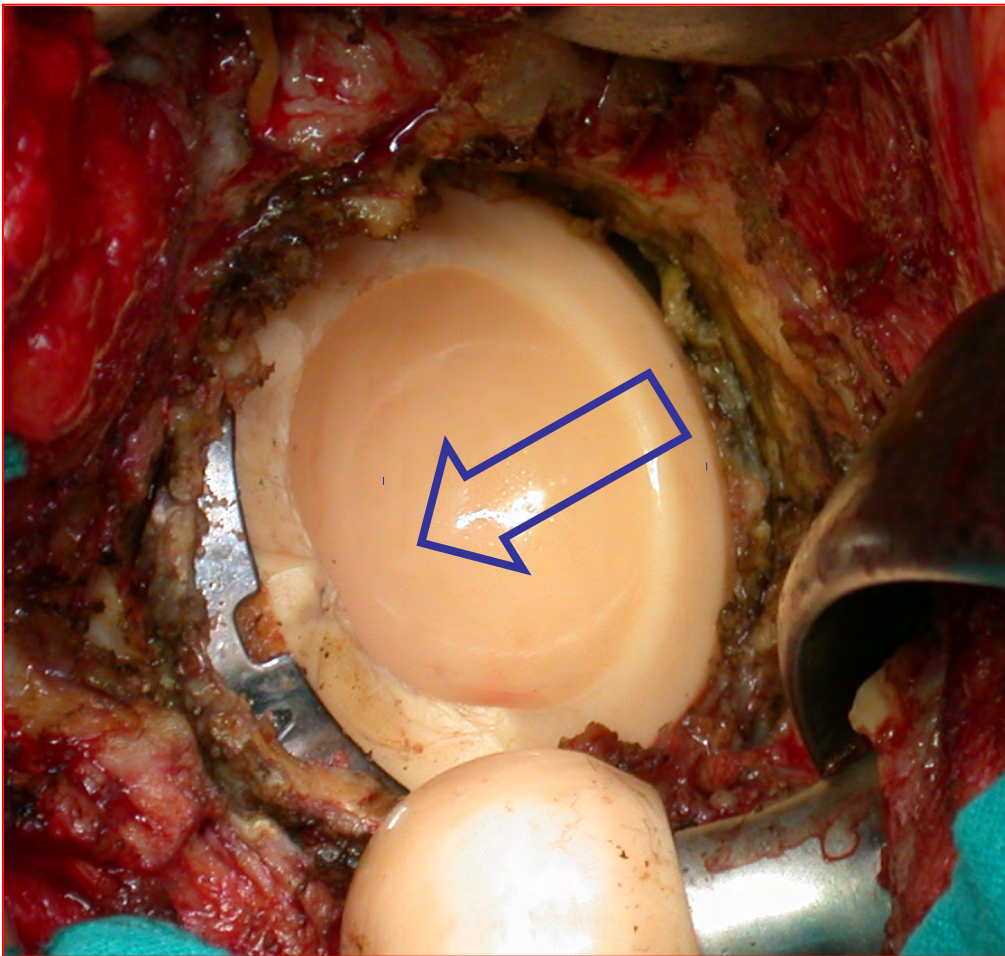
**RUMORI (Squeacking, ma non solo)**









**LUSSAZIONE (più frequente?)**





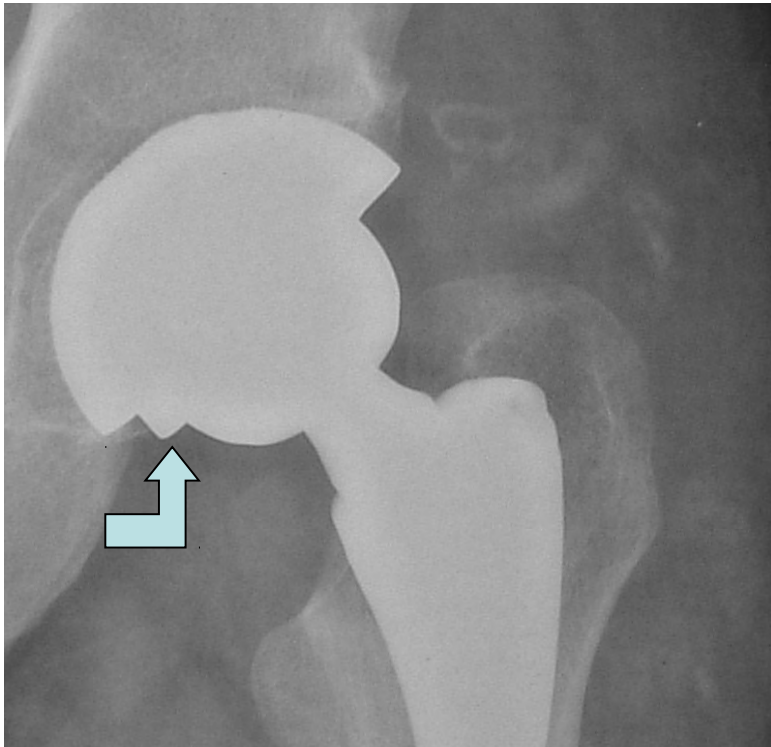
# Complicanza più temuta: Fragilità!



	Biolox® Forte 	Biolox® Delta 	Biolox® Delta   			Biolox® Forte   		
Implants	7.874	7.204	1.137	2.040	4.661	12.360	3.468	2.159
Fractures	28	5	-	1	-	36	1	-
%	0.4%	<b>0,07 %</b>	1 / 7,838 <b>0,01 %</b>			0.3%	0.03%	0%

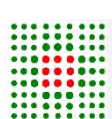
La rottura del Biolox Delta è veramente **EPISODICA** !

# Rotture dell'inserto

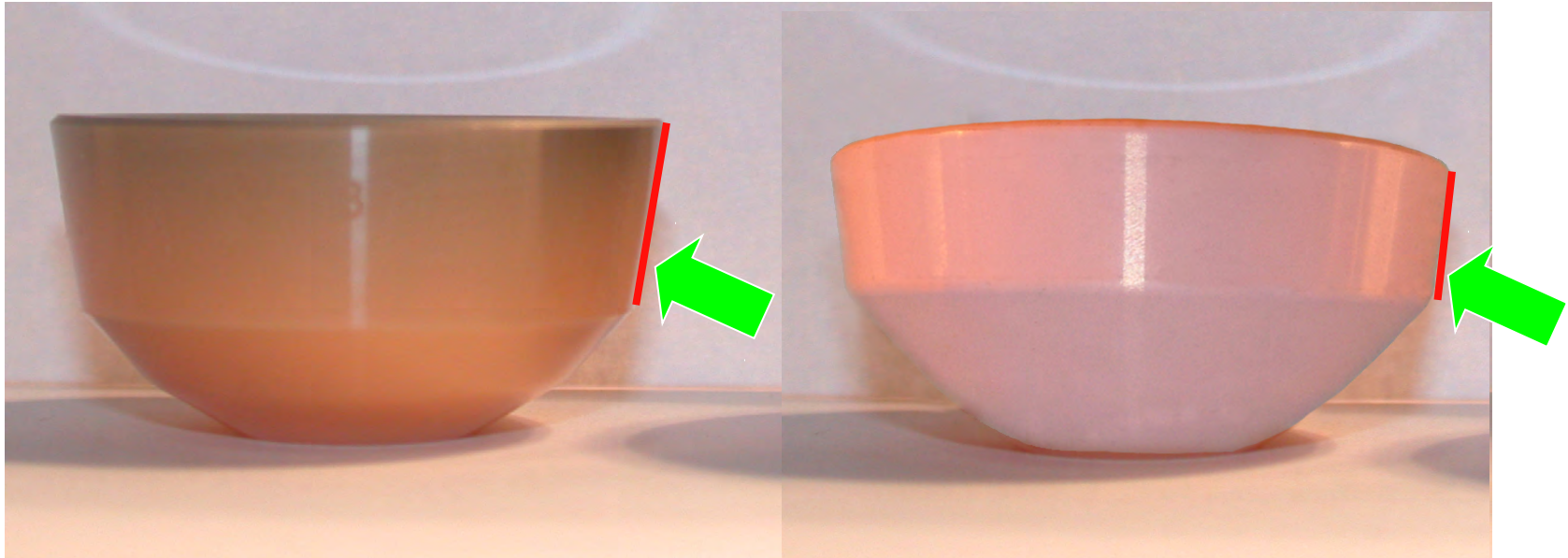


**Inserti di Ceramica  
possono  
danneggiarsi per:**

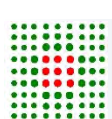
- **Malposizionamento**
- **Microseparazione**
- **Impingement stelo/inserto**



# Rotture inserti Biolox & Delta (disegni diversi)

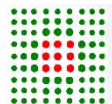
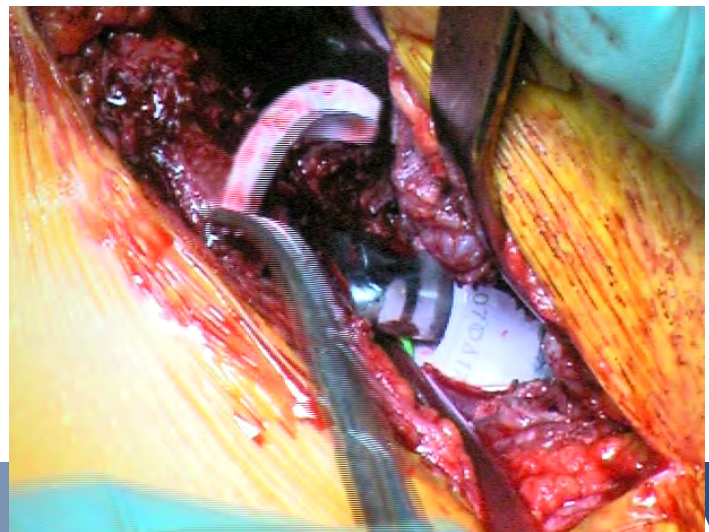
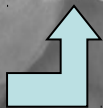


**Malposizionamento dell'inserto  
più facile con taper più corto  
(con 18°)**





# Cosa fare con inserto malposizionato?

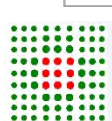


19 Mar, 2008

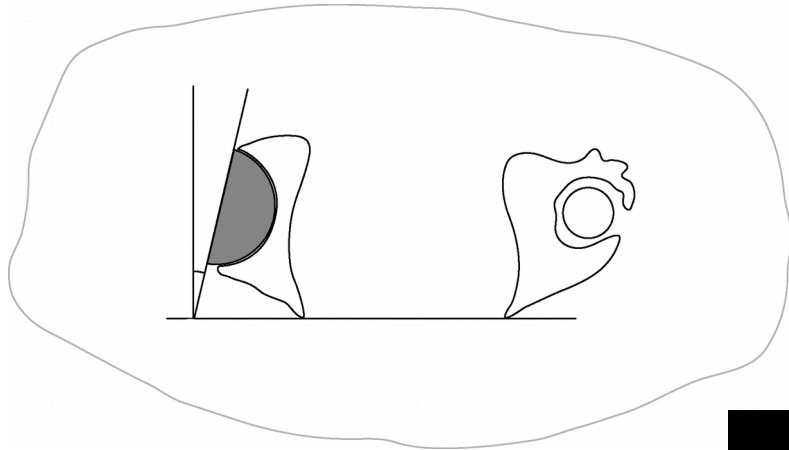


# Fattori di Rischio per rottura inserto di ceramica

	Fractured group (26 hips)	Non-fractured group (49 hips)	p
<b>Abduction angle</b>			
mean/range	43,8(25-60,6)	40(20,1-61,9)	0,09
n°cases outside the range(%)	9(34,6%)	14(28,6%)	0,5
<b>Anteversion angle</b>			
mean/range	25,11(3,5-50)	22,06(10,1-48,2)	0,25
n°cases outside the range(%)	13(59,1%)	15(30,6%)	<b>0,03</b>
<b>Off-set(mm)</b>			
mean/range	39,4(19,5-60)	36(18,1-49,7)	0,08
<b>Height of the center of rotation(mm)</b>			
mean/range	22(7,5-38,5)	23,8(9,9-48,7)	0,3
n°cases (%)	4(15,4%)	9(18,4%)	0,7



# Fattori di Rischio per rottura inserto di ceramica



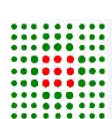
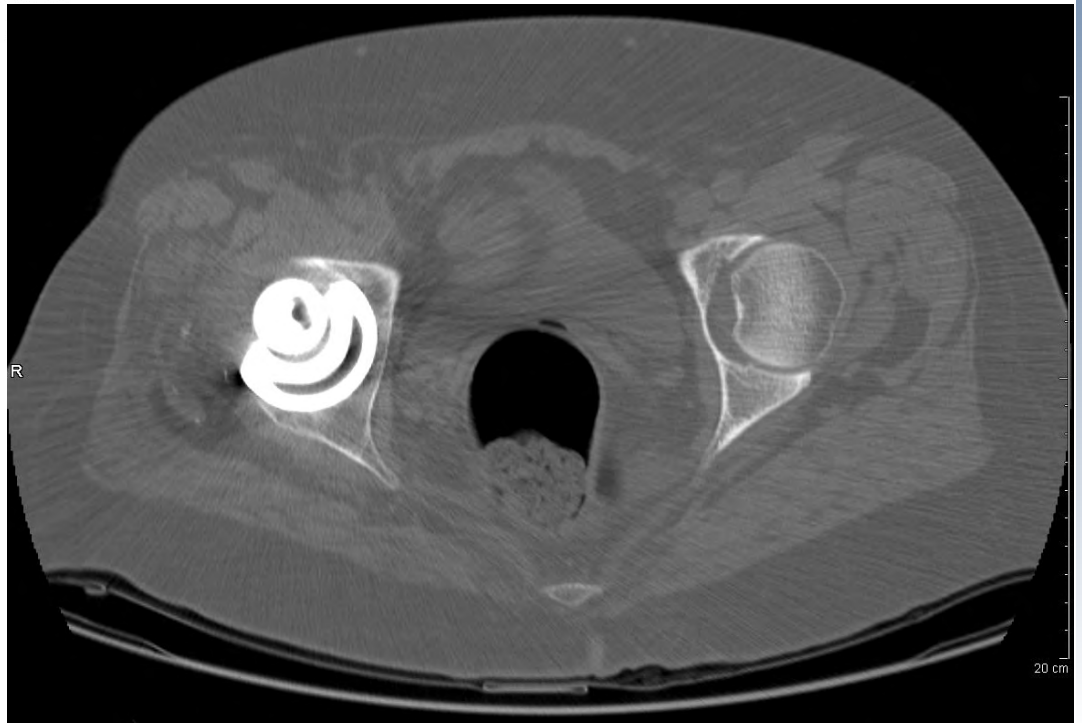
Malposizionamento  
(antiversione)

Più frequente nel  
gruppo dei casi con  
rottura

( $p=0,03$ )

Anche rumorose

21 casi (80,7%) nel  
gruppo con frattura

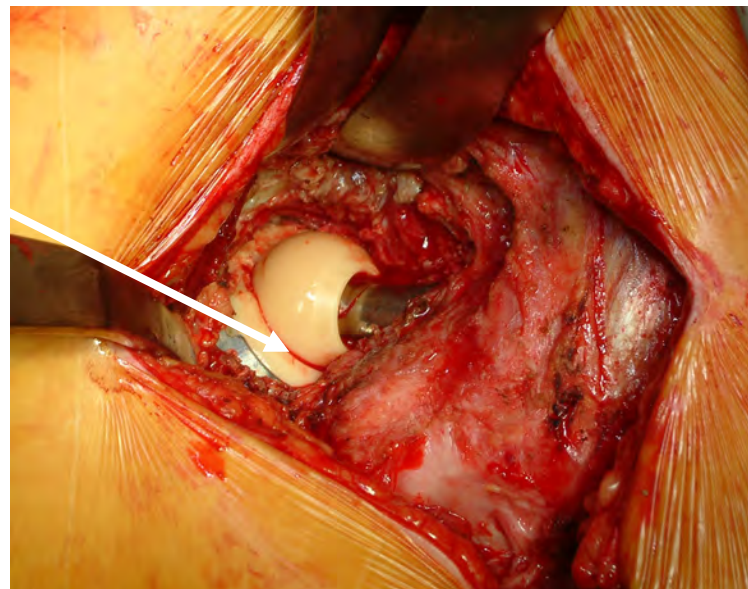
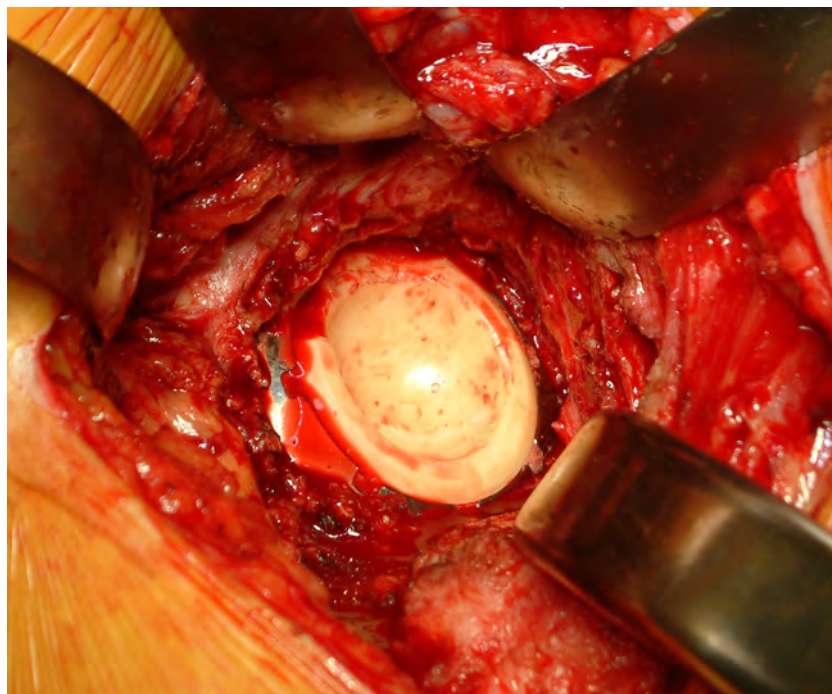


# Fattori di Rischio per rottura inserto di ceramica

Eccessiva antiversione

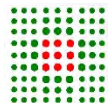


Impingement



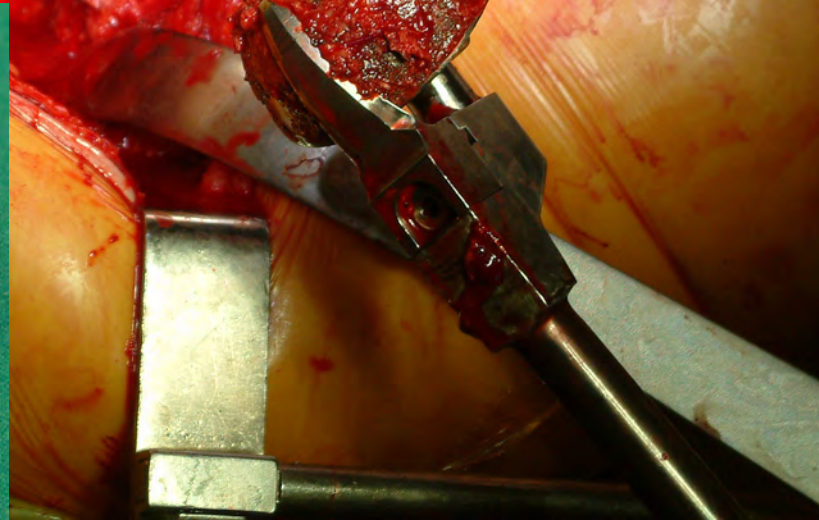
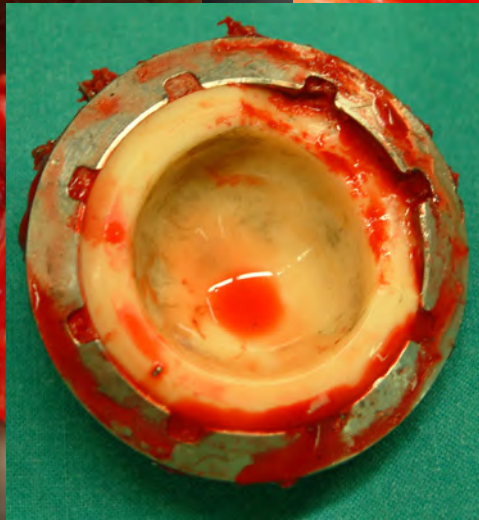
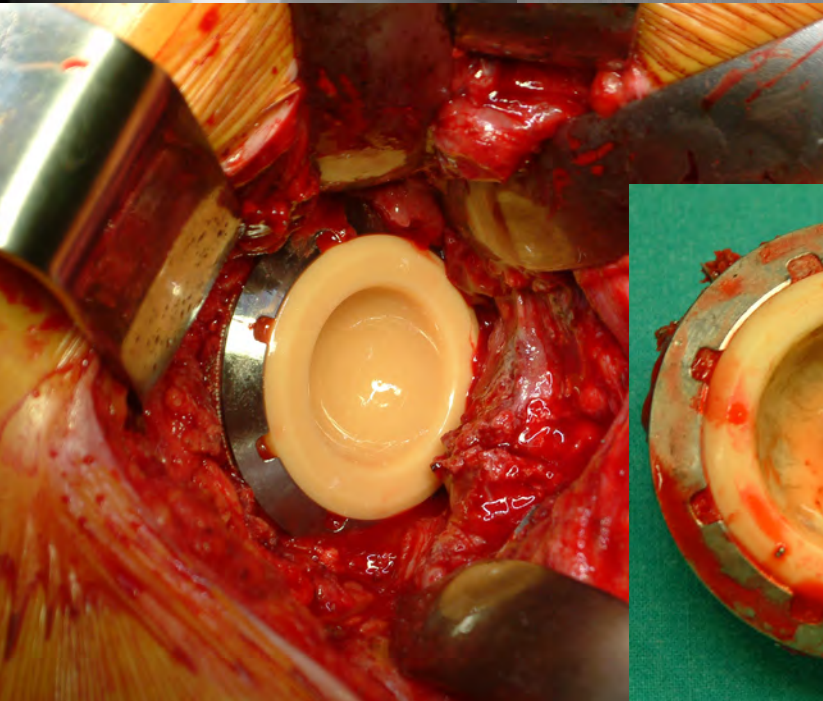
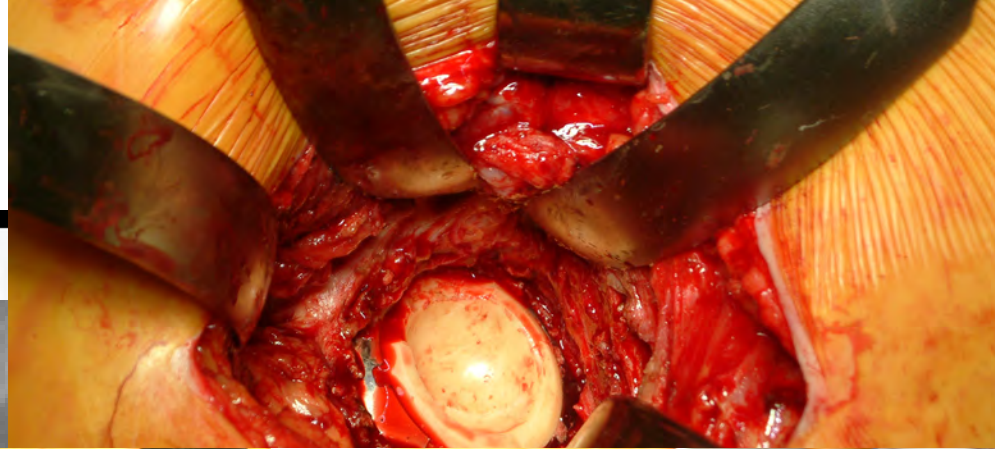
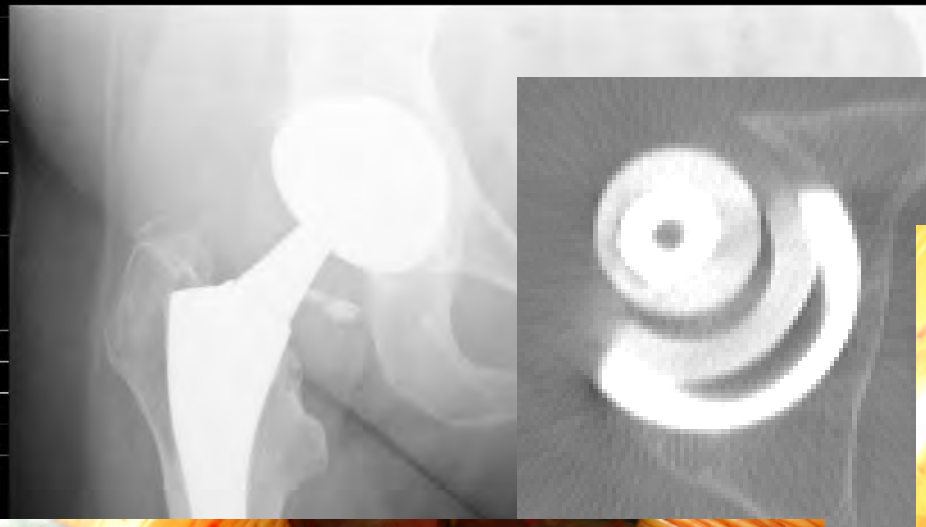
Rottura dell'inserto (Chipping)

(al polo opposto a quello dell'impingement)





# Malposizione Cotile



# DIFFERENTI SUONI UDIBILI CON PROTESI D'ANCA

- Clicking



*Mouse click*



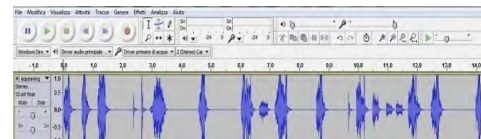
- Popping



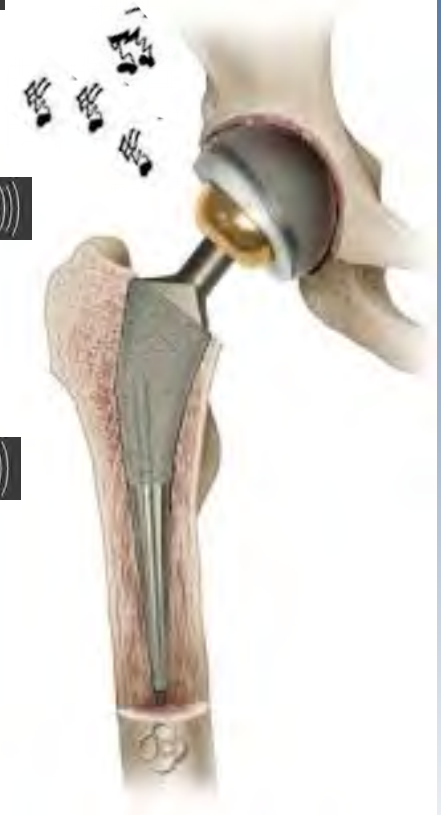
*Palla da tennis  
nella racchetta*



- Squeaking

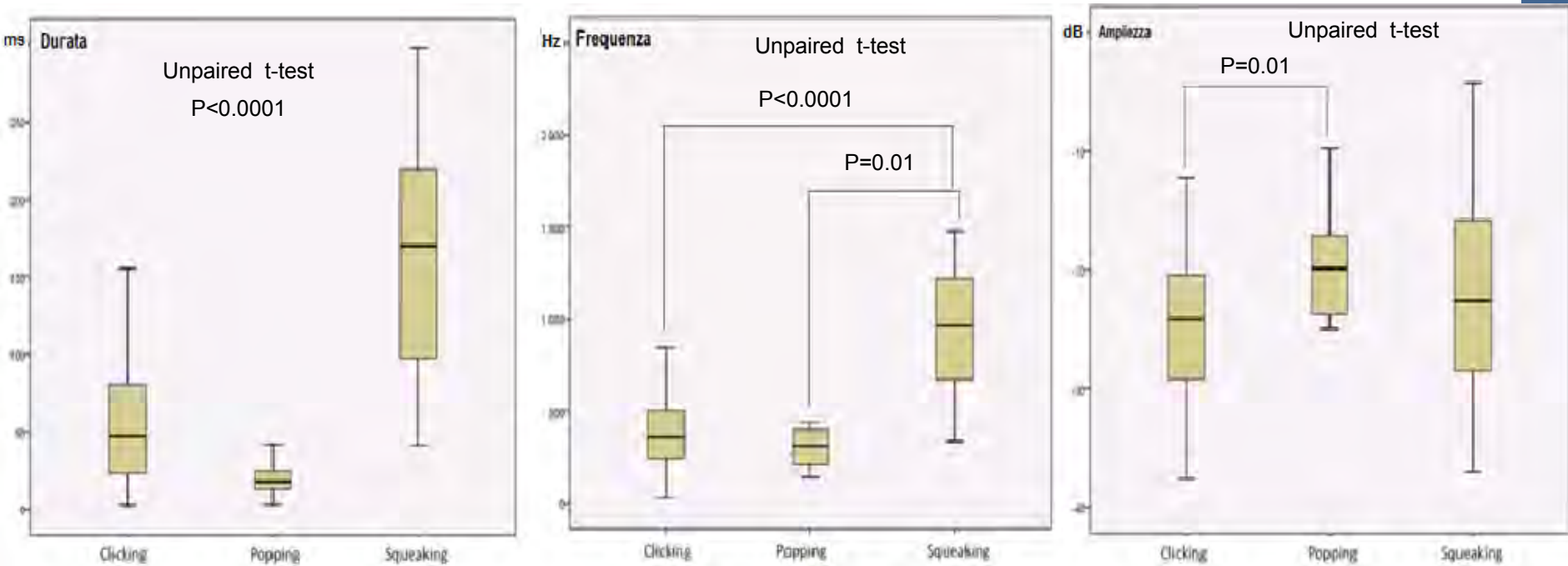


*cigolio*





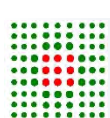
# DIFFERENTI SUONI UDIBILI CON PROTESI D'ANCA



Rumore	Durata media (ms)	Frequenza media (Hz)	Ampiezza media (dB)	Numero eventi
<i>Clicking</i>	69,66±73.66	443,65± 366,63	-24,39±6,99	37
<i>Popping</i>	19,00±10,57	486,34±524,97	-18,72±6,23	16
<i>Squeaking</i>	168,29±82,38	1010,38± 471,8*	-21,89±9,12	18

$P=0.01$

\*Hothan, A., G. Huber, et al. (2011)"The influence of component design, bearing clearance and axial load on the squeaking characteristics of ceramic hip articulations." J Biomech **44(5): 837-41.**



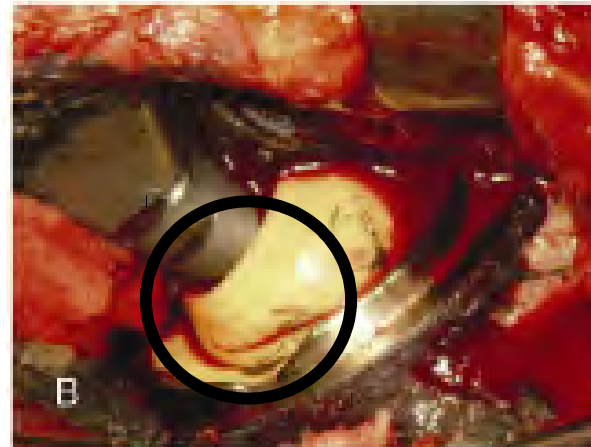
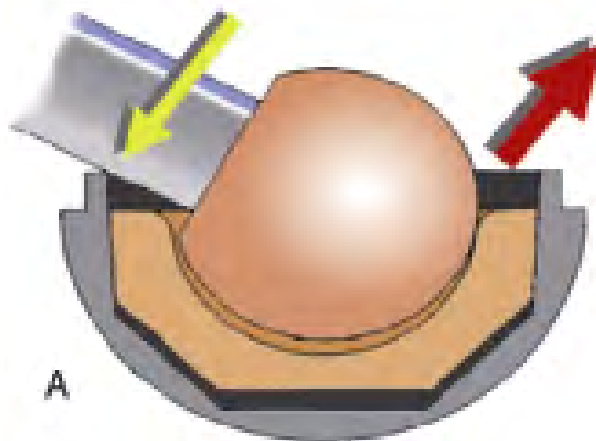
# Squeaking and metal back

The Journal of Arthroplasty Vol. 25 No. 6 Suppl. 1 2010

## Influence of Prosthetic Design on Squeaking After Ceramic-on-Ceramic Total Hip Arthroplasty

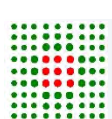
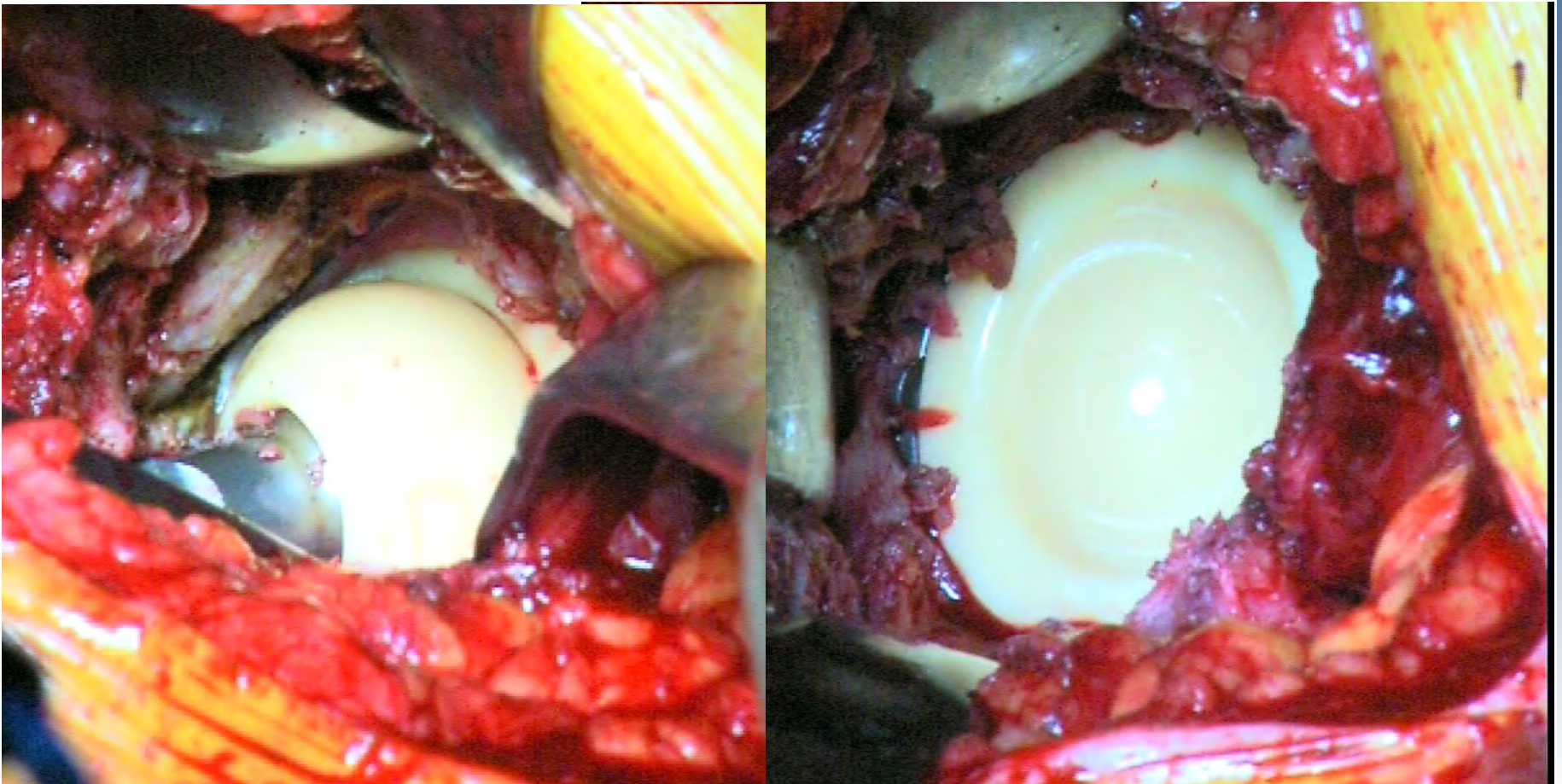
Todd V. Swanson, MD,\* David J. Peterson, PharmD, DO,\*  
Raghavendran Seethala, MS,† Ryan L. Bliss, BBA,\* and Calvin A. Spellmon, BS\*

Acetabular cup design with highest squeaking reported



# Squeaking hip

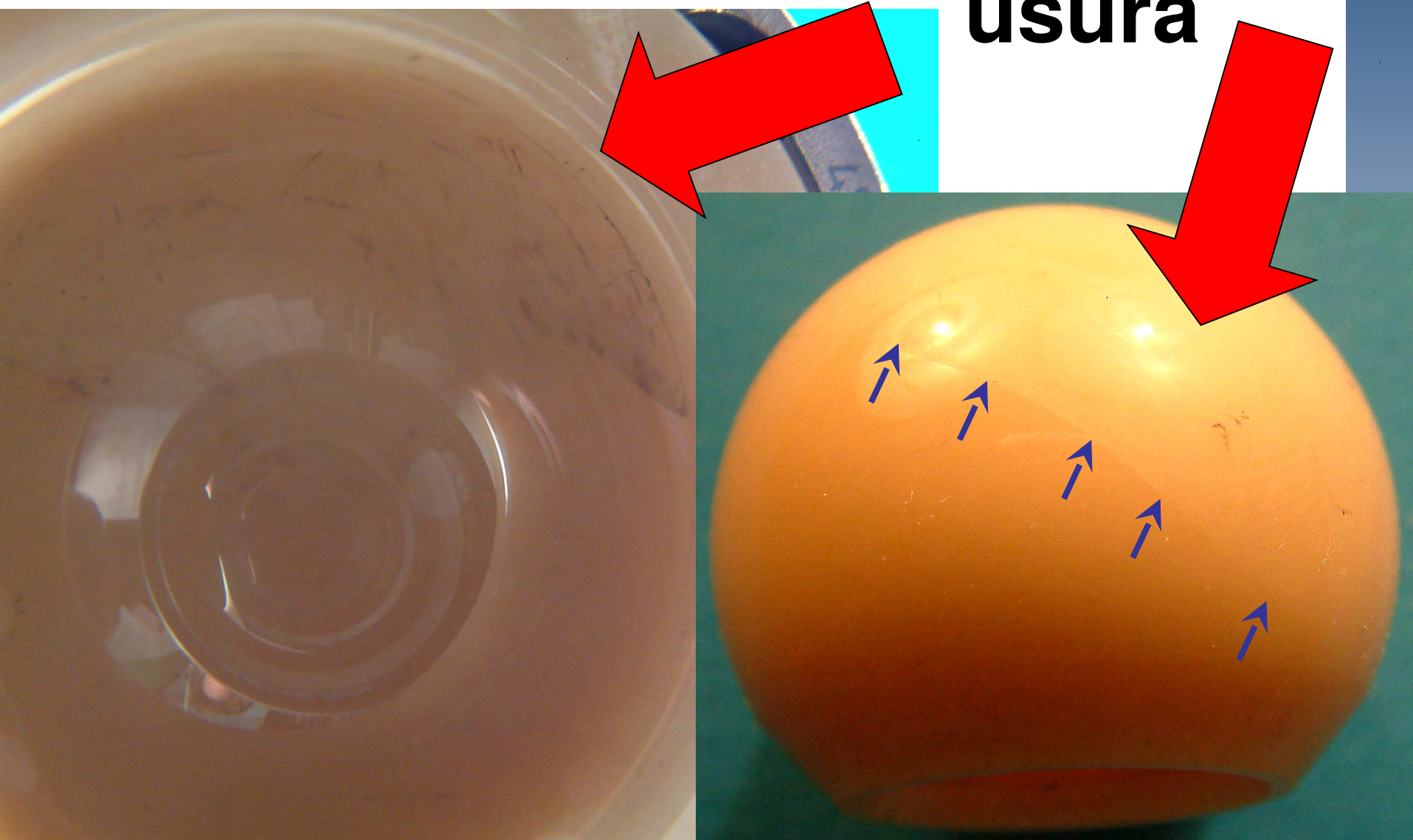
**No danno macroscopico visibile!**





# STRIPE WEAR

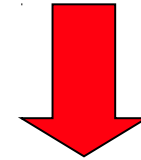
**usura**



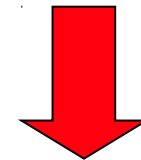
# Possibile Causa di squeacking?



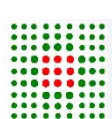
**Detriti liberi in  
articolazione**



**Rottura del film  
di lubrificazione**



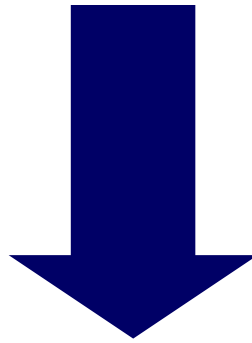
**Squeaking!!**



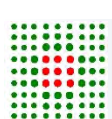


# Squeacking & Rumore

**Con Biolox Forte 0.5% dei pazienti lamentavano rumore correlato con ceramica (0.1% con revisione)**



**Veramente episodico con Delta**





## Indicazioni per Pazienti Attivi

**I Pazienti più attivi richiedono:**

Protesi con bassi tassi di usura

Ampio “Range of Motion”

Basso Rischio di Lussazione

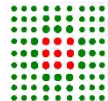


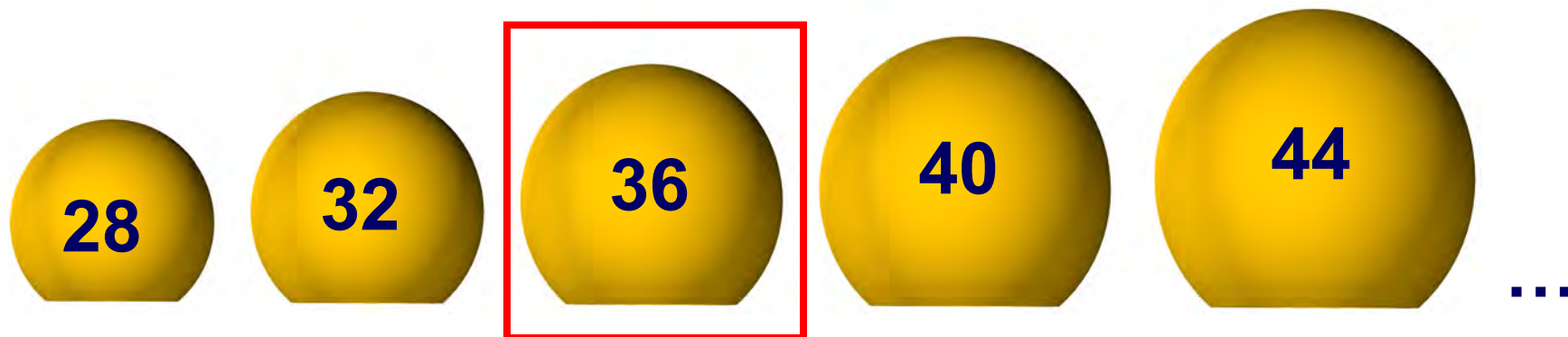
...in poche parole: **THA di Lunga Durata & Alta Prestazione**

### TESTE GRANDI

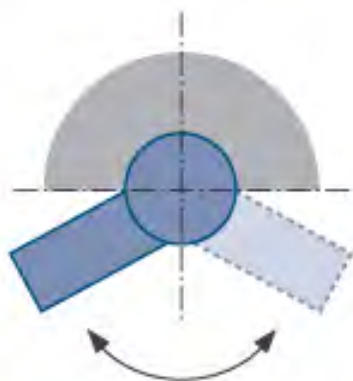


MoM CoC or HXLPE

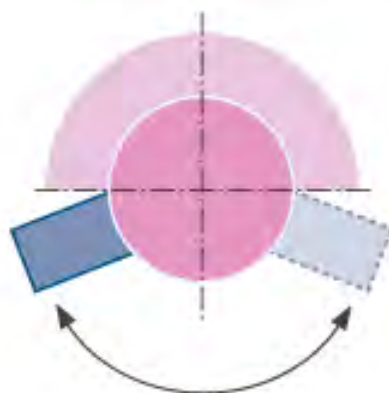




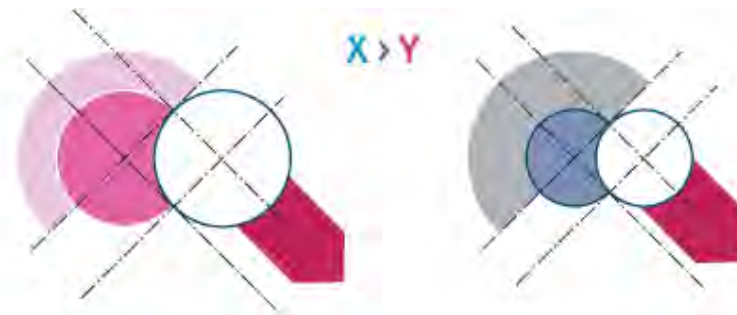
**Quanto “Più Grande” è necessario?**



Small Diameter Head

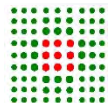


Large Diameter Head



Study	Dislocation Rate
Hummel et al <sup>1</sup> (Revision Study)	28mm 10.6% (14/132), 32mm 2.7% (3/110)
Dowd et al <sup>4</sup>	28mm 3.7% (13/358), 32mm 1.2% (4/308), 36mm 0.2% (1/515)
Peters et al <sup>3</sup>	28mm 2.5% (4/160), 38mm 0% (0/136)
Cuckler et al <sup>2</sup>	28mm 2.5% (2/78), 38mm 0% (0/616)
Howie et al <sup>6</sup>	28mm 4.4% (12/275), 36mm 0.8% (2/258)

**Maggior Diametro: più movimento & meno lussazioni!**



# Revisione causato da Lussazione

## VS

### Diametro della Testa (21.641 Teste Biolox Delta)



Revisione da  
Lussazione

Biolox Delta  
Impianti  
N°

Revisioni

28mm

20

1.610

1.2 %

32mm

20

6.980

0.3 %

36mm

23

10.871

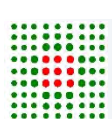
0.2 %

40mm

10

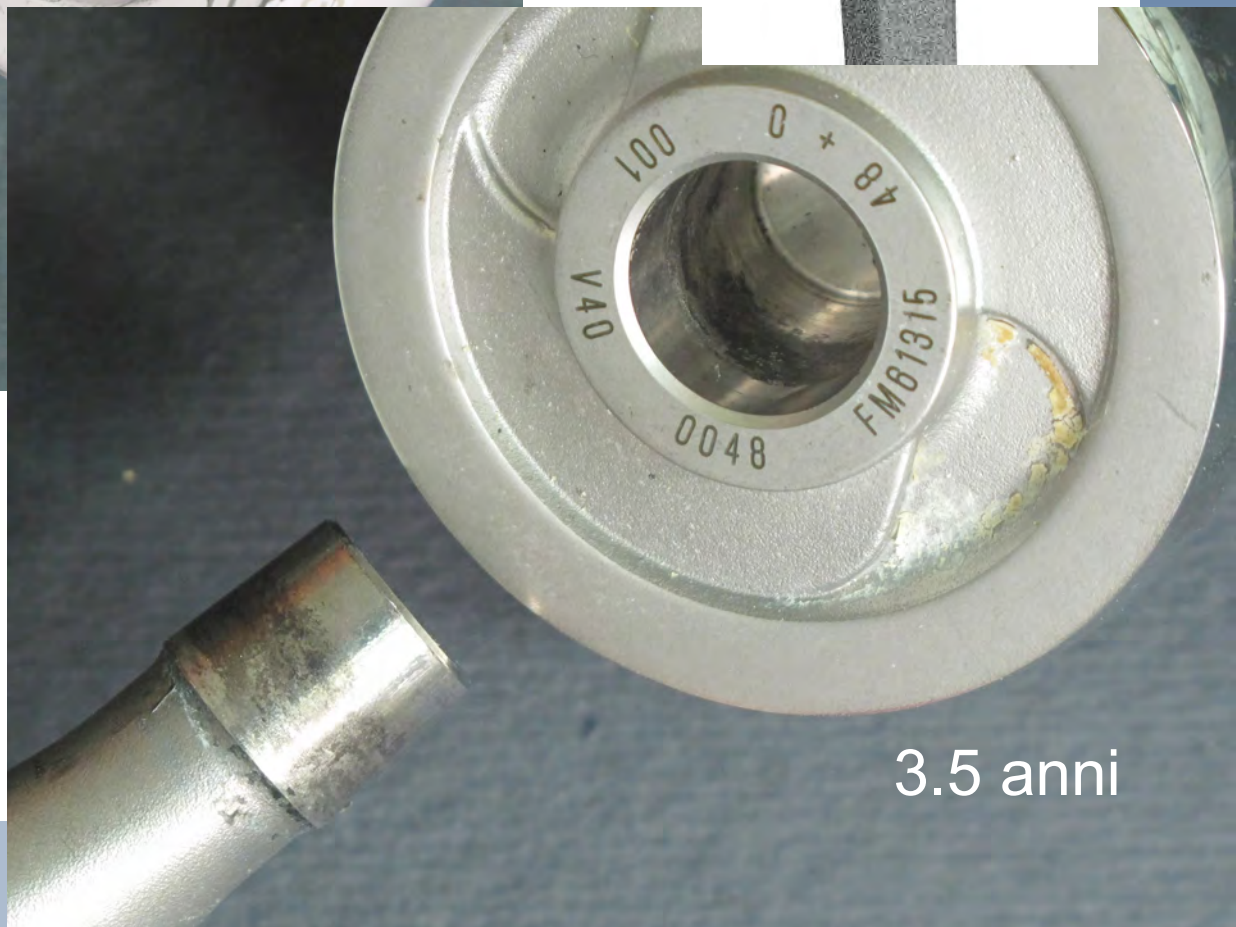
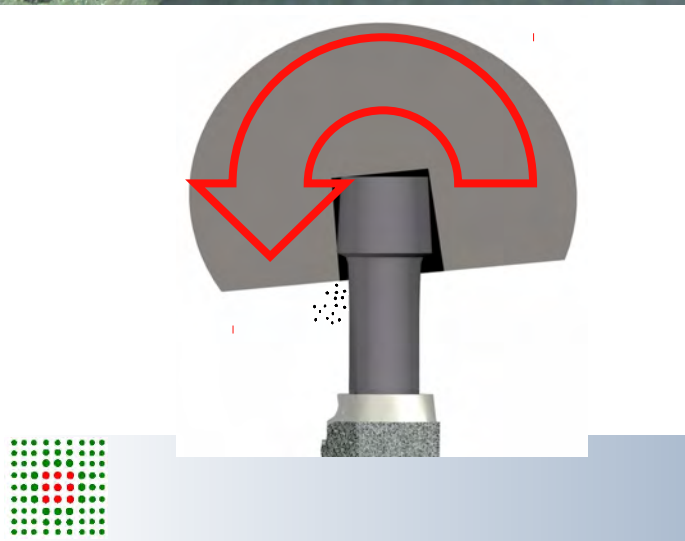
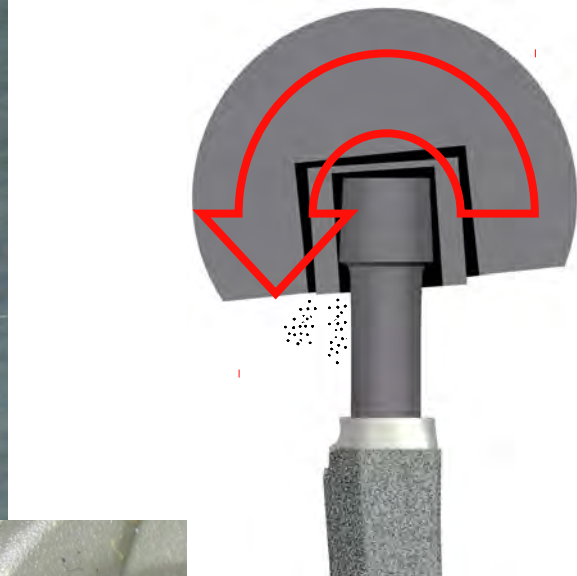
2.180

0.5 %

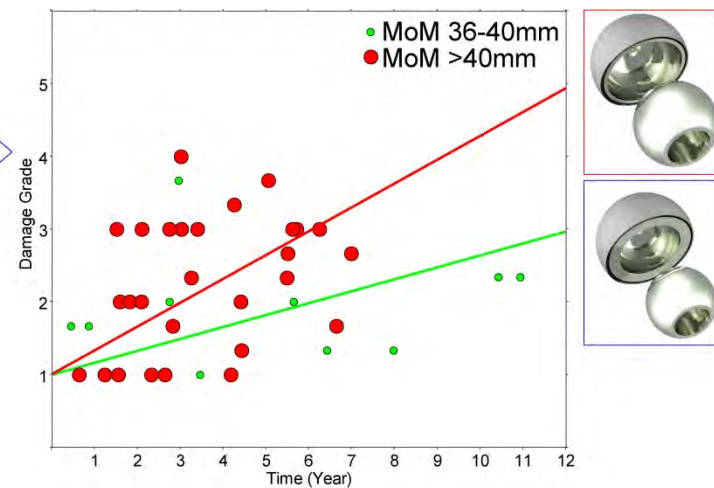
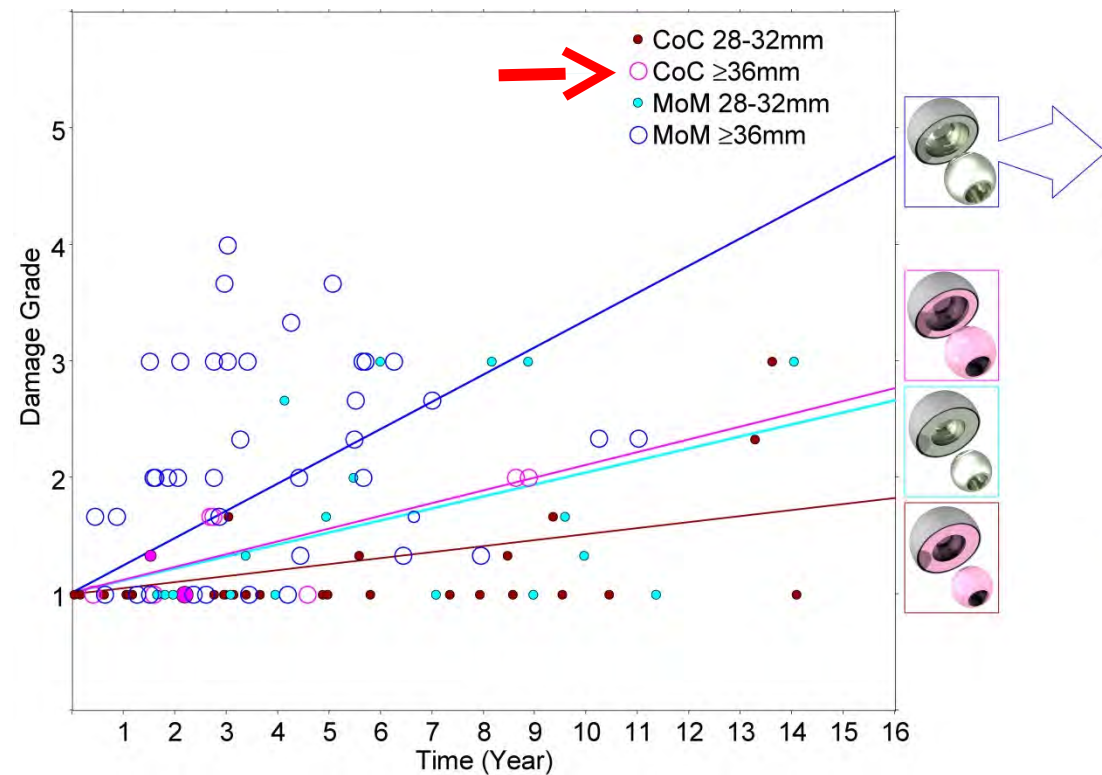




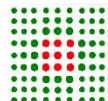
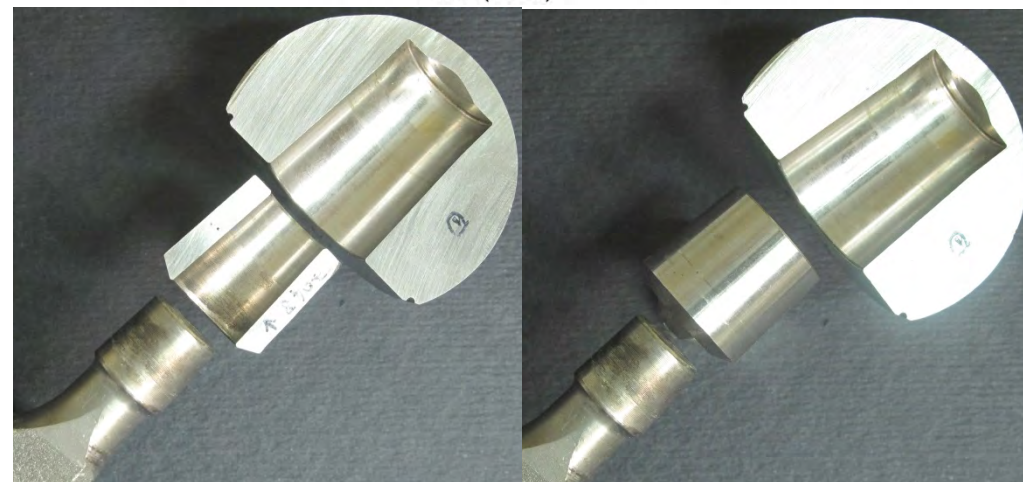
8.5 anni



3.5 anni



## 95 retrieved devices



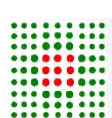
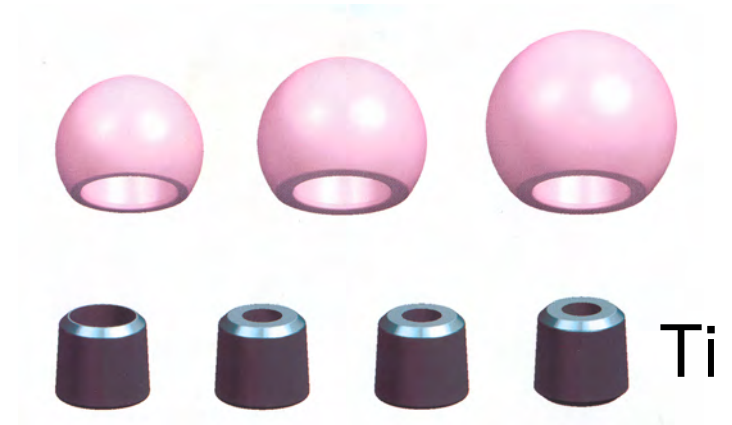


**Teste grandi  $\geq 40$  mm  
causano maggiori  
stress al cono 12/14**

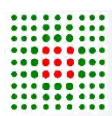
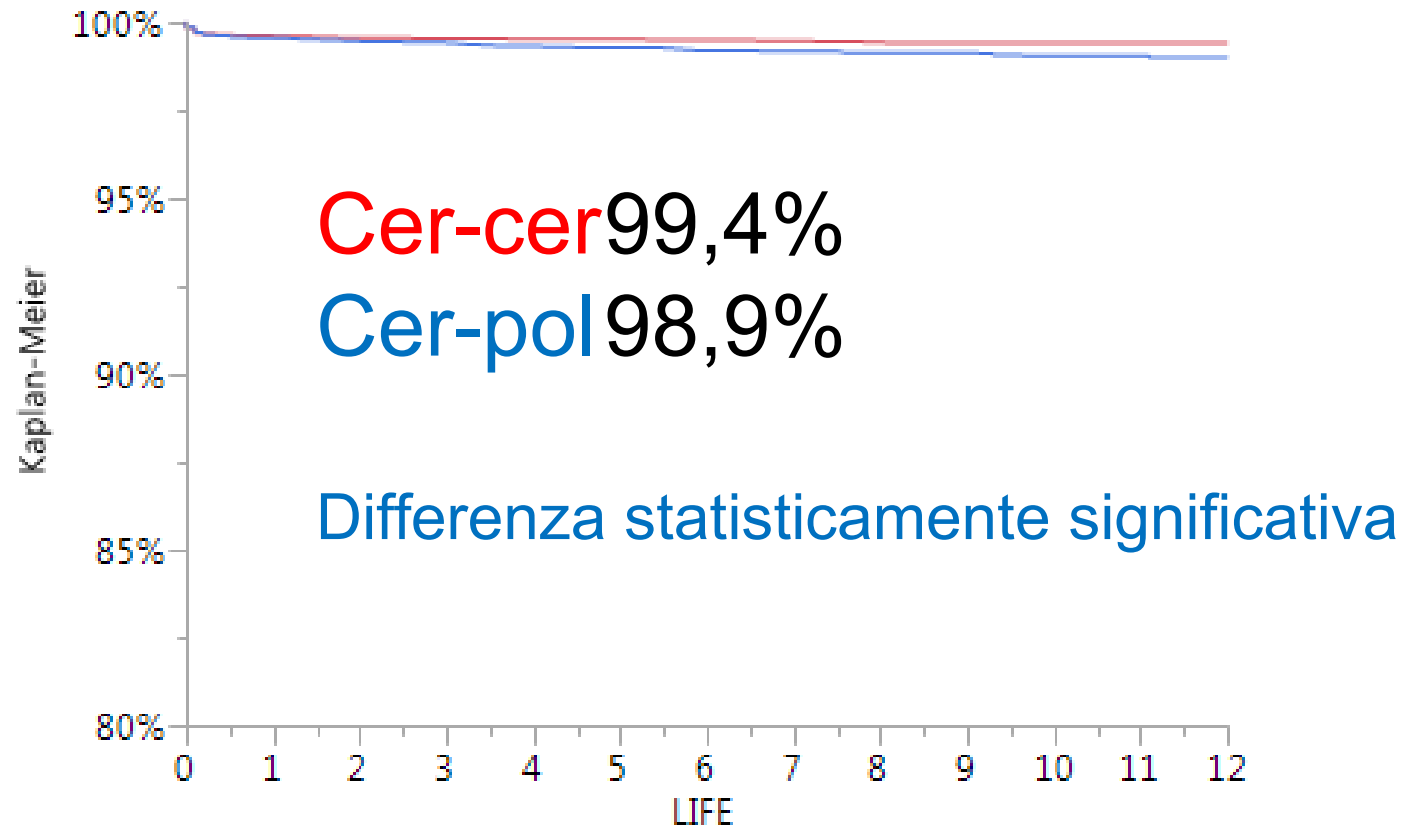
**Si consiglia uso delle  
teste OPTION**

**che hanno**

**Adattatore di **Titanio**  
per ridurre i danni da  
“Crevice Corrosion”**



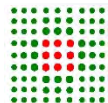
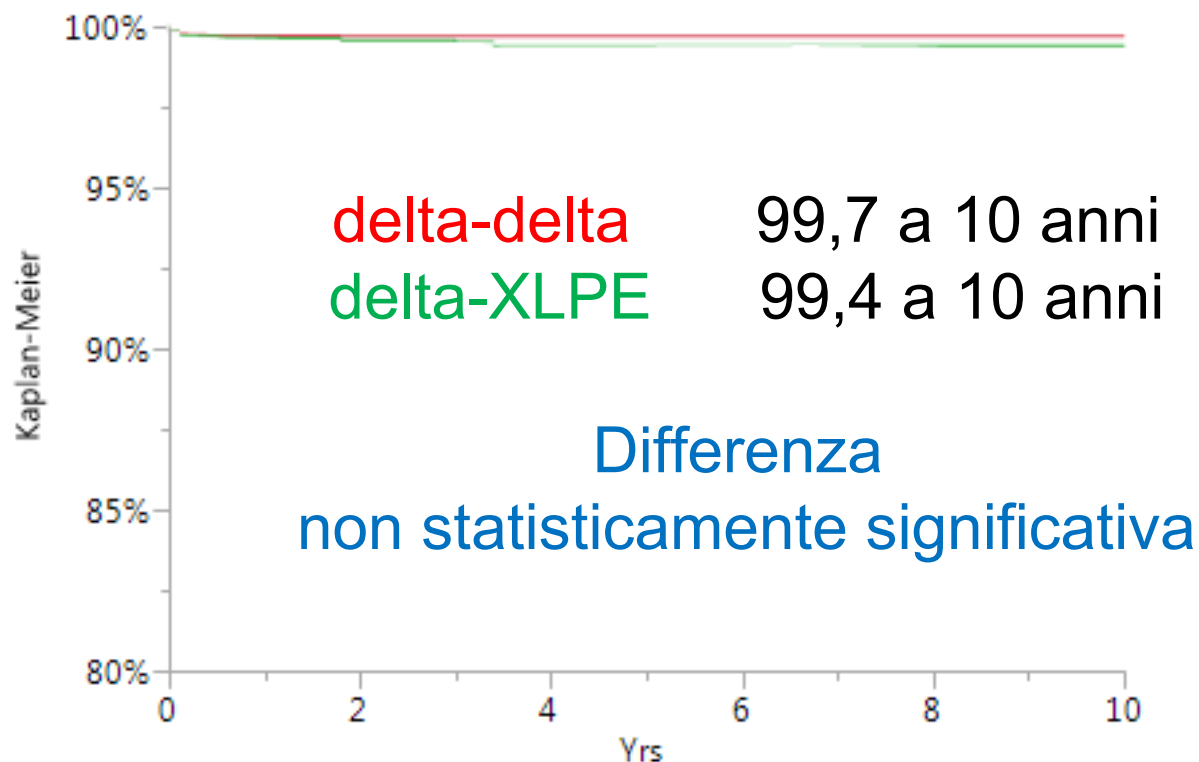
# SOPRAVVIVENZA SOLO LUSSAZIONE CERAMICA VS POLIETILENE



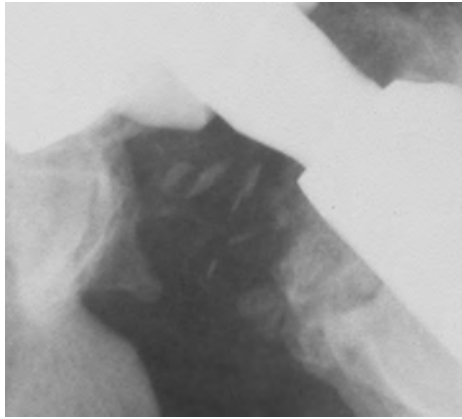


# SOPRAVVIVENZA SOLO LUSSAZIONE

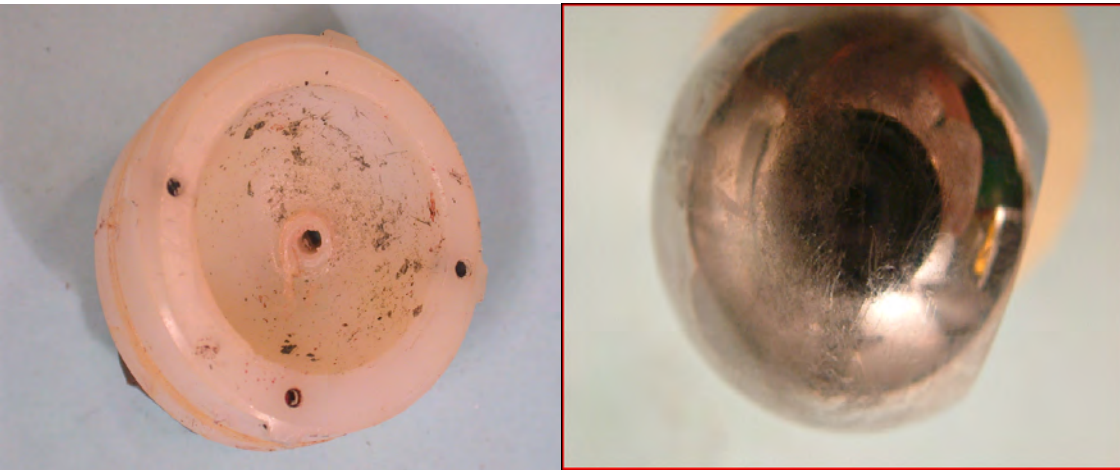
## biolox delta vs polietilene cross linked



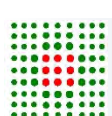
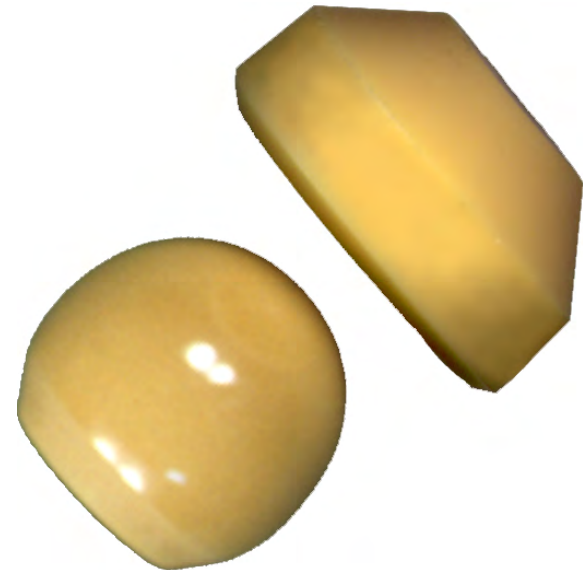
# Revisione dopo rottura ceramica



SOLO CON  
ALTRA  
**CER-CER** o  
**CER-XLPE**



METALLOSI DA DETRTI  
INTRARTICOLARI DI CERAMICA



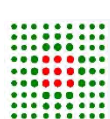
# Conclusioni

L' OSTEOLISI  
È SCOMPARSA CON LA  
CERAMICA!!



<b>ROTTURA DELLA TESTA BIOLOX DELTA</b>	<b>0,01 %</b>
<b>ROTTURA (“Chipping”) DELL’INSERTO DELTA</b>	<b>0,07 %</b>
<b>Revisione per SQUEACKING</b>	<b>Bilox Forte 0,5 %</b>
<b>Bilox Delta</b>	<b>0,1 %</b>

**INCIDENZA DELLA REVISIONE PER LUSSAZIONE  
RECIDIVANTE UGUALE FRA CER-CER E CER-XLPE**



# Conclusioni

**BIOLOX DELTA  
SOPRAVVIVENZA  
MIGLIORE A  
10 ANNI**



## **ATTENZIONE:**

### **Posizionamento del cotile**

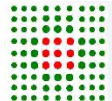
**evitare antiversione eccessiva**

**evitare cotile  $> 50^\circ$  di abduzione**

### **Allineamento dell'inserto**

**Non martellare la testa di ceramica**

**NON USARE TESTE METALLICHE DOPO ROTTURA  
CERAMICA**





# GRAZIE



**Primo intervento di chirurgia ortopedica  
fatto all' Istituto Rizzoli nel 1896**



CONGRESSO NAZIONALE  
DELLA SOCIETÀ  
ITALIANA DELL'ANCA



**COMPLICANZE: PREVENZIONE E  
TRATTAMENTO NELLA CHIRURGIA DELL'ANCA  
DALL'ARTROSCOPIA ALLA PROTESI**

Con il Patrocinio



**Monza, 23-24 Novembre 2017**

*Presidente Onorario: Paolo Cherubino*

*Presidente: Giovanni Zatti*



**UNIVERSITÀ  
DEGLI STUDI DI BARI  
ALDO MORO**

**UU.OO. ORTOPEDIA E  
TRAUMATOLOGIA  
Direttore: Prof. B. Moretti**

**MAIN SESSION TOPIC 3**

**PRIMO IMPIANTO: COMPLICANZE CERAMICA CERAMICA**

Moderatori: **Sandro Giannini** (Bologna), **Bruno Marelli** (Milano)

**DESCRIZIONE DEL PROBLEMA**

**Aldo Toni** (Bologna)

**PREVENZIONE**

**Giuseppe Solarino** (Bari)

**TRATTAMENTO**

**Luigi Zagra** (Milano)

**G. Solarino**



Emission of noise from total hip arthroplasties (THAs) is mostly considered to be benign; however, there are few cases of troublesome noises, possibly with impaired function or pain, which can influence the patient’s satisfaction with their implanted device and need to be addressed accordingly.

Different kinds of noises are reported and these have been described as “popping, snapping, clicking, clunking, knocking, crunching/grinding, and squeaking”

If the THR has any distraction, for example, during a gait cycle, the relocation impact of the two surfaces could be interpreted as a **click, pop, knock, or snap**.

Some noises may be related to soft tissue impingement or movement, for instance, **snap or pop**.

**Crunching, grinding or squeaking** can indicate, for example, a mismatched wear couple, third-body particles within the bearing, bearing fracture, or edge loading

Sound	Bearing				
	Metal-on-Polyethylene	Ceramic-on-Polyethylene	Metal-on-Metal Polyethylene Sandwich	Metal-on-Metal	Ceramic-on-Ceramic
Pops	Yes	Yes	Yes	Yes	Yes
Snaps and/or thuds	Yes	Yes	Yes	No	No
Knocking	Yes	Yes	Yes	Yes	No
Crunching	No	Yes	Yes	Yes	No
Grating	No	Yes	Yes	Yes	Yes
Cracking	No	No	Yes	Yes	Yes
Squeaking	No	No	No	Yes	Yes
Duration of sound	Isolated	Isolated	Isolated	Sustained	Sustained



**Clicking and Squeaking: In Vivo Correlation of Sound and Separation for Different Bearing Surfaces**

Diana Glaser, Richard D. Komistek, Harold E. Cates and Mohamed R. Mahfouz  
*J Bone Joint Surg Am.* 2008;90:112-120. doi:10.2106/JBJS.H.00627

**All bearing couples may be noisy!**



Noises including squeaking are not a new phenomenon but have become more prevalent with the more frequent use of hard-on-hard bearings.

Squeaking itself is thought to be caused by a forced vibration comprising a frictional driving force (due to temporary loss of fluid film lubrication, third-body particles, mismatched bearing, etc.) and a dynamic response (resonance of the hip components at their natural frequency).

## Squeaking - Grades

### Grade

1. Rare
2. Occasional or intermittent
3. Frequent
4. Every step or position change

# Squeaking of hard-on-hard bearings is multifactorial, requiring a certain combination of patient, implant, and surgical factors.

Squeaking has been associated with younger, taller, heavier and more active patients as well as with specific THR systems.

The surgical technique including the component orientation can directly influence the chance of squeaking.

Generally, factors that increase the mechanical forces across the hip joint and factors that increase the risk of neck-to-rim impingement and edge loading are those that predispose a THR to squeaking. However, one should note that squeaking can also occur with correctly positioned implants and in the absence of neck-to-rim impingement.

Aspects of stem design, such as the material, weight, and geometry of the components, may affect the ability of the stem to resonate.





- This study reports mid-term results of Delta ceramic on ceramic (COC) in total hip arthroplasty (THA). Subjects received Delta COC THA in a prospective multi-center study with either 28 mm or 36 mm articulations.
- 3 liner **fracture**

28 mm: 2/177=1.1%

36 mm: 1/168=0.6%

- More patients reported **squeaking** with a 36 mm bearing

28 mm: 7/177

36 mm: 19/168 (P = 0.013)

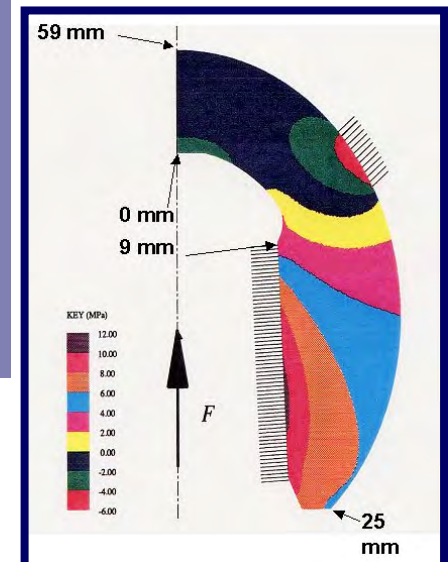
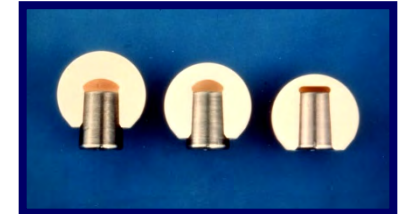
Squeaking was first reported at 3.8 ± 1.6 years after surgery for the COC28 group and at 3.2 ± 1.7 years for the COC36 group

# Risk of fracture of a ceramic ball

		BIOLOX <sup>®</sup> (dal 1974)		BIOLOX <sup>®</sup> forte (dal 1995)		BIOLOX <sup>®</sup> delta (dal 2004)	
Variabile	Unità	Media	Divergenza	Media	Divergenza	Media	Divergenza
Al <sub>2</sub> O <sub>3</sub>	Vol.-%	99,7	0,15	> 99,8	0,14	81,6	0,17
ZrO <sub>2</sub>	Vol.-%	n.d.	–	n.d.	–	17	0,1
Altri ossidi	Vol.-%	residui	–	residui	n.d.	1,4	0,01
Densità	g/cm <sup>3</sup>	3,95	0,01	3,97	0,00	4,37	0,01
Dimensione dei grani Al <sub>2</sub> O <sub>3</sub>	µm	4	0,23	1,750	0,076	<b>0,560</b>	0,036
Resistenza alla flessione (4 punti) <sup>1)</sup>	MPa	500	45	631	38	<b>1384</b>	67
Modulo E	GPa	410	1	407	1	358	1
Tenacità alla rottura K <sub>IC</sub> <sup>2)</sup>	MPa m <sup>1/2</sup>	3,0	0,45	3,2	0,4	<b>6,5</b>	0,3
Durezza HV1	GPa	20	–	20	–	19	–

<sup>1)</sup> Valori medi rilevati per BIOLOX<sup>®</sup>delta dal 2006

<sup>2)</sup> La tenacità alla rottura è la capacità di un determinato materiale a resistere alla propagazione di cricche; K<sub>IC</sub> è il valore caratteristico corrispondente.



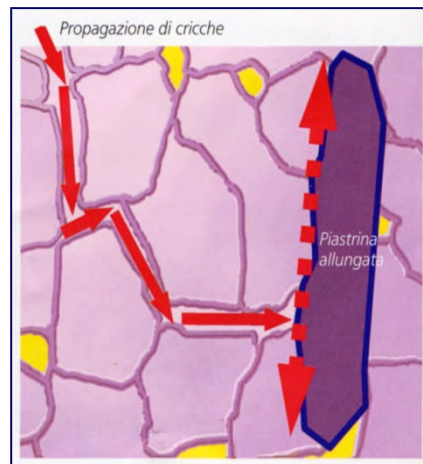
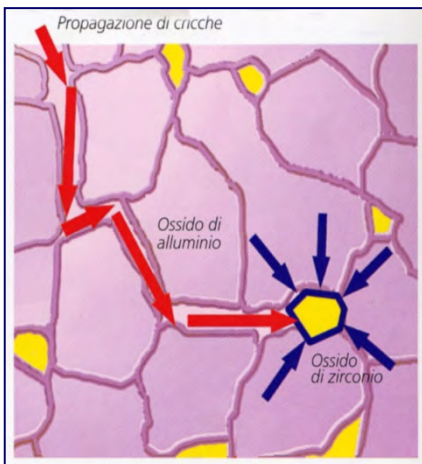
Concerns with alumina forte ceramic bearing remain, including ceramic head and, more significantly, liner fracture. Therefore, **alumina matrix composite** (Bilox Delta) was developed to address some of the concerns raised with the alumina forte ceramic-on-alumina forte ceramic bearing.

The material has a smaller grain size (<0.8 mm) compared with the grain size of alumina forte ceramic (1-5 mm).

The mechanical properties of this combination result in a bearing that has improved toughness and wear characteristics when measured in a laboratory setting.

This ceramic is composed of 82% alumina and 17% zirconia (volumetric composition) and has twice the tenacity (resistance to crack propagation) of pure alumina.

Fracture rates of the femoral head have reduced from 0.021% for Biolo Forte, to 0.003% for Biolo Delta. The fracture rate of cup inserts has remained virtually unchanged, however, at a rate of 0.03%.



# Alumina Delta-on-Alumina Delta Bearing in Cementless Total Hip Arthroplasty in Patients Aged <50 Years

Young-Hoo Kim, MD <sup>a,\*</sup>, Jang-Won Park, MD <sup>b</sup>, Jun-Shik Kim, MD <sup>b</sup>

The Journal of Arthroplasty 32 (2017) 1046–1053



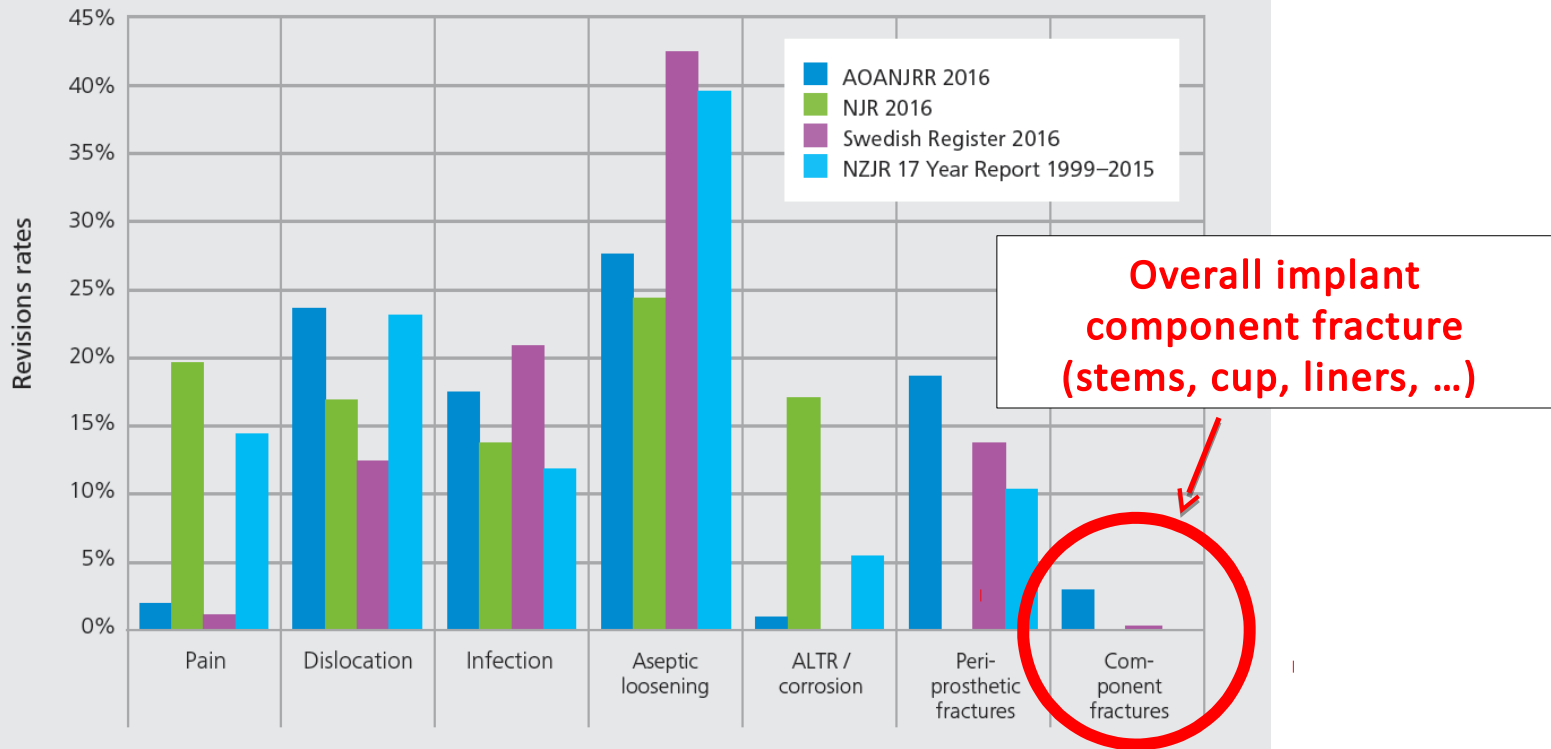
Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: [www.arthroplastyjournal.org](http://www.arthroplastyjournal.org)



# Implant fracture in THA is rare



AOANJRR: Australian Orthopaedic Association National Joint Replacement Registry, Annual Report 2016

NJR: National Joint Registry for England, Wales, Northern Ireland and the Isle of Man, 13th Annual Report, 2016

Swedish Hip Arthroplasty Register, Annual Report 2016, procedures 2006–2015, p. 65 (Swedish edition)

NZJR: New Zealand Joint Registry, 17 Year Report, procedures 1999–2015, p. 22



# ***THE HEAD***









BioMed Research International  
Volume 2013, Article ID 157247, 8 pages

*Review Article*

## **Fracture of Ceramic Bearing Surfaces following Total Hip Replacement: A Systematic Review**

Francesco Traina,<sup>1</sup> Marcello De Fine,<sup>1</sup> Alberto Di Martino,<sup>1,2</sup> and Cesare Faldini<sup>1</sup>

***The only risk factor:  
28 mm head with short neck***

	<b>Bilox® Forte</b>	<b>Bilox® Delta</b>	<b>Bilox® Delta</b>			<b>Bilox® Forte</b>		
			  			  		
<b>Implants</b>	7.874	7.204	1.137	2.040	4.661	12.360	3.468	2.159
<b>Fractures</b>	28	5	-	1	-	36	1	-
<b>%</b>	0.4%	0.1%	1 / 7,838 <b>0,01 %</b>			0.3%	0.03%	0%

The fracture of BioloX Delta has been really EPISODIC !

# SURGEON

MECHANICAL  
FACTORS

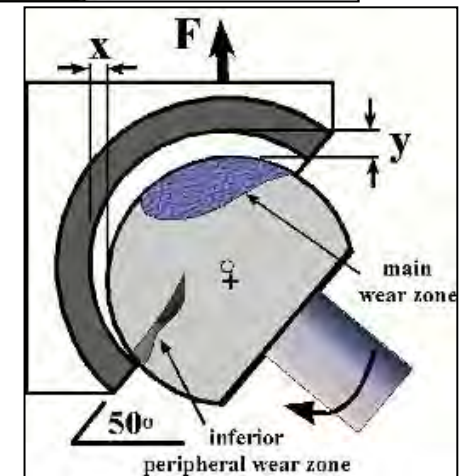
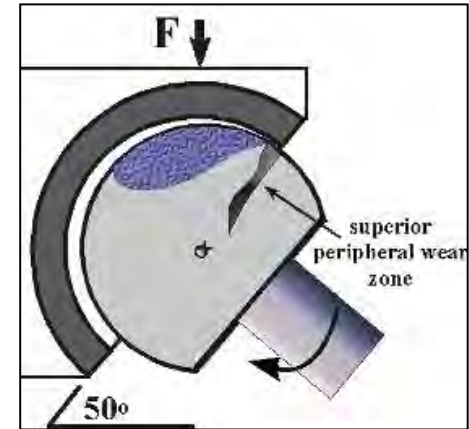
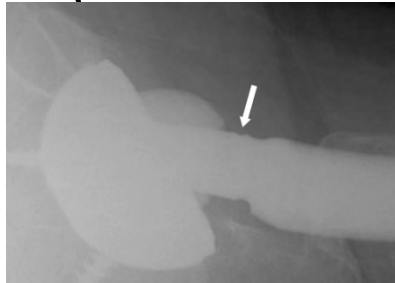
BIOLOGICAL  
FACTORS

*FAILURE OF THE IMPLANT*



# The Implant - Influenced by Surgeon

- Increased cup inclination
- Excessive cup anteversion
- Leg length difference – laxity and increased micro-separation
- Increased offset
- Lateralisation of hip centre
- Malpositioned liners
- Short neck lengths (Socket – neck impingement)



- Head sizes – ?  $\geq 36\text{mm}$
- Material – ? Biolox delta ceramics

Ecker T, Robbins C, van Flanden G et al Orthopaedics 2008; 31: 875

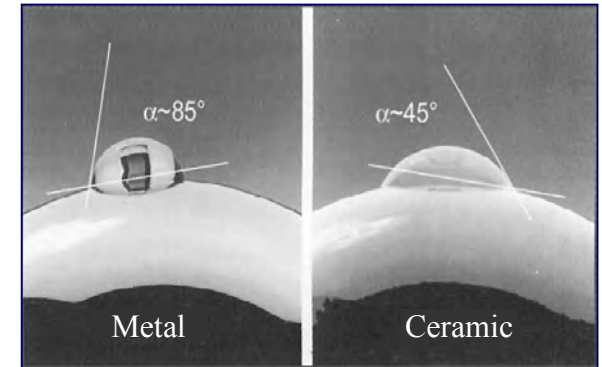
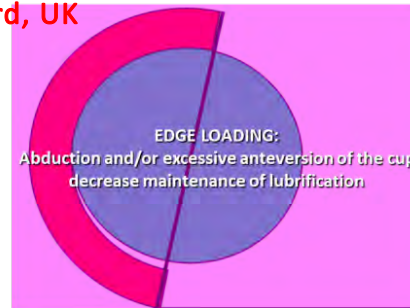
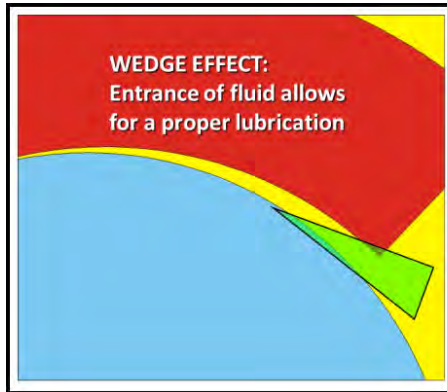
Ul Haq R, Park K-S, Seon J-K, Yoon T-R J Arthroplasty 2012; 27: 909-915

Hamilton W, McAuley J, Blumenfeld T Lesko J, Himden S, Dennis D J Arthroplasty 2015; 30: 110-115



# Ceramics with Edge Loading

Richie Gill, Nuffield Dept. of  
Orthopaedics, Rheumatology and  
Musculoskeletal Science, University of  
Oxford, UK



- Ceramics sensitive to positioning
- Correct cup inclination is 'the' basic pre-requisite
- Edge loading induces severe contact stresses with break up of the ceramic grain boundary
- Chipping of ceramics initiates noise
- 3<sup>rd</sup> body wear – causes squeaking with friction induced vibration
- ⚡ wear leads to ⚡ friction

Nevelos J, et al. J of Materials Science 2001;12:141-44  
Dalla Pria P. Ferdinand Enke Verlag; 1996: 84-91  
Toni A, et al. J Bone Joint 2006; 88:726-734  
Sariali E, et al. J Orthop Res 2010; 44: 326-333  
Sanders A, et al. J Orthop Res 2012; 30: 1377-1383

# Implant Design - Trident cup



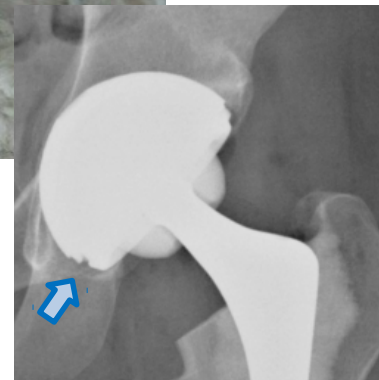
- **Raised metal rim with recessed ceramic liner**
- Flush ceramic liners squeak less than a raised liners (0.6 vs 3.2%)
- Reduced arc and early neck-rim impingement
- Trident uncemented ceramic acetabular THR component in 2 parts
- Metal shell, hydroxyapatite coated
- Metal-backed ceramic liner (ceramic alone brittle)
- Shell implanted first, liner inserted separately
- **Cup deformation**
- **Acetabulum under-reamed for press fit**

# Implant Design - Trident cup

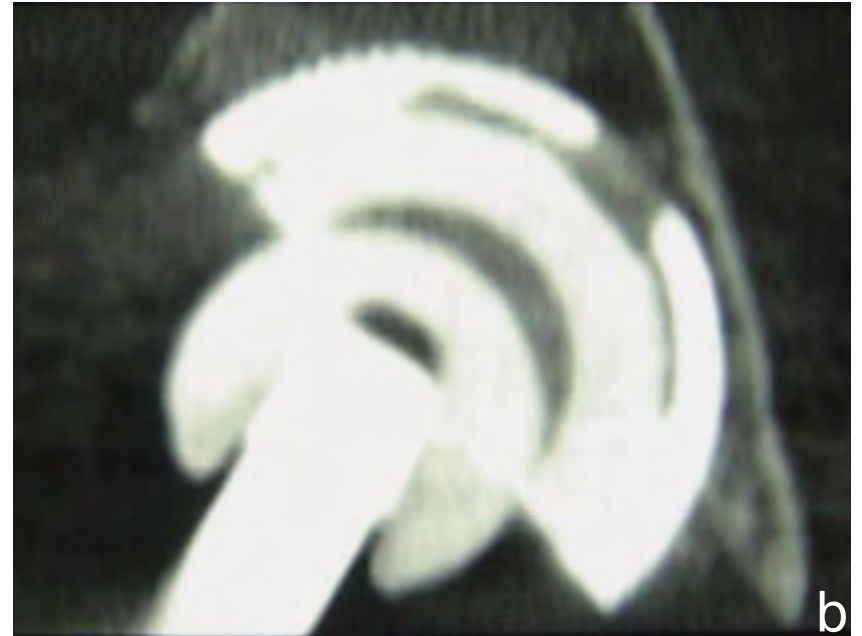
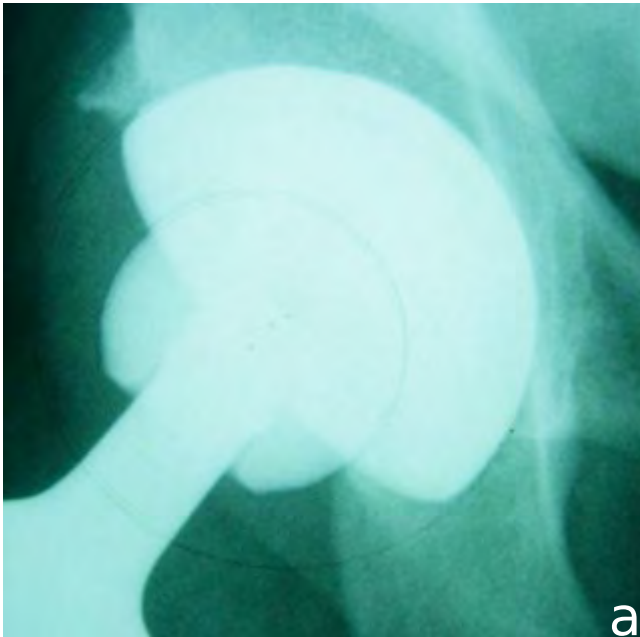
- Taper locking mechanism with rim castellation for rotational control



- Mis-seating of liner leads to malalignment of cup



# OR Planning and Choice of Implant



Incorrect choice of femoral ball head and insert diameter, which cannot be easily seen on the conventional radiograph (a). The patient complained about noises. Computed tomography confirmed the too large choice of component (b).

Source: M.M. Morlock MD, PhD, Technical University Hamburg-Harburg



# Implant Design – Stem and Taper

- V40 taper increased squeaking by 7 fold (18.4% vs 2.6%)
- V40 taper and a slender neck - amplifies the vibration



**Results:** The prevalence of squeaking was seven times higher for patients who received the titanium-molybdenum-zirconium-iron-alloy stem (twenty-seven patients, twenty-eight hips [18.4%]) than in those who received the titanium-aluminum-vanadium-alloy stem (three patients, four hips [2.6%]); this difference was significant ( $p < 0.0001$ ).

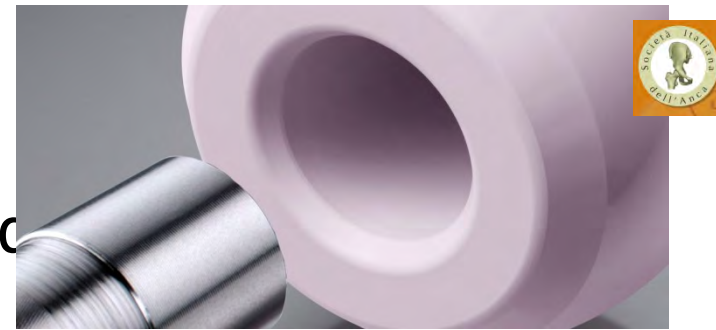
**Conclusions:** Our study suggests that different stem alloys, stem geometries, or neck geometries can have an impact on the frequency of squeaking following a ceramic-on-ceramic total hip arthroplasty.

The Effect of Stem Design on the  
Prevalence of Squeaking Following  
Ceramic-on-Ceramic Bearing  
Total Hip Arthroplasty

By Camilo Restrepo, MD, Zachary D. Post, MD, Brandon Kai, BS, and William J. Hozack, MD

# Neck Taper and Compatibility

## What Does the Surgeon Have to Consider



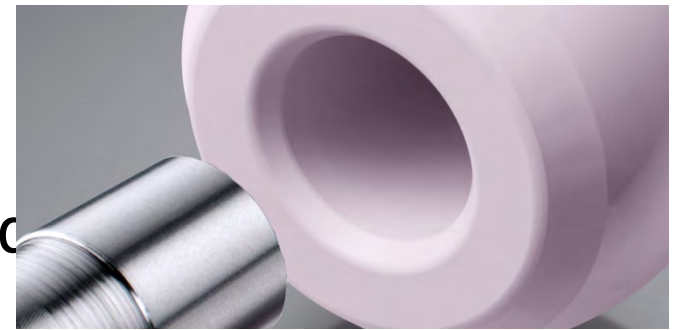
Modern hip arthroplasties are based on a **modular construction**. This modular construction, particularly the combination of a stem and femoral ball heads of differing neck lengths, is an accepted solution that enables flexible adjustment to the individual situation of patients during surgery.

The intervals between the neck lengths (s, m, l and xl) are also not standardized and can vary from manufacturer to manufacturer by several millimeters.



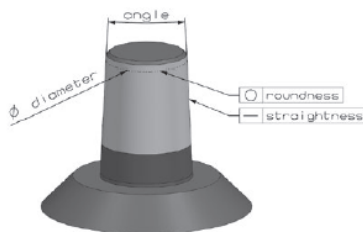
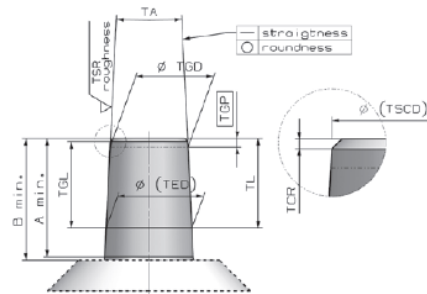
# Neck Taper and Compatibility

## What Does the Surgeon Have to Consider



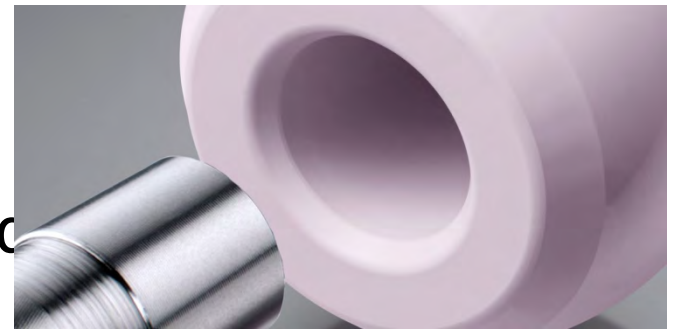
### Features of an implant taper

A taper fixation is made up of a stem taper and a taper in the femoral ball head (drill hole). Each of these tapers has characteristic properties such as taper angle, diameter, straightness and roundness and surface properties, which are essential for a precise matching of the components. For secure taper locking, the fit of the taper fixation between the femoral ball head and the stem taper is very important.



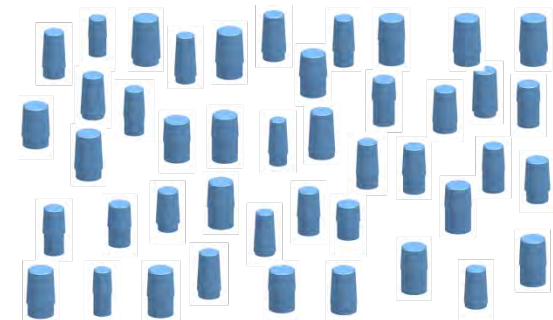
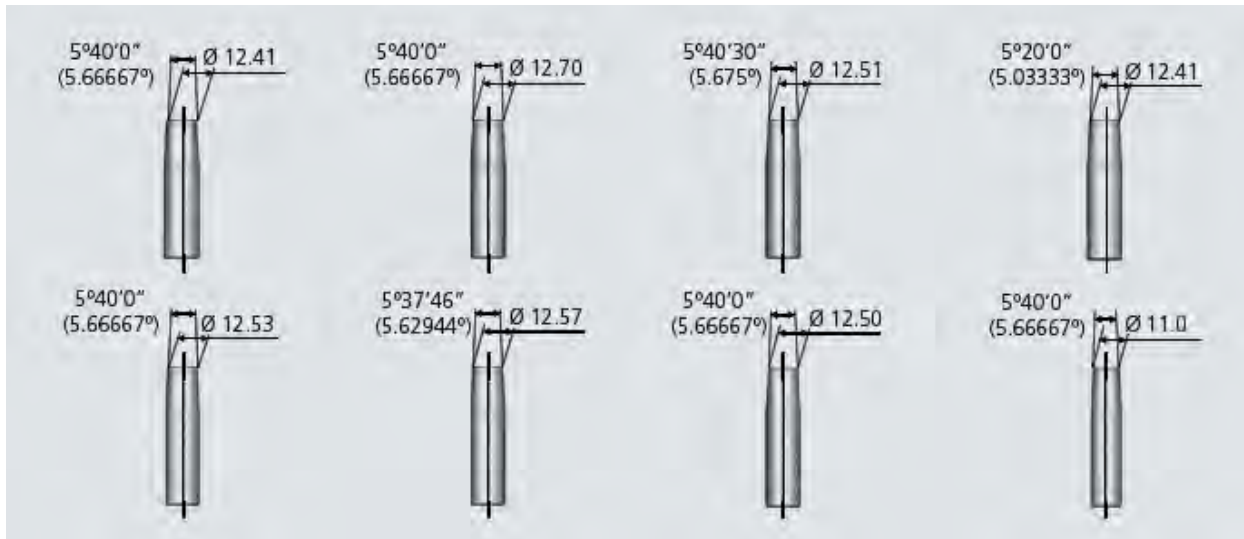
# Neck Taper and Compatibility

## What Does the Surgeon Have to Consider



**The taper fixation** between a femoral ball head and a stem, familiar in hip arthroplasty, was developed at the start of the 1970s by the industry partners Sulzer AG (endoprosthesis manufacturer and predecessor of Zimmer, Winterthur, Switzerland) and Feldmühle AG (ceramics manufacturer and predecessor of CeramTec GmbH, Plochingen, Germany).

**There is still no standard for the stem taper.** Implant manufacturers continue to use tapers with their own specifications (for example, various 12/14 tapers), which differ in terms of geometry, structure and surface properties

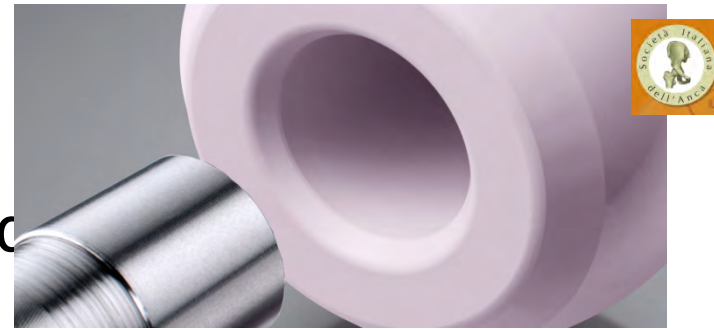


*Different tapers all of which are designated "12/14"*



# Neck Taper and Compatibility

## What Does the Surgeon Have to Consider



### Compatibility

It is vital that surgeons combine only those arthroplasty stems and femoral ball heads that the implant manufacturer has declared to be compatible.

The implant manufacturers are responsible for the release of the stem taper/ femoral ball head combinations and supply the components to the hospitals. The surgeon must comply with the details regarding approved combinations provided by the implant manufacturer in the instructions for use and other written information.

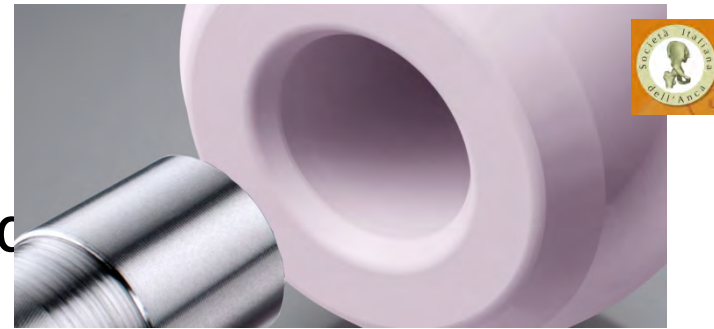
**Do not combine implant components from different endoprosthesis manufacturers!**

A survey of the New Zealand Orthopaedic Association showed that 23% of the surgeons had implanted mismatched components within the last 5 years.

Stokes AP, Rutherford AD.  
Mismatch of modular prosthetic components in total joint arthroplasty. The New Zealand experience.  
JBJS Br 2005 87-B:(SUPP I), 32

# Neck Taper and Compatibility

What Does the Surgeon Have to Consider



## TAKE HOME MESSAGE

There is no uniform, standardized stem taper.

There is no “Eurotaper” or 12/14 standard taper.

It is essential that you check the compatibility of femoral ball heads and stem tapers!

There is no standardized external geometry for ceramic inserts.

Implant geometry is always specific to a particular manufacturer.

# SURGICAL TECHNIQUE



*"Let's just start cutting and see what happens."*

**PREVENTION  
IS THE BEST  
TREATMENT**

## SURGICAL TECHNIQUE: Cup Positioning

The cup must be positioned in the safe zone as defined by Lewinnek.

The inclination should not exceed or fall below a value of 40–45°;

the anteversion should not exceed or fall below 10–20°.

**With a cup position outside these values, a ceramic insert must not be used.**



Surgical technique involves check of position and possibly seating before reduction of hip

Technique varies between surgeons

Mis-seating occurs despite this



## SURGICAL TECHNIQUE: The inner shell



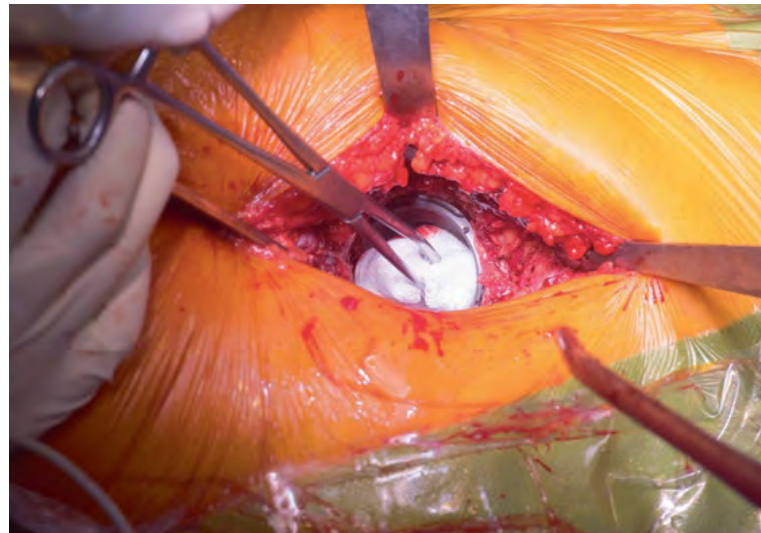
Any screws used must be completely sunk into the metal shell. Peripheral osteophytes must be removed to avoid impingement.

**The metal shell must be**

**clean and dry prior to the ceramic insert being positioned.**

Fluids, fatty tissue, bone fragments, and traces of cement cannot be compressed and must be removed from the metal shell.

Protect the inside of the metal shell with a sterile gauze pad and remove it immediately prior to the final positioning of the ceramic insert.



## SURGICAL TECHNIQUE: The liner

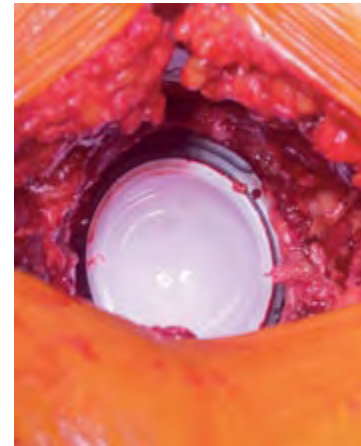
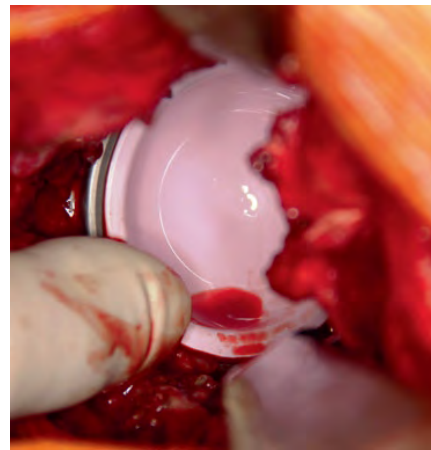
The correct seat of the ceramic insert in the metal shell is checked by feeling the cup rim with the finger.

**The metal and ceramic rim must lie flush with one another.**

The incorrectly positioned ceramic insert must be removed with instruments recommended by the endoprosthesis manufacturer.

A ceramic insert that has been positioned and removed must not be reused.

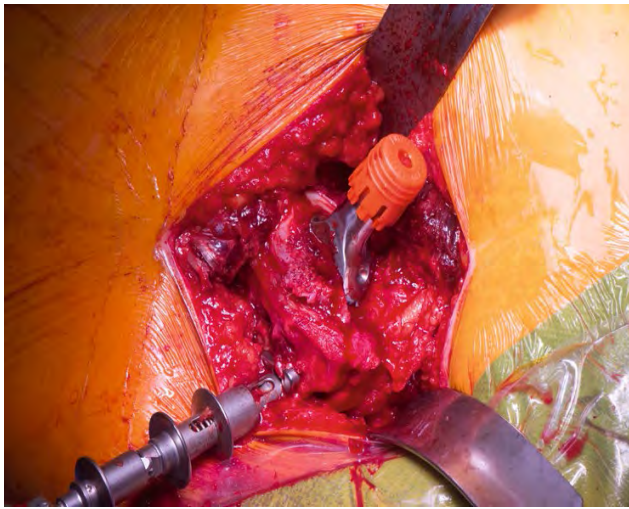
For the final fitting of the ceramic insert, an impactor suitable for ceramic inserts is used to firmly position it with a **slight hammer stroke in the axial direction**



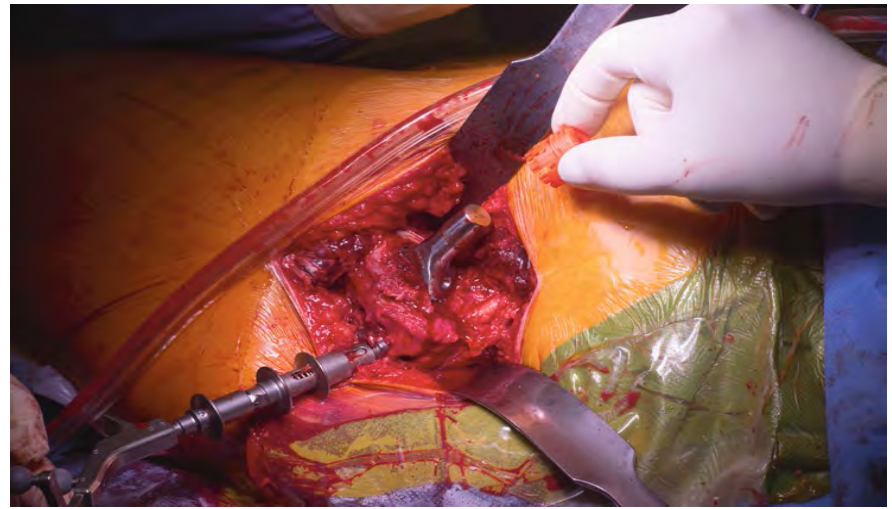
## SURGICAL TECHNIQUE: Protective cap



The protective taper cap **must not be removed too soon** to avoid mechanical damage to the stem taper by instruments or other objects



a) Protective taper cap

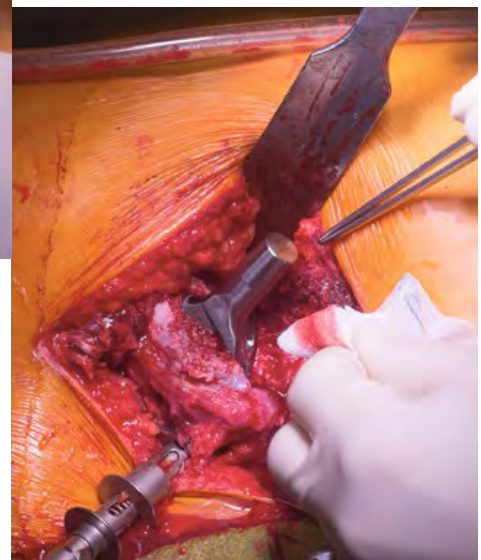
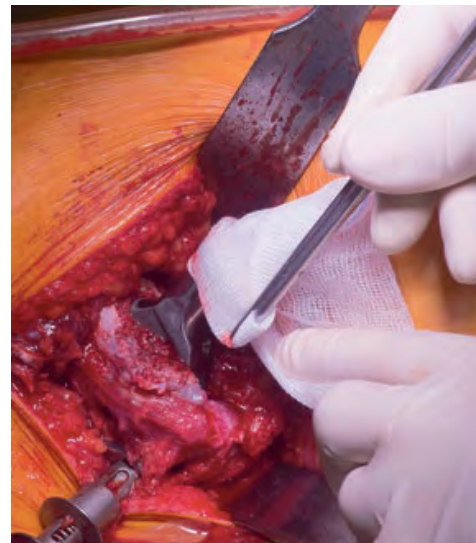


b) Removing the protective taper cap



## SURGICAL TECHNIQUE: Careful Cleaning and Drying of the taper

foreign material (tissue, cement, bone, blood, etc.)  
affects the transfer of force to the ceramic femoral ball head  
and has a negative impact on the fracture strength  
of the femoral ball head



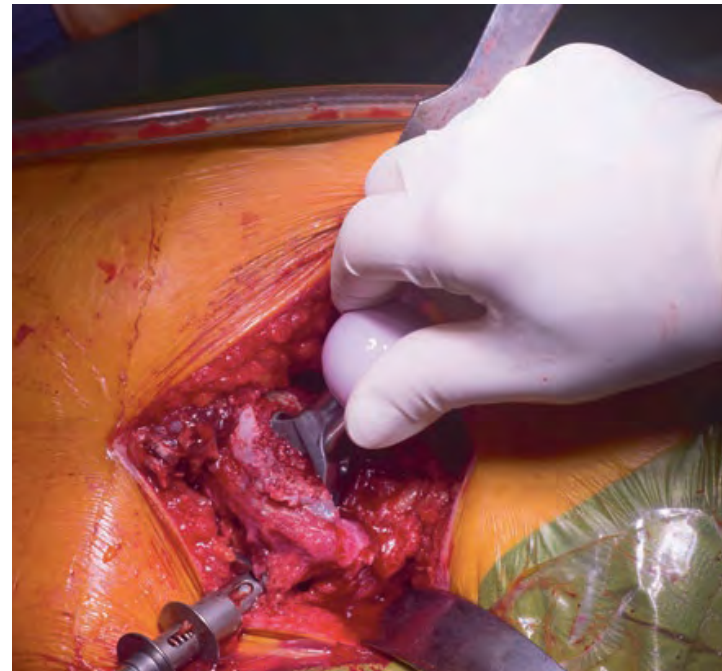


## SURGICAL TECHNIQUE: Taper Locking

Secure taper locking ensures that relative movements between the components are avoided and the possibility of stem-side corrosion and release of metal particles and ions is excluded.



The stem taper macrostructure has surface roughness



**Positioning of the head in the axial direction. Slight turning motion when positioning the femoral ball head**

## SURGICAL TECHNIQUE: Impacting the femoral ball head

with a suitable instrument, **using a moderate hammer blow on the impactor in the axial direction of the stem taper** will ensure the femoral ball head is seated firmly.

A single hammer blow is sufficient, although several blows are permitted.



# Prevention for Primary (and Revision) Surgery

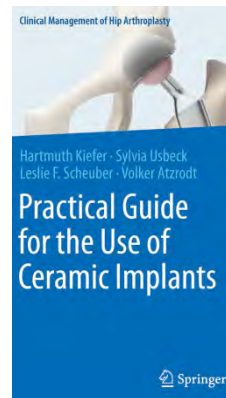
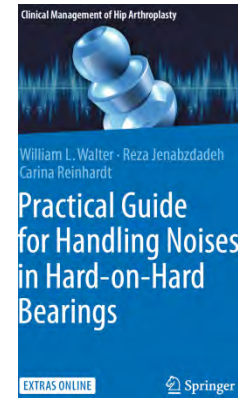
The risk of squeaking/fracture can be minimized by:

## 1. Correct component positioning:

- Avoid impingement
- Ensure concentric loading

## 2. Correct soft tissue balancing:

- Optimize soft tissue tension
- Avoid soft tissue impingement



Hip



EFORT open reviews

What every surgeon should know about  
Ceramic-on-Ceramic bearings in young patients

Philippe Hernigou  
François Roubineau  
Charlie Bouthors  
Charles-Henri Flouzat-Lachaniette

EFORT | VOLUME 1 | APRIL 2016  
DOI: 10.1302/2058-5241.1.000027  
www.efort.org/openreviews

# Prevention for Primary (and Revision) Surgery

**The risk of squeaking/fracture can be  
minimized by:**

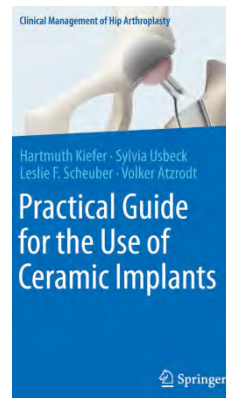
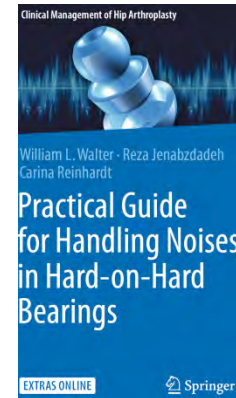
3. Only using correctly assembled and undamaged implant components

4. Appropriate implant selection

e.g. thin more flexible

femoral and/or acetabular components  
are more likely to squeak

5. Follow instructions for use of the  
implant components



Hip



EFORT open reviews

Philippe Hernigou  
François Roubineau  
Charlie Bouthors  
Charles-Henri Flouzat-Lachaniette

What every surgeon should know about  
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www.efort.org/openreviews



# Prevention for Primary (and Revision) Surgery

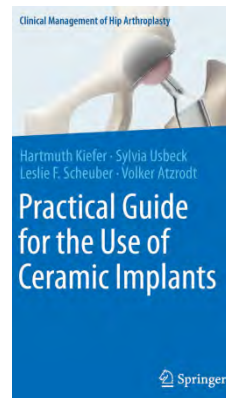
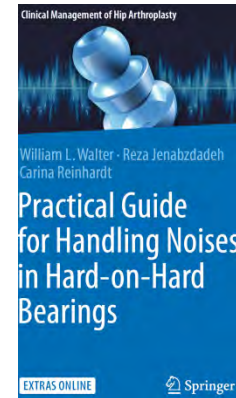
The risk of squeaking/fracture can be minimized by:

6. Despite similarities, highest-quality implants are specifically designed according to manufacturers specifications and thus have to be implanted according to instructions provided by them.

7. Don't mix and match is one of the basic rules.

8. It is of outmost importance that the surgeon follows a number of procedures

that adhere to manufacturer's instructions



Hip



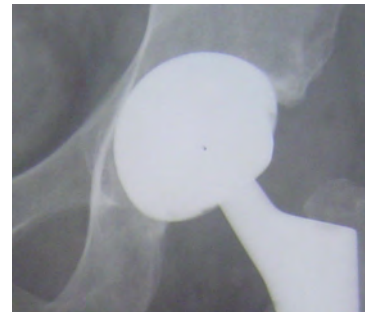
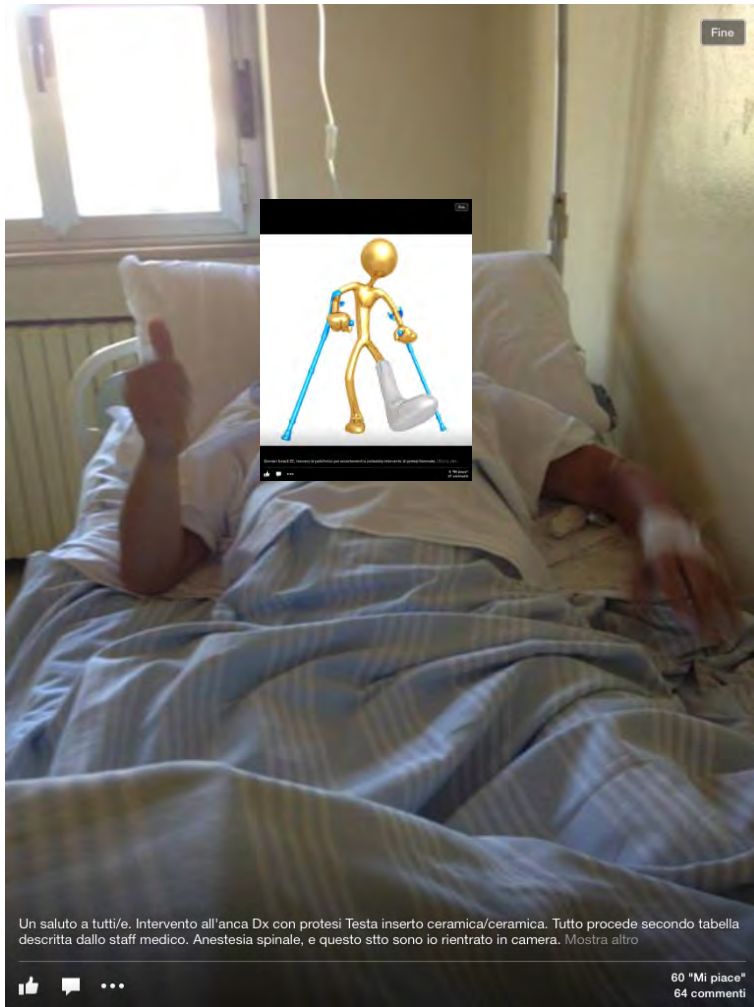
EFORT open reviews

What every surgeon should know about  
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EFORT | VOLUME 1 | APRIL 2016  
DOI: 10.1302/2058-5241.1.000027  
www.efort.org/openreviews

# Patient informed consent must include risk of noise (and breakage).



*"When we want your opinion,  
we'll give it to you."*

# Ceramic-on-Ceramic (CoC) total hip arthroplasty presents significant advantages

CoC bearings decrease wear and osteolysis

CoC bearings decrease the cumulative long-term risk of dislocation

CoC decreases muscle atrophy

Ceramic head decreases head-neck taper corrosion

Solarino et al. BMC Musculoskeletal Disorders 2011, 12:32  
http://www.biomedcentral.com/1471-2474/12/32



RESEARCH ARTICLE

Open Access

Alumina-on-alumina total hip replacement for  
femoral neck fracture in healthy patients

Giuseppe Solarino\*, Andrea Piazzolla, Claudio M Mori, Lorenzo Moretti, Silvio Patella, Angela Notarnicola

J Orthopaed Traumatol (2012) 13:21–27  
DOI 10.1007/s10195-011-0174-7

ORIGINAL ARTICLE

Long-term results of 32-mm alumina-on-alumina THA  
for avascular necrosis of the femoral head

Giuseppe Solarino · Andrea Piazzolla ·  
Angela Notarnicola · Lorenzo Moretti ·  
Silvio Tafari · Silvana De Giorgi · Biagio Moretti

142 GIOT maggio 2013;39:142-152

ARTICOLO DI AGGIORNAMENTO

ARTROPROTESI D'ANCA CERAMICA-CERAMICA  
Ceramic on ceramic total hip arthroplasty

G. SOLARINO, G. VICENTI, A. PIAZZOLLA,  
C. PICONI\*, B. MORETTI  
Clinica Ortopedica, Università di Bari "Aldo Moro";  
\*Clinica Ortopedica, Università Cattolica  
del "S. Cuore", Roma



Should we use ceramic-on-ceramic coupling with  
large head in total hip arthroplasty done for  
displaced femoral neck fracture?

Giuseppe Solarino, MD\*, Antonella Abate, MD, Arcangelo Morizzo, MD,  
Giovanni Vicenti, MD, and Biagio Moretti, MD

Orthopaedic Section, Department of Neuroscience and Organs of Sense, University of Bari, Bari, Italy

A minimum-20 years outcome of 100 consecutive alumina on alumina  
arthroplasties performed by a single surgeon.

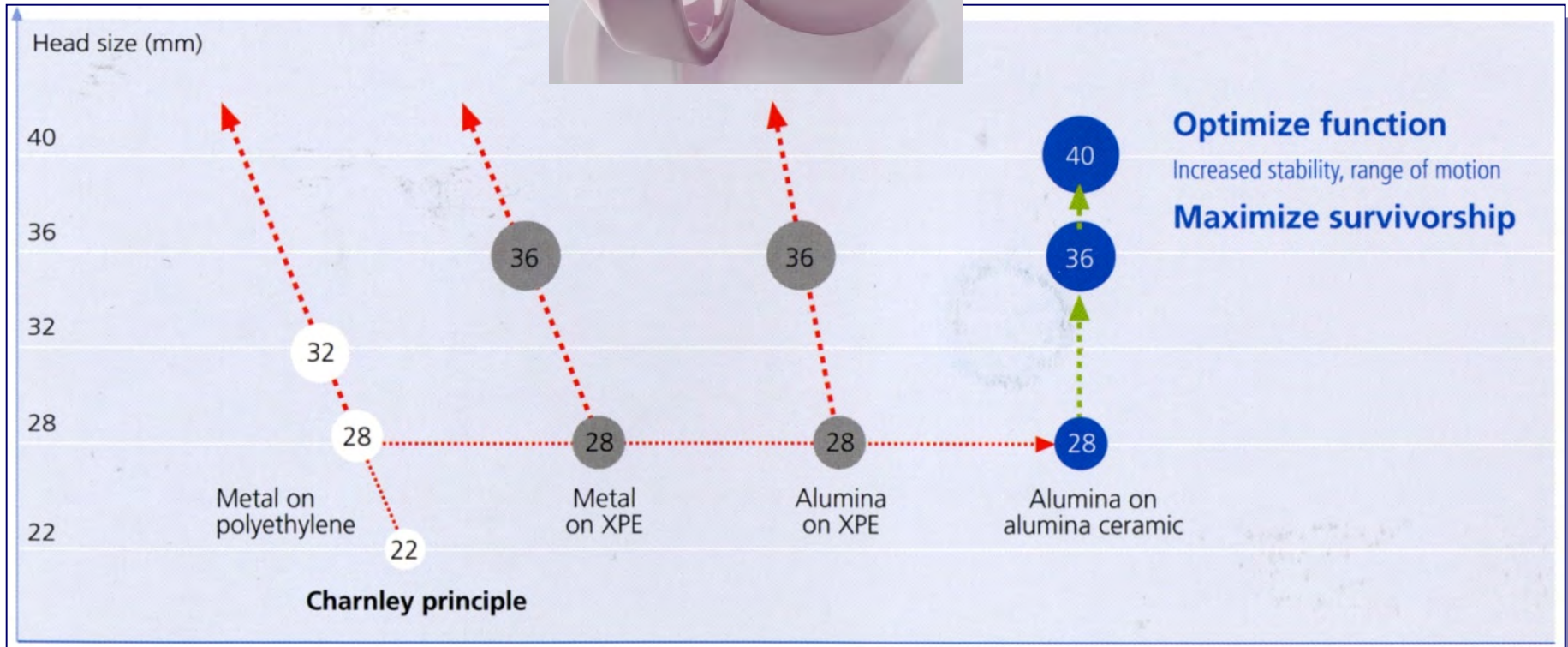
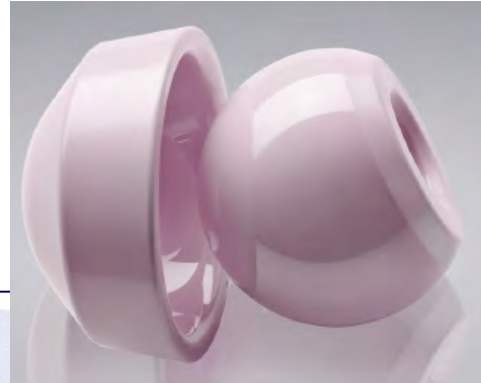
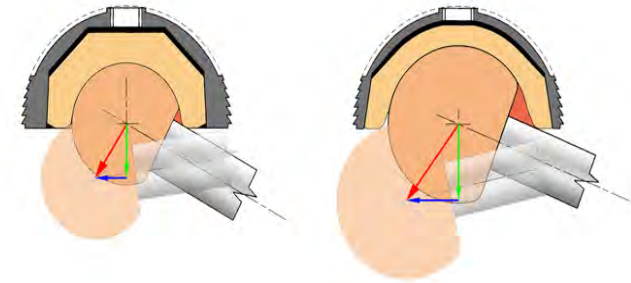
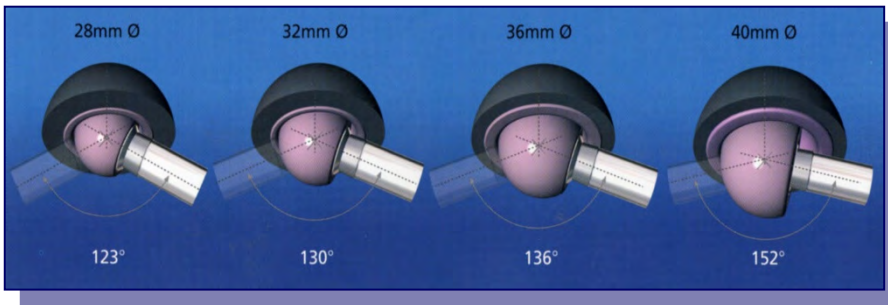
Prof MD Giuseppe Solarino<sup>1</sup>, MD Andrea Piazzolla<sup>1</sup>, MD Lorenzo Moretti<sup>1</sup>, MD  
Giovanni Vicenti<sup>1</sup>, Prof MD Biagio Moretti<sup>1</sup>

<sup>1</sup>Department of Neuroscience and Organs of Sense, Orthopaedic Unit, Faculty of  
Medicine and Surgery, University of Bari, Bari, Italy

Submitted to









Grazie  
per  
l'attenzione

**Vi aspettiamo  
a Bari!**







# Complicanze Ceramica - Ceramica Trattamento

*Luigi Zagra*



I.R.C.C.S. ISTITUTO  
ORTOPEDICO  
**GALEAZZI**



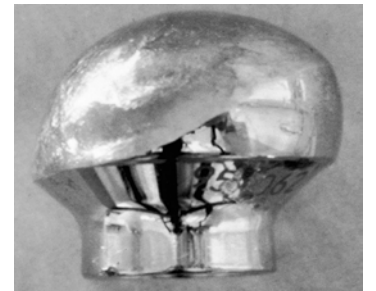
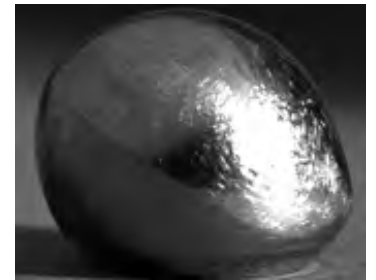
## *Disclosure*

- *Lima Corporate: grants for educational activity and research funds to the Hospital Department*
- *Zimmer Biomet, DePuy, CeramTec and Menarini: travelling and accommodation costs for meetings and grants for educational events*
- *Adler Ortho and Medacta: travelling and accommodation costs for meetings*

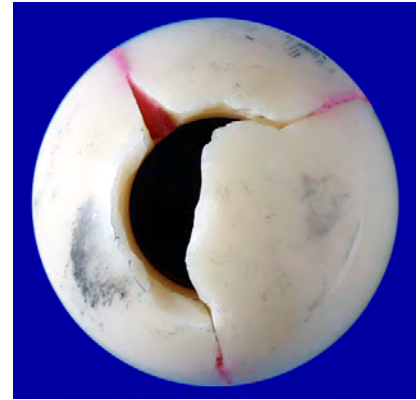


Ceramic breakage is still a reason of concern,  
as revision in case of ceramic fracture has been  
affected by poor results and severe complications  
due to third body wear, caused by ceramic fragments.

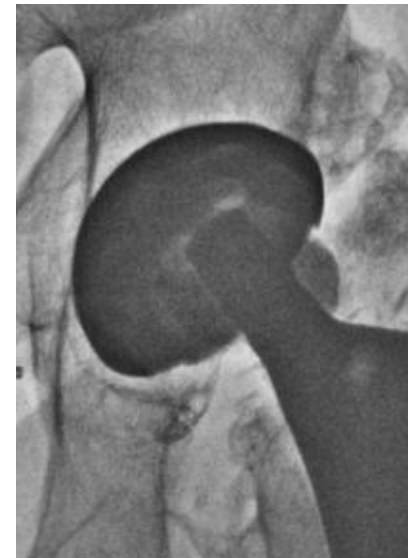
- Allain, *JBJS Am*, 2003
- Koo, *J Arthroplasty*, 2014
- Gozzini, *Hip Int*, 2002
- Ikeda, *Muscle Nerve*, 2010
- Sharma, *Orthopaedics*, 2013



## The head



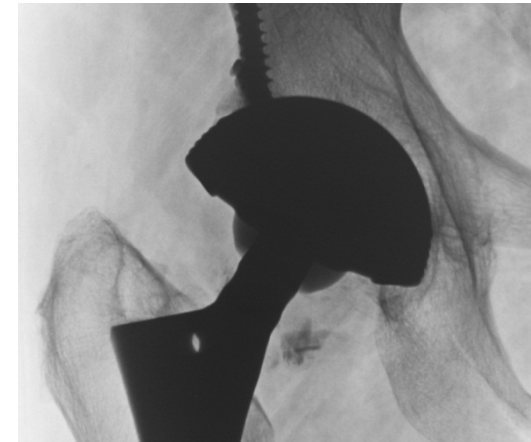
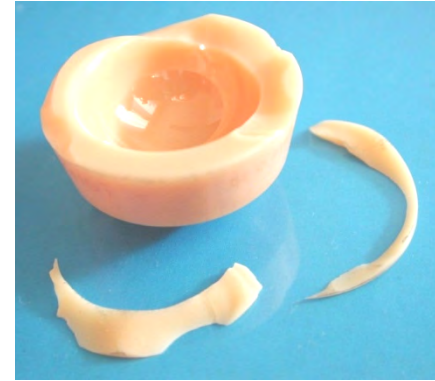
- The breakage is sudden and complete, noisy
- The patient immediately realizes that something has happened
- Clear evidence in X-rays



Dalla Pria P, Zagra L Breakage and noises in ceramic on ceramic couplings.  
*Eur Orthop Traumatol*, 1:53-59 (2010)

## The liner

- Never related to trauma
- Subtle and underestimated event
- Not felt by the patient in the first stages
- Difficult to be detected on X-rays
- Can cause a secondary fracture of the head



Dalla Pria P, Zagra L Breakage and noises in ceramic on ceramic couplings.  
*Eur Orthop Traumatol*, 1:53-59 (2010)

# The liner

BioMed Research International  
Volume 2013, Article ID 157247, 8 pages

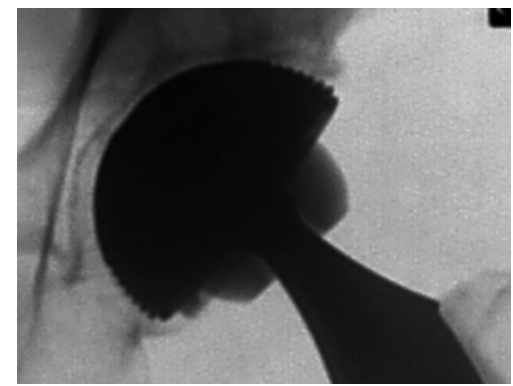
## *Review Article*

### **Fracture of Ceramic Bearing Surfaces following Total Hip Replacement: A Systematic Review**

Francesco Traina,<sup>1</sup> Marcello De Fine,<sup>1</sup> Alberto Di Martino,<sup>1,2</sup> and Cesare Faldini<sup>1</sup>

## Risk factors:

- Misalignment during insertion or metal back damage
- Cup malposition (impingement and edge loading)



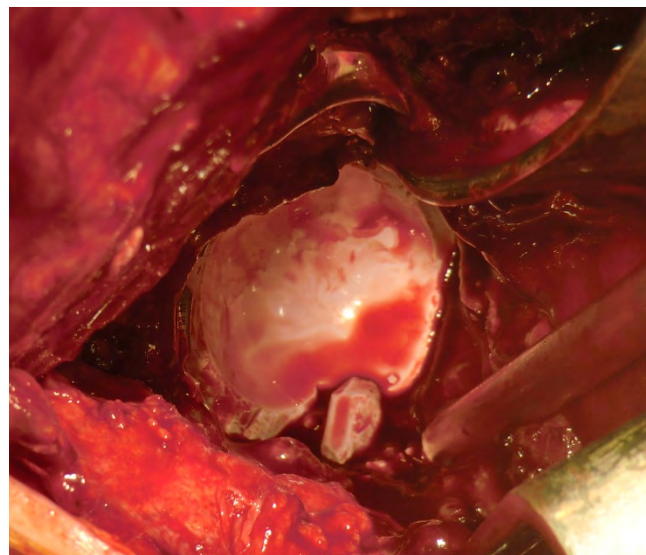
The Journal of Arthroplasty Vol. 27 No. 4 2012

### **Fracture Propagation Propensity of Ceramic Liners During Impingement-Subluxation**

A Finite Element Exploration

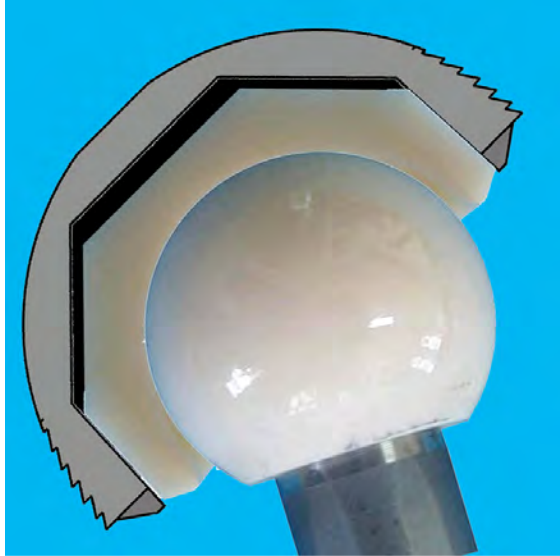
Jacob M. Elkins, MS,\*† Douglas R. Pedersen, PhD,\*†  
John J. Callaghan, MD,\*†‡ and Thomas D. Brown, PhD\*†



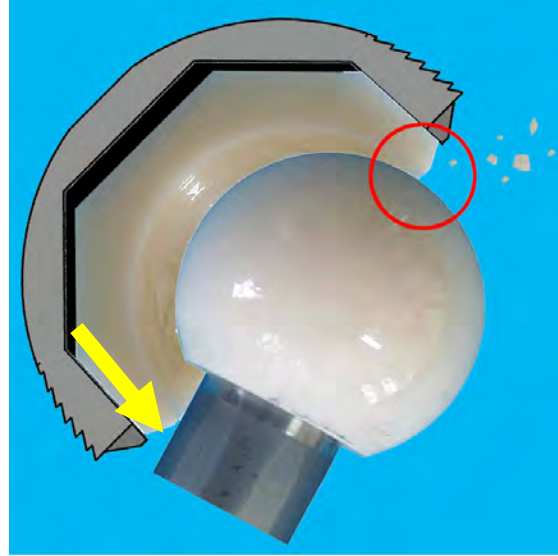


On courtesy of L. Marega

# Fracture mechanics



Malorientation or  
bad rim design

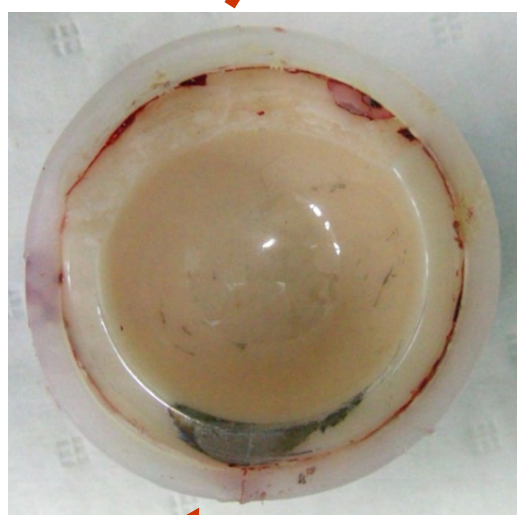
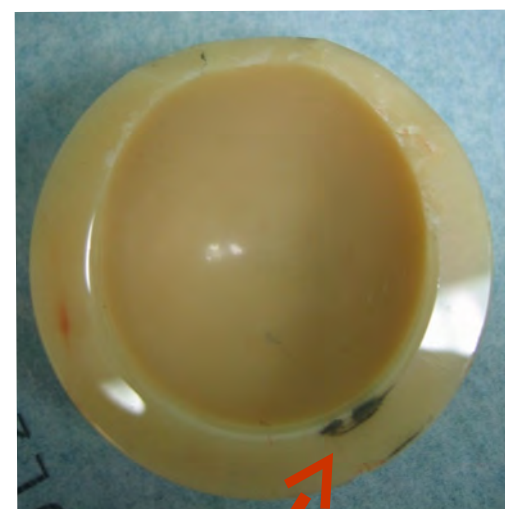
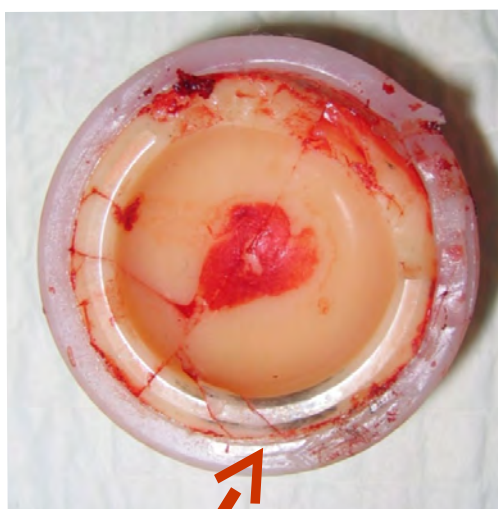


- Neck impingement –  
sub dislocation
- Very small contact on the  
rim
- Grain detachment



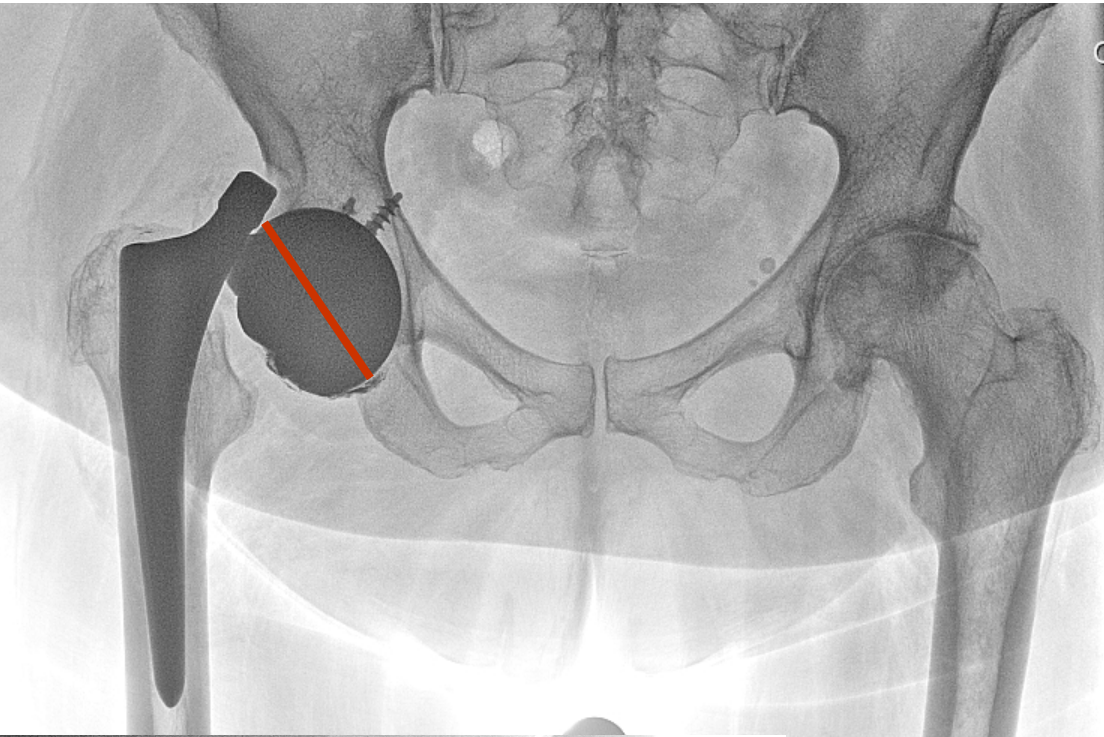
- Third body wear
- Crack propagation

Dalla Pria P, Zagra L Breakage and noises in ceramic on ceramic couplings.  
*Eur Orthop Traumatol*, 1:53-59 (2010)

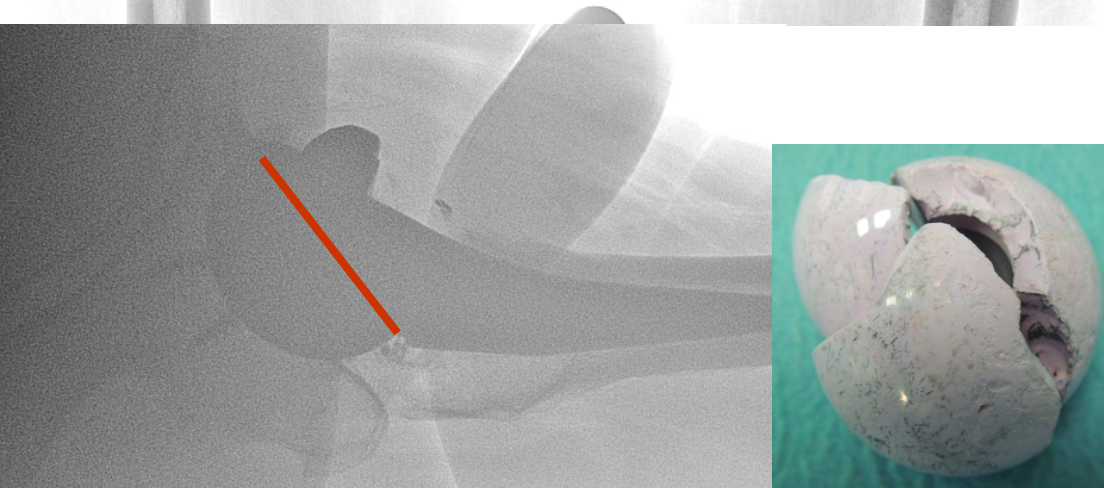




Female, 73 years, obese  
Steep and anteverted cup



Cup revision  
TT XPE,  
Biolog option 36 mm





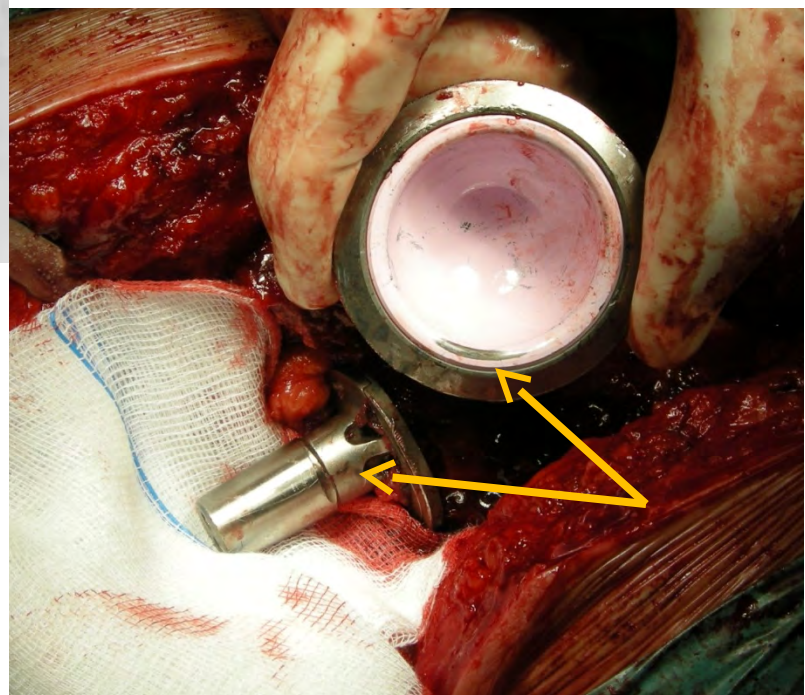
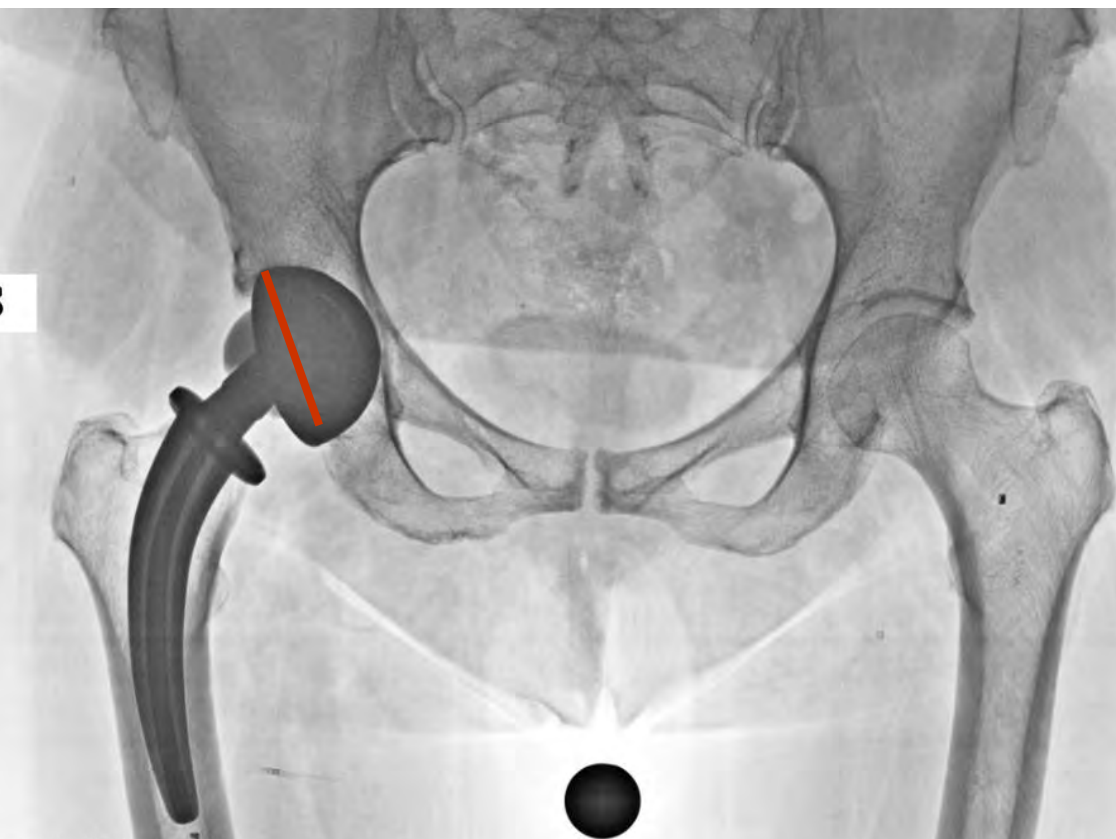
In case of sub-optimal positioning

Strict clinical and X-rays f.u.

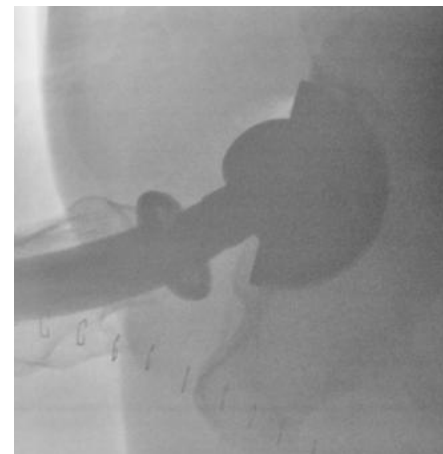
In case of pain, increasing or late noises  
or doubt



Early revision



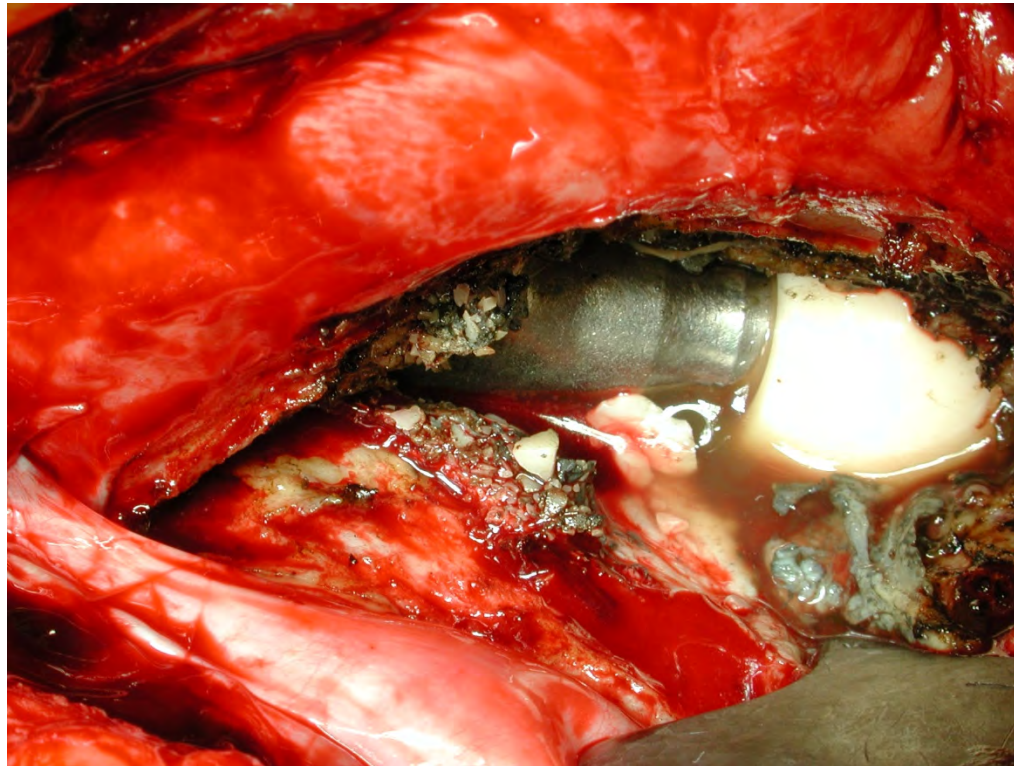
Female, 61 years  
1,5 year post op. Pain, hip noises



Correct orientation, Cer-XPE, 32 mm Biolox Option

1 year later

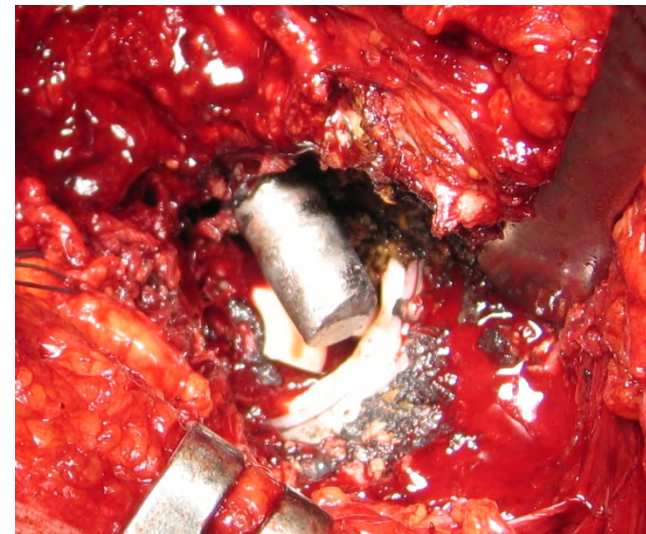
IT IS AN  
EMERGENCY!



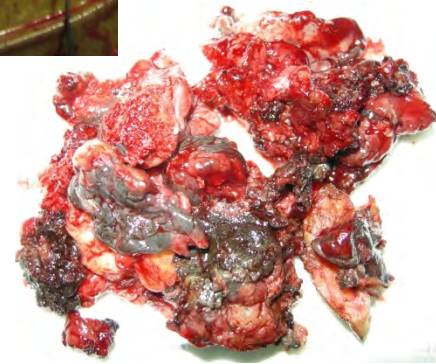
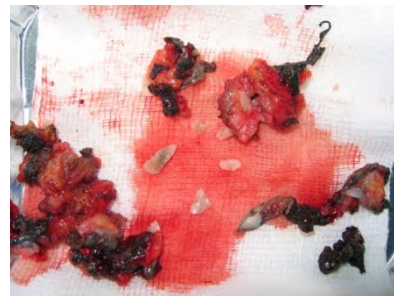
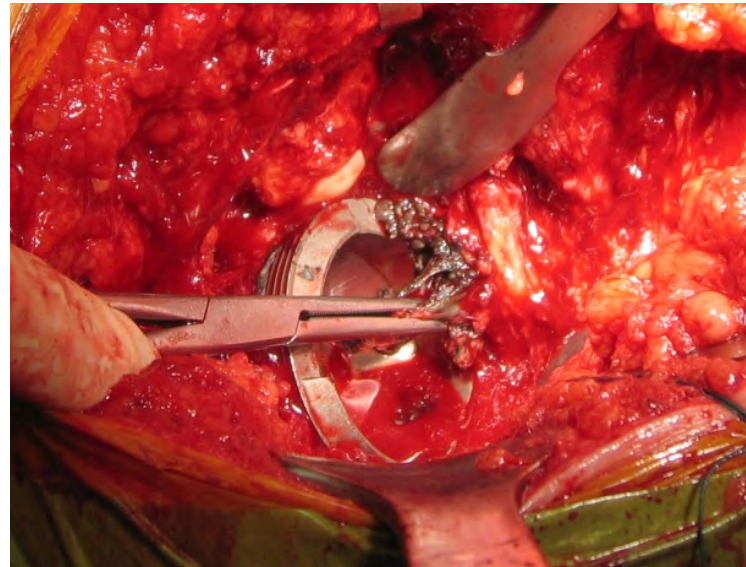
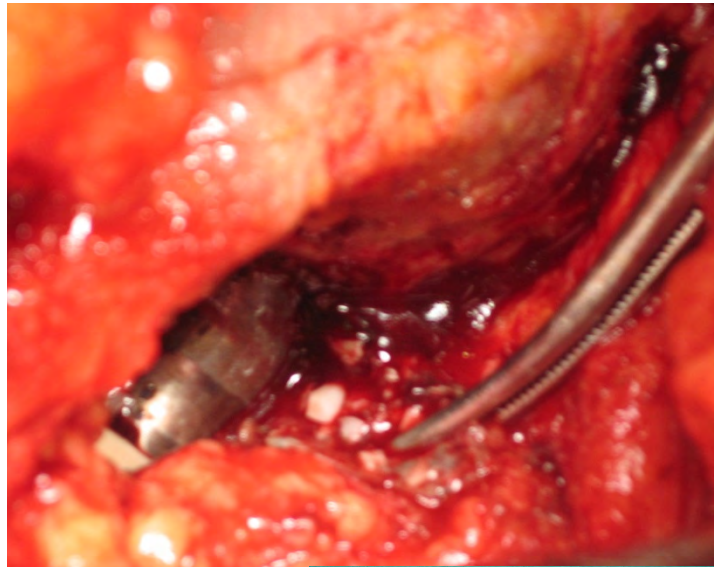


For two main reasons:

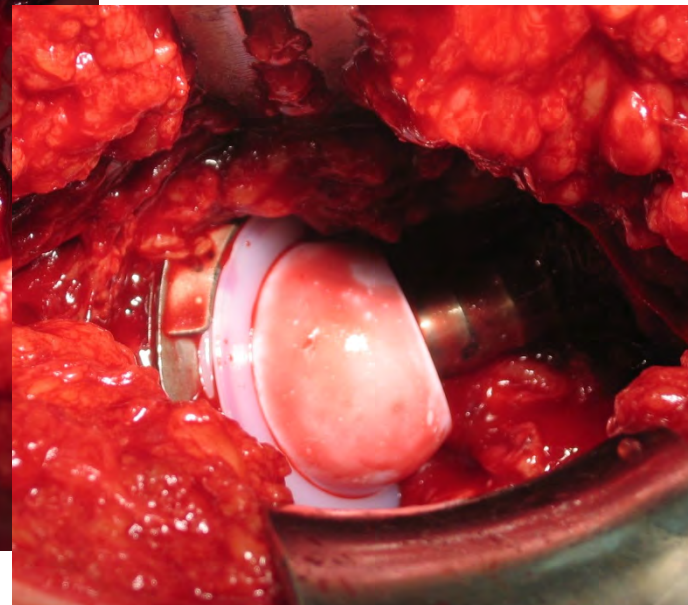
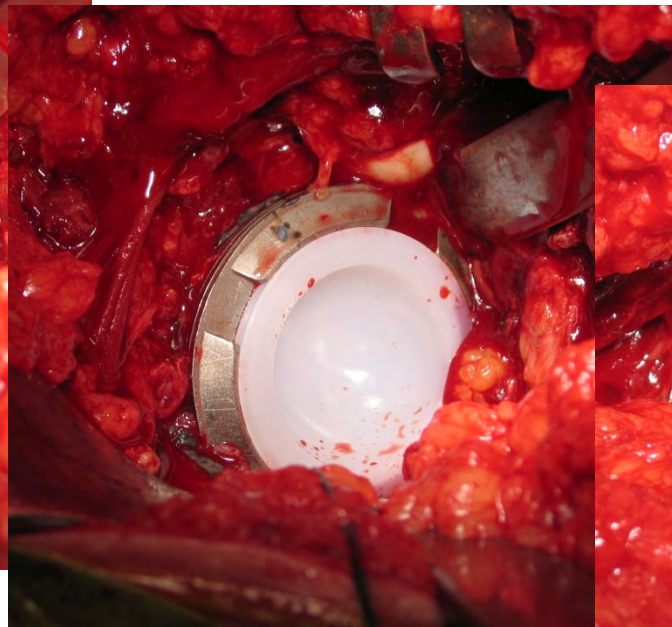
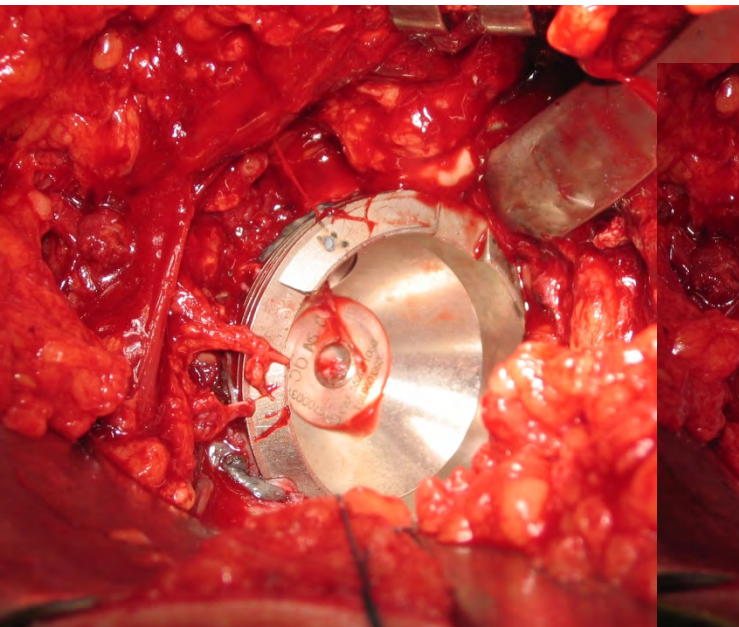
- The ceramic fragments can spread all around the tissues
- The metal components (taper) can be rapidly damaged with metallosis



- Removal of all the visible fragments
- “Aggressive” soft tissue debridement and synovectomy
- Wash out

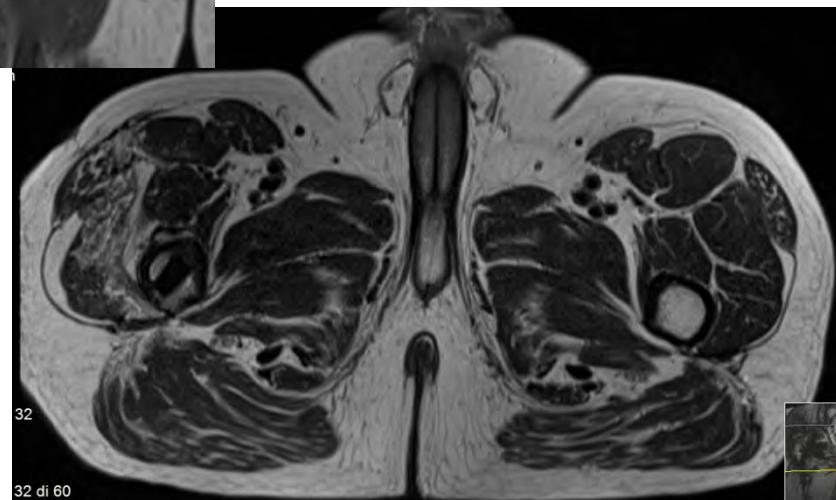
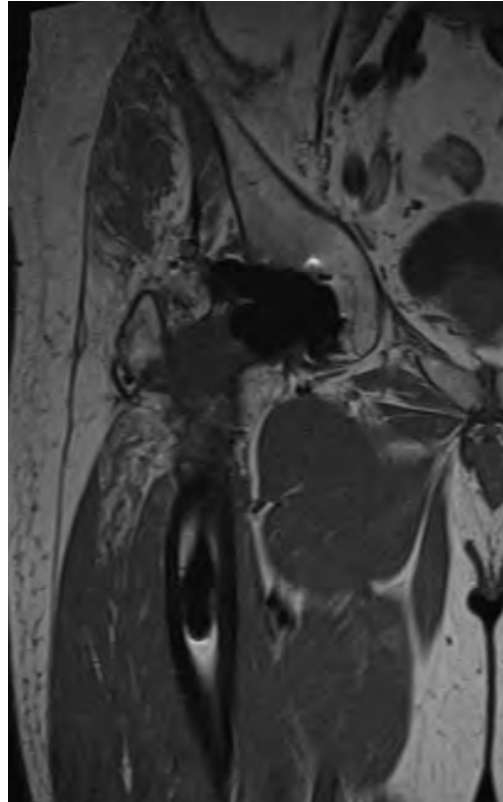


- In case of damaged metal back, of malposition or of a new ceramic liner: **cup revision**
- If the metal back is not damaged: **new PE liner**
- If the taper has not a major damage: **new head on the stable stem**





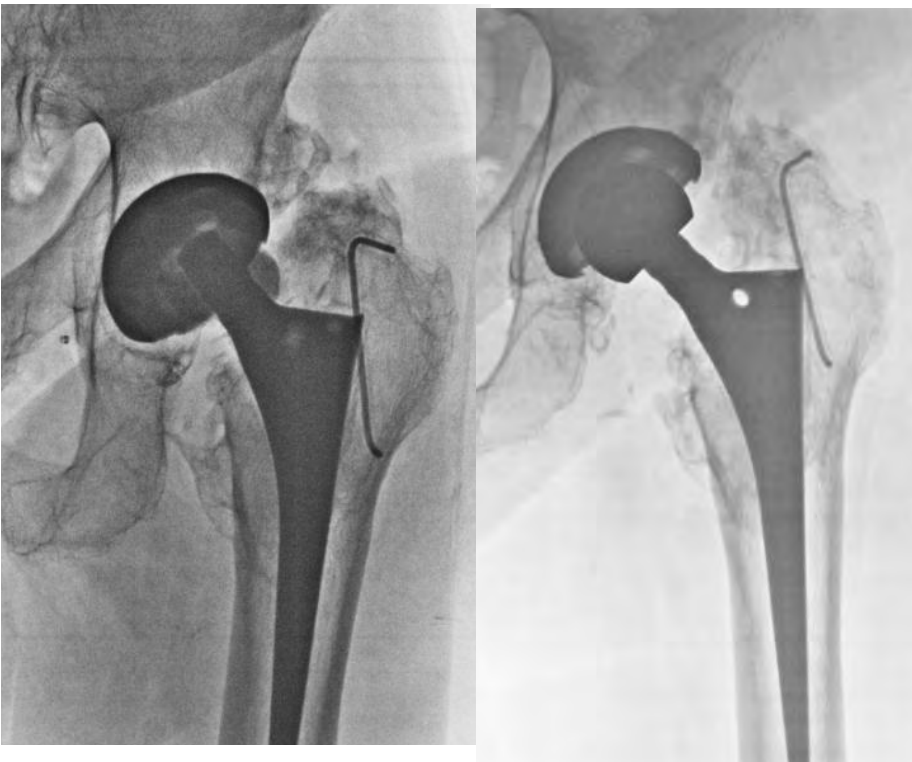
Only the ceramic liner: no!



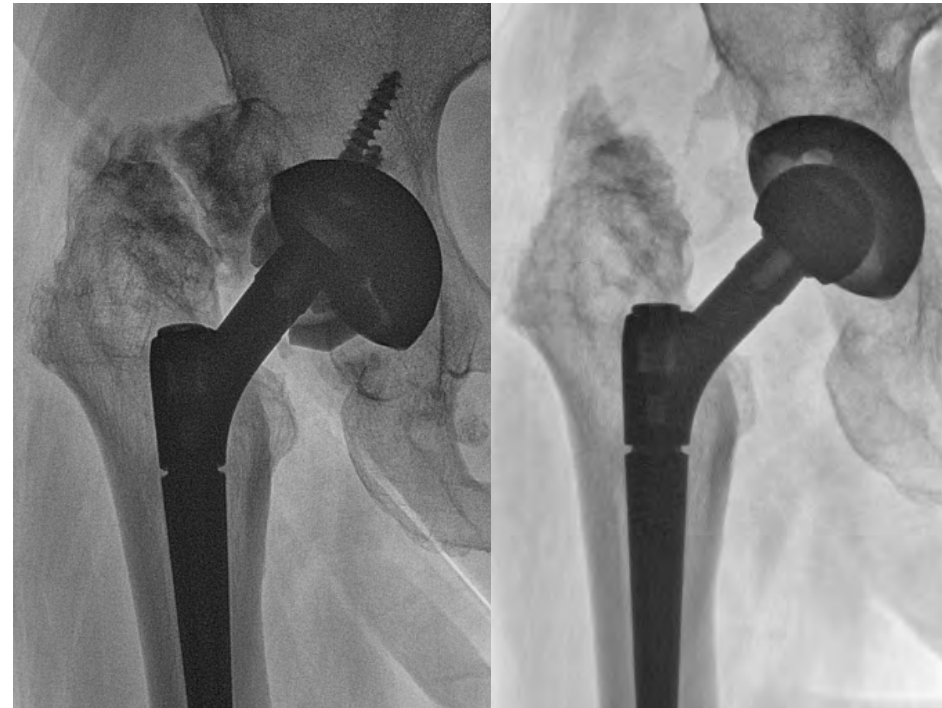
Male 57 years  
Ceramic liner exchange



# Bony impingement



Female, 75 years,  
16 years post op., H.O.  
Liner and head fracture



Female, 73 years,  
15 years post op., H.O.  
Liner fracture

# There is no consensus on the bearing of choice after ceramic fracture:

The Journal of Arthroplasty Vol. 25 No. 3 2010

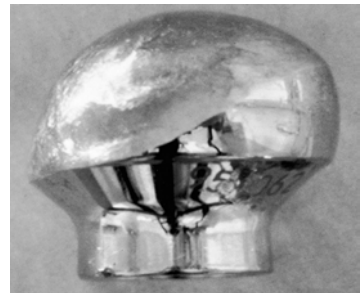
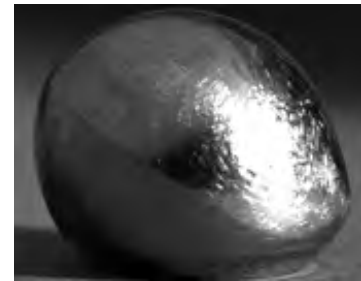
## **Revision Total Hip Arthroplasty for Ceramic Head Fracture**

A Long-Term Follow-Up

Vineet Sharma, MD, Amar S. Ranawat, MD, Vijay J. Rasquinha, MD,  
JoAnne Weiskopf, R-PAC, Holly Howard, BA, and Chitranjan S. Ranawat, MD

## Metal on Poly

- Gozzini, *Hip Int*, 2002
- Hasegawa, *Acta Orthop*, 2006
- Ikeda, *Muscle Nerve*, 2010
- Sharma, *Orthopaedics*, 2013



# Selection of a bearing couple in cases of revision after a fractured ceramic component.

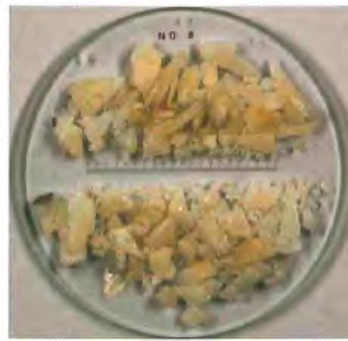
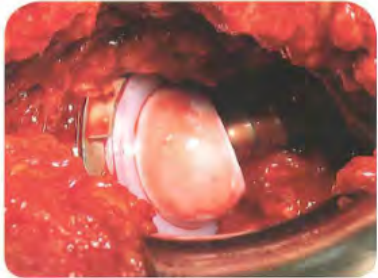


Fig. 1: Ceramic particles inserted between the sliding surfaces during the test

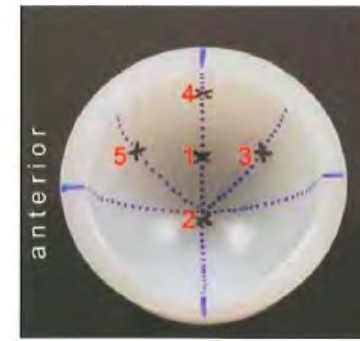


Fig. 2: Points 1–5, ceramic particles were inserted at these points before the start of the test



Fig. 3: Surface of BIOLOX®delta after 5 million cycles

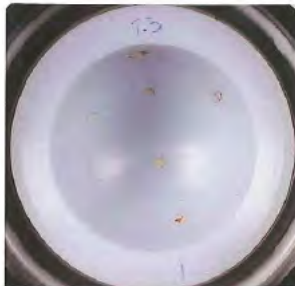
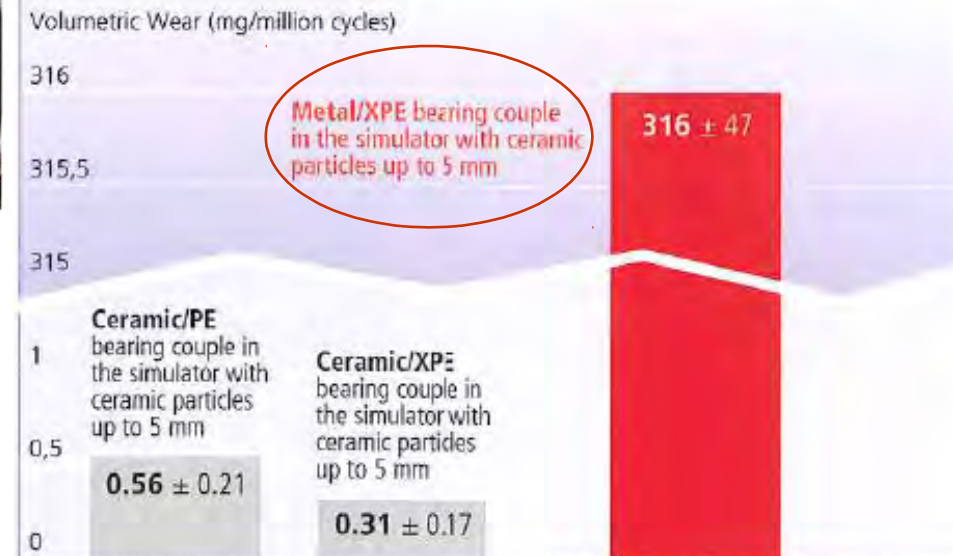


Fig. 4: Surface of XPE insert after 5 million cycles

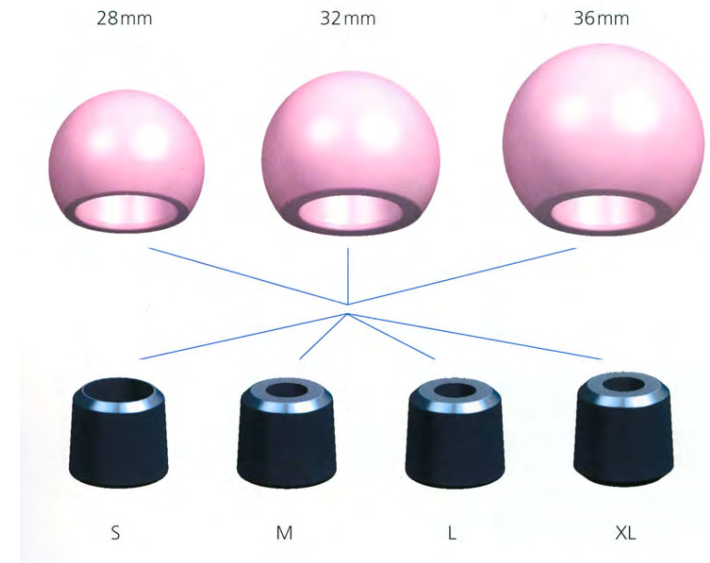
“the use of Met-PE is contra-indicated”





When the stem is retained:

## Revision ceramic heads



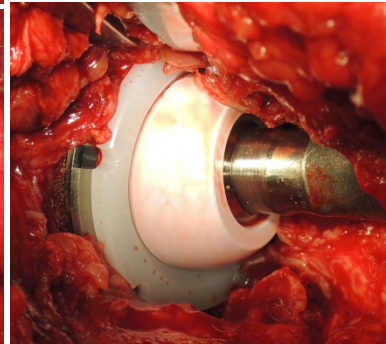
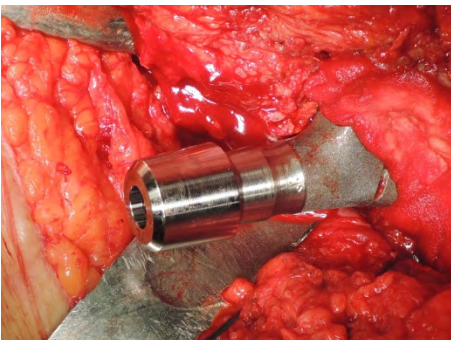
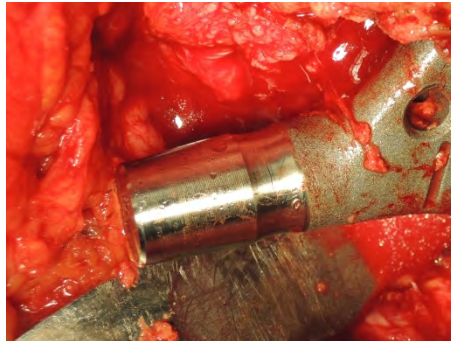
Biolox Option Delta®

International Orthopaedics (SICOT) (2013) 37:15–19  
DOI 10.1007/s00264-012-1735-y

ORIGINAL PAPER

**Modular sleeves with ceramic heads in isolated acetabular cup revision in younger patients—laboratory and experimental analysis of suitability and clinical outcomes**

Peter Helwig • Lukas Konstantinidis • Anja Hirschmüller • Anke Bernstein •  
Oliver Hauschild • Norbert P. Südkamp • Björn G. Ochs





1



2



3



# There is no consensus on the bearing of choice after ceramic fracture:

J Bone Joint Surg Am. 2011 Dec 21;93(24):e147.

## Revision of ceramic hip replacements for fracture of a ceramic component: AAOS exhibit selection.

Traina F, Tassinari E, De Fine M, Bordini B, Toni A.

Laboratory for Medical Technology, Department of Hip and Knee Surgery, Rizzoli Orthopaedic Institute, Bologna, Italy. [traina@tecnio.ior.it](mailto:traina@tecnio.ior.it)

Couple chosen at revision	N. of patients	Average Follow-Up	Results	Case report
 Cer-Cer	30	3,3 Yrs (1-14)	No osteolysis No radiografic failures 93.3% good results	
 Cer-Pol	2	7,5 Yrs (4-11)	No osteolysis No radiografic failures Both good results	
 Met-Pol	8	6,1 Yrs (4-9)	6 Poly wear + osteolysis 1 revision 87.5% bad results	

**Cer-Cer** for the scratch resistance to third body wear









# There is no consensus on the bearing of choice after ceramic fracture:

J Bone Joint Surg Am. 2011 Dec 21;93(24):e147.

## **Revision of ceramic hip replacements for fracture of a ceramic component: AAOS exhibit selection.**

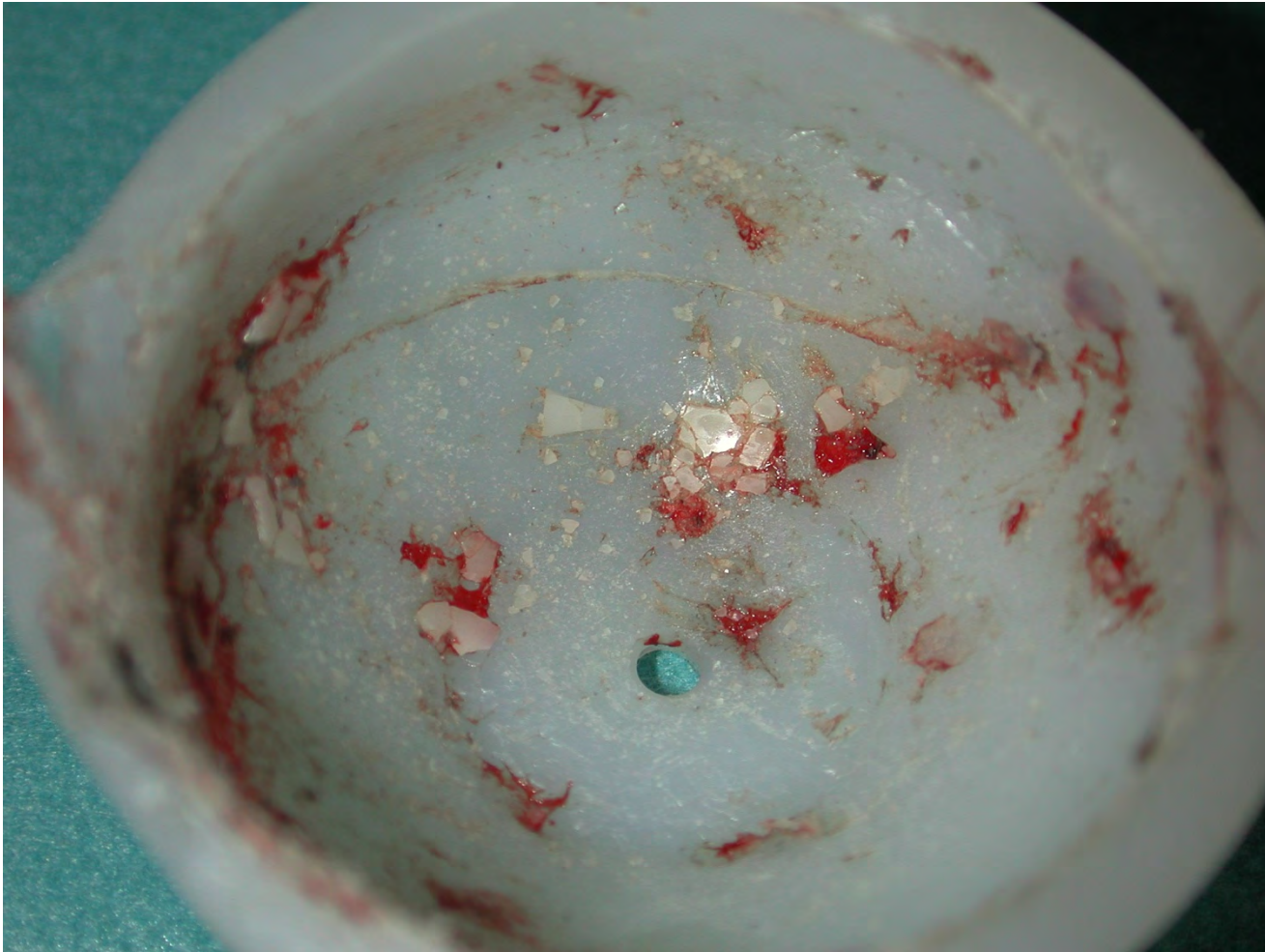
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Cer-Poly

## Ceramic on Poly



Small ceramic fragments can impact in PE, less damage



## Ceramic on Poly

One more good reason:

Do not use a Tribology that already failed!





Revision of ceramic fracture with ceramic-on-polyethylene in total hip arthroplasty: Medium-term results

L. Zagra\*, L. Bianchi, R. Giacometti Ceroni

*Hip Department, IRCCS Istituto Ortopedico Galeazzi, via Riccardo Galeazzi 4, 20161, Milan, Italy*

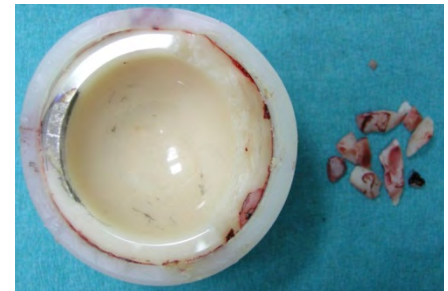
## 12 patients

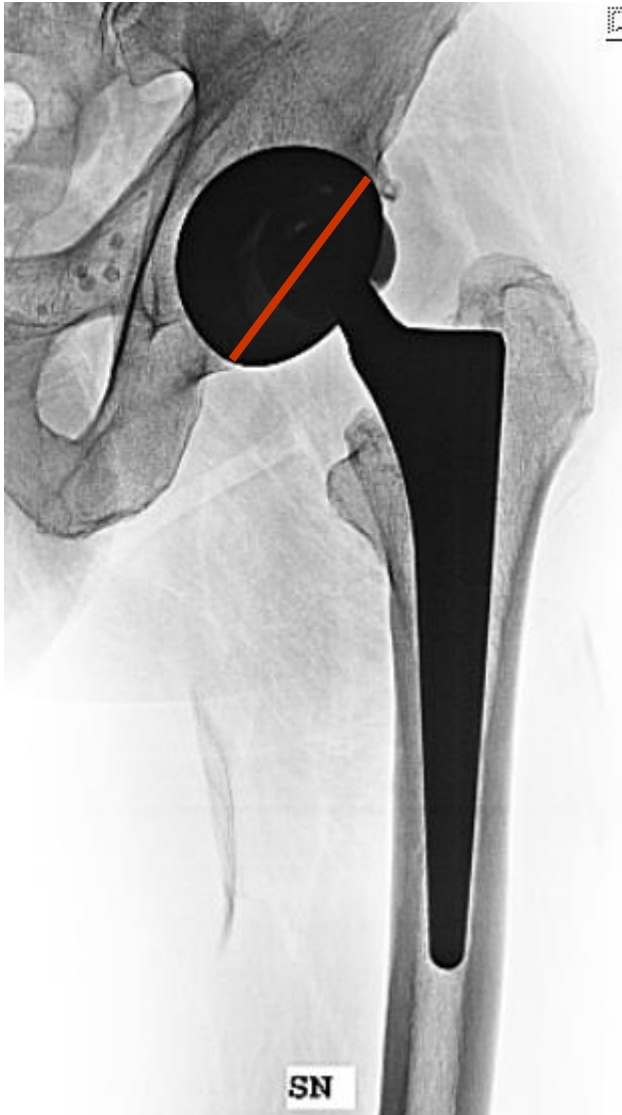
## revised for ceramic breakage between 2002-2013, with **Cer on PE**

- 7 men and 5 women
- Mean age at revision 66,5 years (38-75)
- Mean of 9.1 (1.5-16) years after the indexed surgery

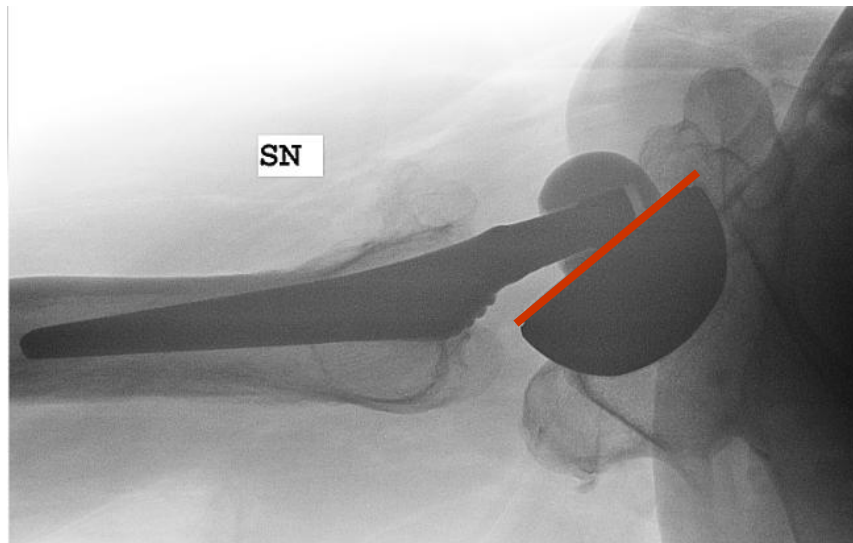
## Breakage

- 11 Biolox Forte, 1 Bionit
- All fractured liners:
  - 9: PE-cer sandwiches 28 mm,  
1: 32 mm,  
2: 36 mm
- 2 fractures also of the head (28, 32 mm)
- 1 massive wear (Bionit, fracture and third body wear, “pseudotumor”)



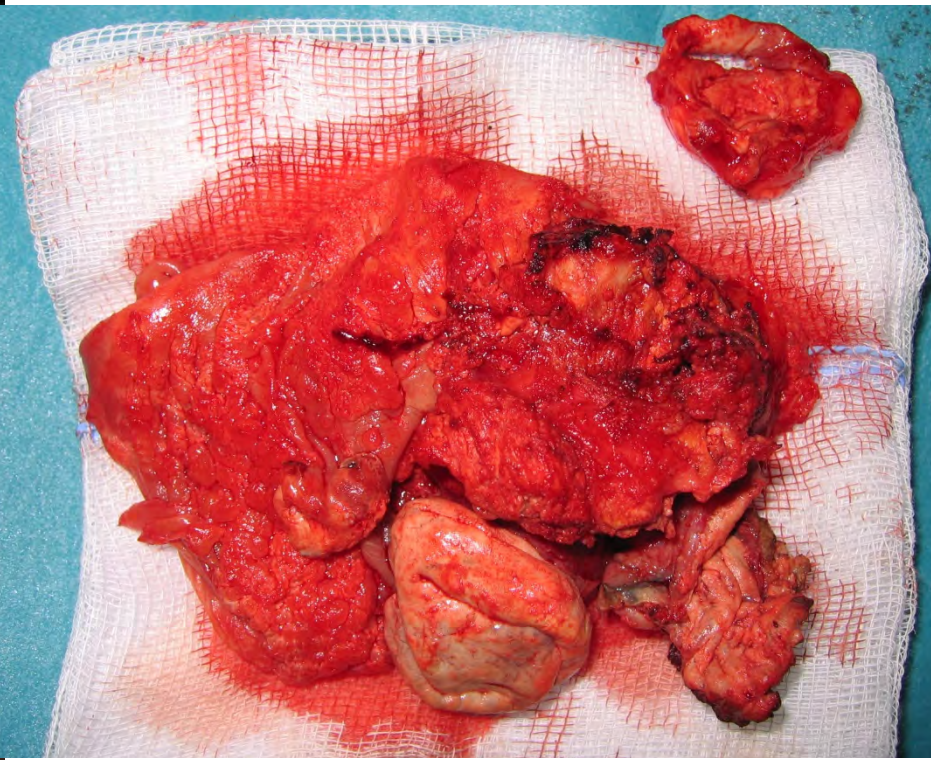


Malposition of the cup  
(anteversion and inclination)



Male, 67 years, 36 mm  
1,5 year post op. No pain, 2 dislocations









Cup revision: correct orientation, Cer-XPE (Biolog Option)

## Treatment

- 4 cup revisions: (1 malposition, 2 loosening, 1 uncertain stability)
- 8 liner exchanges (stable cups)
- In all the cases the head was replaced:  
(no major damage of the cone): 4 Biolox Forte  
8 Biolox Delta Option



Mean f.u. 6,0 years (range 1.5 - 13 years)

- No cases of breakage of the head
- 1 major wear after 9 years (8.3% of failure)  
(clear malposition)
- No other cases of major osteolysis

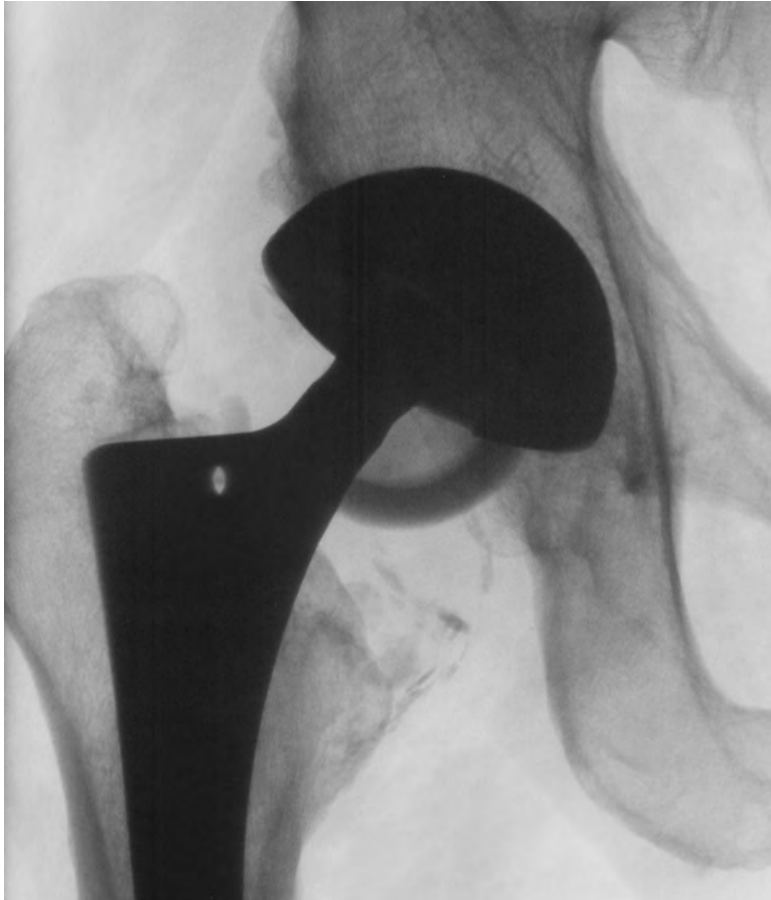




Male, 74 years, fracture of PE sandwich ceramic liner



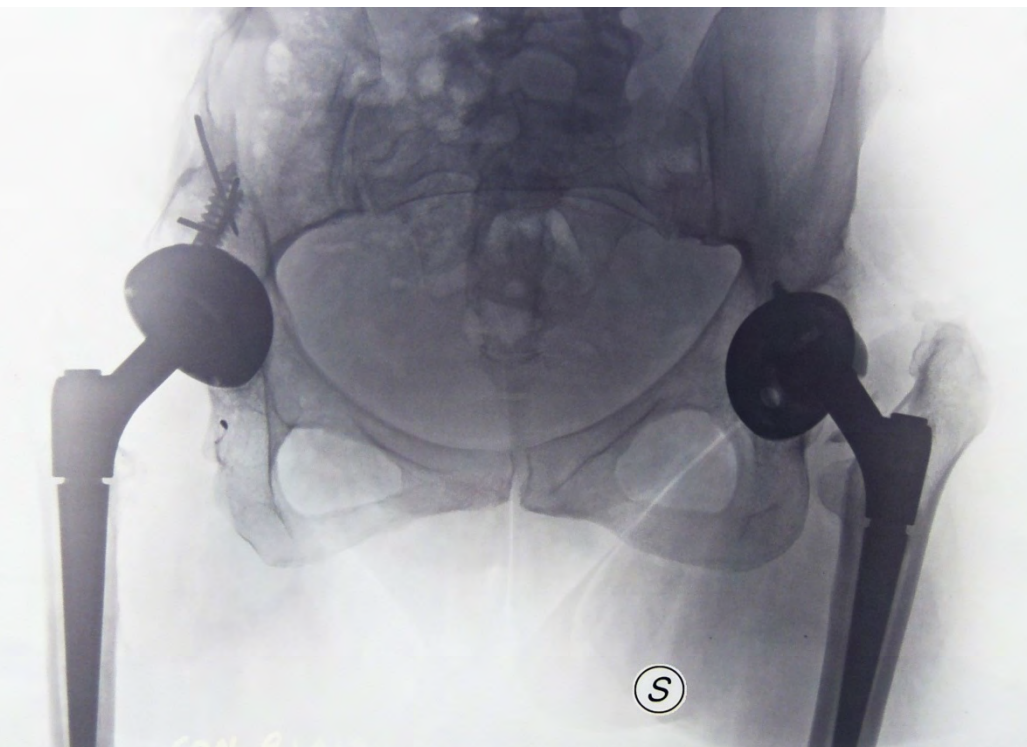
Cer-PE 10 years post op.



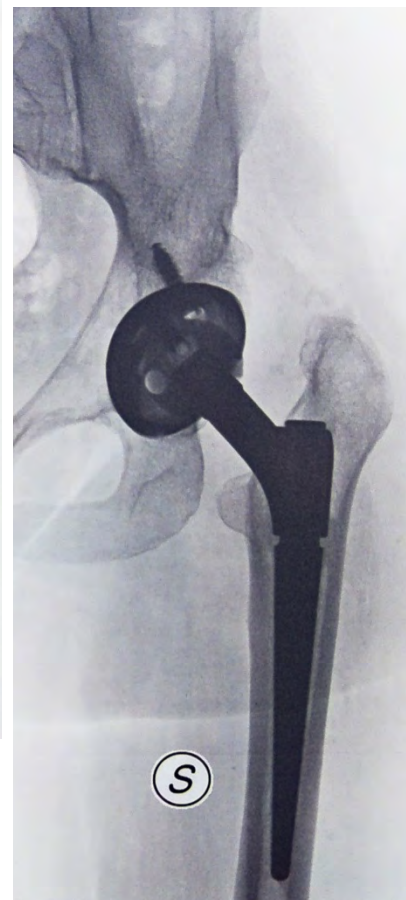
Male, 70 years, fracture of PE sandwich ceramic liner 2.5 years after THA



Cer-PE 13 years post op.



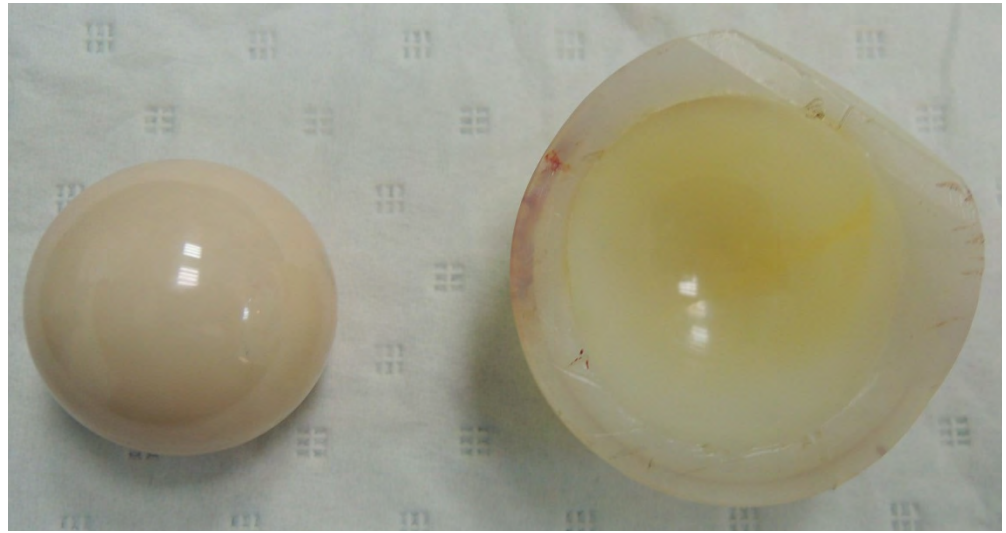
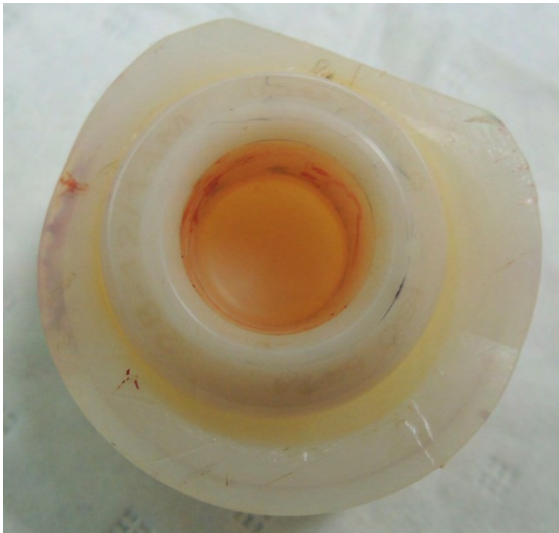
Female, 38 years old, bilateral DDH,  
breakage of sandwich liner, 6 years post



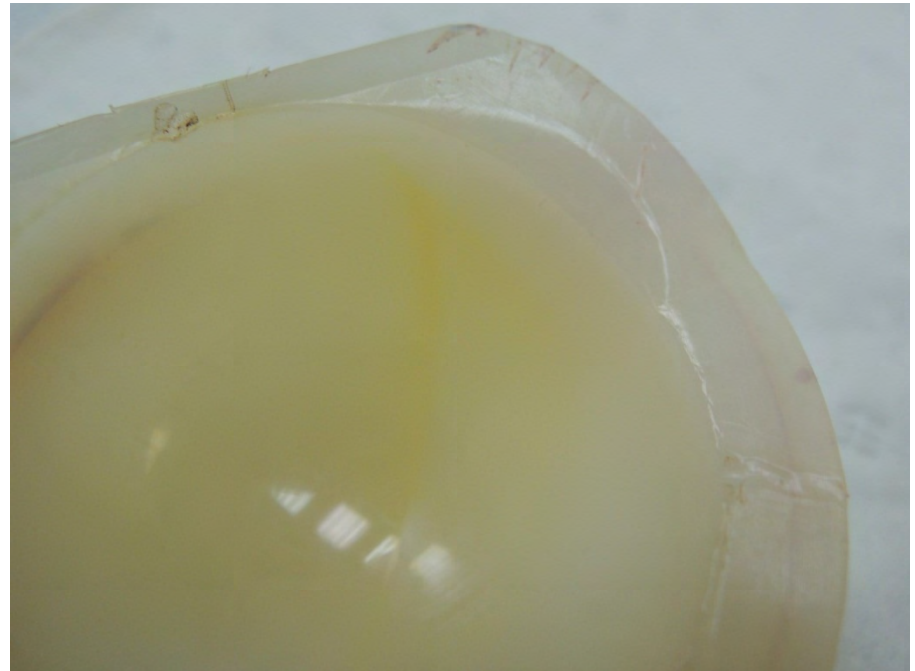
PE Liner, Biolog Forte head



Wear 9 years later



PE wear 10 years after surgery,  
no ceramic fragments







Cup revision, bone graft, XPE-Cer (BioloX Option 32mm)  
(2 years post-op)

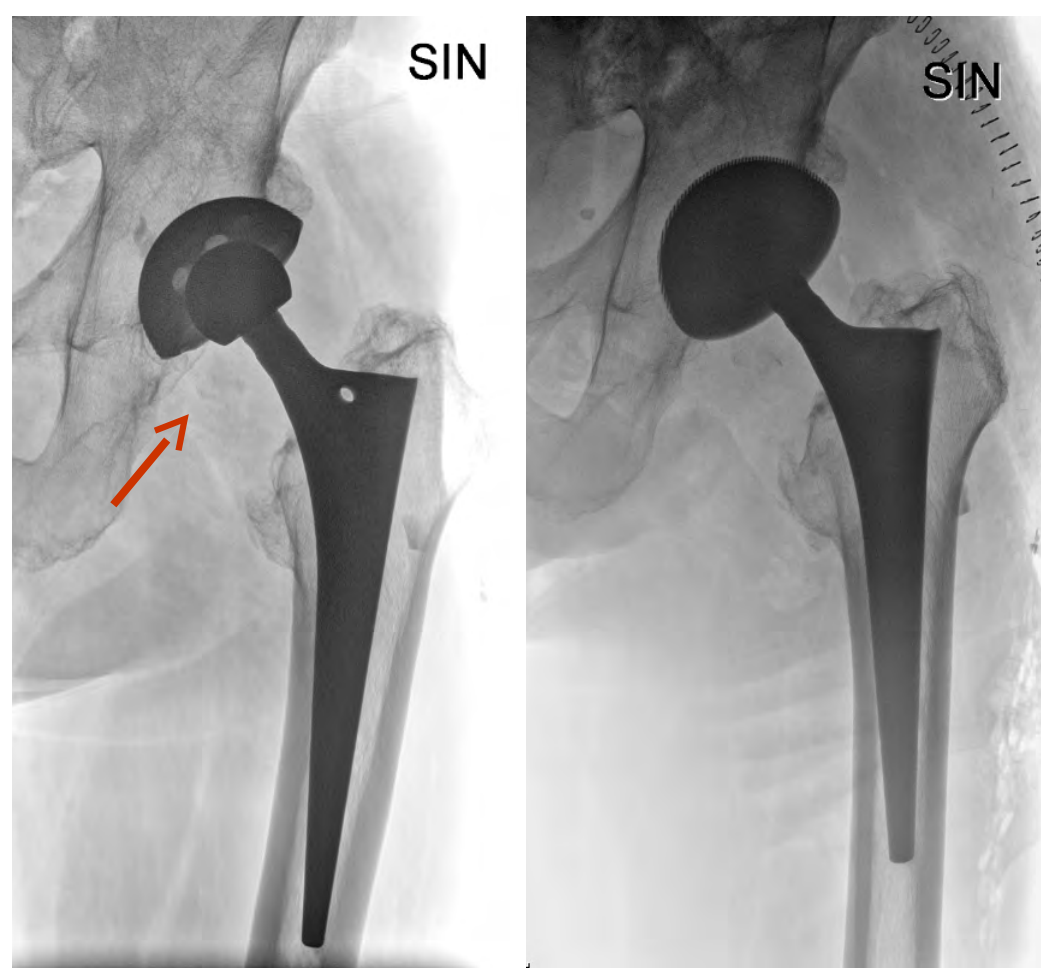
## Complications

- 4 cases of early dislocation (all in the liner exchange group, 50%, 1 revised)
- Probably due to underestimated impingement/malposition and aggressive soft tissues release

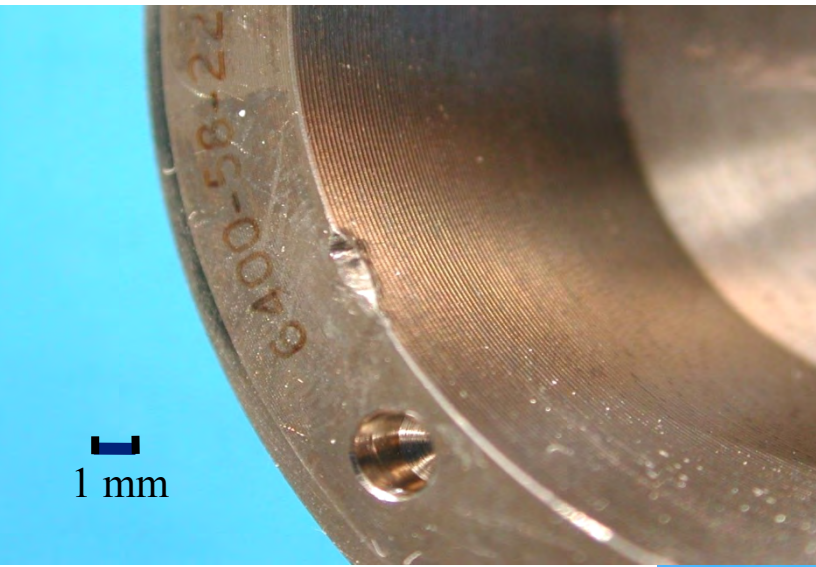


## An “off-label” use

- Dual mobility in case of dislocation (Cer-PE-Cer)



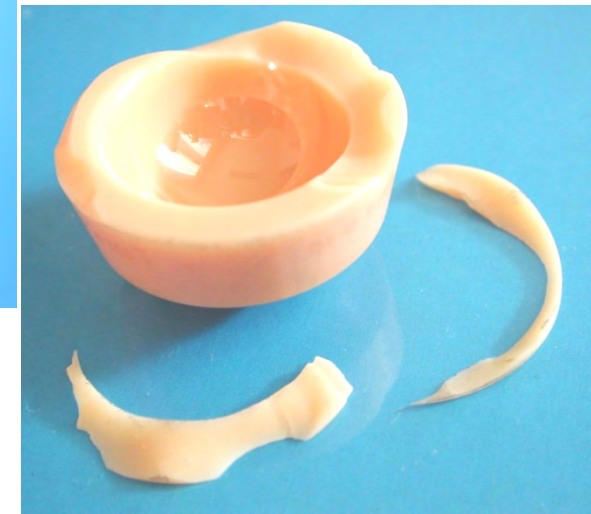
# Damage of the metal back



Breakage during the  
insertion of the liner

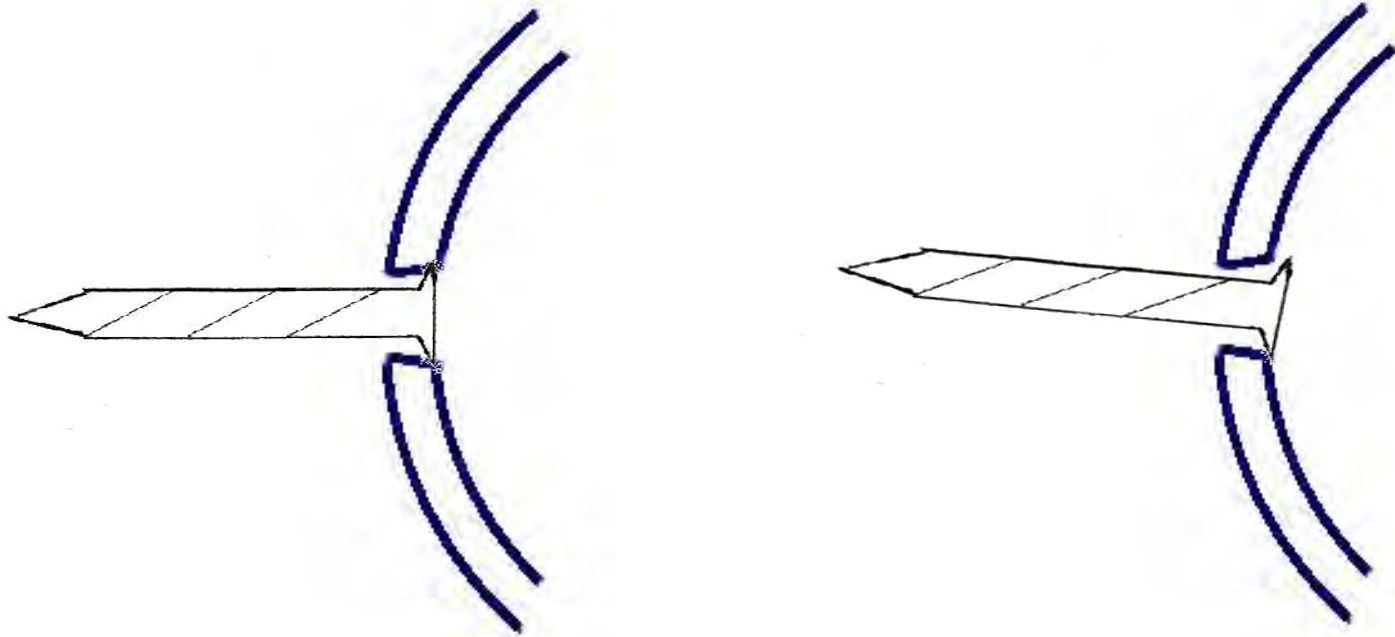


Pay attention in handling  
the metal back





## Additional screws

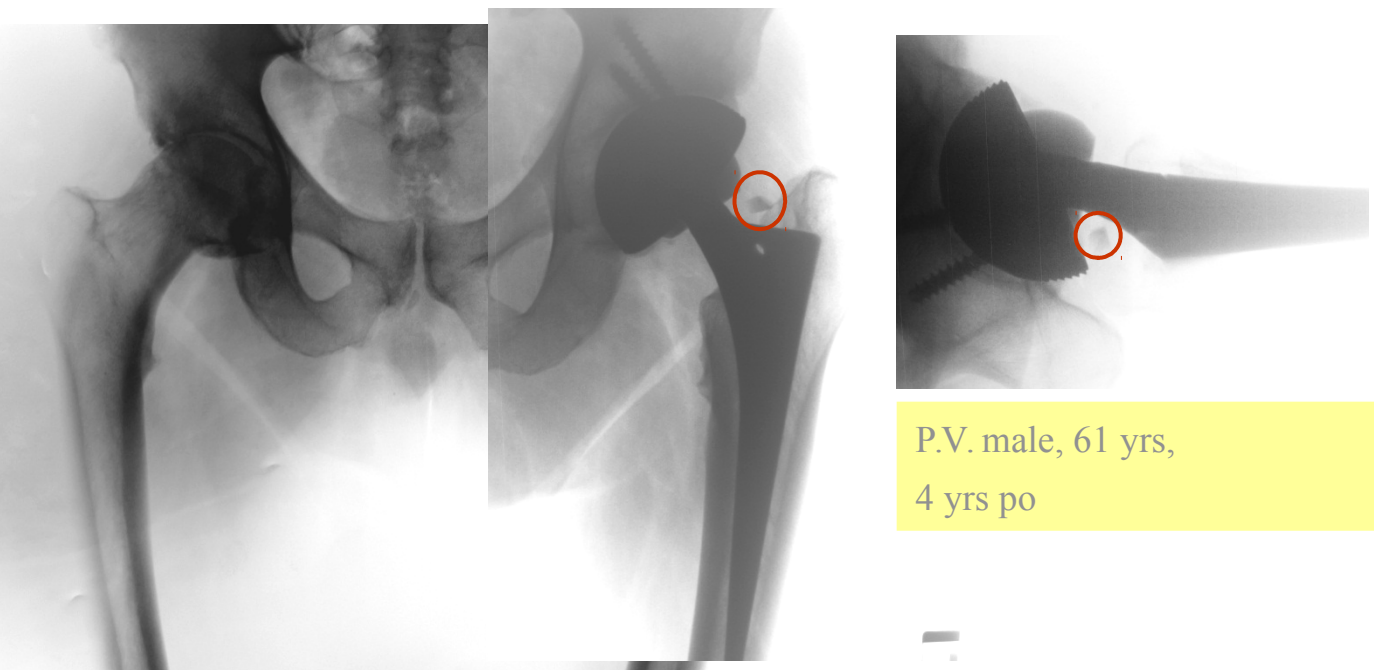


Orthopaedics MAY 2010 | Volume 33 • Number 5

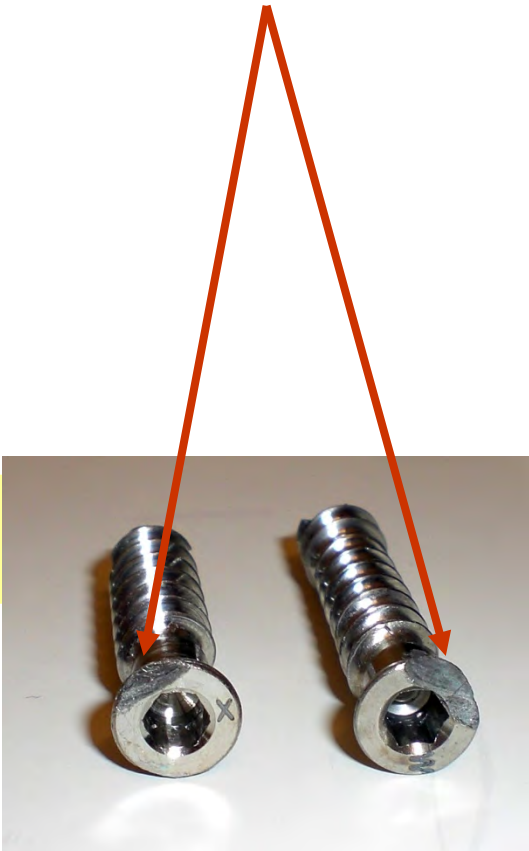
### **Acetabular Screw Head-induced Ceramic Acetabular Liner Fracture in Cementless Ceramic-on-Ceramic Total Hip Arthroplasty**

SU CHAN LEE, MD; KWANG AM JUNG, MD; CHANG HYUN NAM, MD; TEA HO KIM, MD;  
NONG KYOUM AHN, MD; SEUNG HYUN HWANG, MD

Fracture of the liner probably due to “malpositioning” of the screws protruding into the metal back



P.V. male, 61 yrs,  
4 yrs po



Female, 69 years

Loosening of the cup after 5 years of  
cer-cer, osteolysis due to Ti debris

Cer-XPE 36 mm



1 year later

## Squeaking

We had frequent cases of post-op separation noises, but only three cases of occasional typical squeakers.

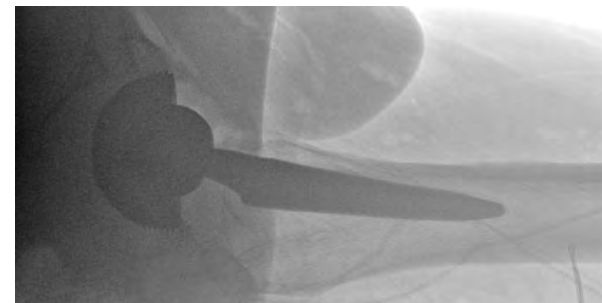
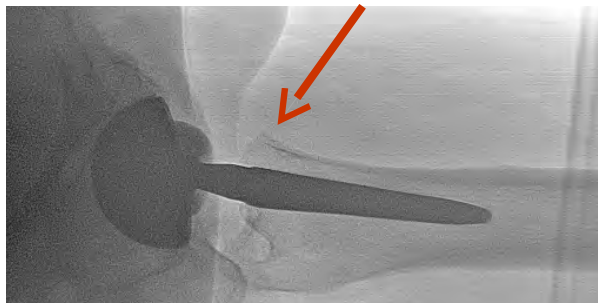


## Squeaking

Anyhow, the occurrence of a new delayed noise in a ceramic joint, particularly if linked to pain, must be carefully considered.

1.5 years after, squeaking and groin pain (stable implant retained, liner and head exchange, reshaping of the neck, ileopsoas tenotomy)

Cer-XPE, longer neck



# Conclusions

## *CORR* Insights<sup>®</sup>: Do the Reasons for Ceramic-on-ceramic Revisions Differ From Other Bearings in Total Hip Arthroplasty?

Luigi Zagra MD

Clin Orthop Relat Res / DOI 10.1007/s11999-016-4971-4

### Ceramic on Ceramic

- Indication in young and active patients  
(for the higher wear resistance and biocompatibility).
- More sensitive in handling of the components and positioning of the implant.

# Conclusions

In case of ceramic breakage:

- Accurate fragments removal and synovectomy,
- Replacement of damaged components,
- Correction of malpositioning and impingement are the key points



# Conclusions

In case of ceramic breakage:

- At the moment there is no clear evidence of the bearing of choice, but metal should be avoided

# Conclusions

## In case of ceramic breakage:

- At the moment there is no clear evidence of the bearing of choice, but metal should be avoided
- Revision using Cer revision heads on PE liners (as alternative to Cer on Cer), can yield favorable results at mid-term f.u.

Grazie!

