Custom od impianti modulari per le revisioni acetabolari complesse?

Indicazioni, limiti e vantaggi dei due approcci

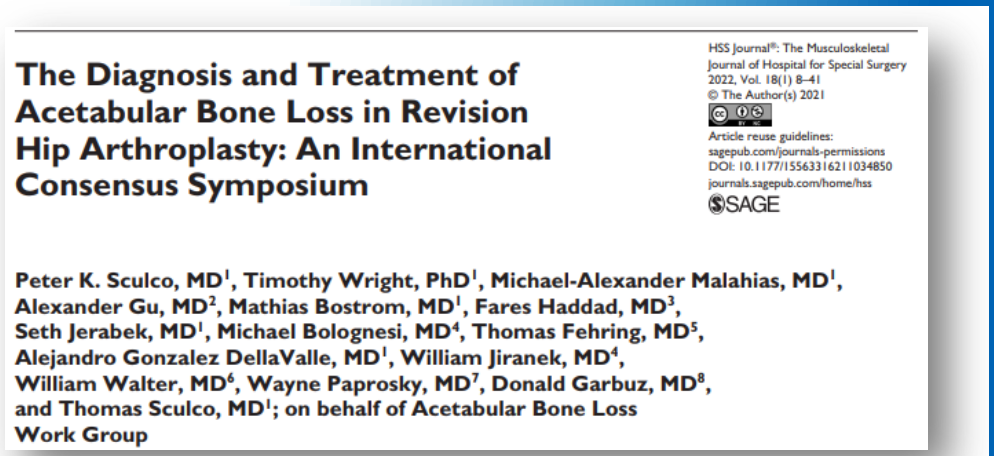
Prof. Francesco Traina

Chief of the Hip and Knee Departement - Istituto Ortopedico Rizzoli
University of Bologna

Acetabular reconstruction

The ideal acetabular reconstruction:

- Biological reconstruction
- Stable construct with minimal micromotion (<400 µm)
- Bone stock restoration
- COR position restoration
- Anti-bacterial environment



The Diagnosis and Treatment of Acetabular Bone Loss in Revision Hip Arthroplasty: An International Consensus Symposium

HSS Journal®: The Musculoskeletal Journal of Hospital for Special Surgery
2022, Vol. 18(1) 8–41

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Peter K. Sculco, MD[1], Timothy Wright, PhD[1], Michael-Alexander Malahias, MD[1], Alexander Gu, MD[2], Mathias Bostrom, MD[1], Fares Haddad, MD[3], Seth Jerabek, MD[1], Michael Bolognesi, MD[4], Thomas Fehring, MD[5], Alejandro Gonzalez DellaValle, MD[1], William Jiranek, MD[4], William Walter, MD[6], Wayne Paprosky, MD[7], Donald Garbuz, MD[8], and Thomas Sculco, MD[1]; on behalf of Acetabular Bone Loss Work Group

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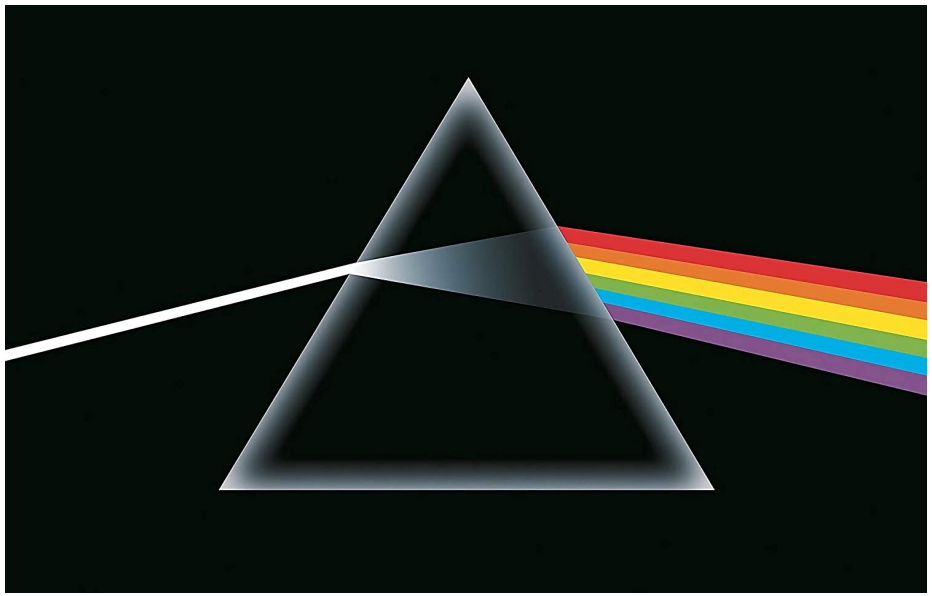
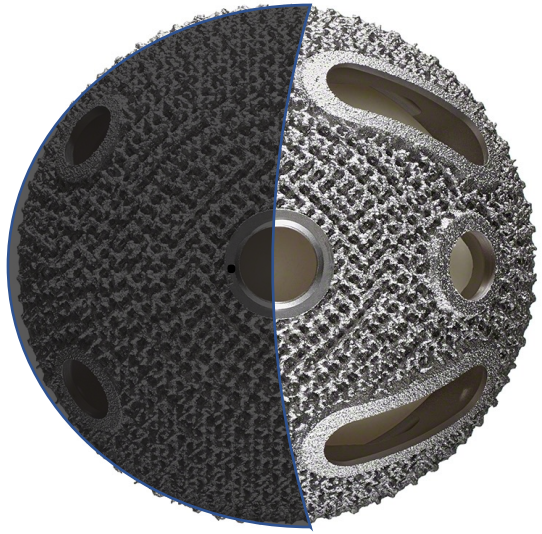
Università di Bologna

Hip revision surgery

Hip revision could be straight forward...





..but there is a dark side of it

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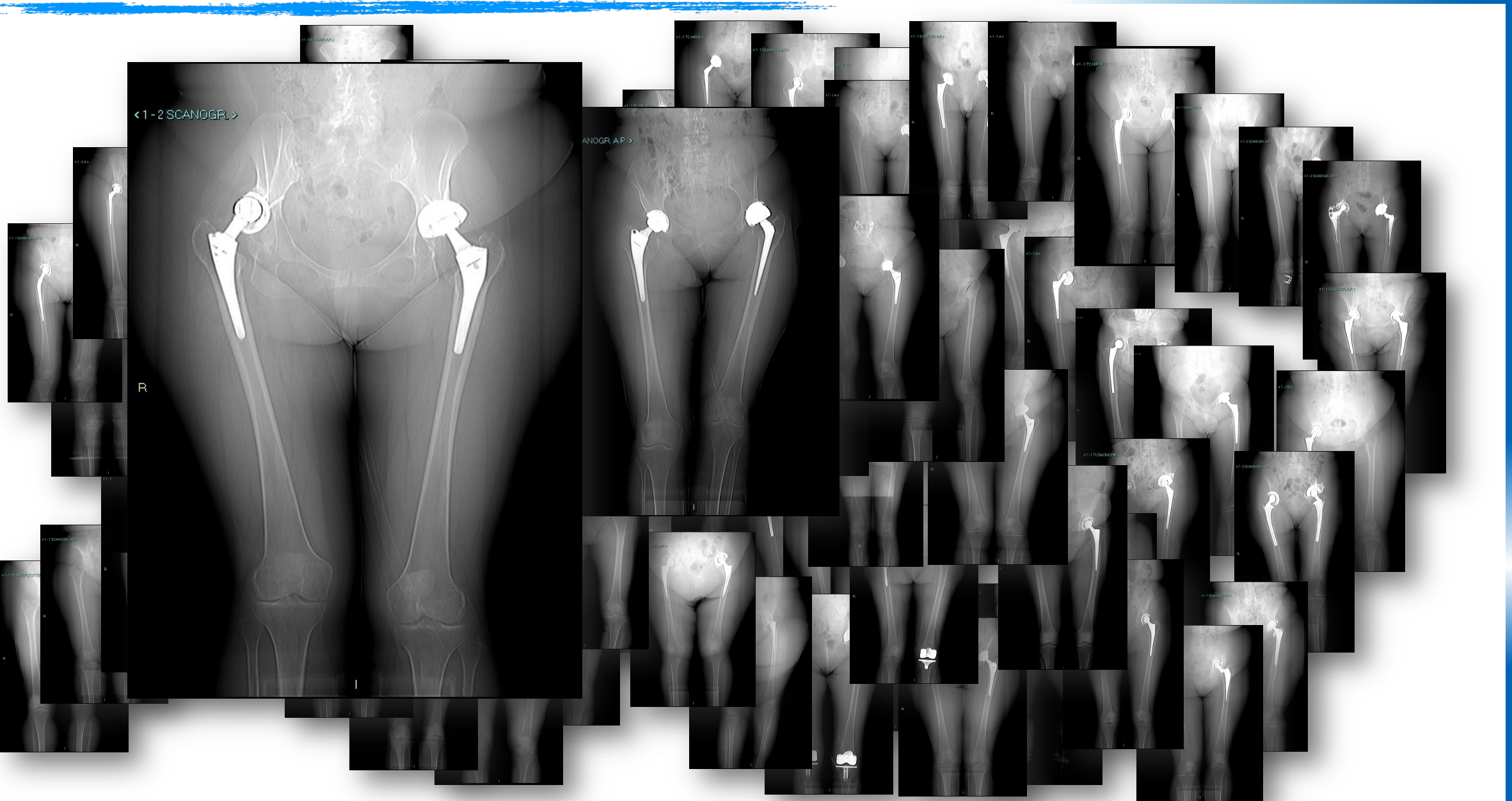
BONE LOSS: we do a CT scan for every revision surgery



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We use a CT based classification for bone loss

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Method for quantitative assessment of acetabular bone defects

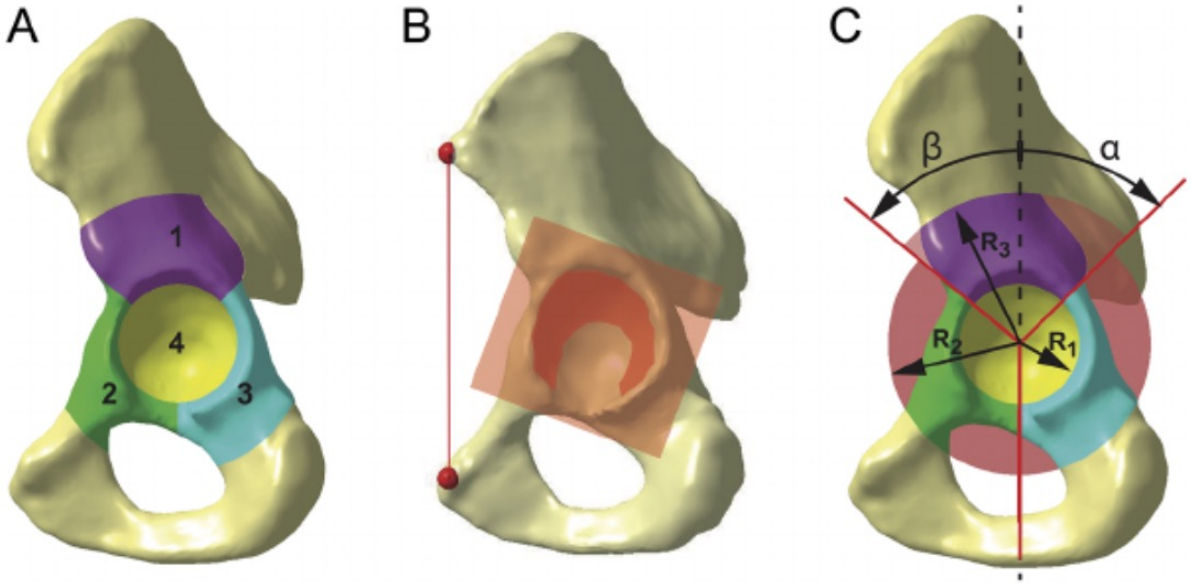
Georg Hettich, Ronja A. Schierjott, Heiko Ramm, Heiko Graichen, Volkmar Jansson, Maximilian Rudert, Francesco Traina, Thomas M. Grupp,

PLOS ONE

RESEARCH ARTICLE

Quantitative assessment of acetabular bone defects: A study of 50 computed tomography data sets

Ronja A. Schierjott[1,2]*, Georg Hettich[1], Heiko Graichen[3], Volkmar Jansson[2], Maximilian Rudert[4], Francesco Traina[5,6], Patrick Weber[2], Thomas M. Grupp[1,2]



- Preoperative
- Quantitative
- Topographic
- Help to chose the strategy before surgery

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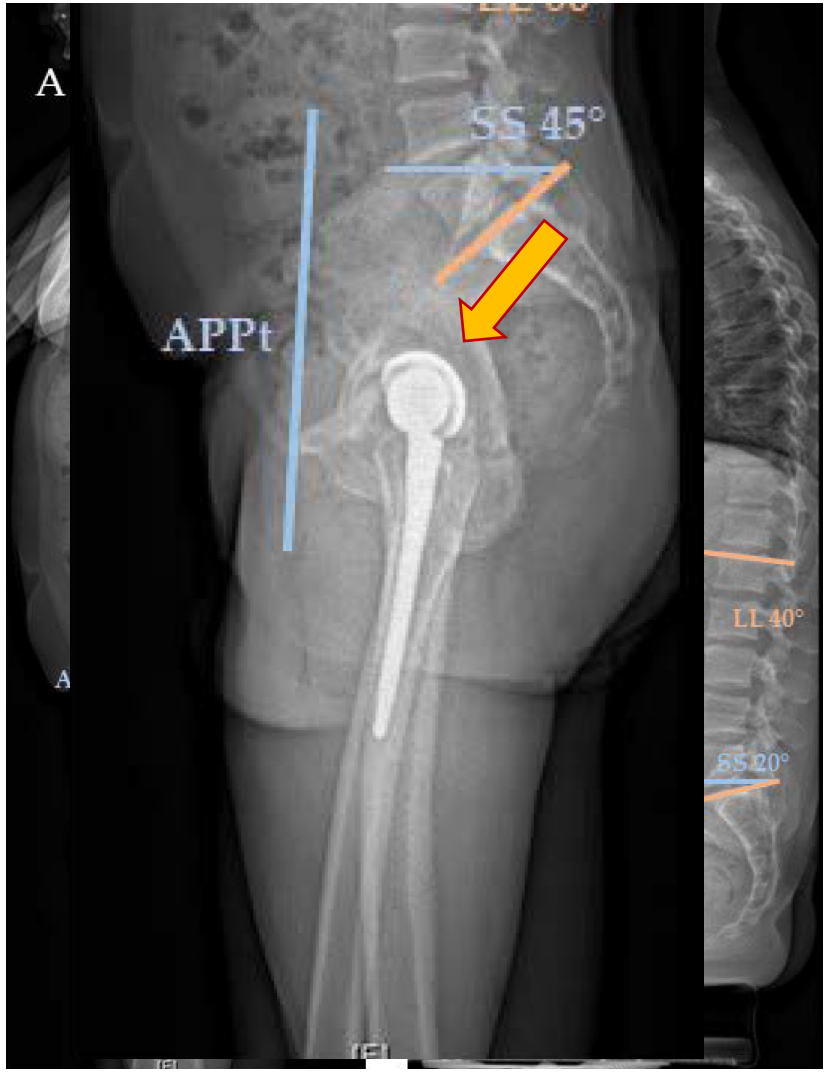
Acetabular revision strategy: biomechanics

Posterior column and load

- In a standing position the peak of load is on the posterior-superior column
- Bone grafting under high load is subject to reabsorption and could lead to implant failure
- Implant–host bone direct contact should be achieve as much as possible in this area.



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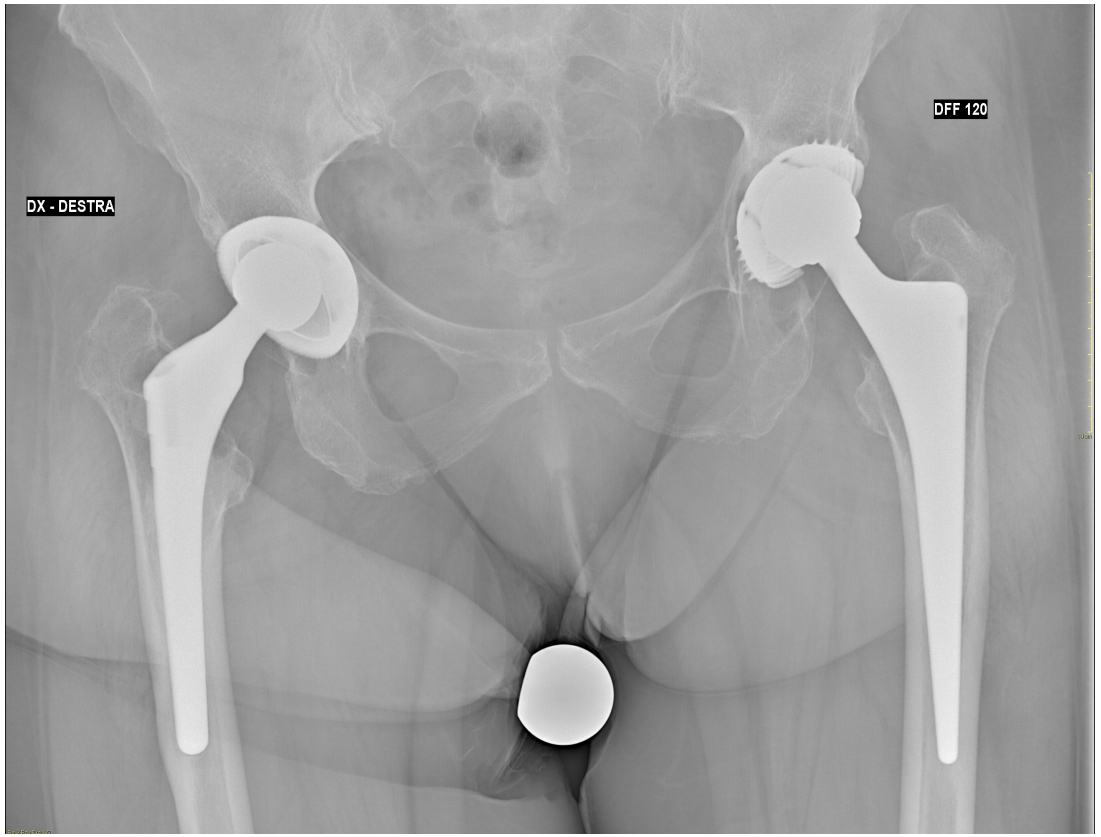
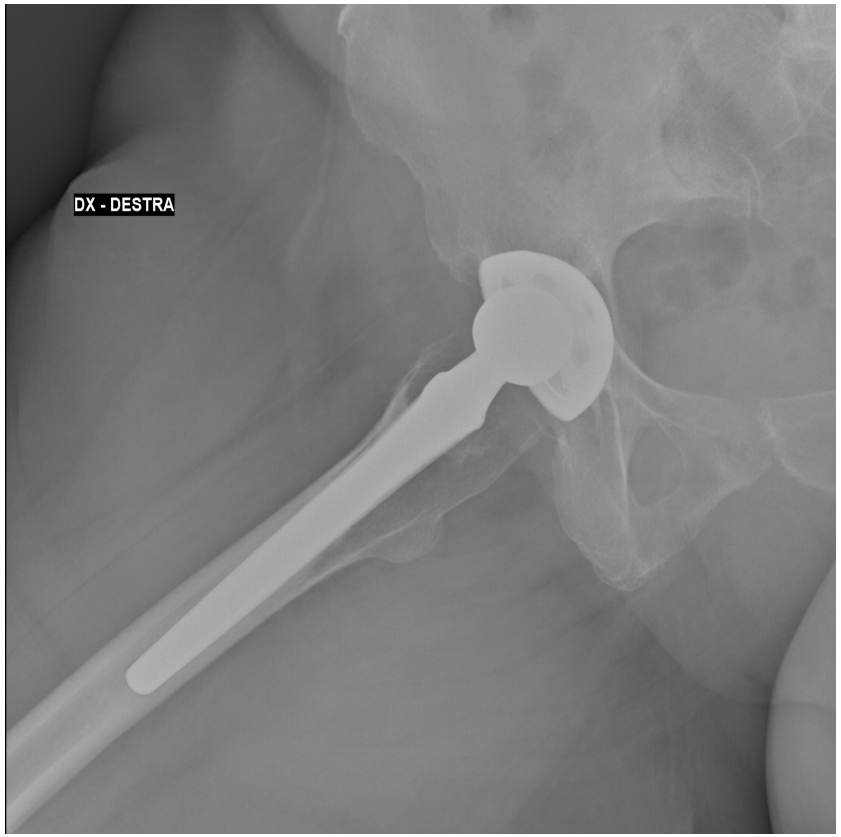
Acetabular revision surgery





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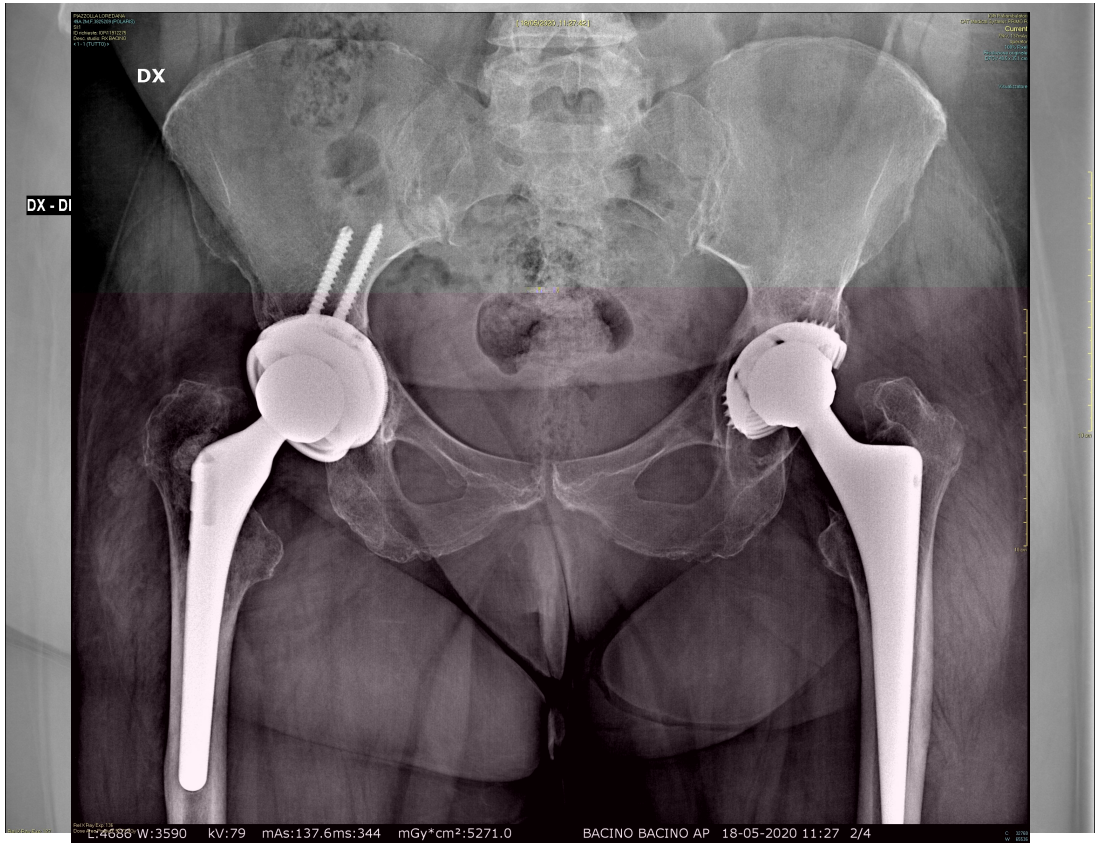
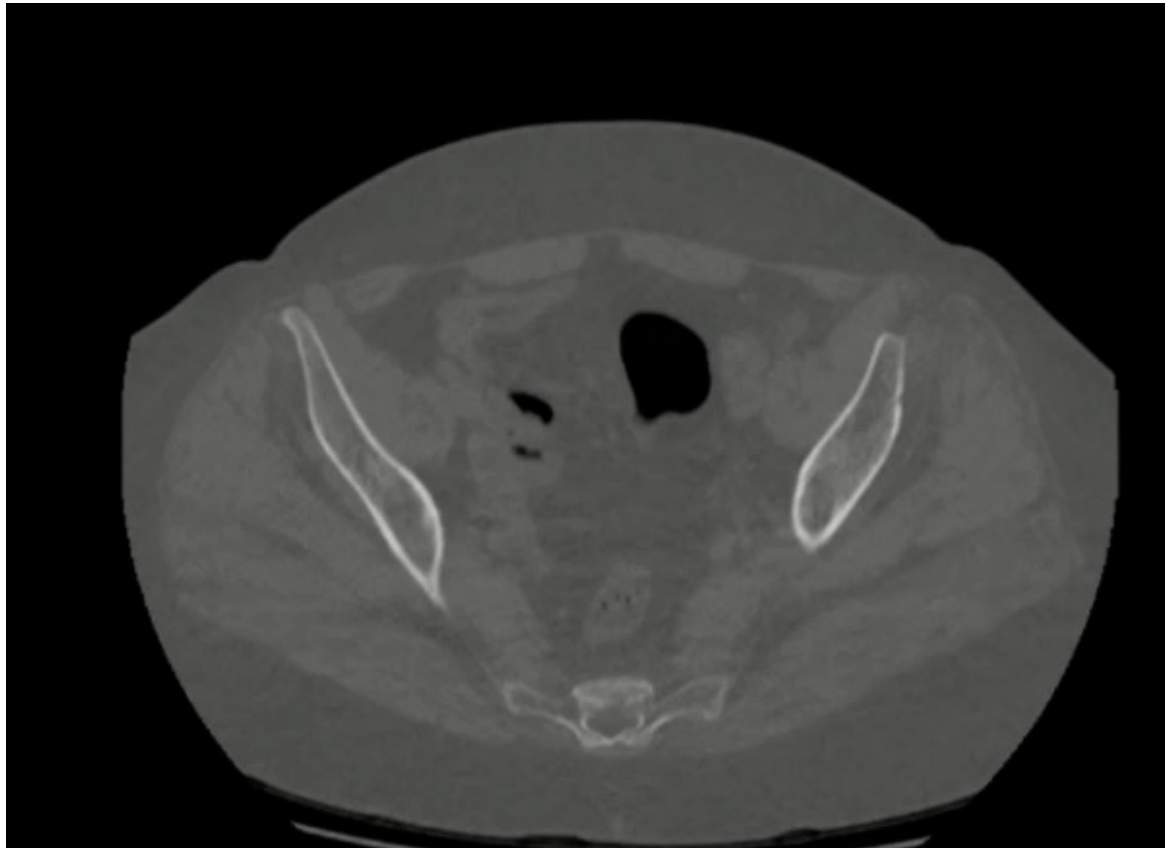
Acetabular revision surgery





Addressing acetabular bone stock is the main factor of a successful surgery

And should be done prior to surgery whenever it is possible

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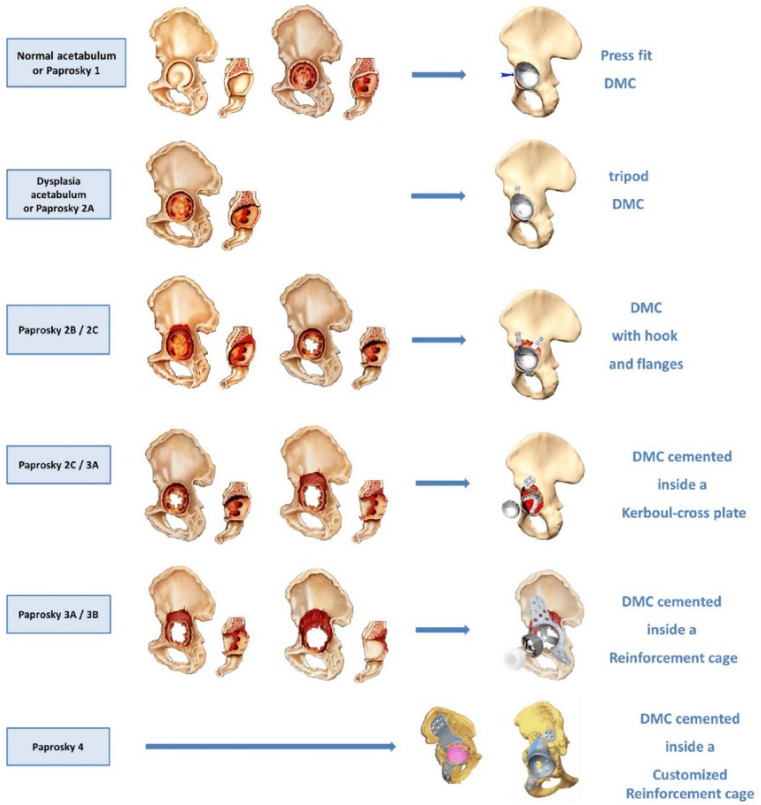
Classics: Paprosky

Addressing acetabular bone stock is the main factor for a successful surgery



- Mostly intraoperative
- Qualitative
- Requires many solutions ready to go

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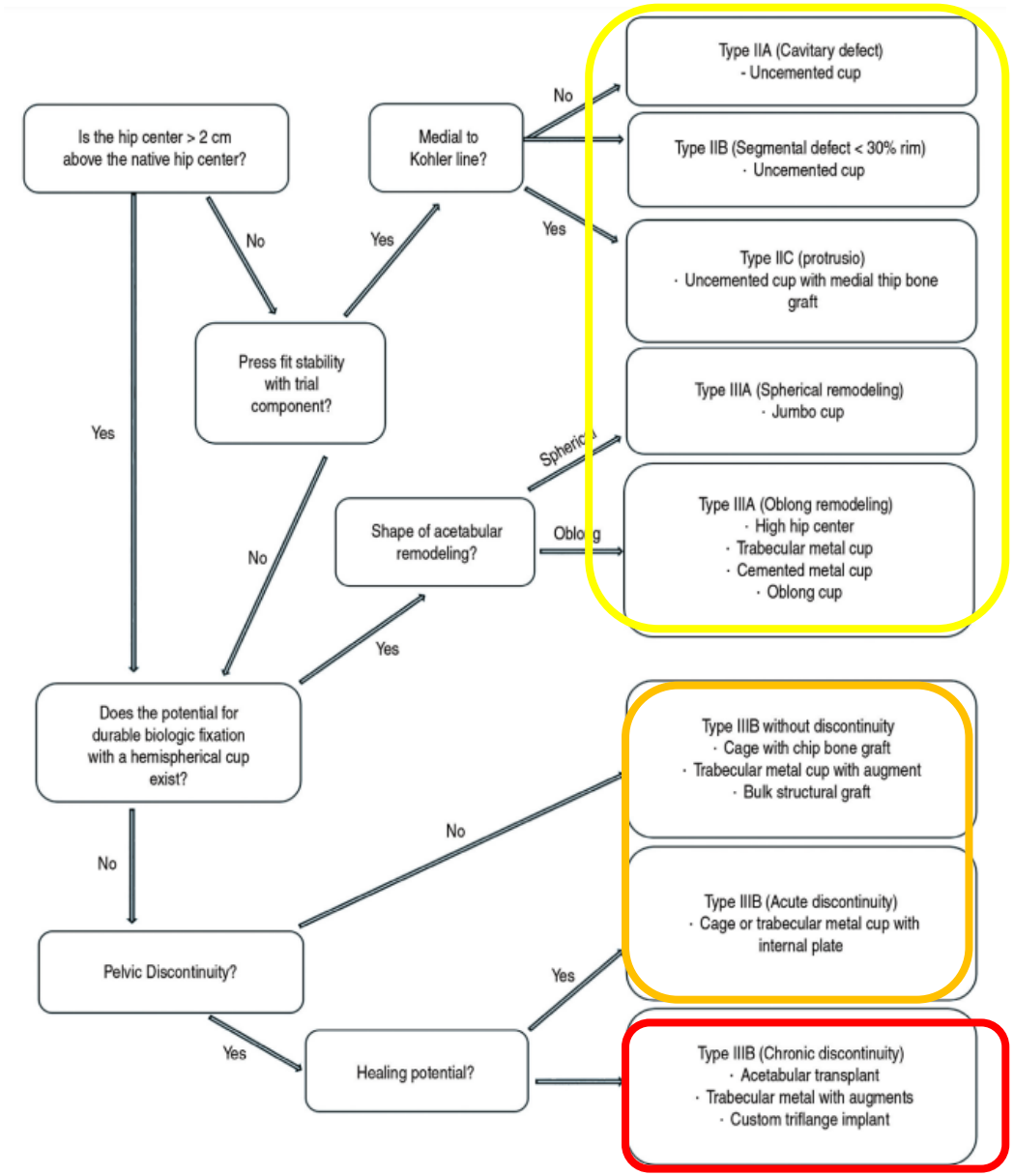
Classical indications



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New classification

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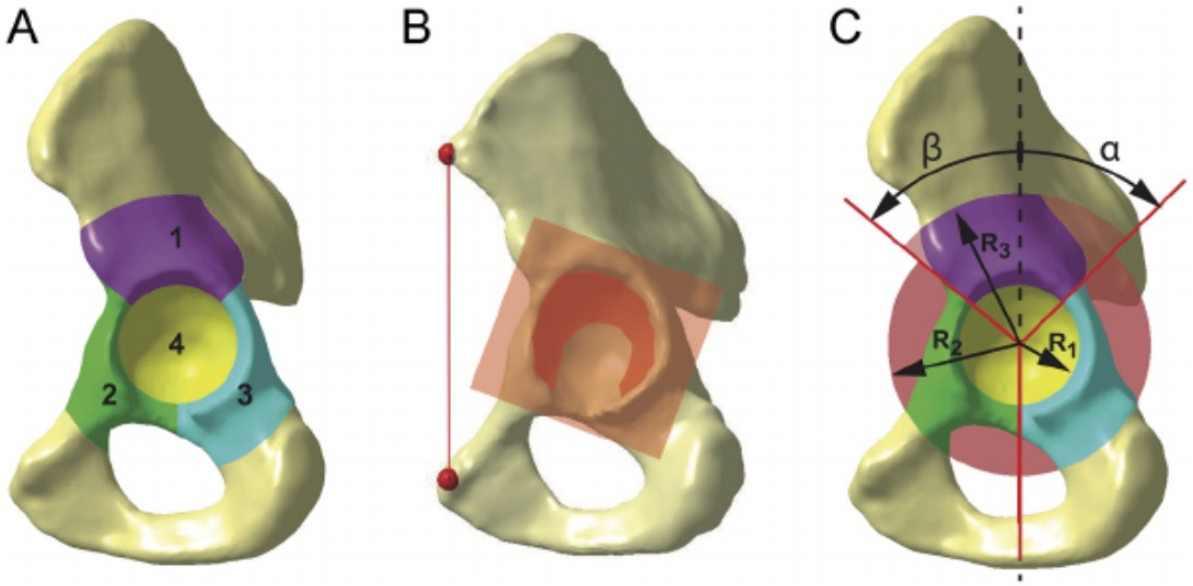
- CT based
- Quantitative
- Topographic



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New classification

PLOS ONE

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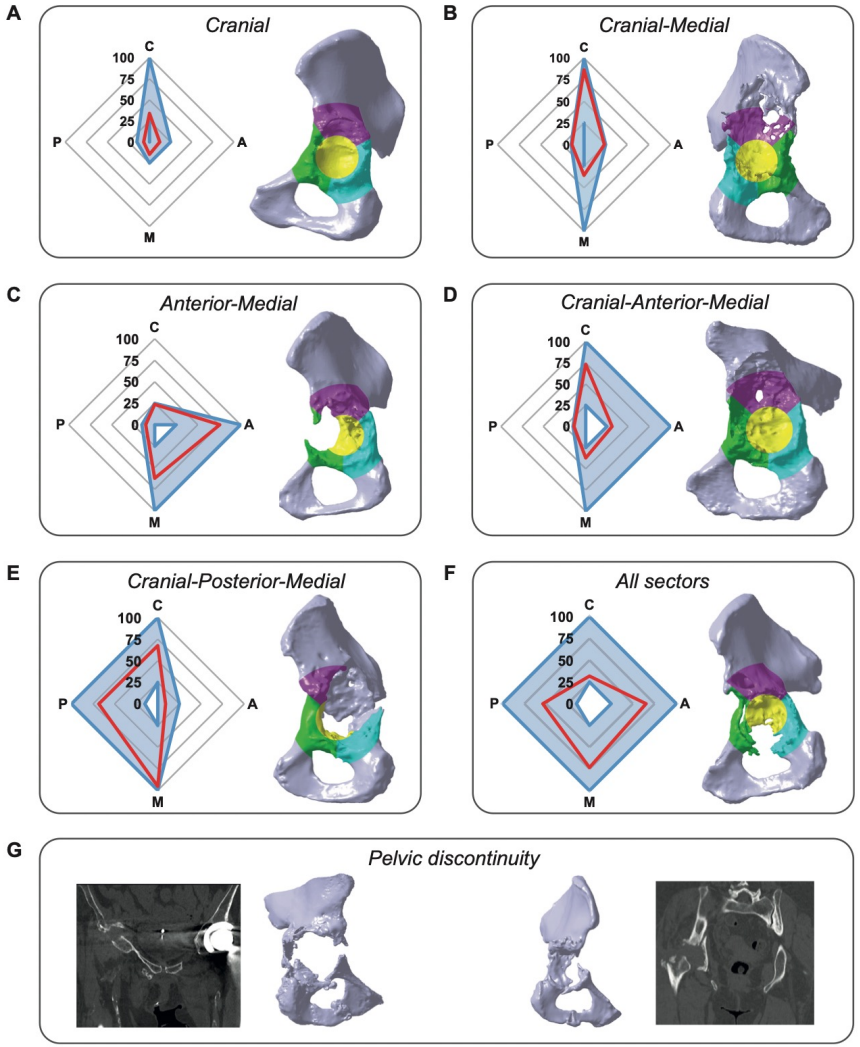

- Preoperative
- Quantitative
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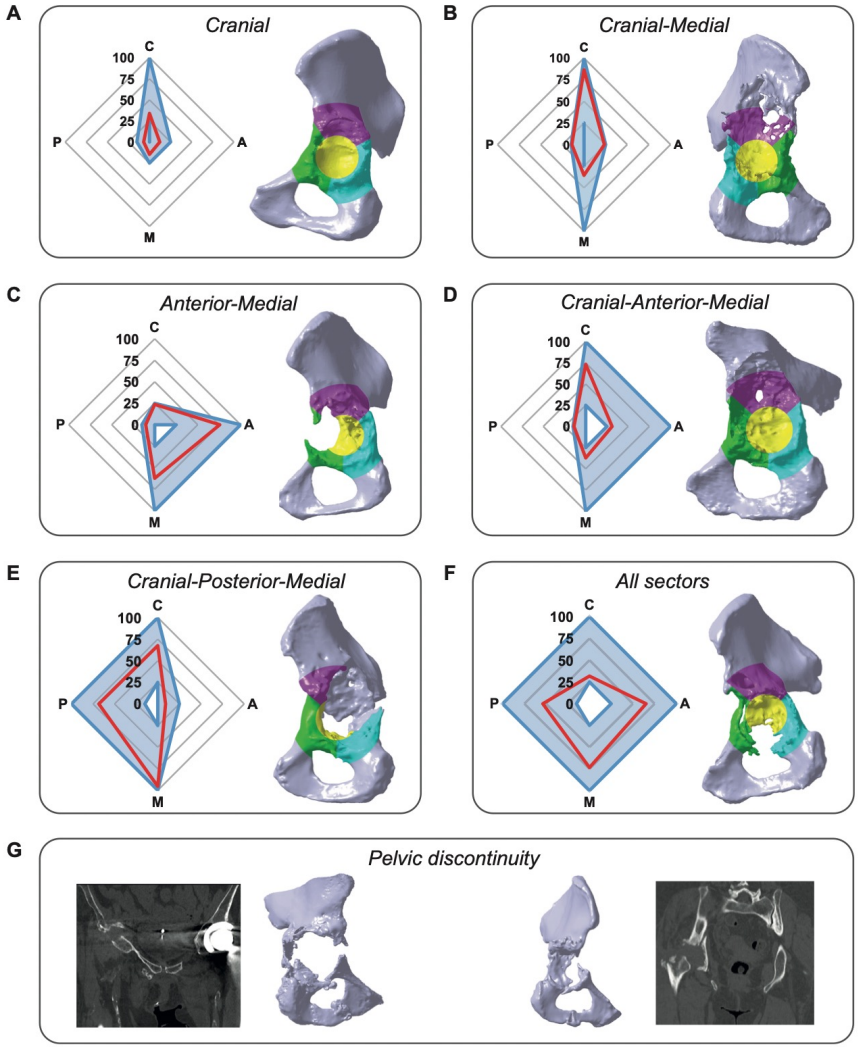
New classification

Quantitative & Topographic

Both are fundamental information to choose the better revision strategy possible



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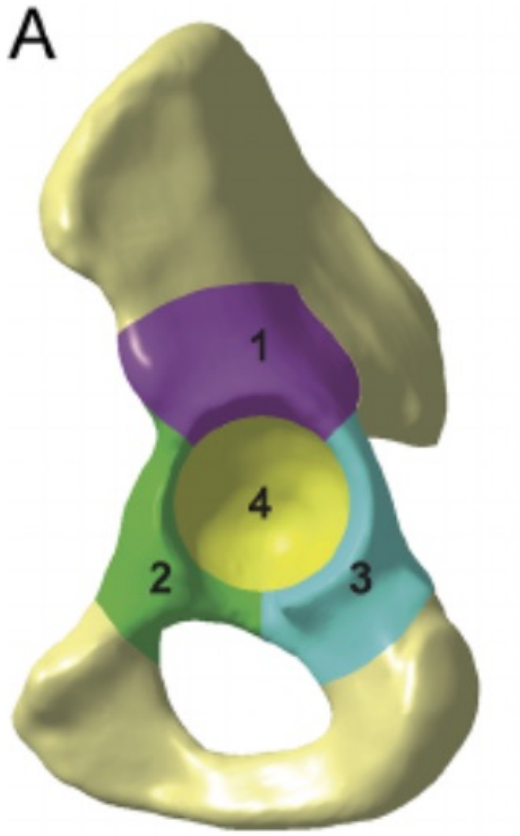
New classification

Quantitative & Topographic

- Contained or uncontained bone loss is very different
- A posterior column (3) is much more difficult to address respect an anterior (2)
- Bone grafting in the upper acetabulum (1) is very little successful since is heavily loaded if left alone



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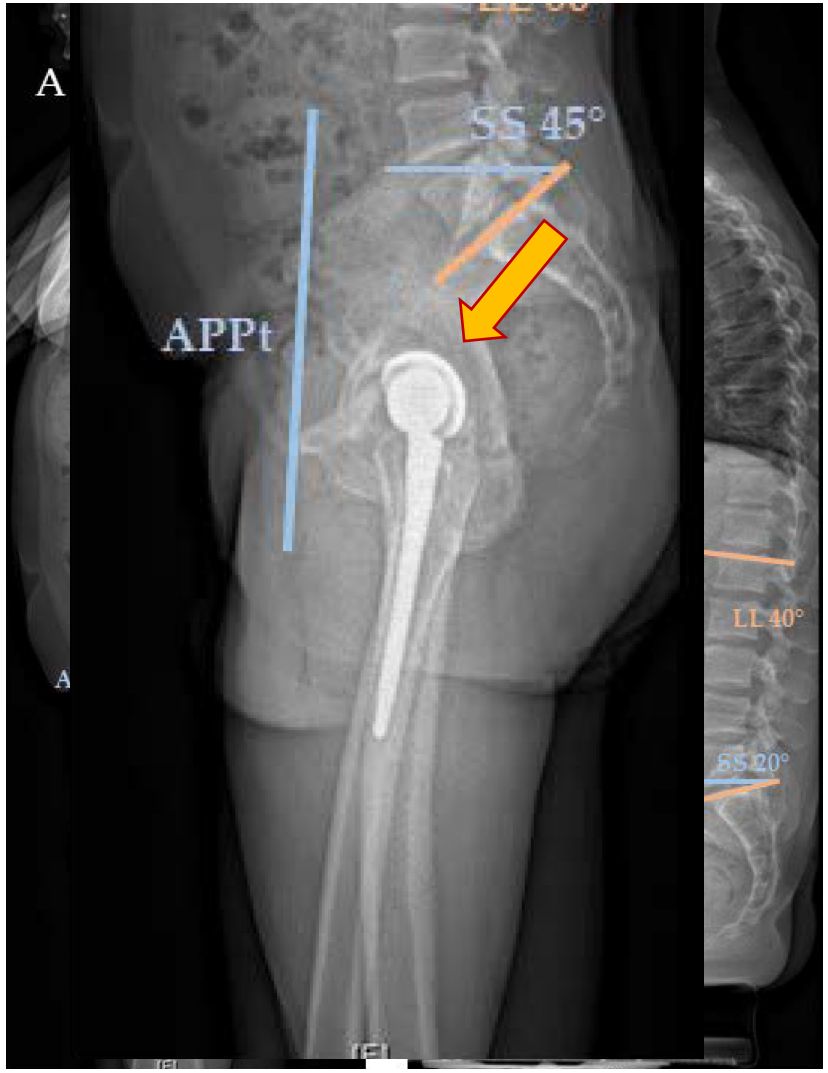

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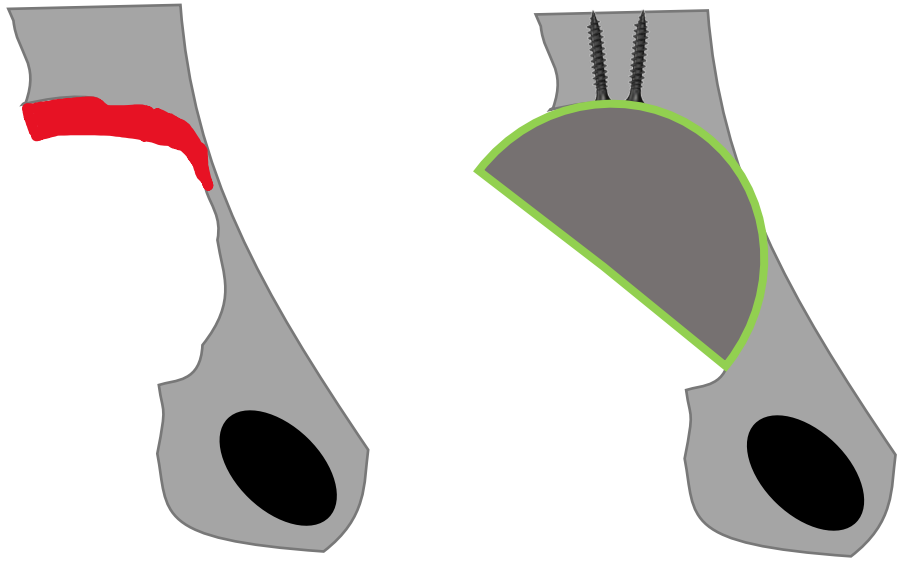
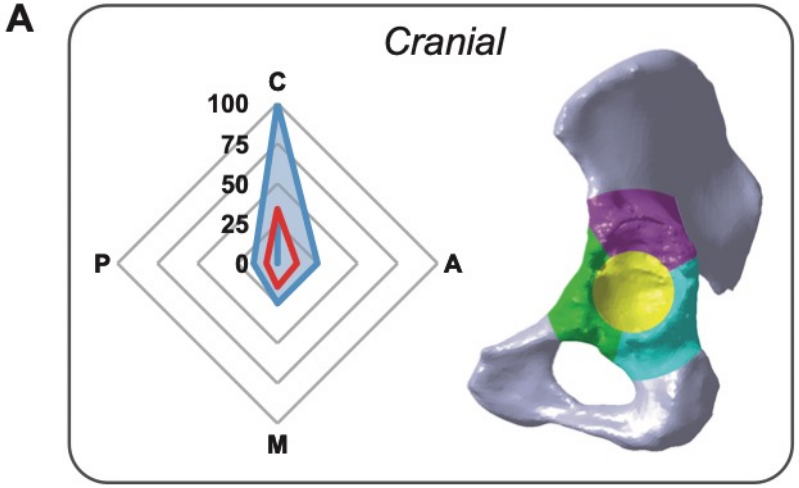
Acetabular revision with cranial bone loss

Less then 25%

- Large cup 2 screws or press fit cup





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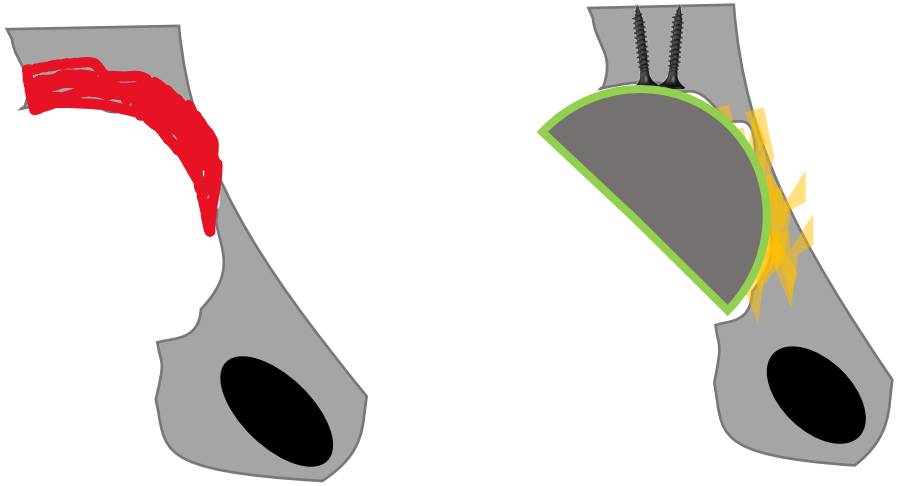
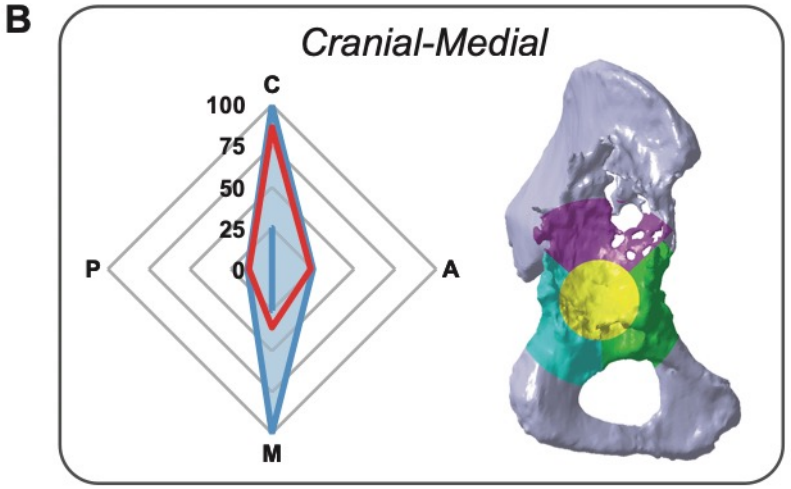
Acetabular revision with cranial-medial bone loss

Less then 25%

- Large cup 2 screws medial bone grafting





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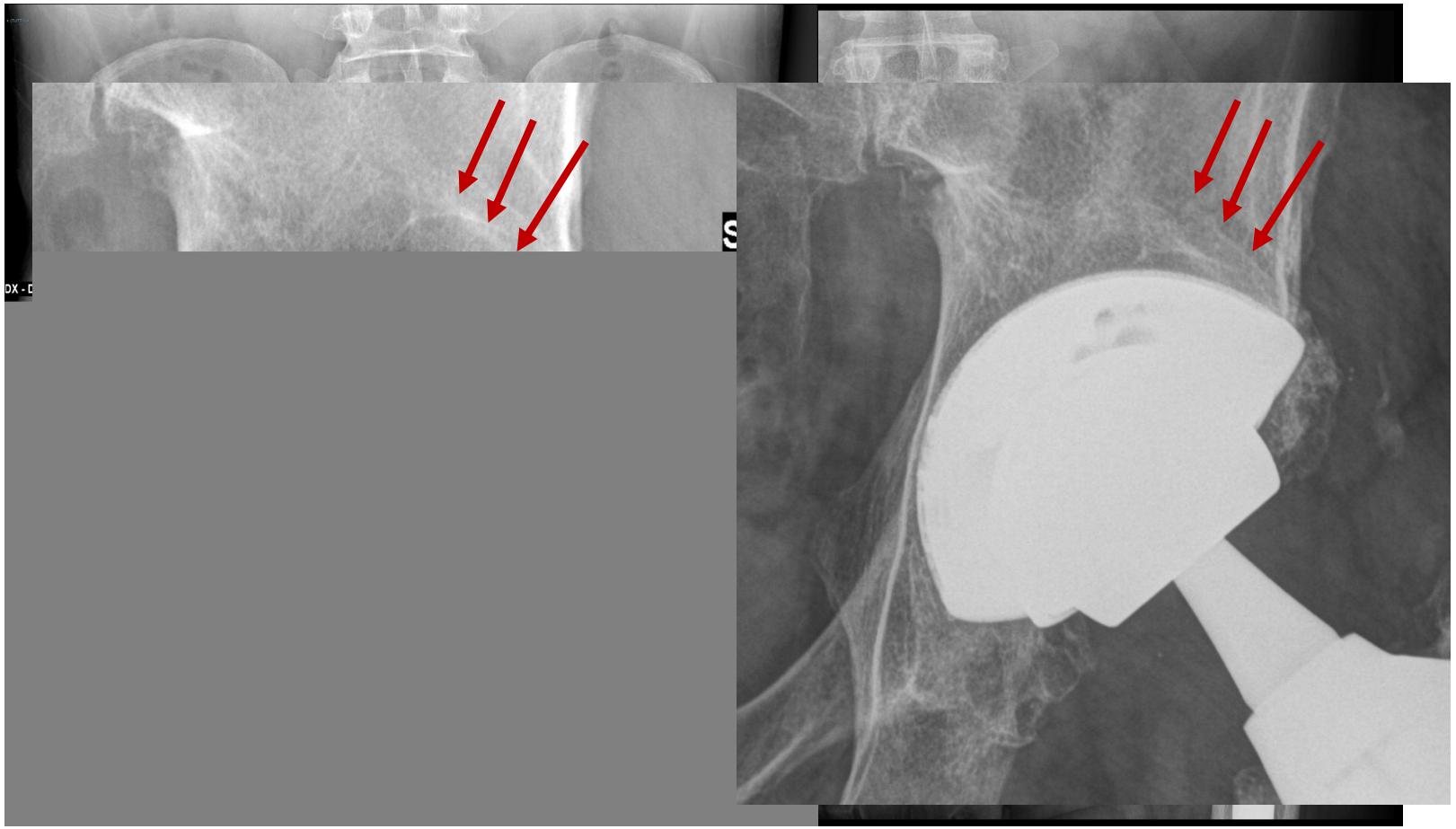
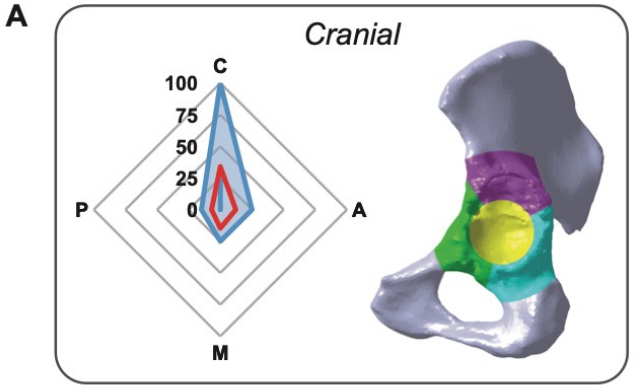
Acetabular revision with cranial bone loss





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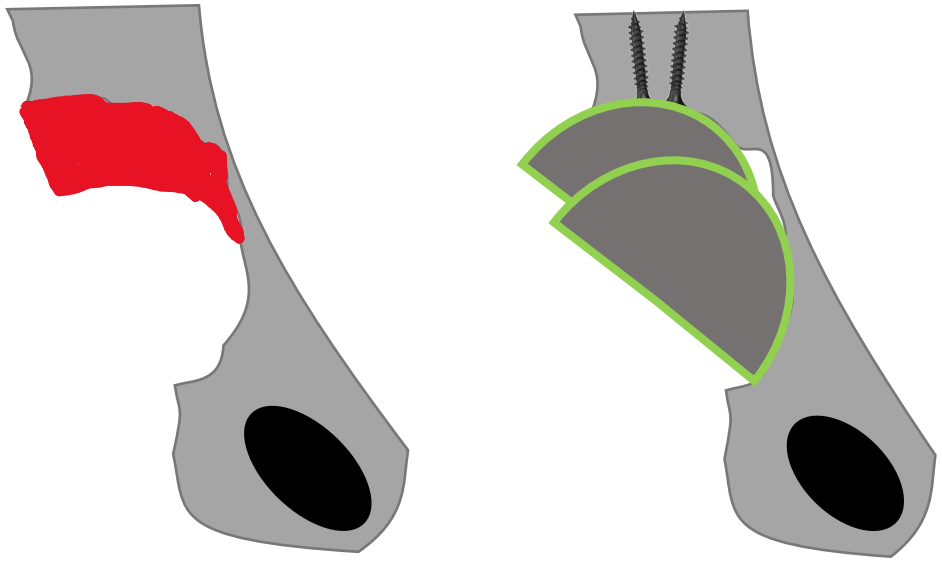
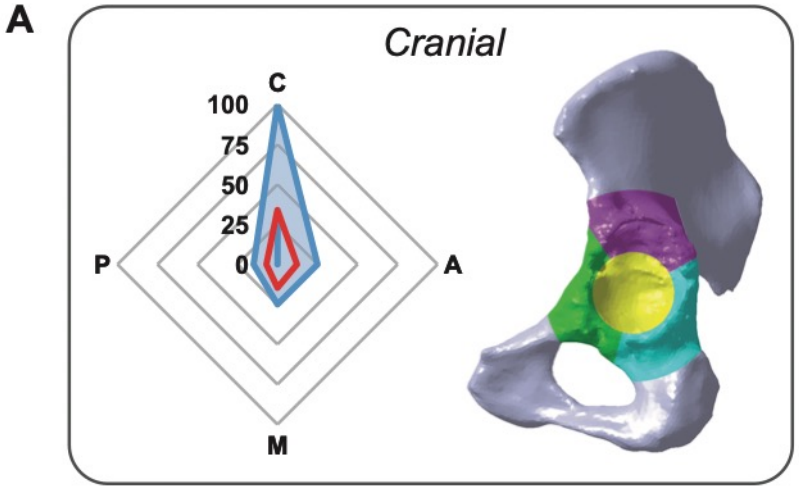
Acetabular revision with cranial bone loss

More then 25%

- Polar augmentation 2 screws





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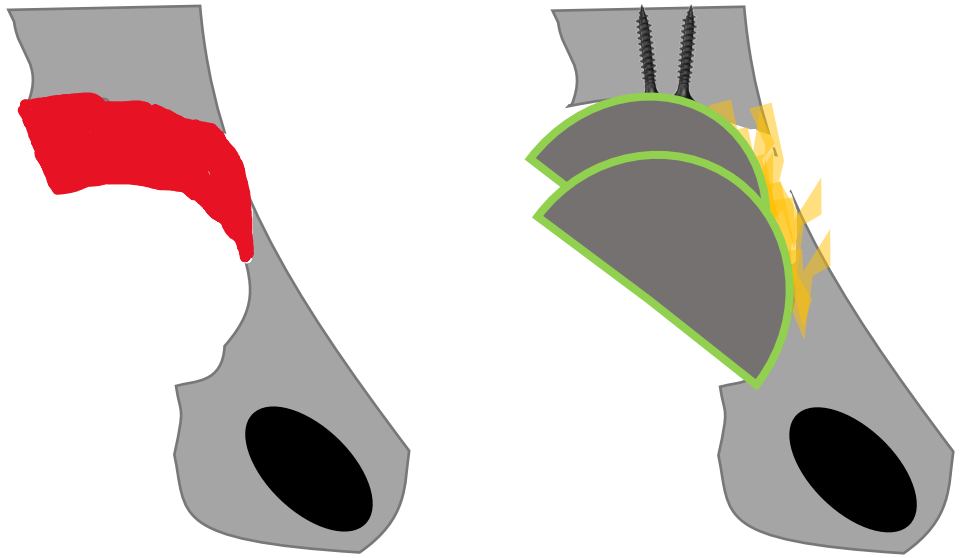
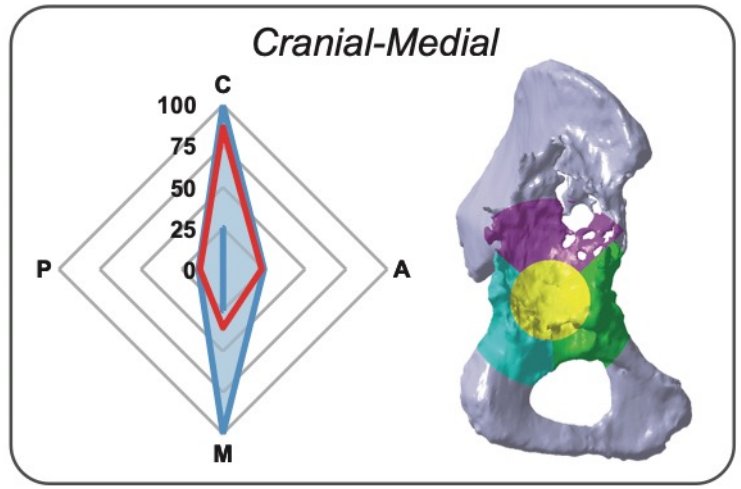
Acetabular revision with cranial-medial bone loss

More then 25%

- Polar augmentation 2 screws medial bone grafting





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Modular implant/augment

SYSTEMATIC REVIEW AND META-ANALYSIS | VOLUME 38, ISSUE 2, P389-396.E1, FEBRUARY 2023

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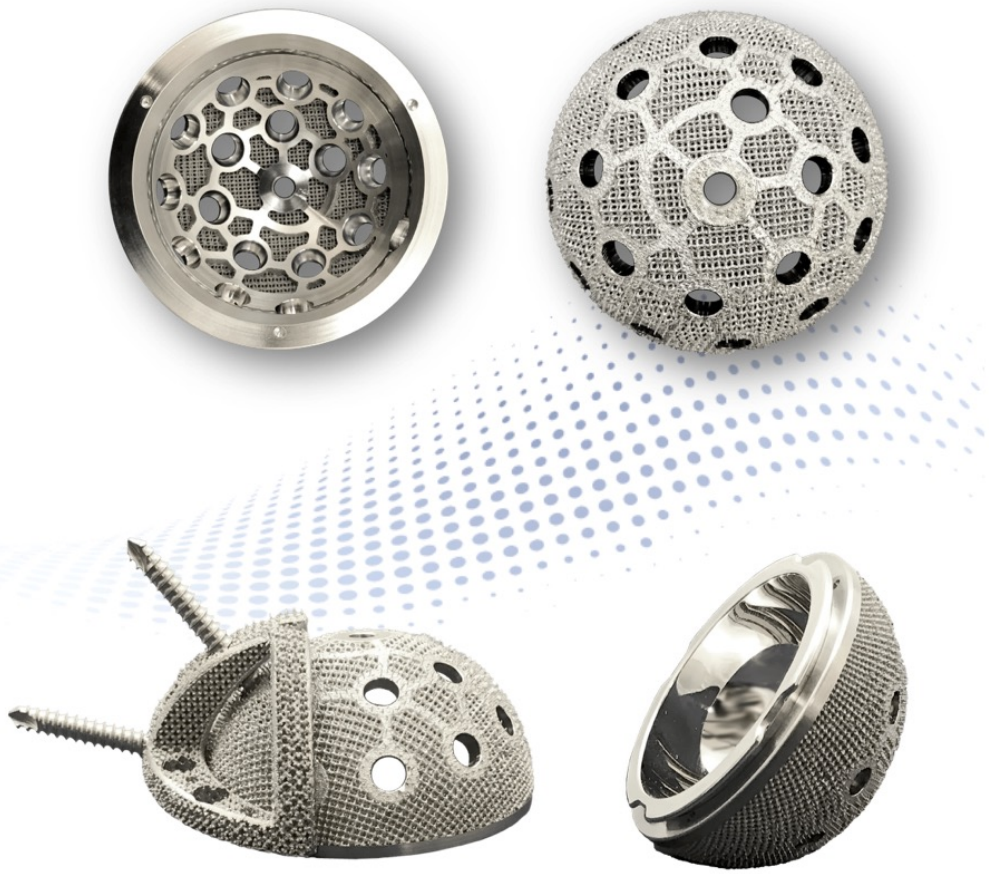
Metal Augments Used in Revision Hip Arthroplasty: A Systematic Review and Single-Arm Meta-Analysis

Chenao Xiong, MD • Dexuan Meng, MD • Renhua Ni, MD • Hong Cai, MD

Published: August 11, 2022 • DOI: https://doi.org/10.1016/j.arth.2022.08.010 • Check for updates



- BETTER BIOMECHANICAL RECONSTRUCTION
- COR RESTORATION
- OFFSET RESTORATION,
- BETTER CUP-CUP MATCH --> PARTICULARLY IN PARPROSKY 3 DEFECTS

- CEMENTED OR UNCEMENTED AUGMENTS

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Istituto Ortopedico Rizzoli
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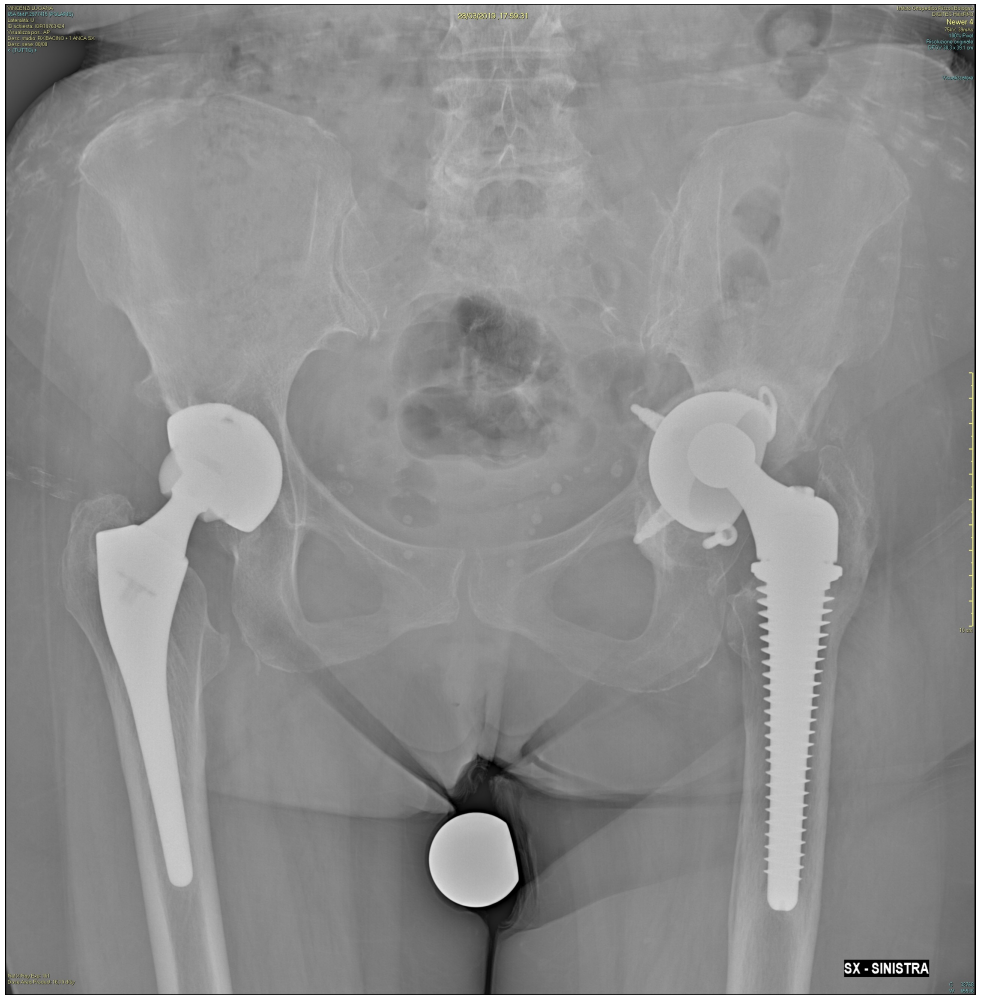
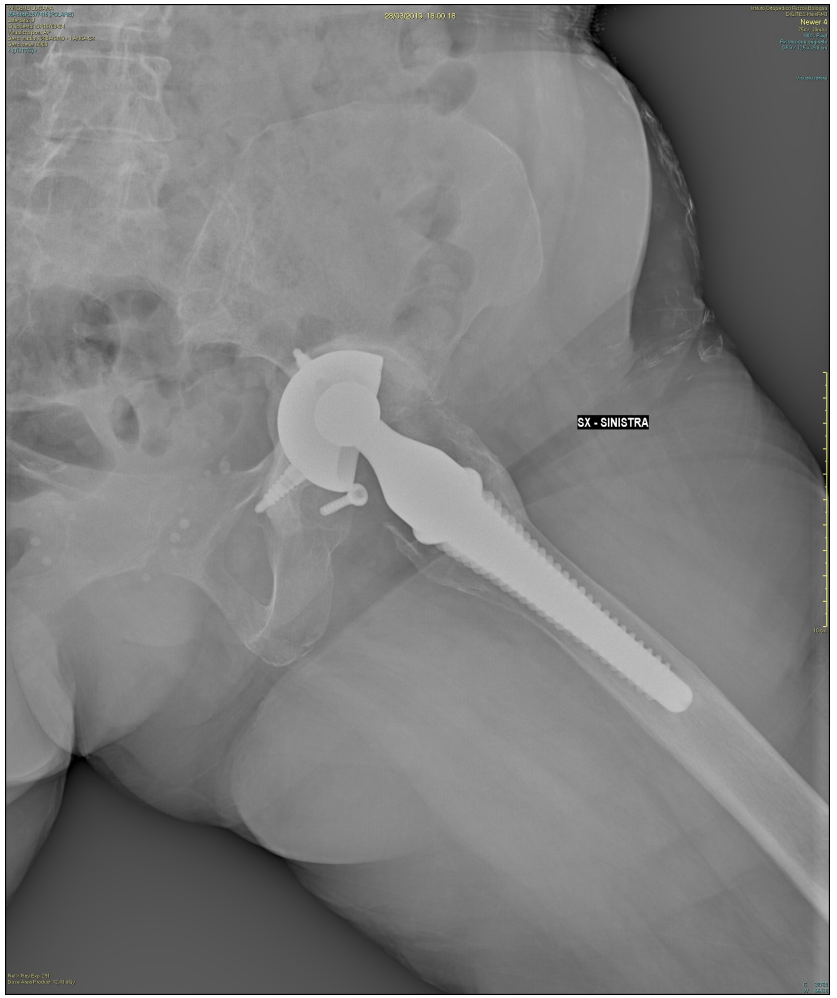
Acetabular revision with cranial-medial bone loss





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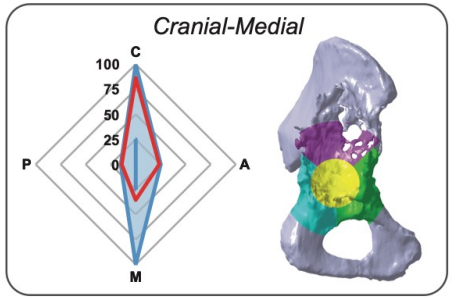

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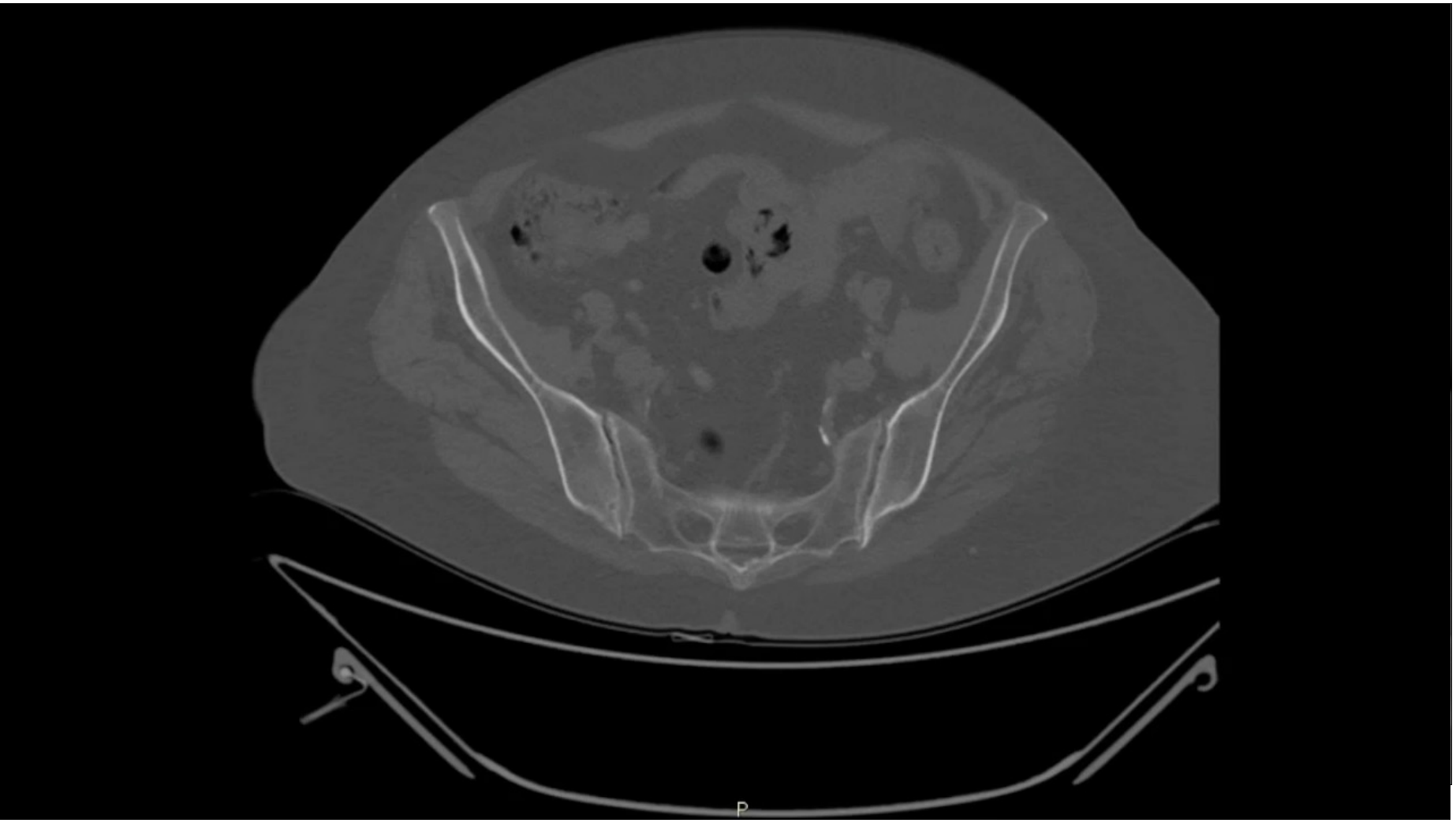
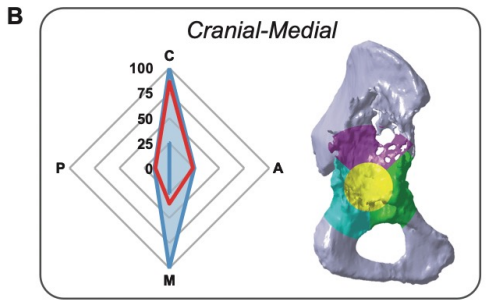
Acetabular revision with cranial-medial bone loss





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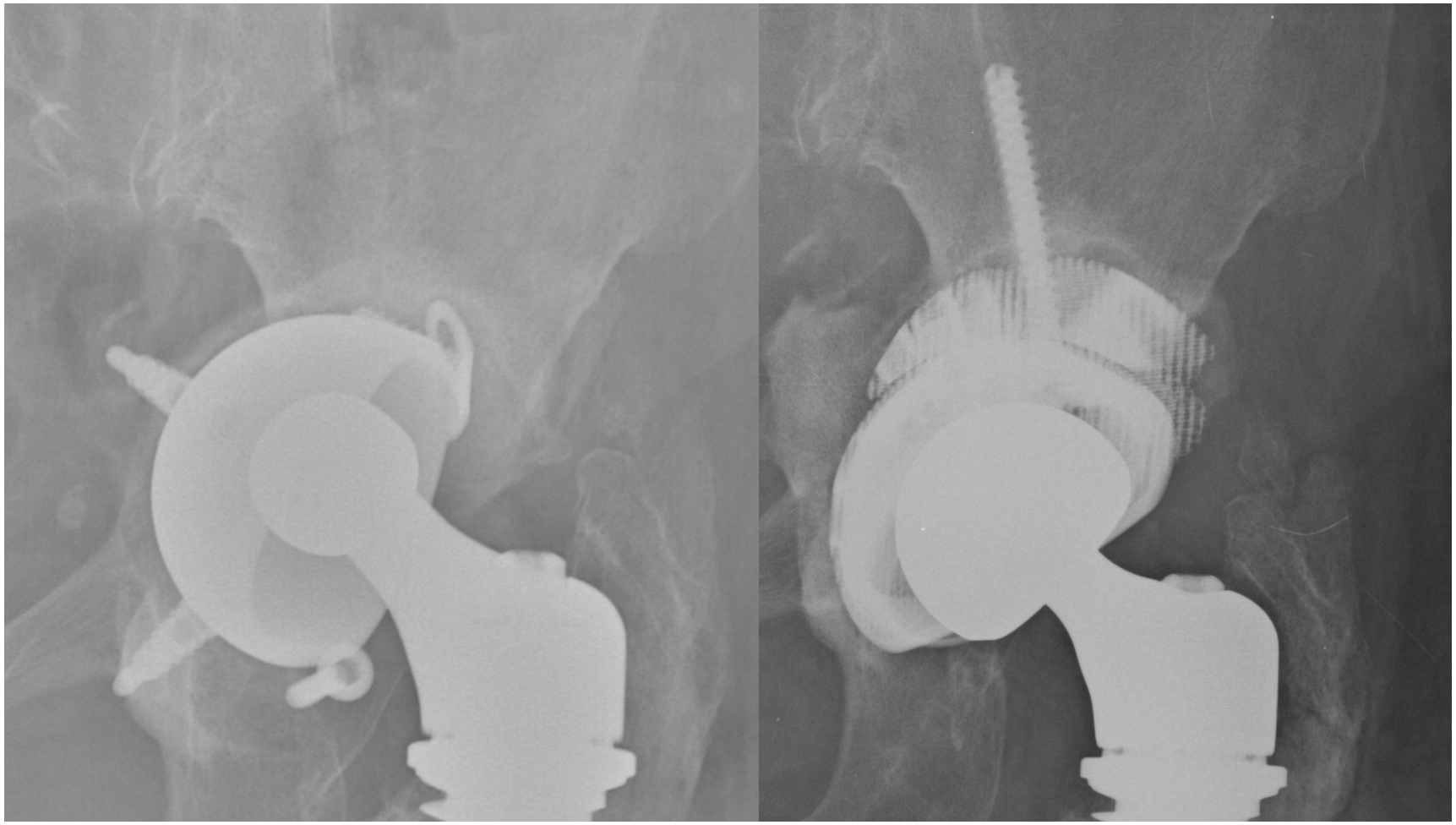

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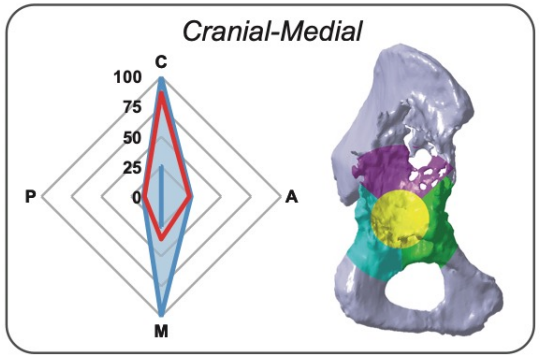

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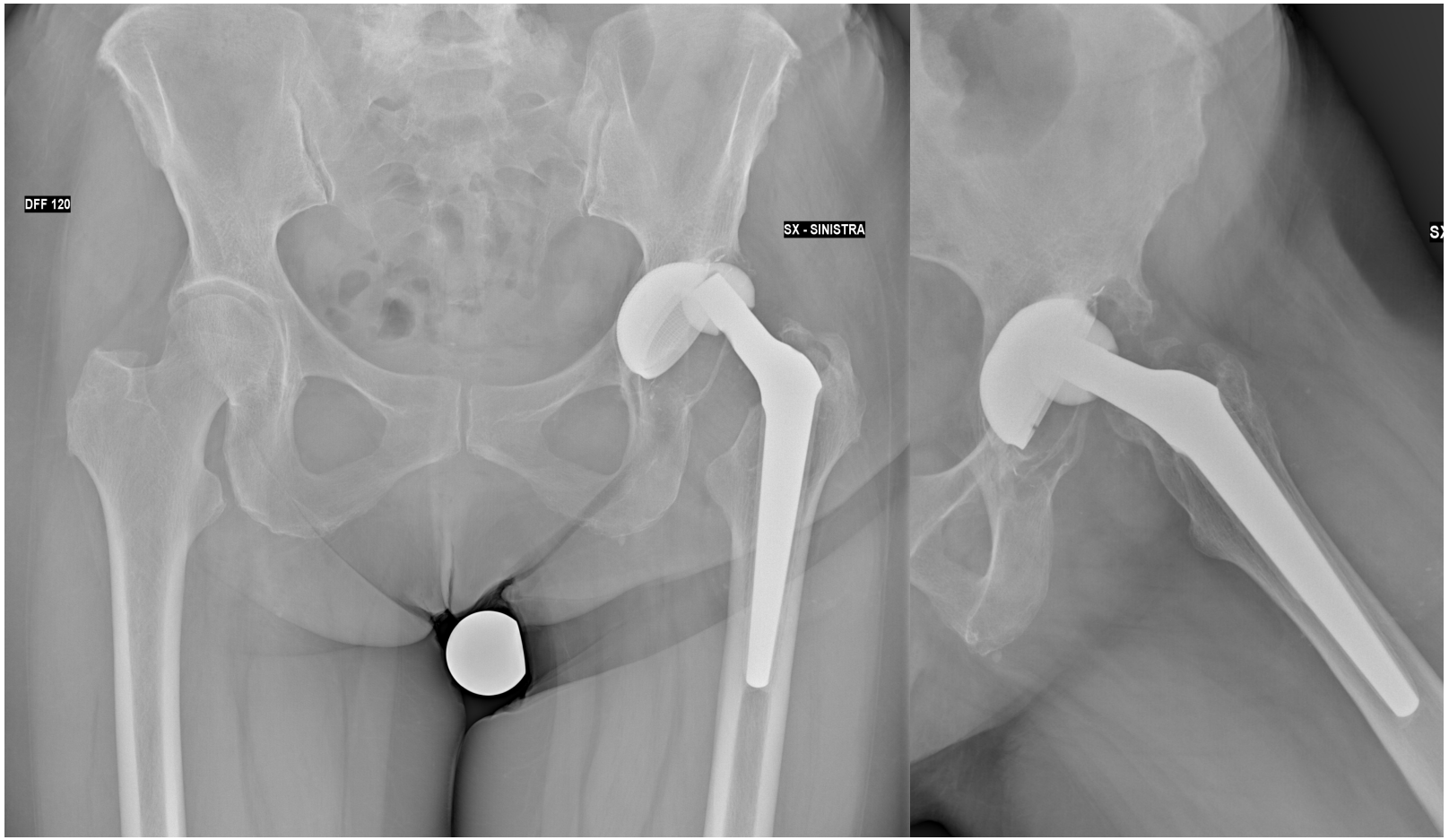

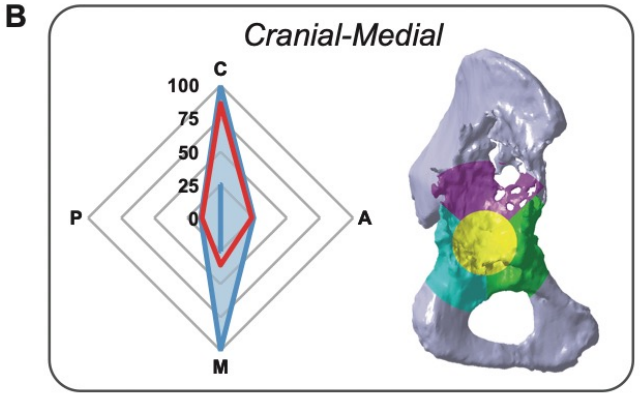

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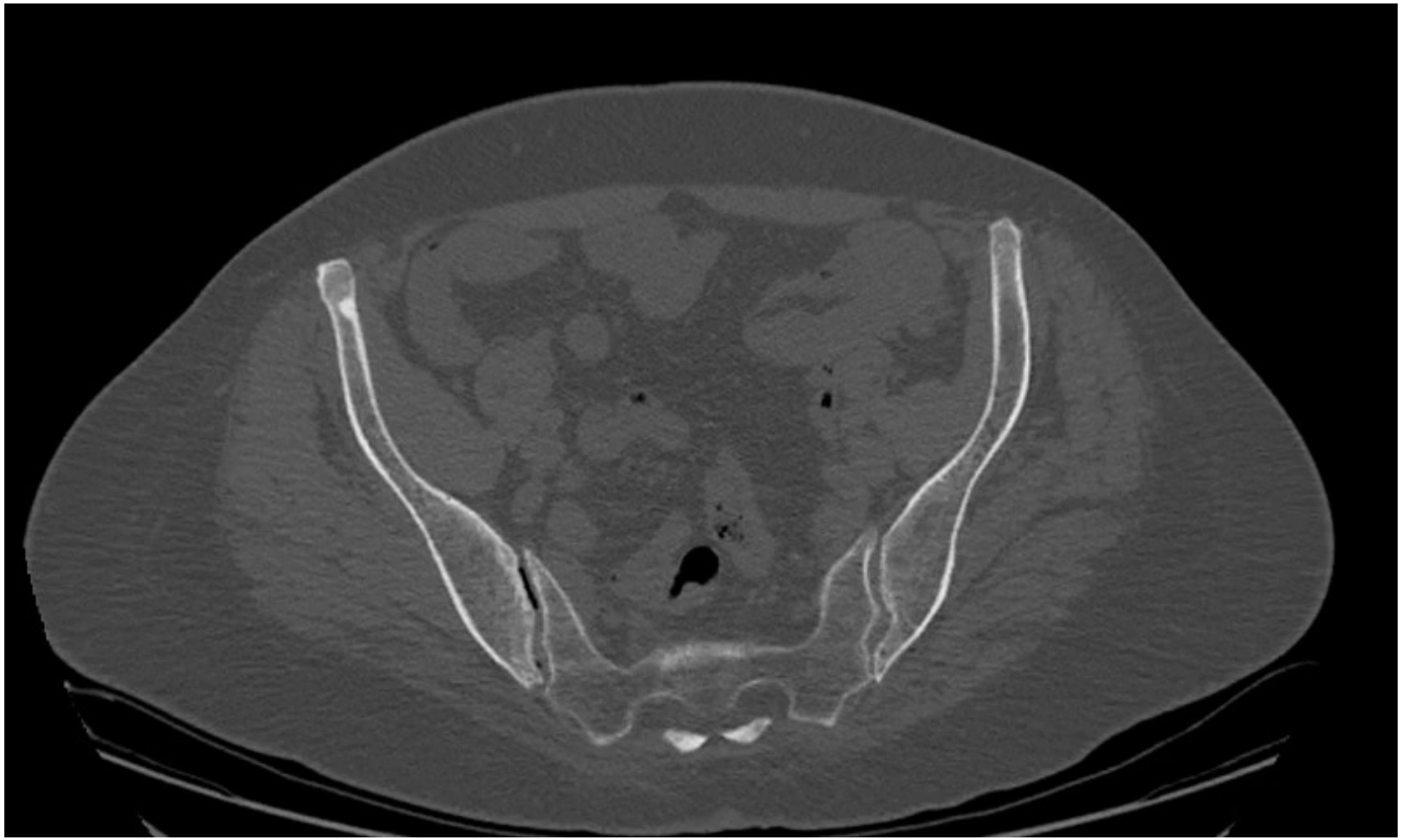

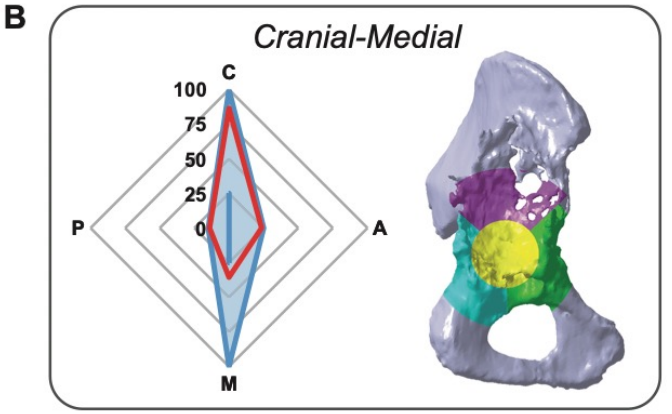

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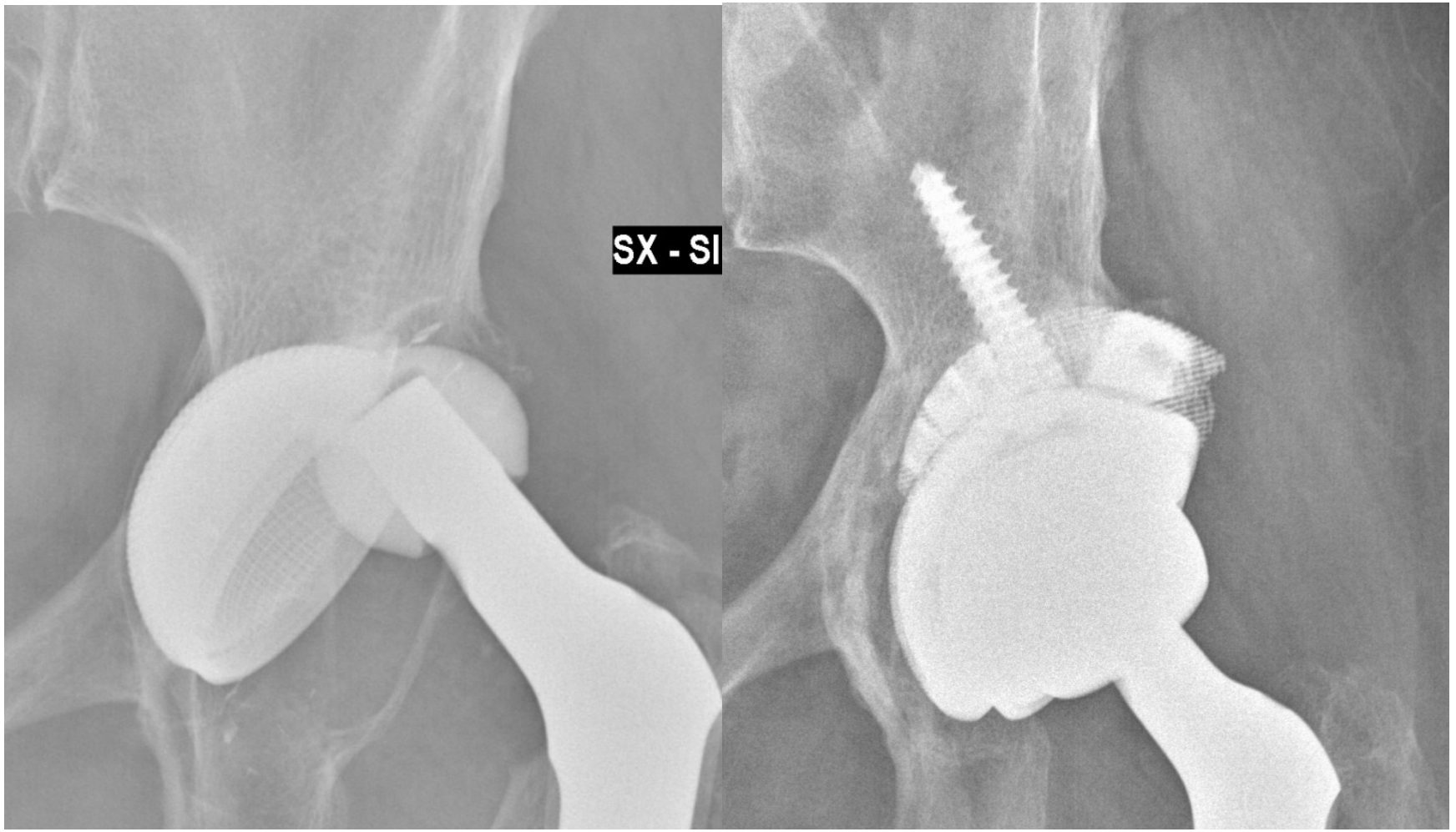

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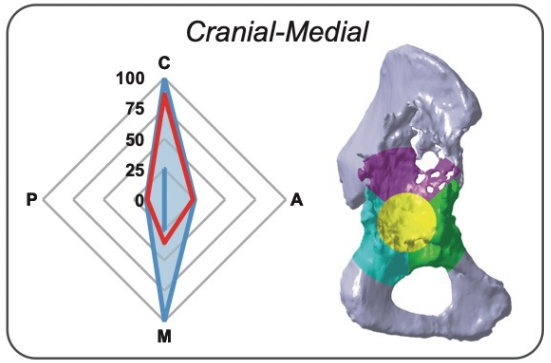

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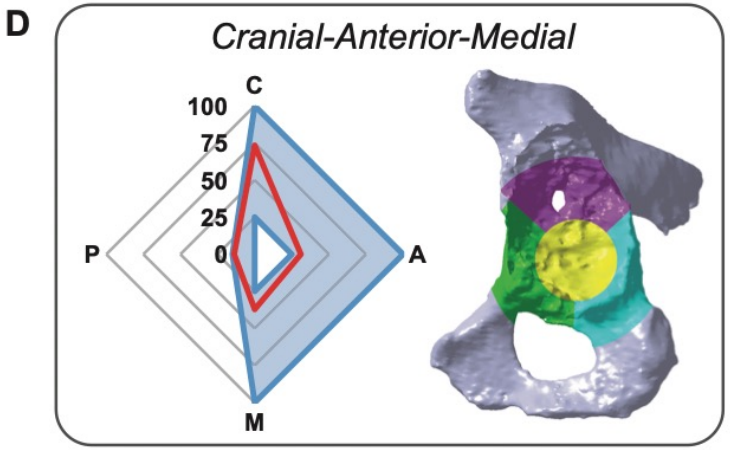
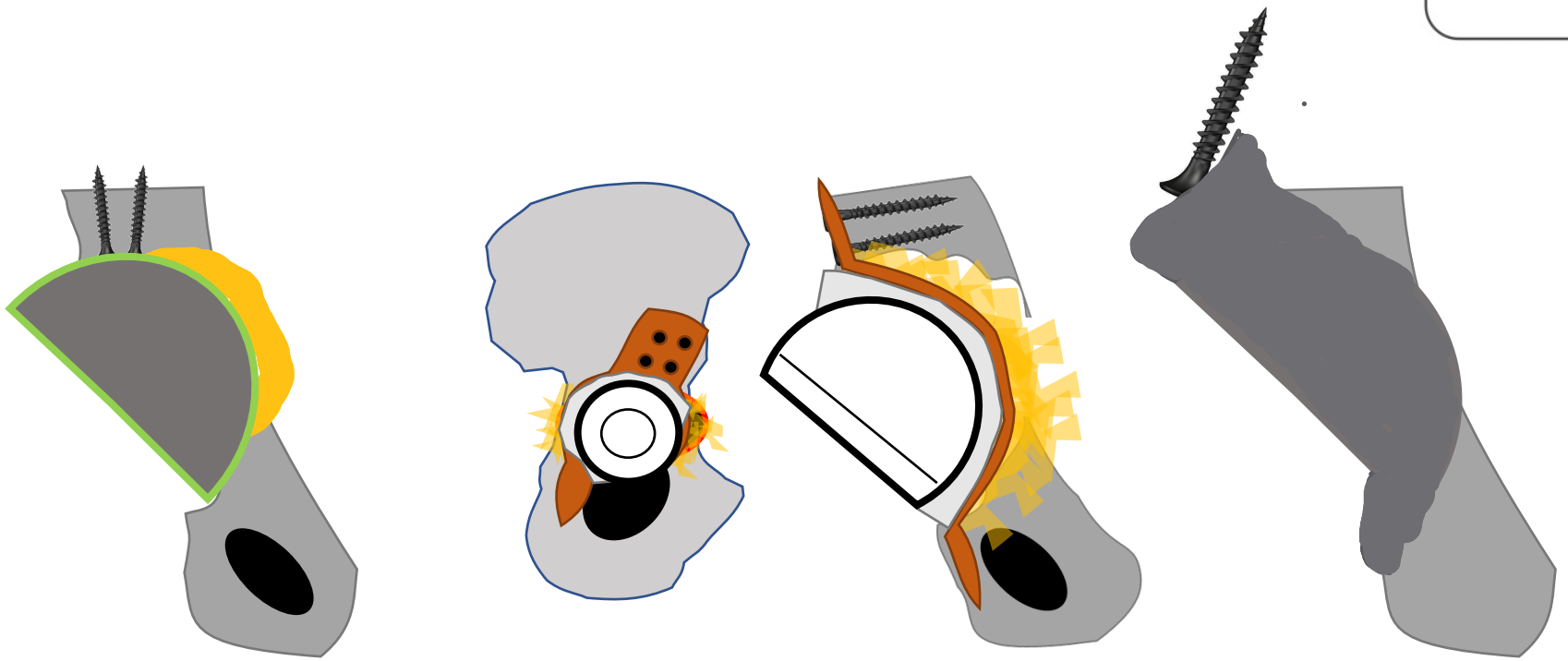
Acetabular revision with cranial-anterior-medial bone loss

- Large cup 2 screws medial and anterior bone grafting, massive bone graft
- Cage grafting cemented cup
- Custom made





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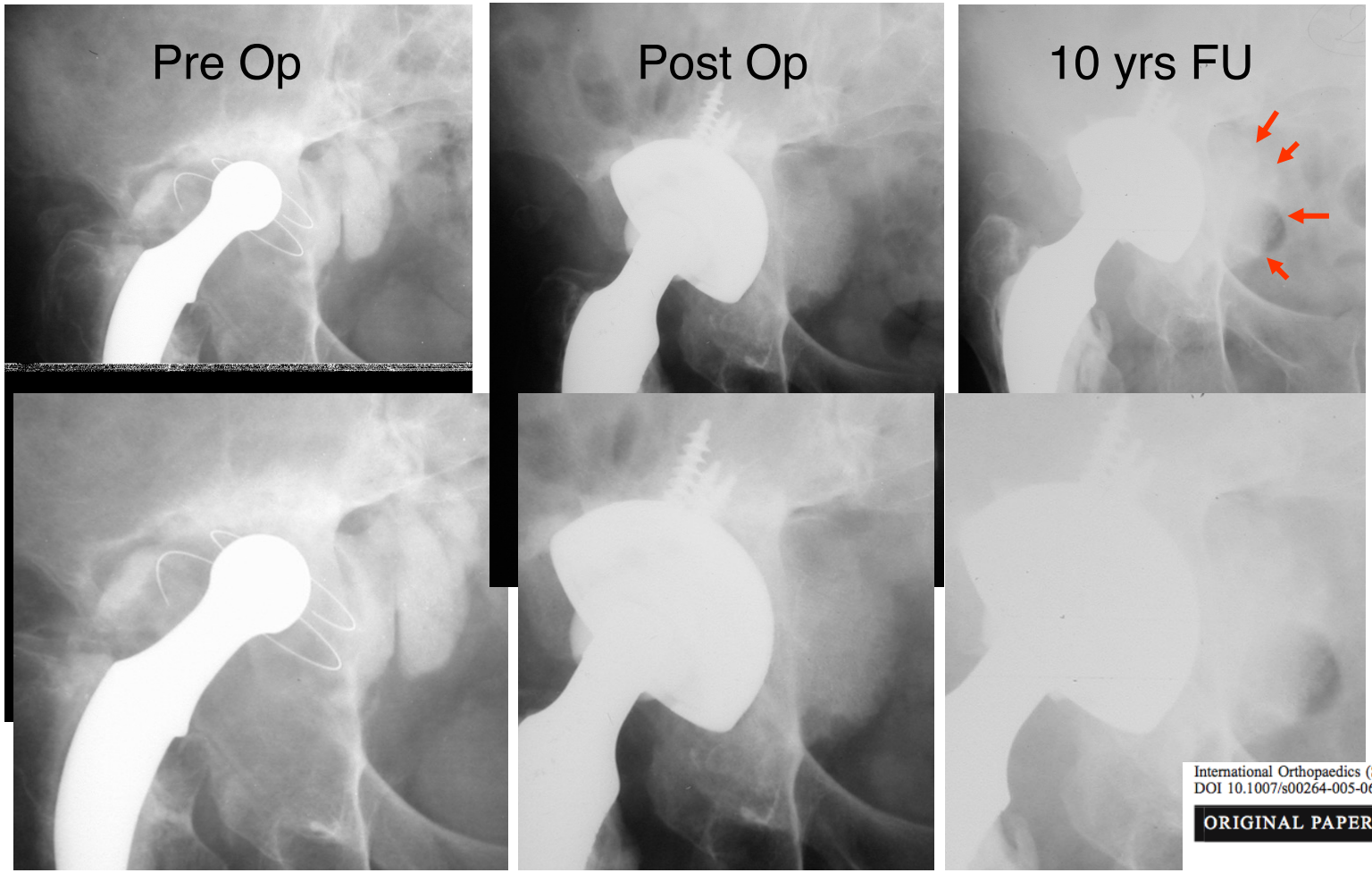
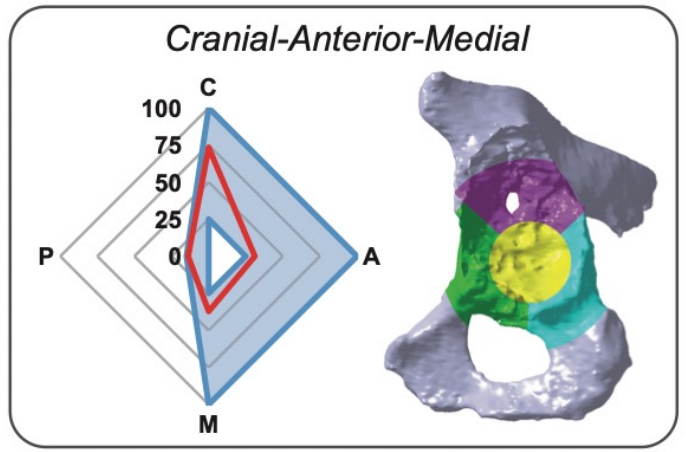
Acetabular revision with cranial-anterior-medial bone loss





International Orthopaedics (SICOT) (2005) 29: 135–139
DOI 10.1007/s00264-005-0640-z

ORIGINAL PAPER

F. Traina · F. Giardina · M. De Clerico · A. Toni

Structural allograft and primary press-fit cup for severe acetabular deficiency

A minimum 6-year follow-up study

Prof. Francesco Traina
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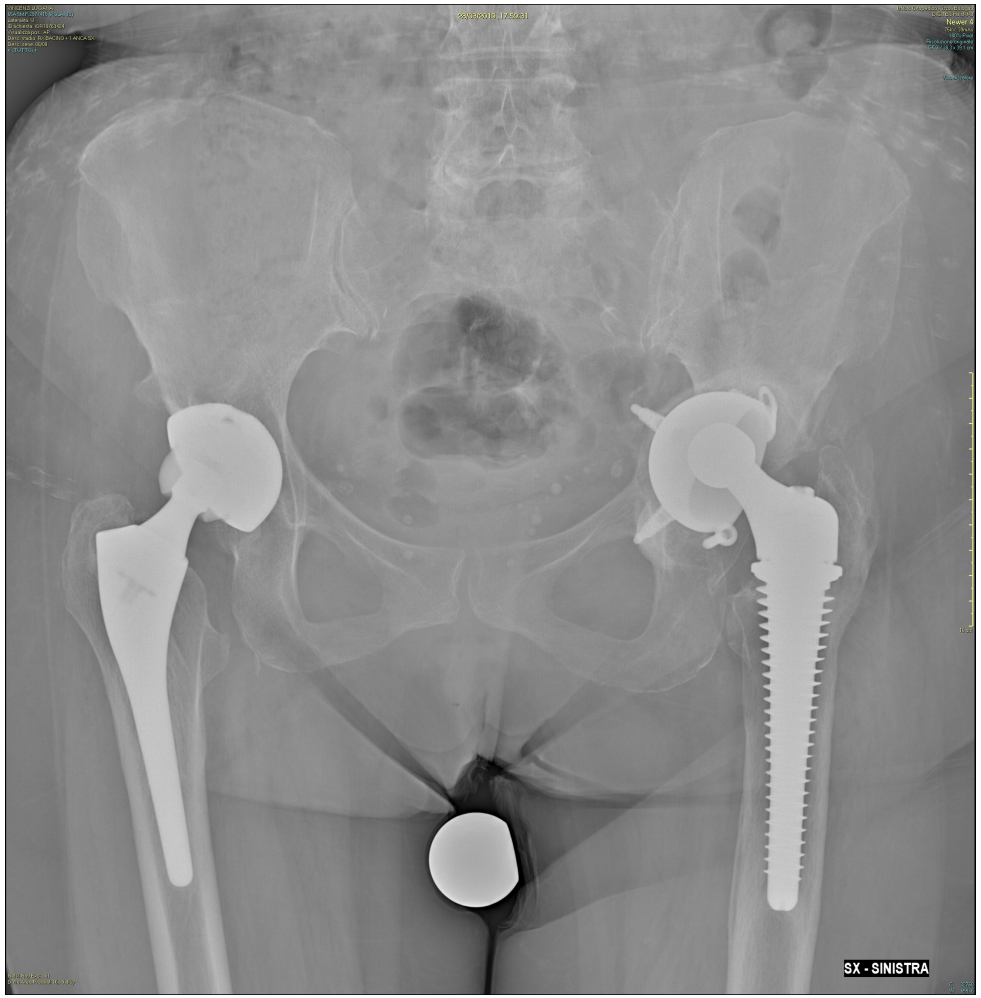
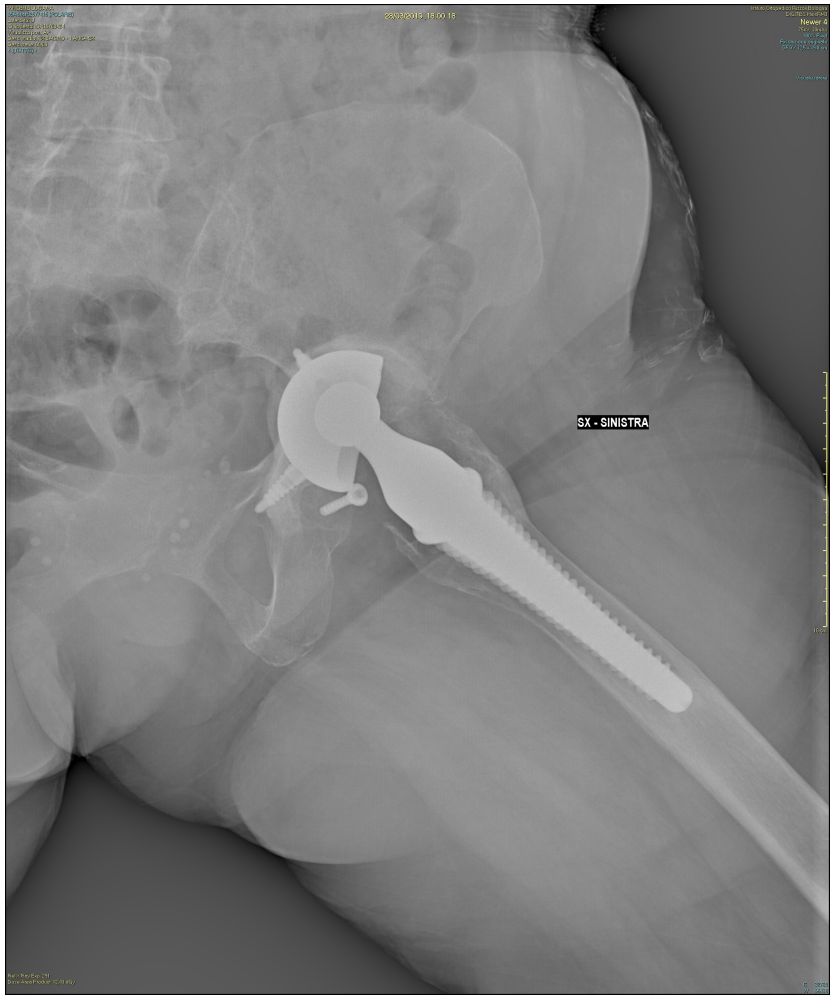
Università di Bologna

Acetabular revision with cranial-anterior-medial bone loss





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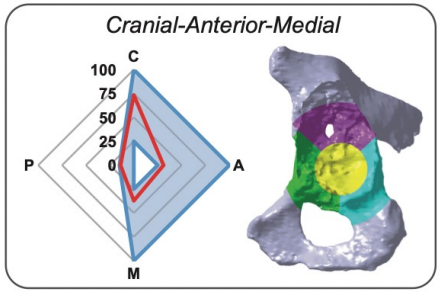

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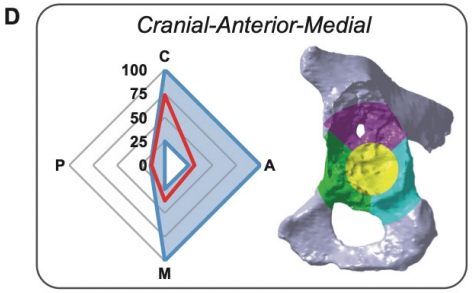

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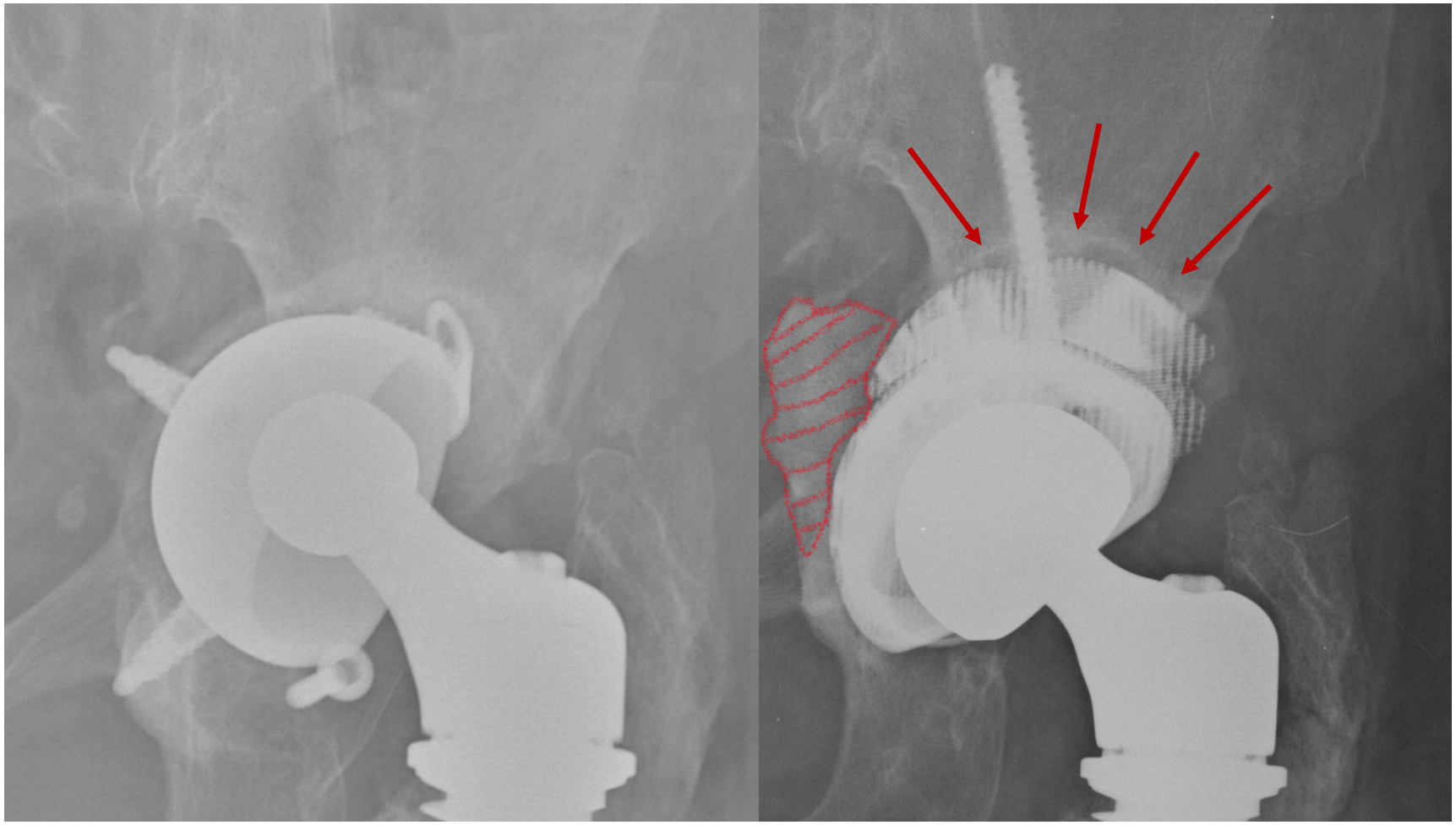

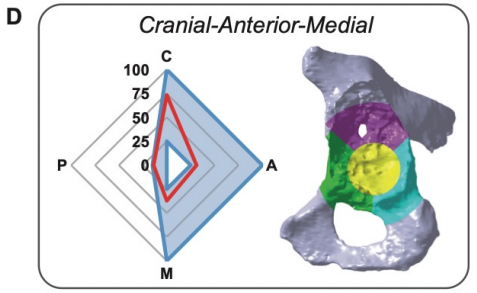

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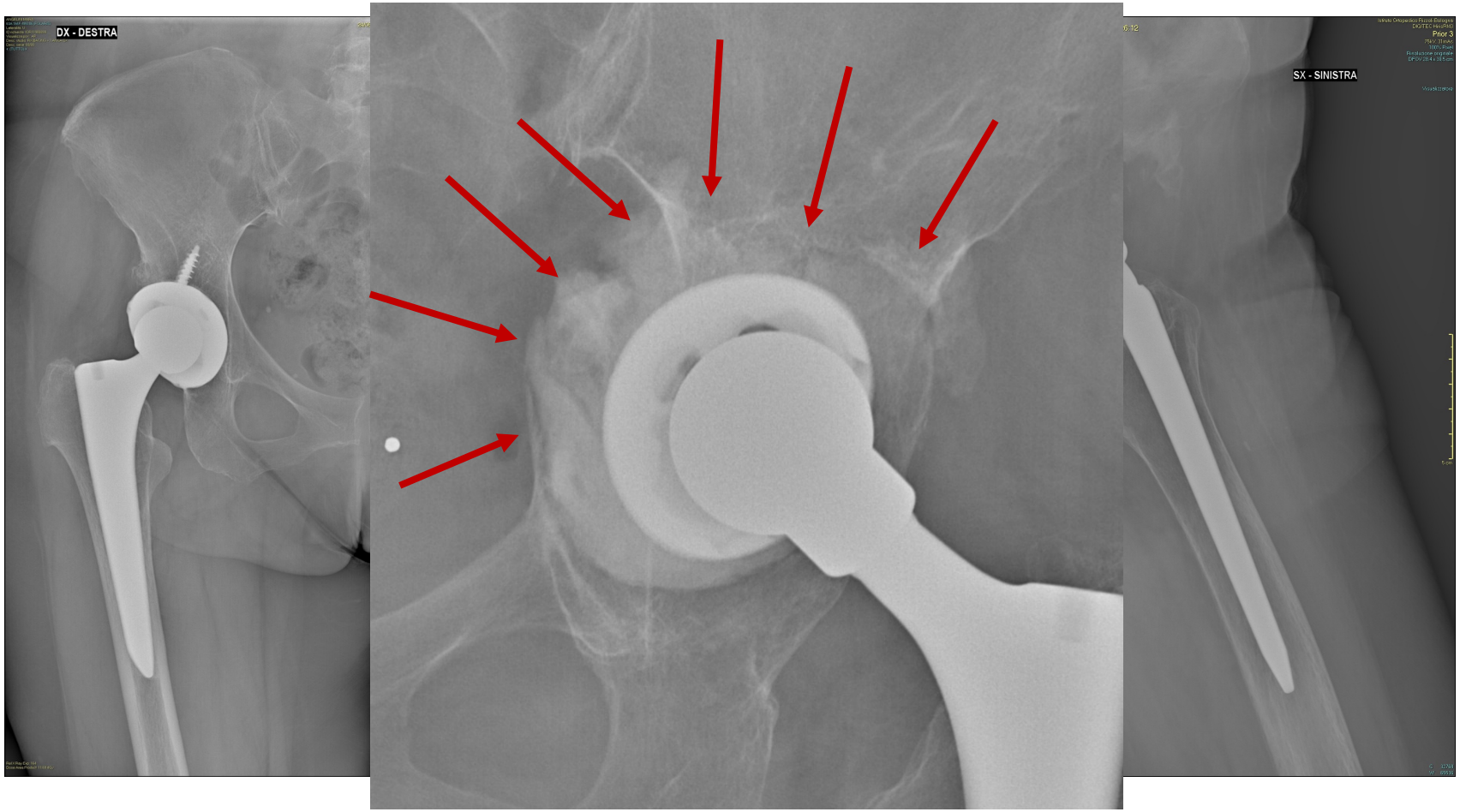

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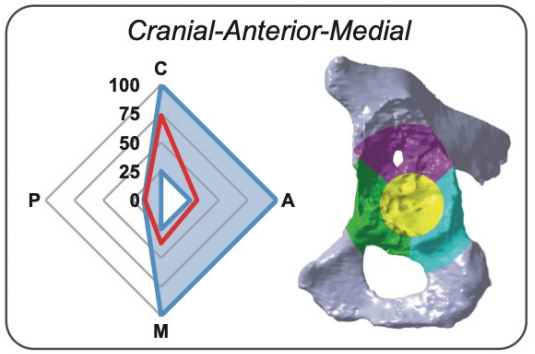

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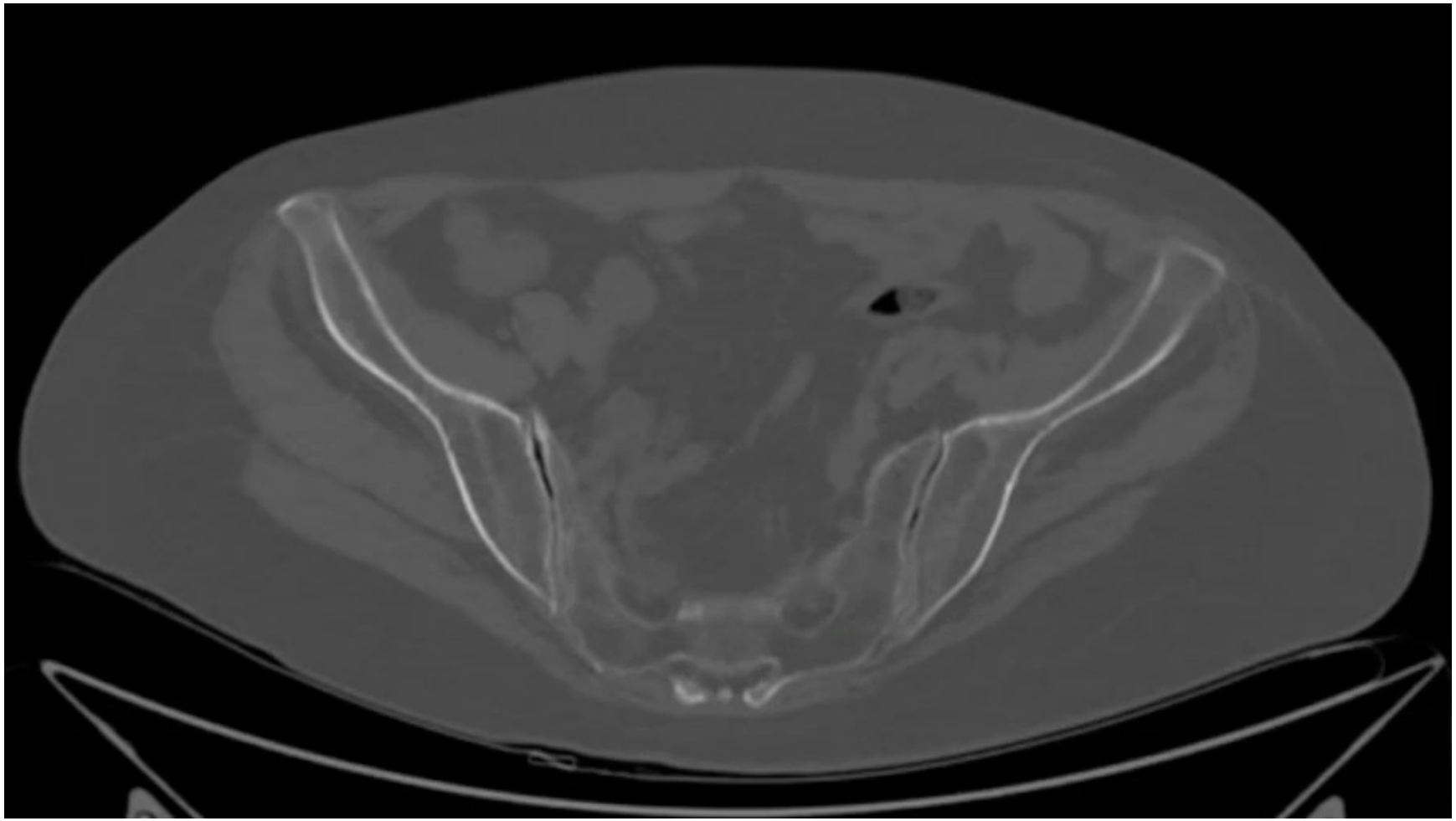

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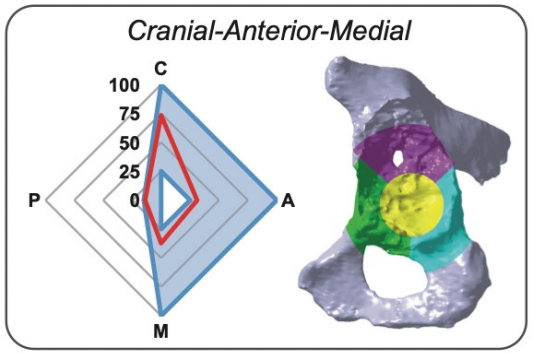

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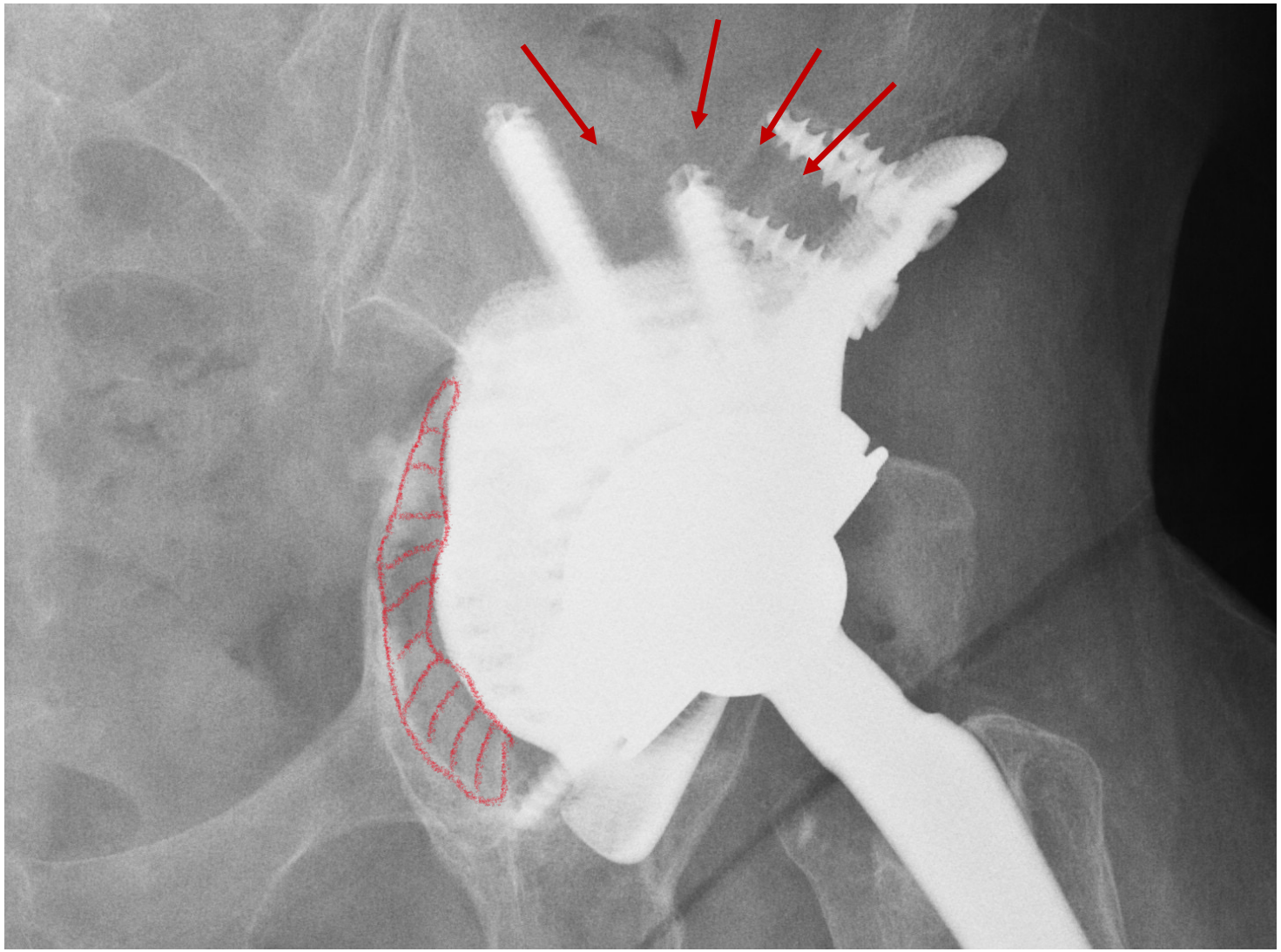

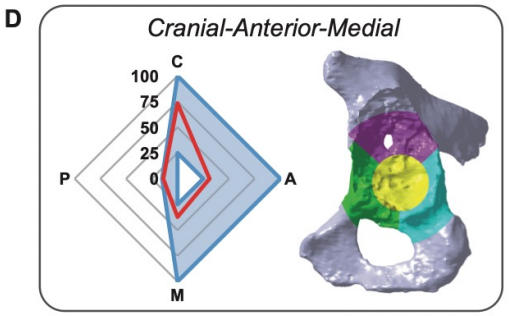

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Review of our first series: Objectives

- Investigate the clinical and radiographic outcomes of a consecutive series of modular cups implanted for a superior or/and anterior wall disruption (min follow up 5 years).
- All component were off the shell components produced with EBM techonology, cups were multi-hole cups
- The system provides augments with ultraporous surfaces and dual mobility bearing surfaces options.

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Our experience: Results

The first 50 patients treated with the technique were enrolled from 2018 -2019.

All the cases were performed for cup loosening and osteolysis.

At a mean follow up of 5yrs±3.1 months, we had 3 failures.

In one case, the component migrated proximally and laterally

Two cases a 2 stage revision for sepsis was required

In one cases there was an implant mechanical failure

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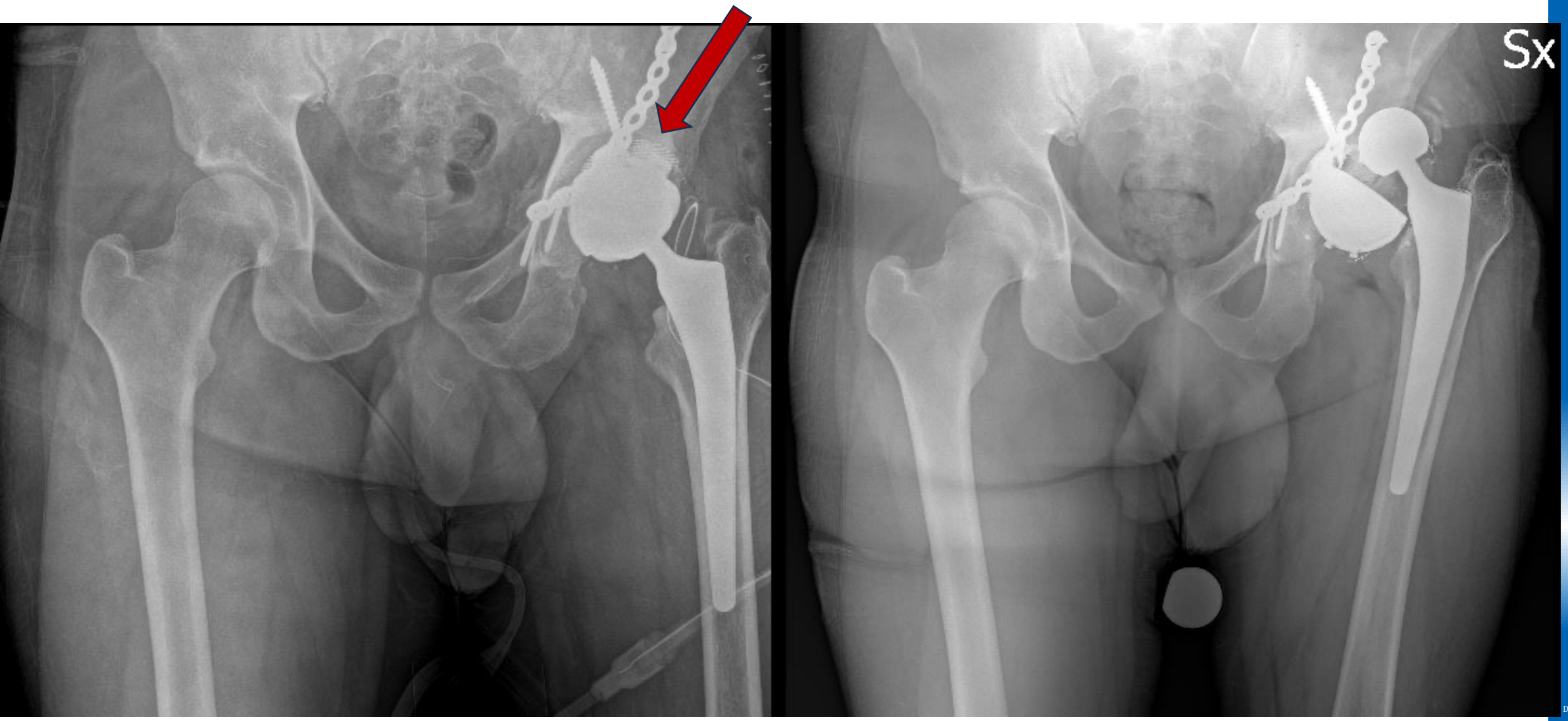
When a modular cup fails?



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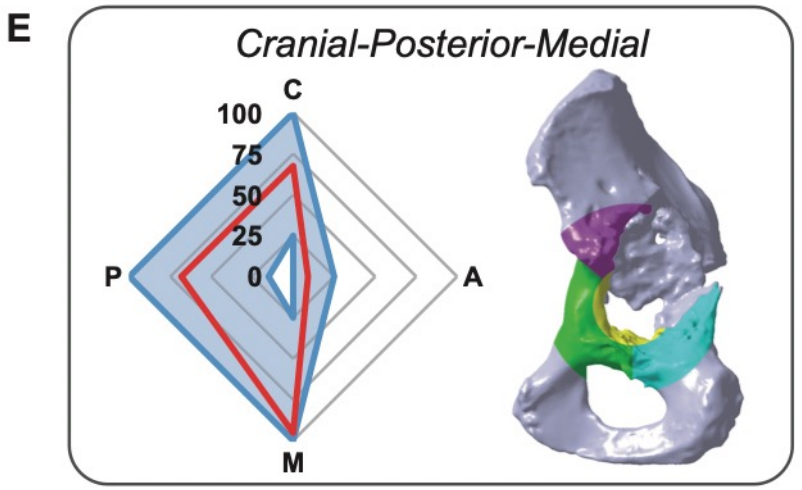
Acetabular revision with cranial-posterior-medial bone loss

One of the most difficult cases to treat

Posterior column fundamental for cup stability



My preferred choice:

- Custom made prosthesis

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Custom made narrative review

Archives of Orthopaedic and Trauma Surgery (2020) 140:415–424
https://doi.org/10.1007/s00402-020-03334-5

HIP ARTHROPLASTY

Acetabular custom-made implants for severe acetabular bone defect in revision total hip arthroplasty: a systematic review of the literature

Francesco Chiarlone[1] · Andrea Zanirato[1] · Luca Cavagnaro[2] · Mattia Alessio-Mazzola[1] · Lamberto Felli[1] · Giorgio Burastero[2]

Received: 21 February 2019 / Published online: 20 January 2020

RELIABLE SOLUTION FOR SEVERE ACETABULAR DEFECTS

(pelvic discontinuity and particular cases of Paprosky Type IIIA-B, AAOS type III–IV)

where the feature of the defect cannot be handled with standard implants.

Table 2 Rate of complication, dislocation, periprosthetic joint infection, re-operation, acetabular re-revision, acetabular custom survival and reason for custom failure extrapolated from the included studies

Authors (year)	Complication rate (%)	Dislocation rate (%)	PJI (%)	Re-operation rate (%)	Acetabular re-revision rate (%)	Acetabular custom survival rate (%)	Reason for custom failure
Christie MJ (2001) [1921]	27.7	17.9	0	8.9	0	100	/
Joshi AB (2002) [2022]	22	3.7	7.4	13.7	0	100	/
Holt GE (2005) [2123]	26.9	7.7	0	3.8	3.8	88.5	3 AL
De Boer DK (2007) [2224]	40	30	0	30	0	100	/
Tauton MJ (2012) [2325]	47.4	21	7	30.3	5.3	95	2 PJI, 1 AL
Colen S (2012) [2426]	0	0	0	0	0	100	/
Wind MA (2013) [2527]	52.6	26	5.2	32	10.5	89.5	1PJI, 1AL
Friedrich MJ (2014) [2628]	33.3	16.7	11.1	27.8	11.1	88.9	2 PJI
Berasi CC (2015) [2729]	26.1	0	8.3	16.6	8.3	91.7	2 PJI
Barlow BT (2015) [2830]	27	–	3.2	27	13.5	86.5	–
Mao Y (2015) [2931]	21.7	8.7	0	4.3	4.3	91.3	2 AL
Li H (2016) [3032]	16.7	4.2	4.2	8	0	100	/
Baauw M (2016) [3133]	33.3	8.3	0	0	0	100	/
Gladnick BP (2017) [3234]	37	9.6	11	35.6	7.9	90.4	6 PJI, 1 AL
Citak M (2017) [3335]	66.7	33.3	0	66.7	11.1	88.9	1 AL
Berend ME (2018) [3436]	22	6.3	6.3	22	7.3	92.7	1 AL, 1 acetabular fracture, other not specified
Kieser DC (2018) [3537]	11	2.8	2.8	2.8	2.8	97.2	1 PJI
Moore KD (2018) [3638]	11.4	0	5.8	8.5	8.5	91.5	2 PJI, 1AL

AL aseptic loosening, *PJI* periprosthetic joint infection, / not applicable, – not reported

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Custom vs Standard/Modular implants

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Revision Arthroplasty

Standard Versus Custom-Made Acetabular Implants in Revision Total Hip Arthroplasty

Check for updates

Rashid M. Tikhilov, MD, PhD, Alisagib A. Dzhavadov, MD *, Anton N. Kovalenko, MD, Stanislav S. Bilyk, MD, Alexey O. Denisov, MD, Igor I. Shubnyakov, MD, PhD

Vreden National Medical Research Center of Traumatology and Orthopedics, Ministry of Health of Russian Federation, St. Petersburg, Russian Federation

Indications for the Use of the CMAI and SAI Depending on the Severity of Defects.

Classification and Defect Type		SAI (n = 45)		CMAI (n = 61)		*P*-Value
		Hemispherical Component with Hemispherical Trabecular Metal Augment	Half Cup-Cage Construct	Triflange Acetabular Implants	Hemisphere with Stem and Iliac Flange	
Gross and Saleh	Uncontained loss of bone stock (type III-IV) n (%)	38 (84.5%)	2 (4.4%)	42 (68.9%)	-	-
	Pelvic discontinuity with uncontained loss of bone stock (type V) n (%)	2 (4.4%)	3 (6.7%)	10 (16.4%)	9 (14.7%)	**0.02**

CMAI, custom-made acetabular implant; SAI, standard acetabular implant.
Statistically significant *P*-values are marked in bold.

106 cases

- CMAI (custom made implant): 61 cases (57.5%)
  1. tri-flange acetabular implants (85.2%)
  2. hemisphere with a stem and iliac flange (like ice-cream cone prosthesis (14.8%)
- SAI (standard implant): 45 cases (42.5%)
  1. hemispherical component with the hemispherical trabecular metal *augment* (88.9%)
  2. half cup-cage construct (trabecular metal revision shell and *antiprotrusio cage with removal of the ischial flange* (11.1%).

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Custom vs Standard/Modular implants

The Incidence of Complications in Patients After Implantation of the SAI and CMAI.

Complications	SAI (n = 45)		CMAI (n = 61)		Total	*P*-Value	
	Uncontained Loss of Bone Stock (III-IV type) (n = 40)	PD with Uncontained Loss of Bone Stock (V type) (n = 5)	Uncontained Loss of Bone Stock (III-IV type) (n = 42)	PD with Uncontained Loss of Bone Stock (V type) (n = 19)	N = 106	Uncontained Loss of Bone Stock (III-IV type)	PD with Uncontained Loss of Bone Stock (V type)
Aseptic loosening	4 (10.0%)	3 (60.0%)	1 (2.4%)	-	8 (7.5%)	0.19	**<0.001**
Periprosthetic joint infection	-	-	2 (4.8%)	1 (5.3%)	3 (2.8%)	0.49	1.0
Dislocations	1 (2.5%)	-	1 (2.4%)	1 (5.3%)	3 (2.8%)	1.0	1.0
Total	5 (12.5%)	3 (60.0%)	4 (9.6%)	2 (10.6%)	14 (13.1%)	0.73	0.18

CMAI, custom-made acetabular implant; PD, pelvic discontinuity; SAI, standard acetabular implant.
Statistically significant *P*-values are marked in bold.

- The treatment of these defects using SAIs is accompanied by a HIGHER INCIDENCE OF ASEPTIC LOOSENING REQUIRING RE-REVISIONS.

- The CMAI provides a RELIABLE PRIMARY FIXATION from the best conformity supplemented with screw fixation.

Tikhilov R.M., *The Journal of Arthroplasty 37 (2022) 119e125*

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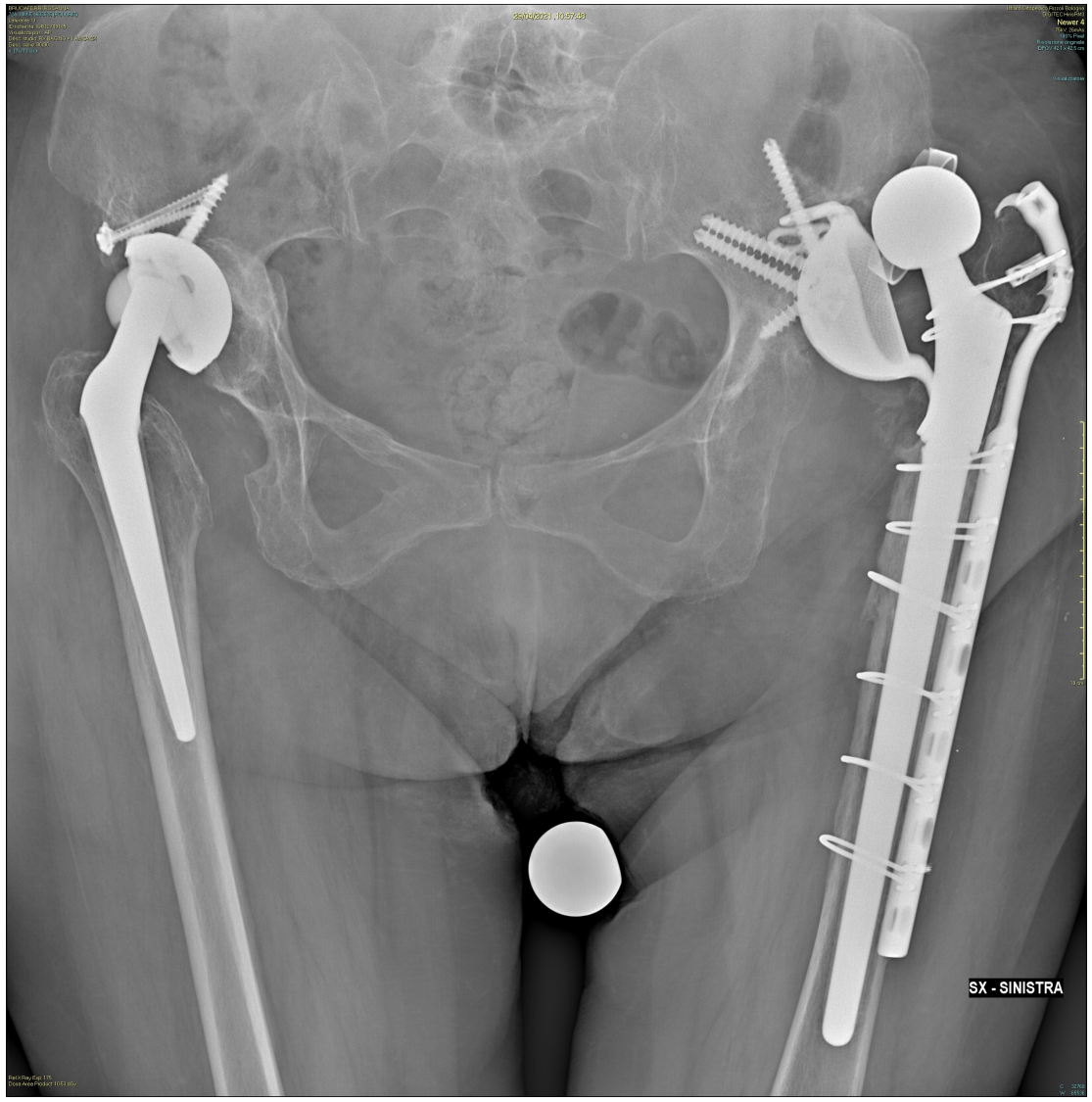
Acetabular revision with cranial-posterior-medial bone loss



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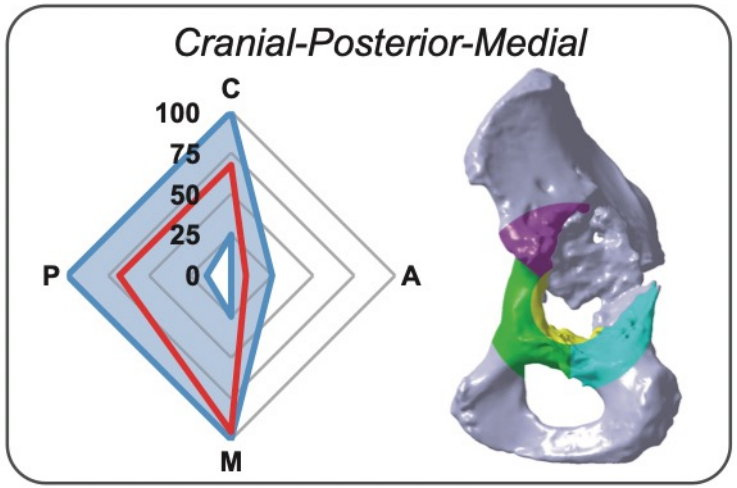

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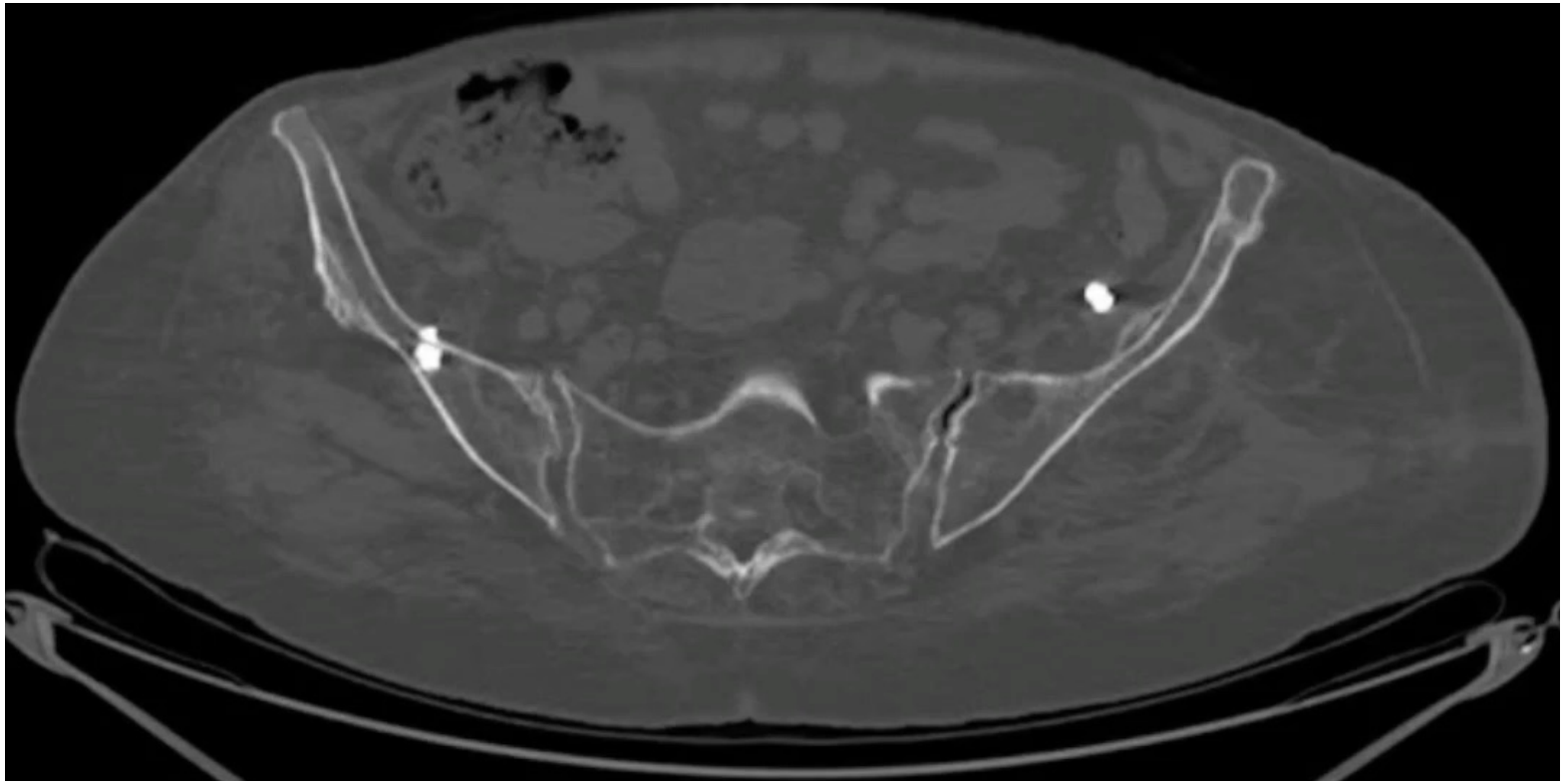

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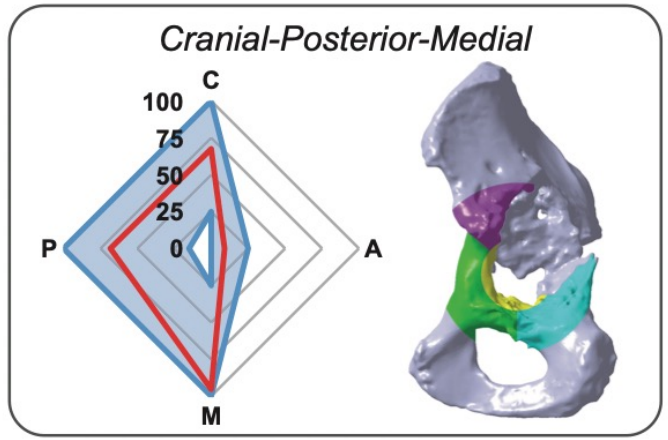

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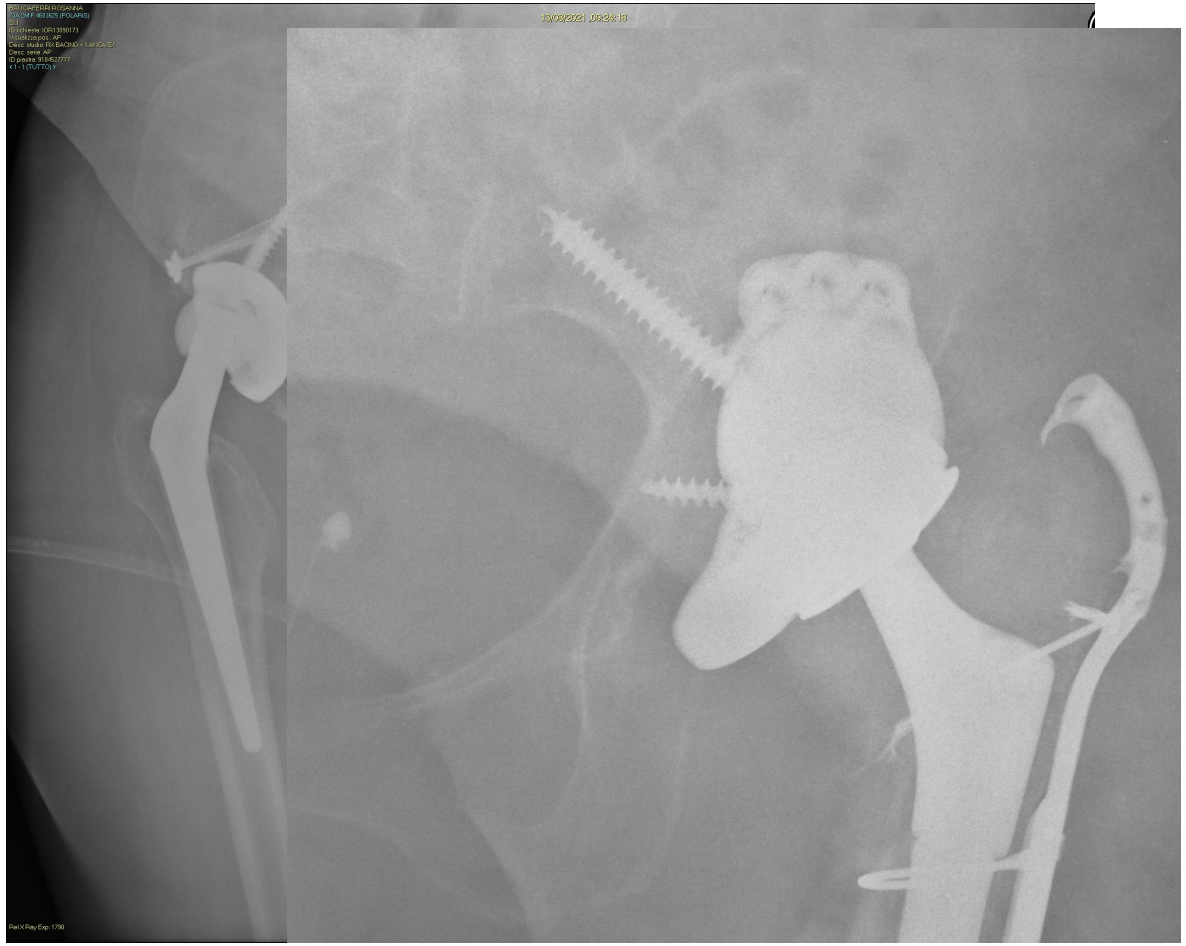

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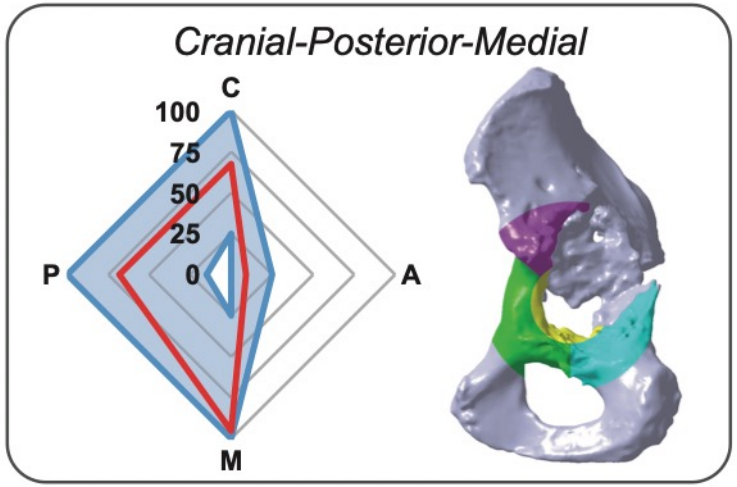

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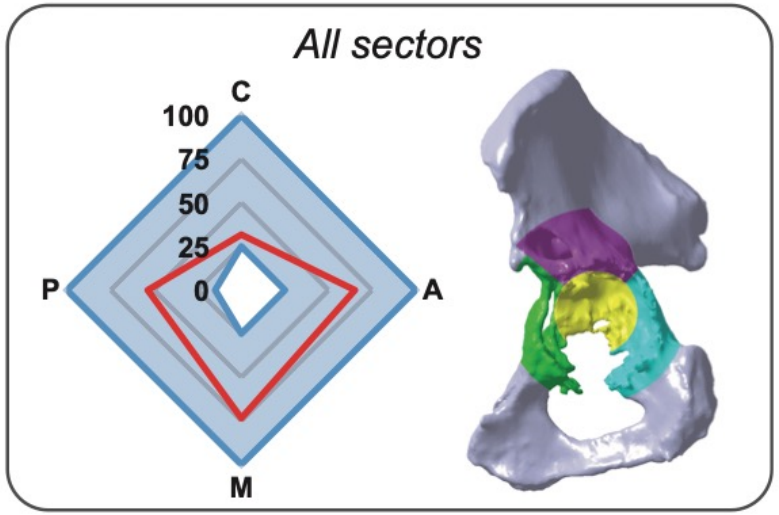
Acetabular revision with bone loss in all sectors or pelvic discontinuity

Challenge procedures, they require a a revision system to achieve primary stability could be either a cage a revision cup with augments or a custom made prosthesis

F



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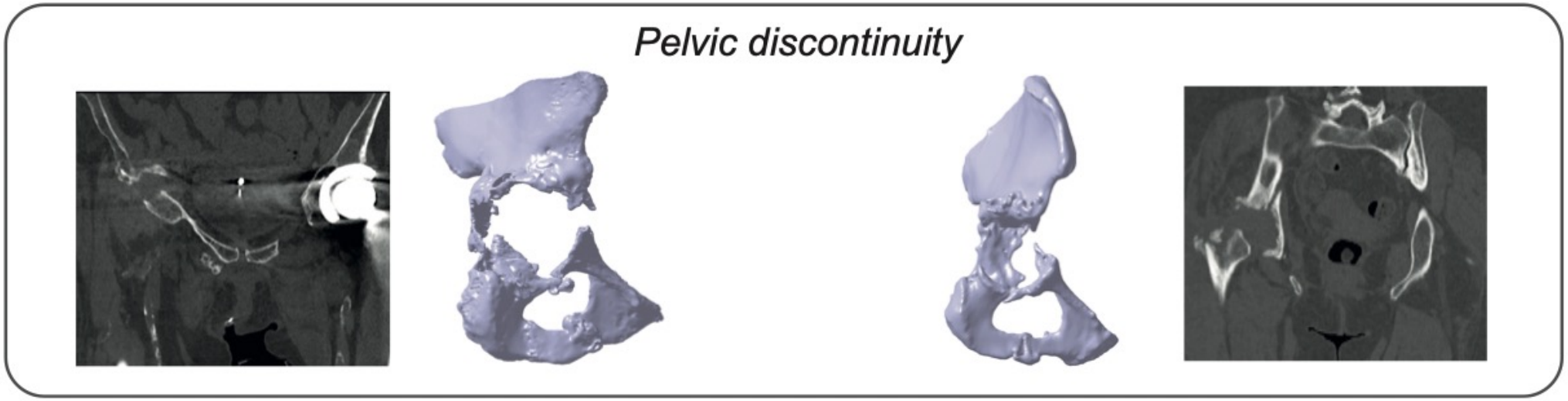

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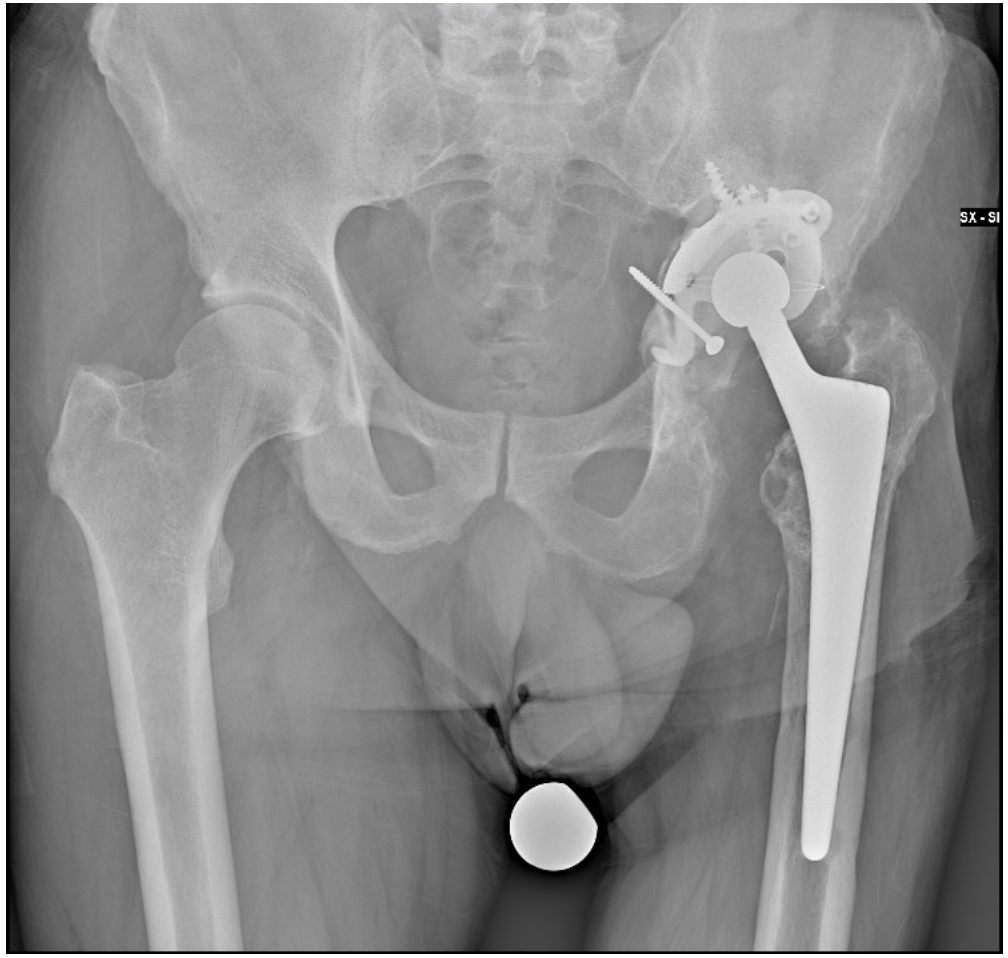

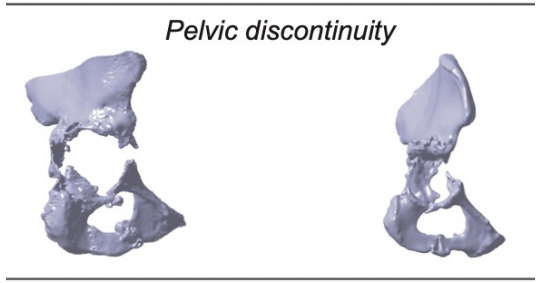

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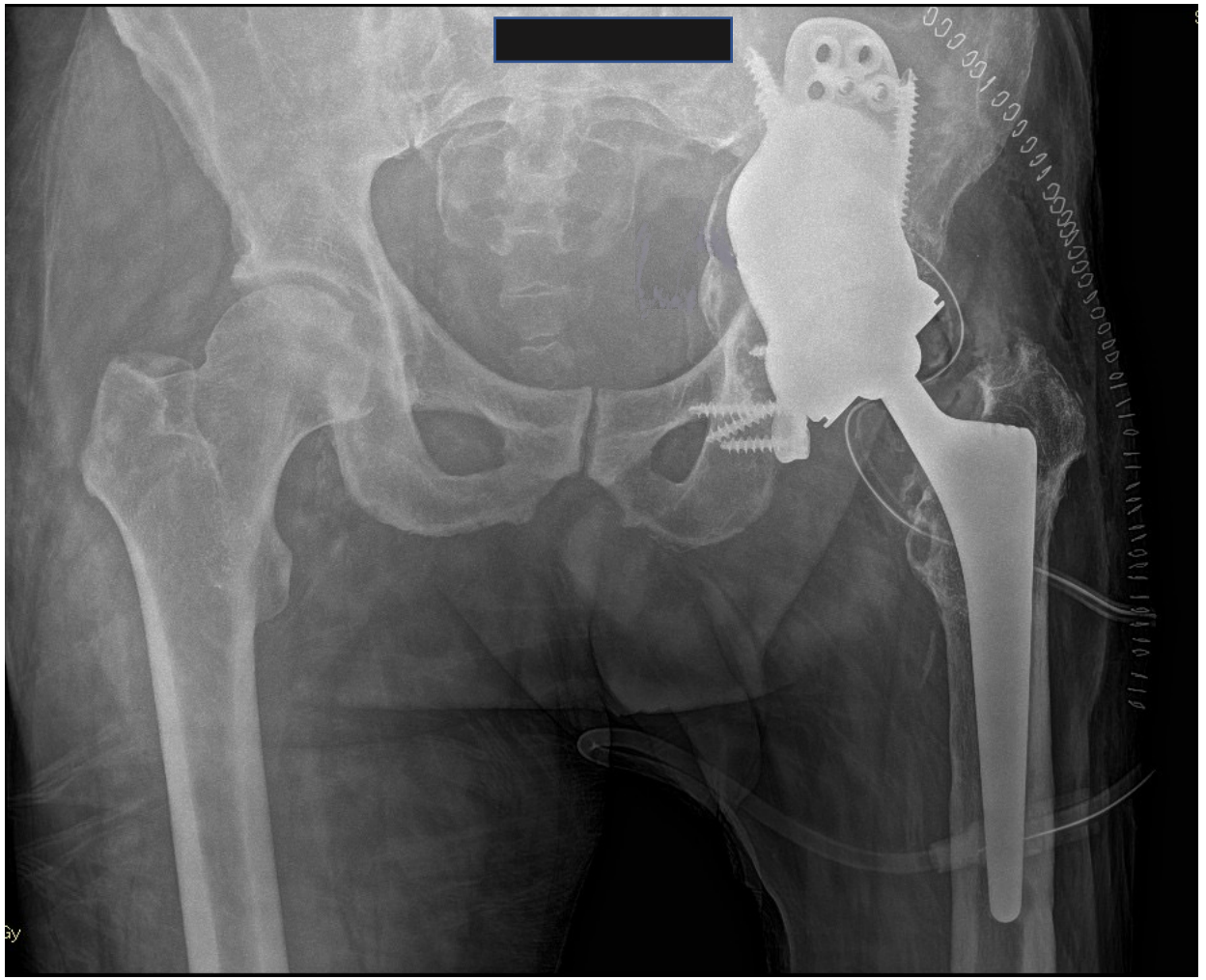

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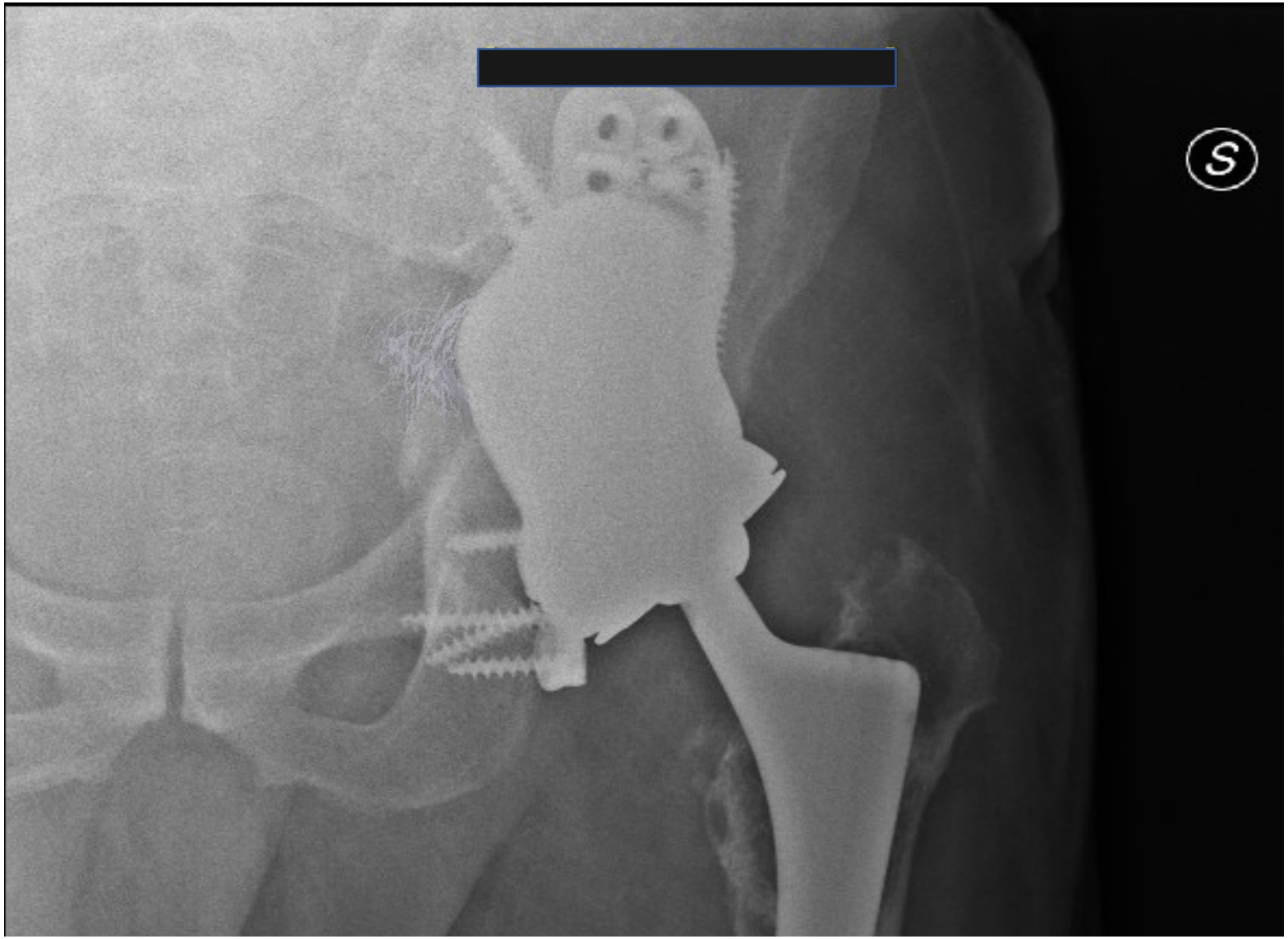

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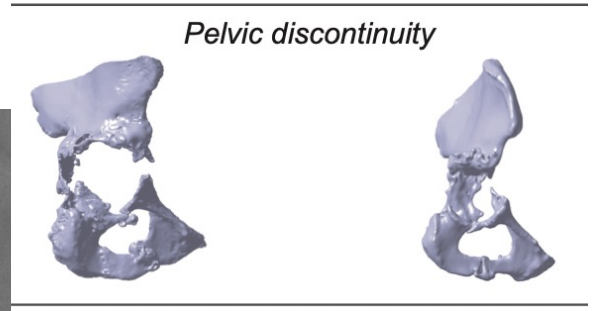

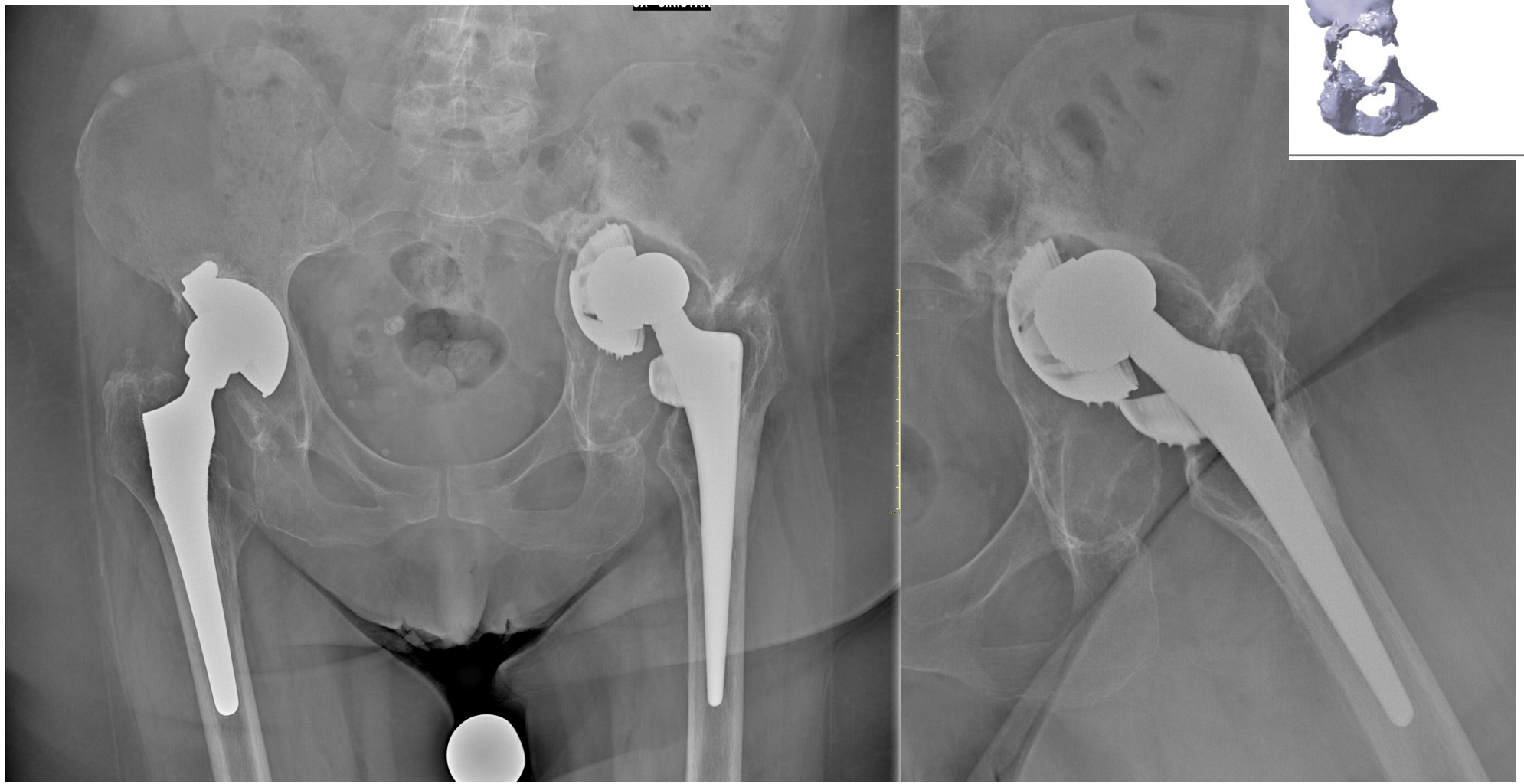

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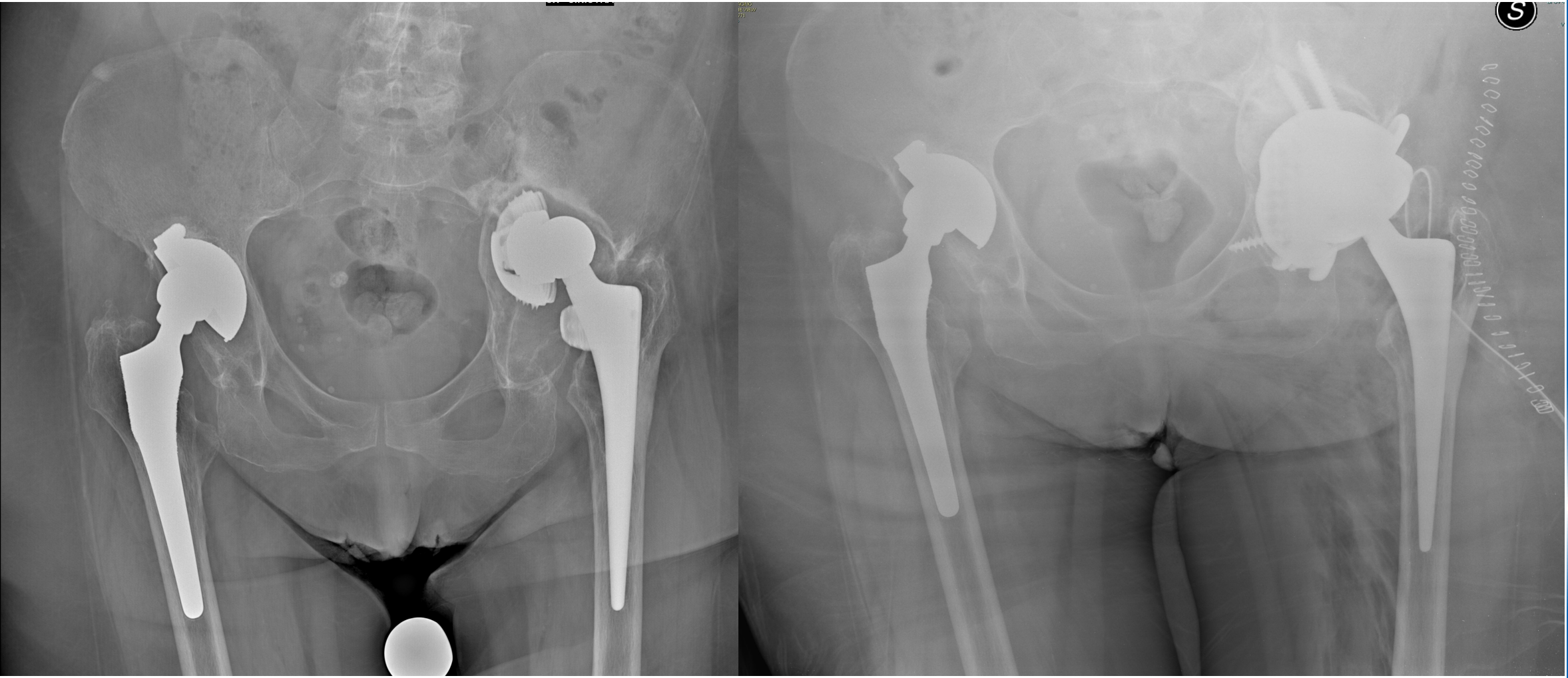

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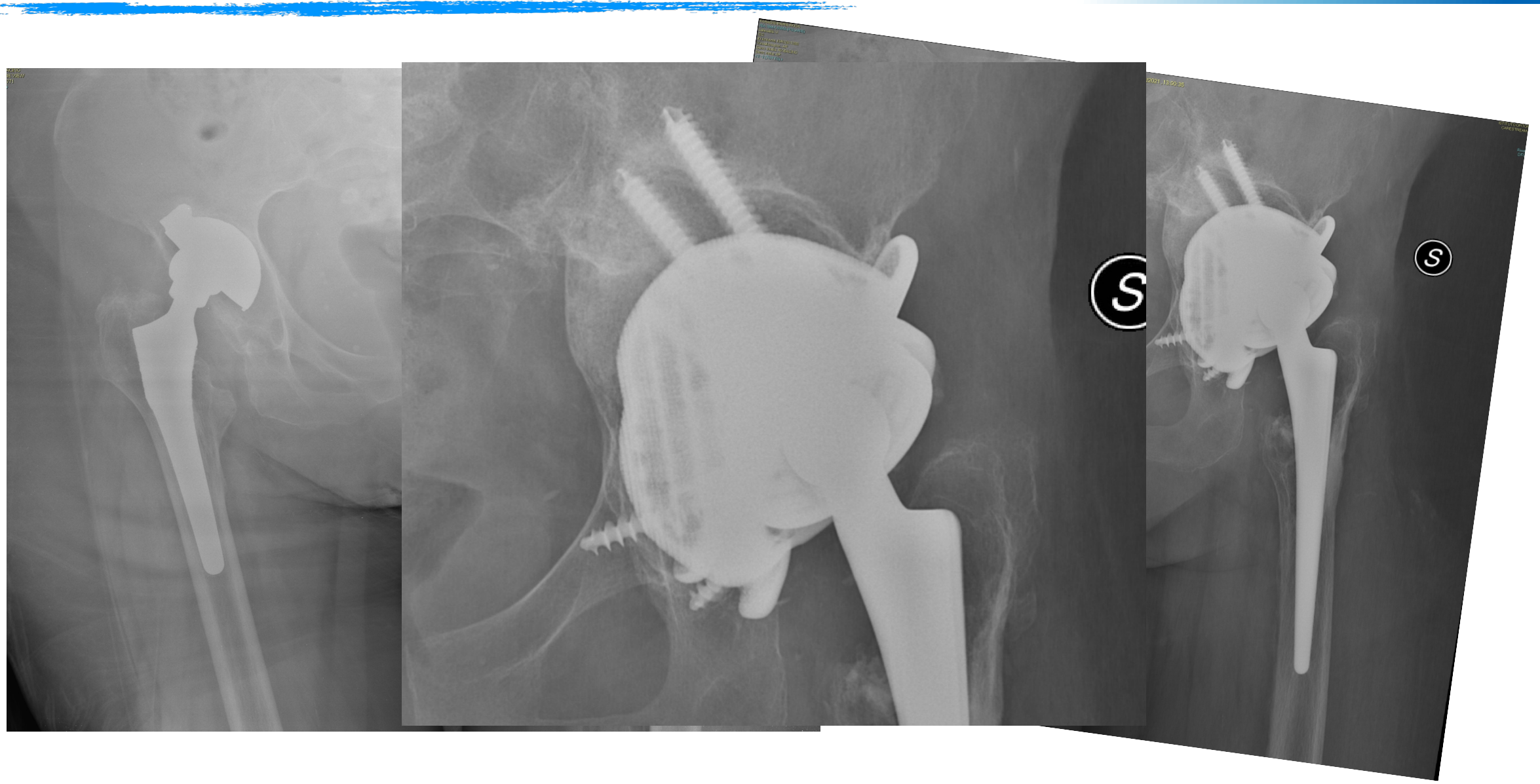

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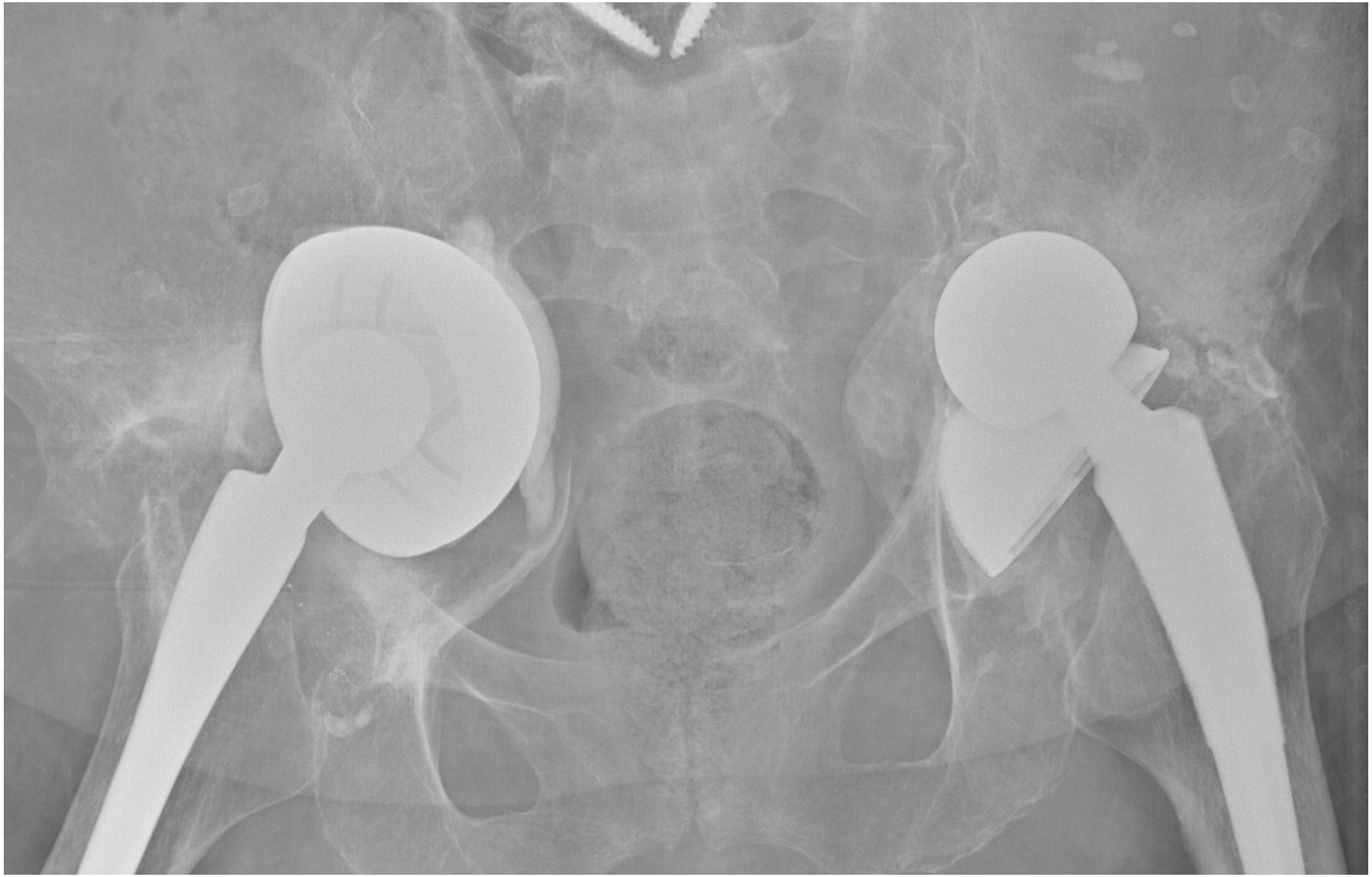
Acetabular revision with bone loss in all sectors or pelvic discontinuity



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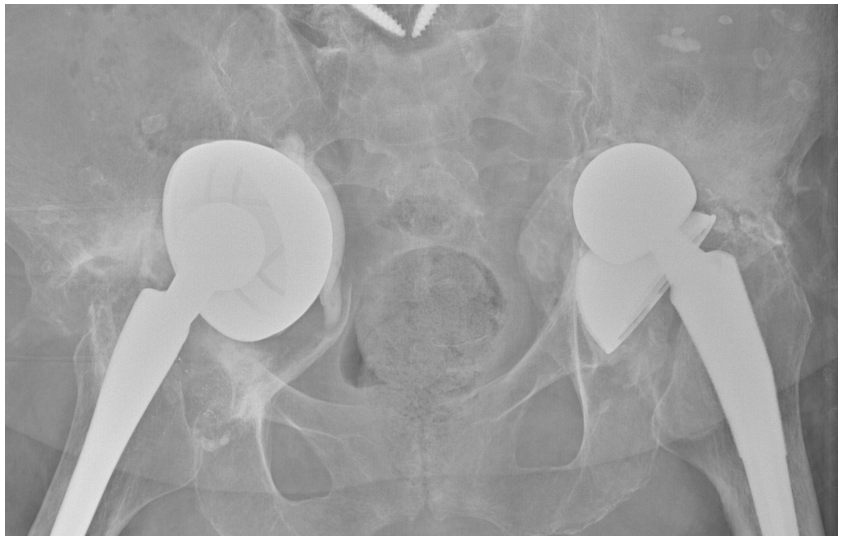

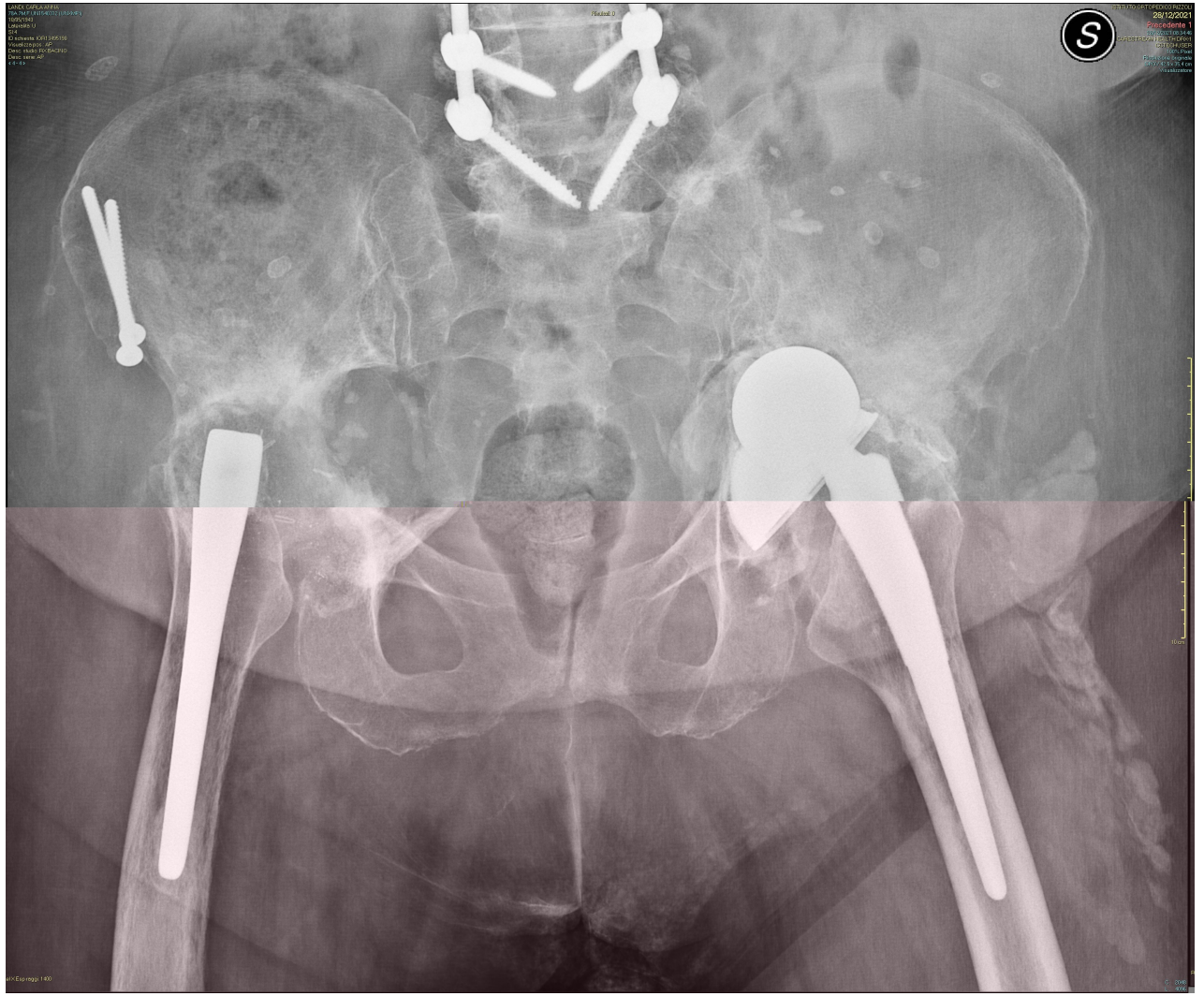

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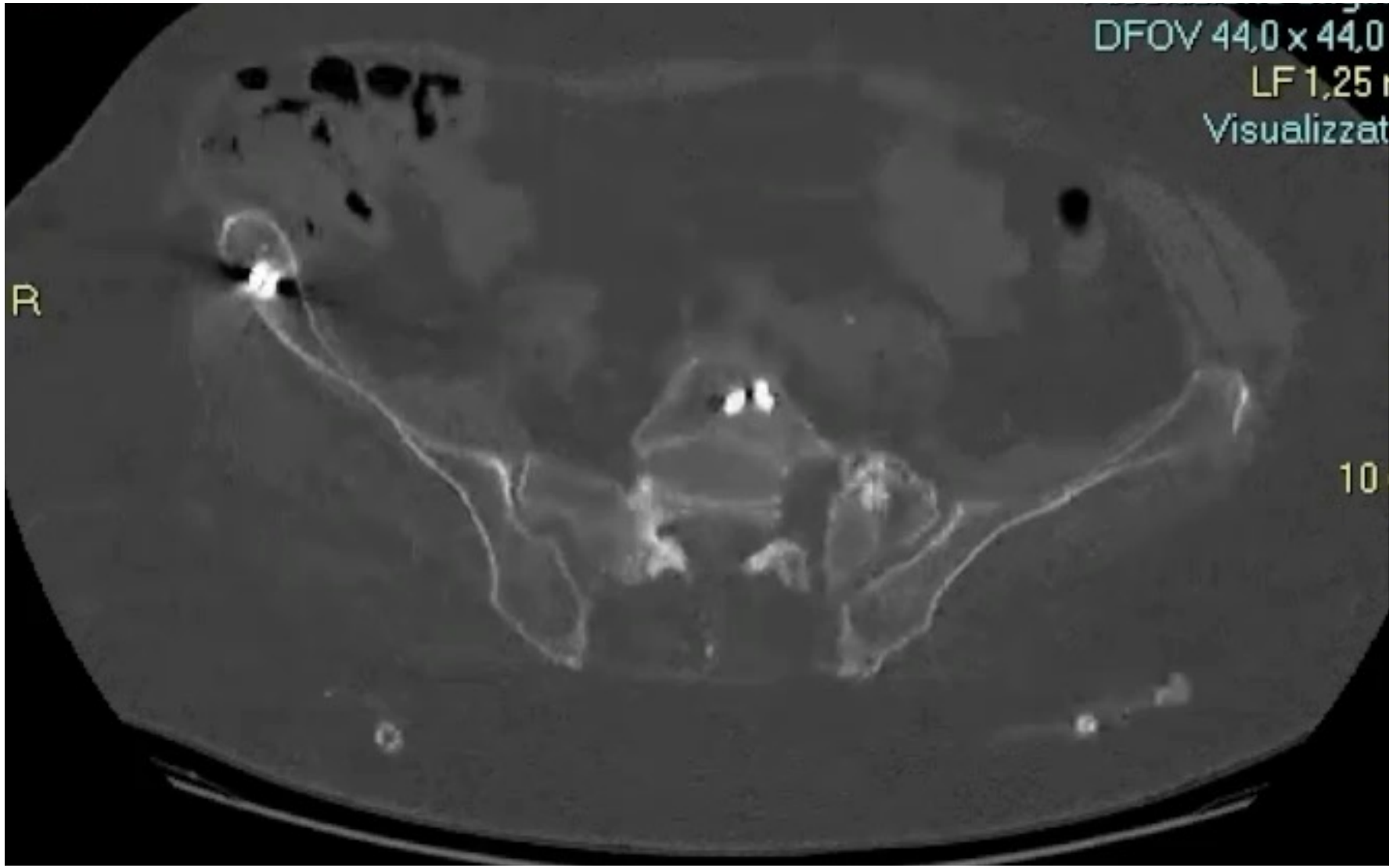

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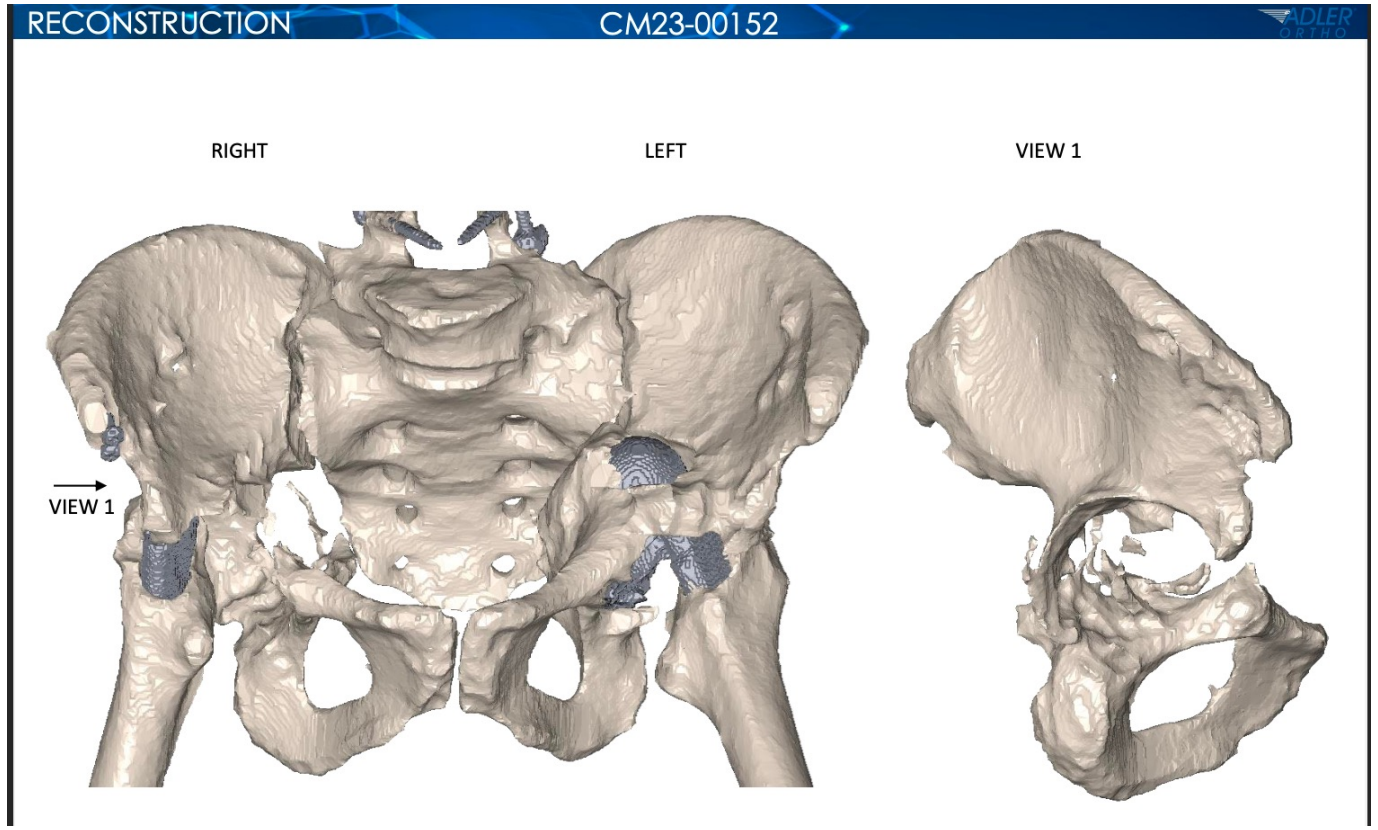

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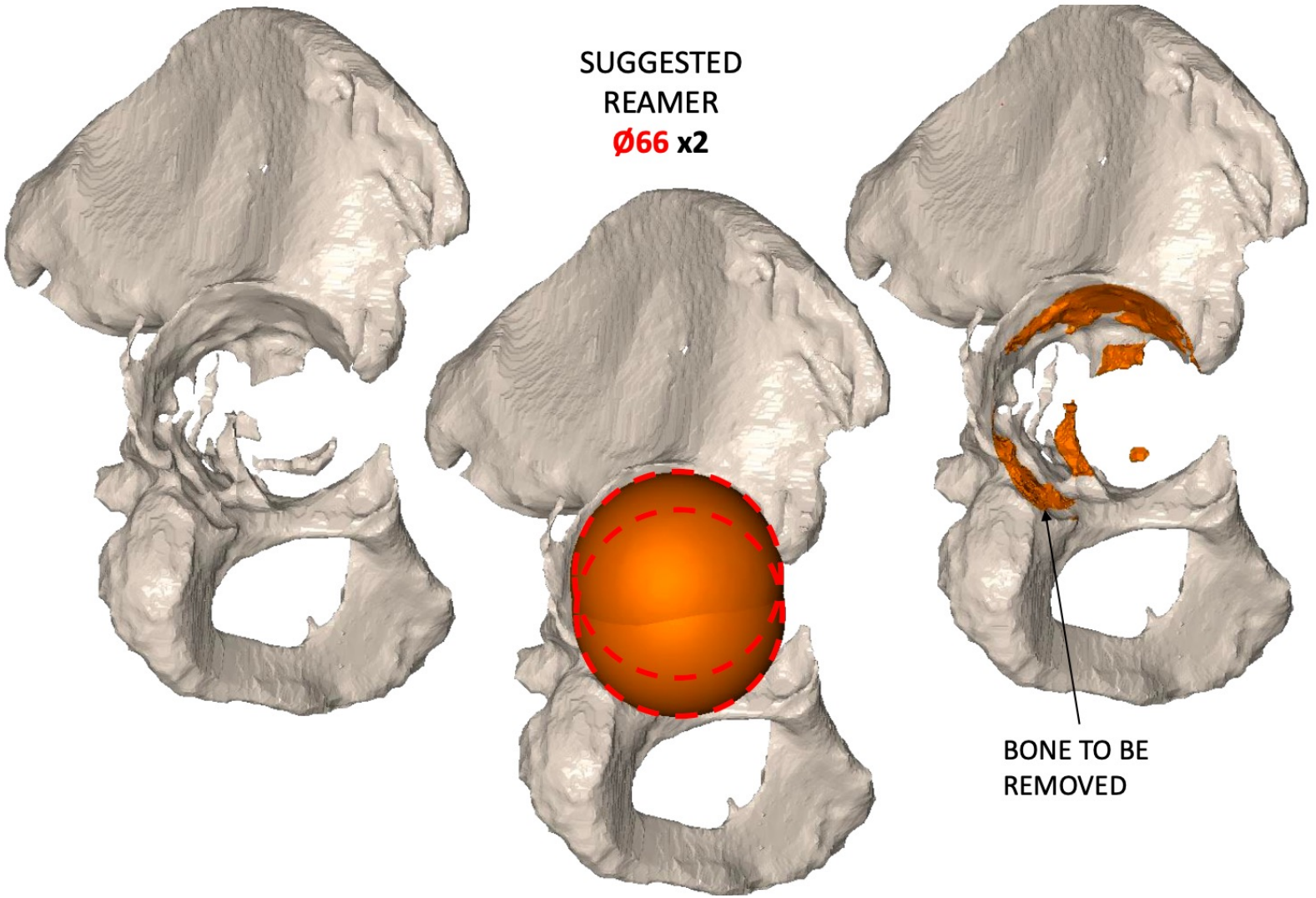

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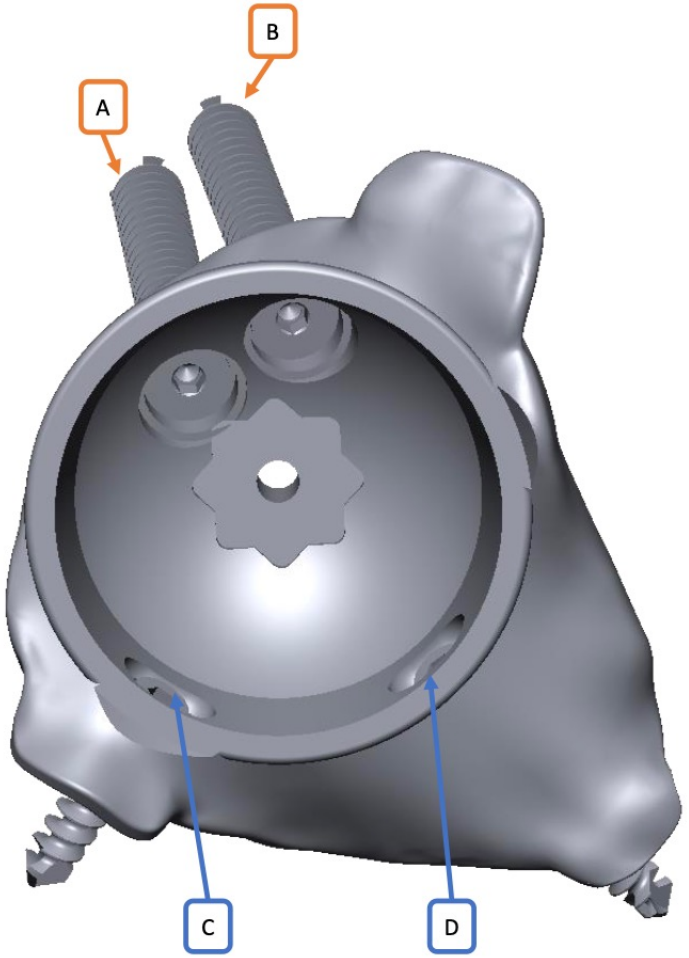

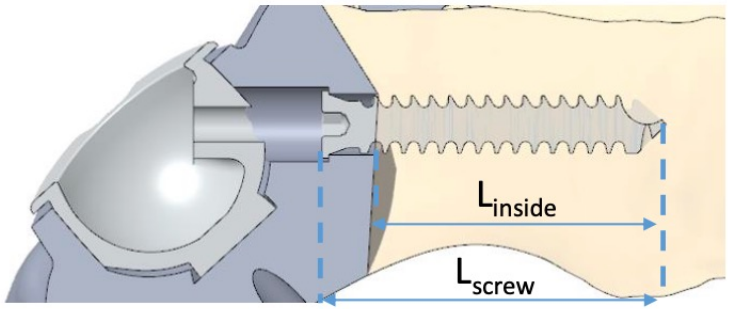

Screws A, B : Ø8.5 mm, pilot hole Ø5.2mm

SCREW	L_{screw}	L_{inside}
A	65 mm	55 mm
B	65 mm	55 mm

Screws C, D: Ø6.5 mm, pilot hole Ø3.2mm

SCREW	L_{screw}	L_{inside}
C	30 mm	18 mm
D	45 mm	17 mm

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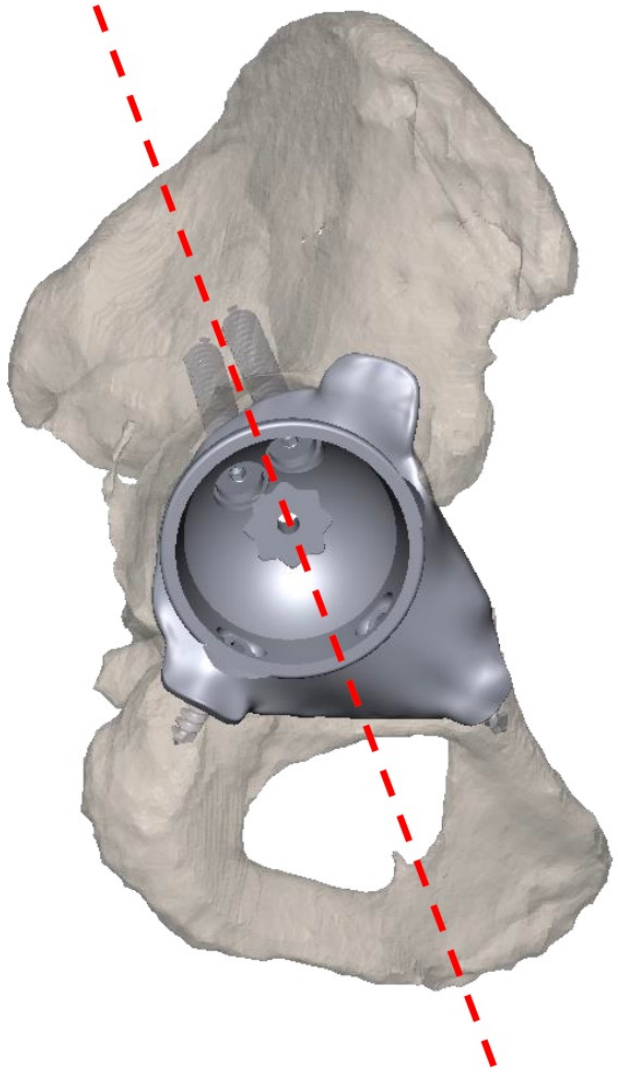

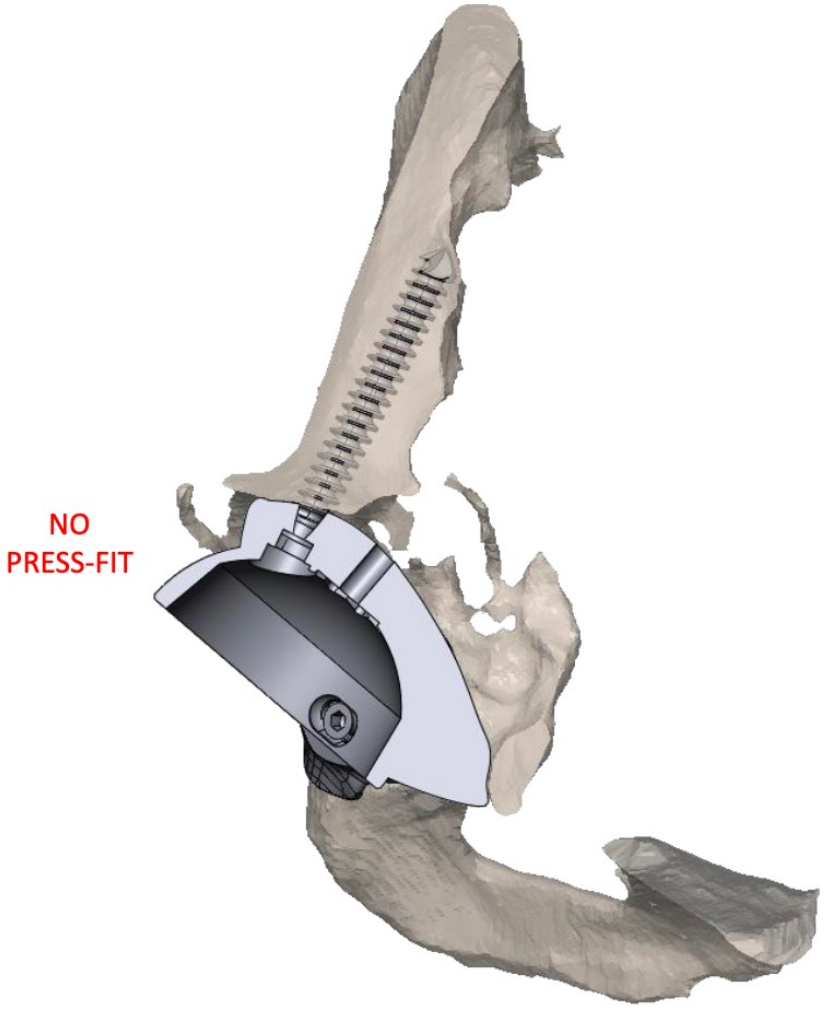

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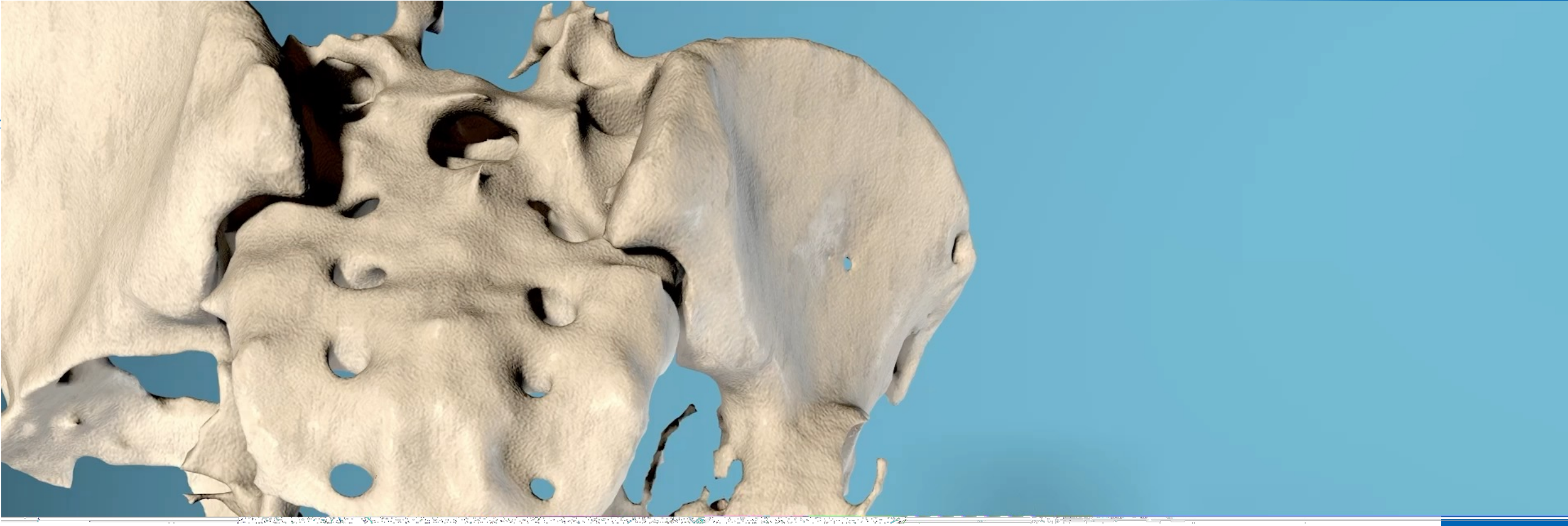

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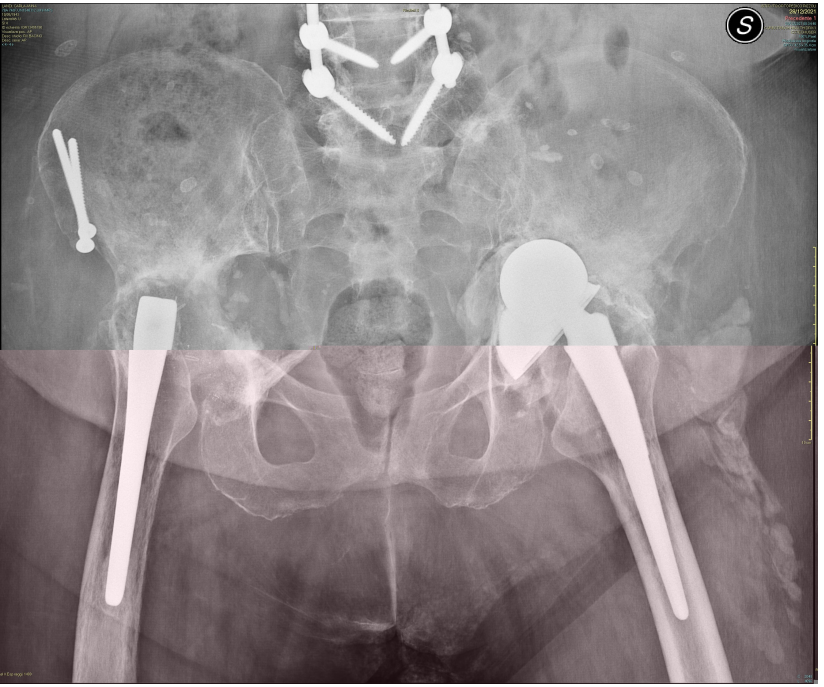

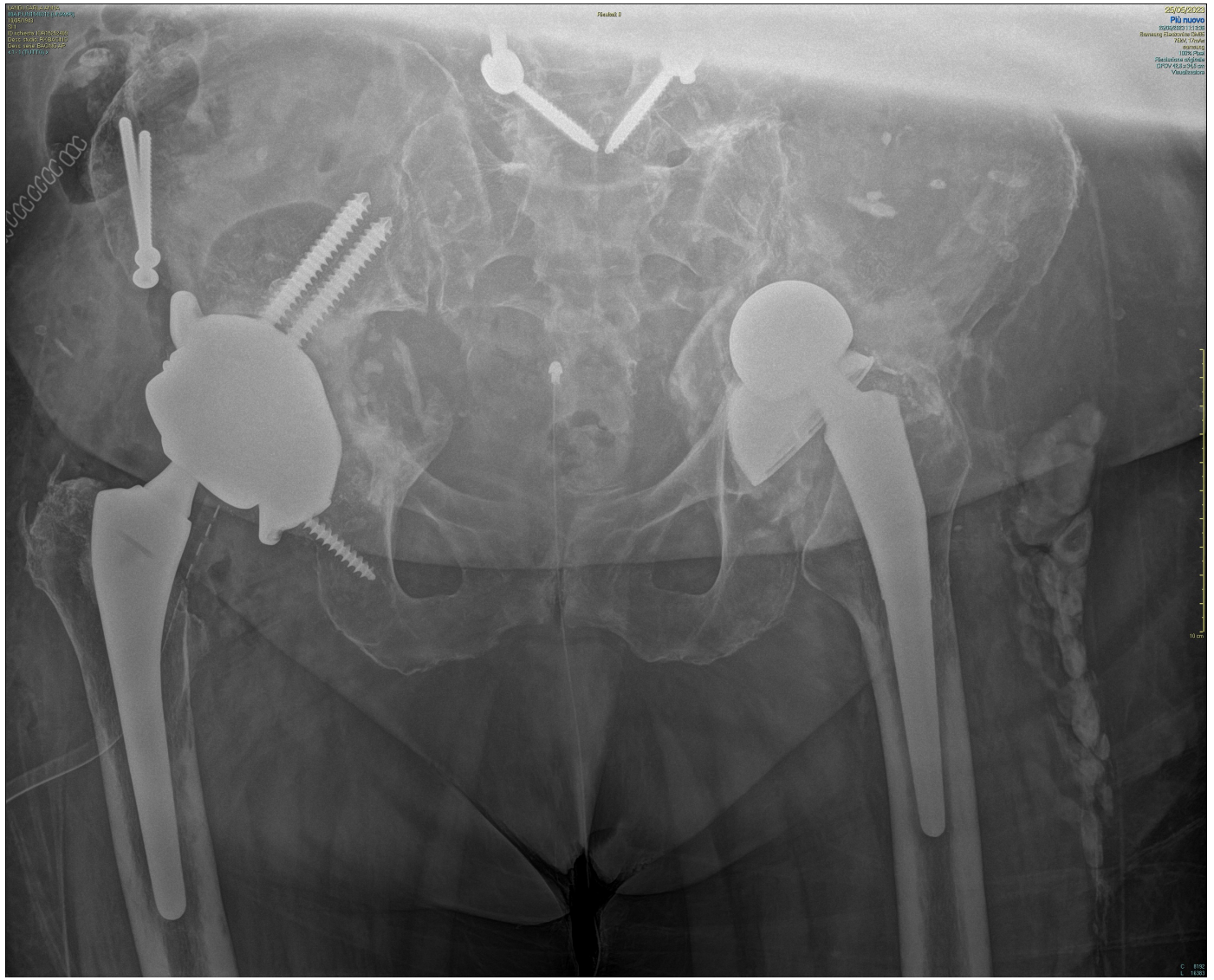

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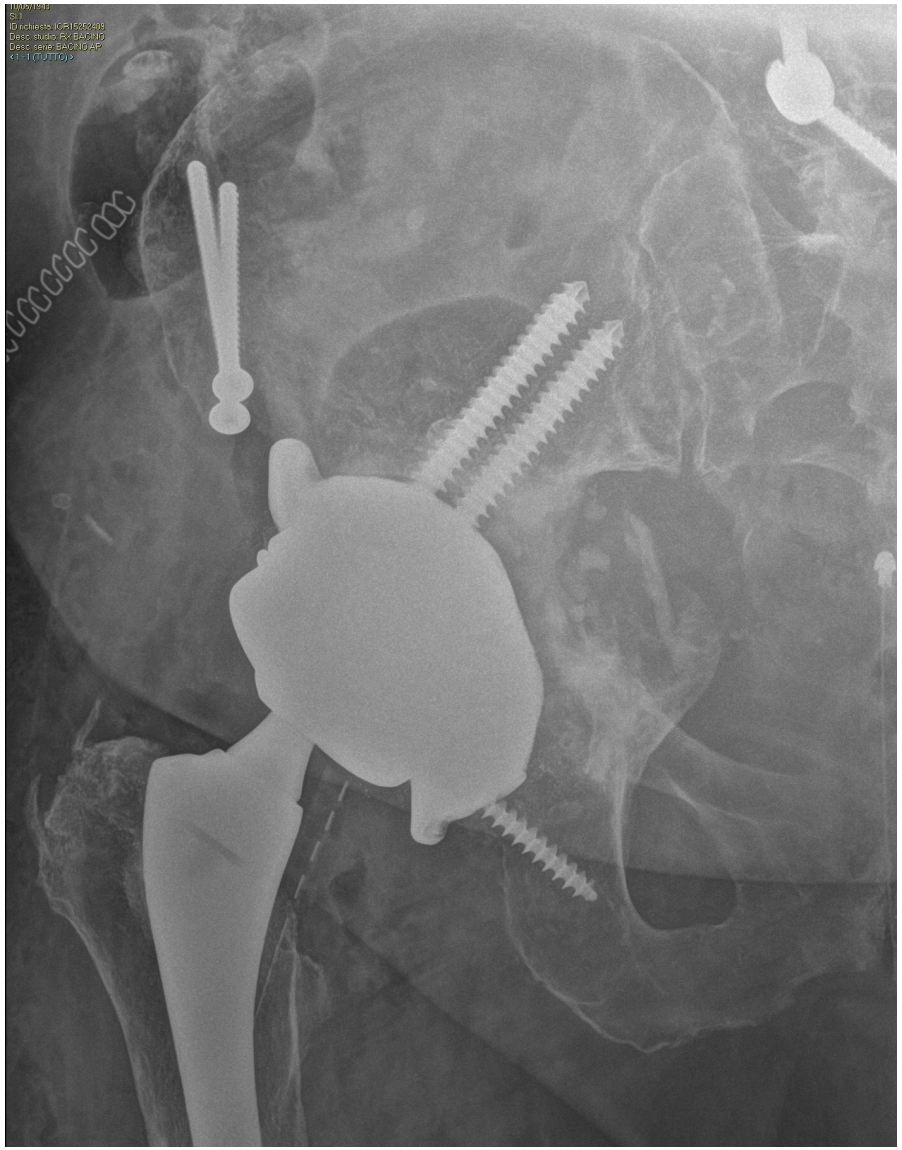

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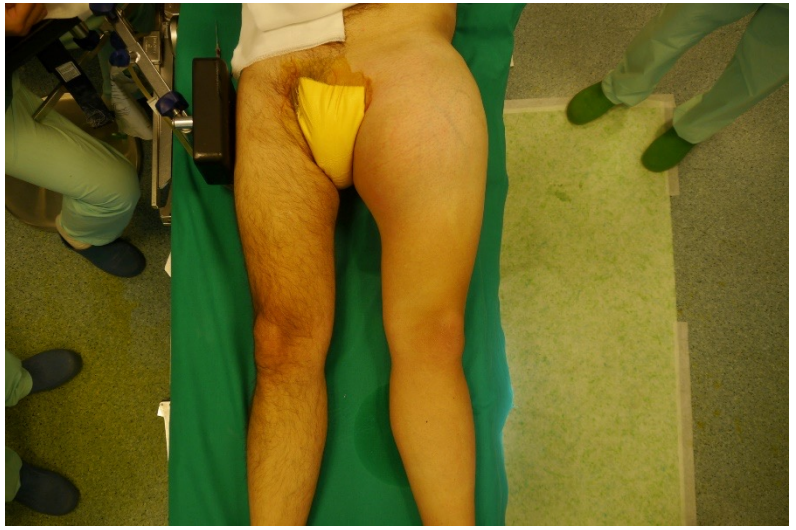

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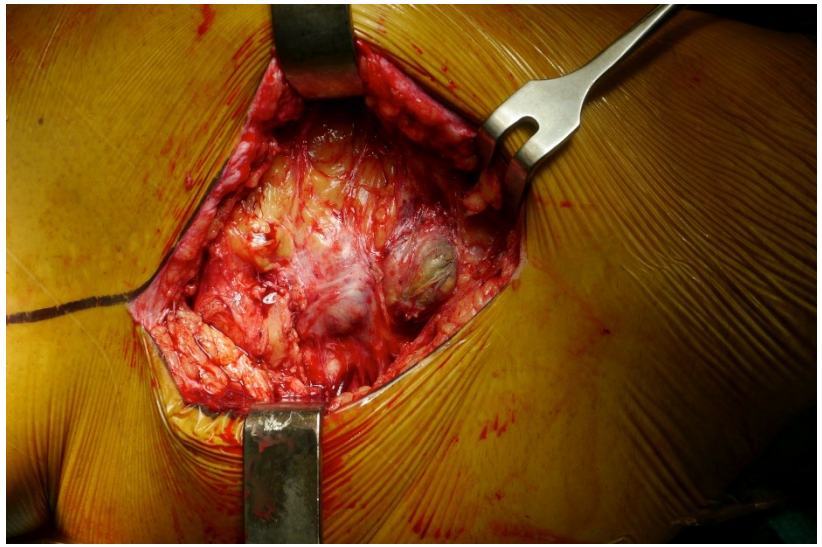

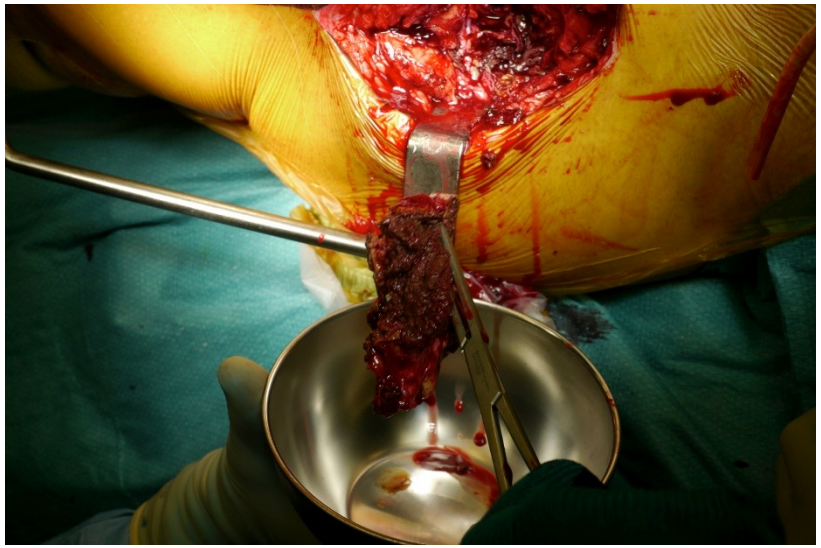

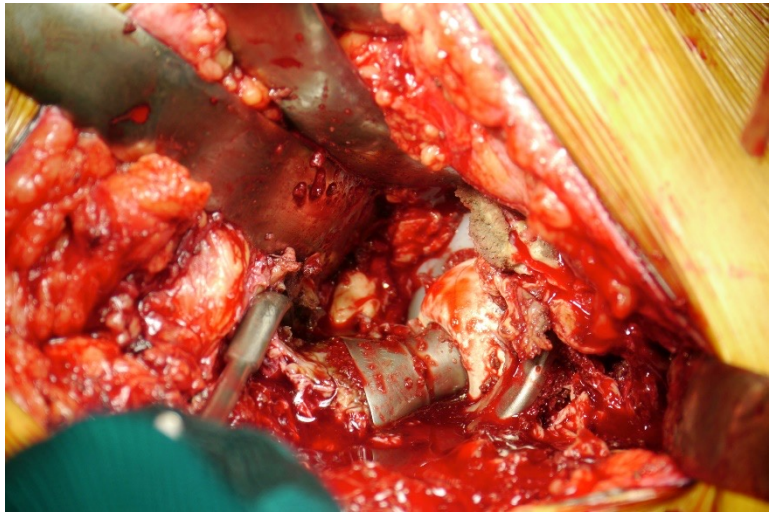

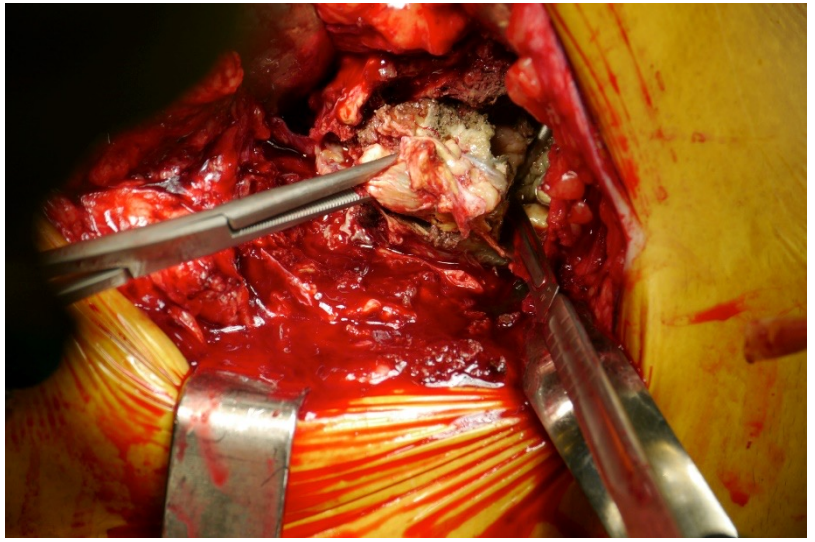

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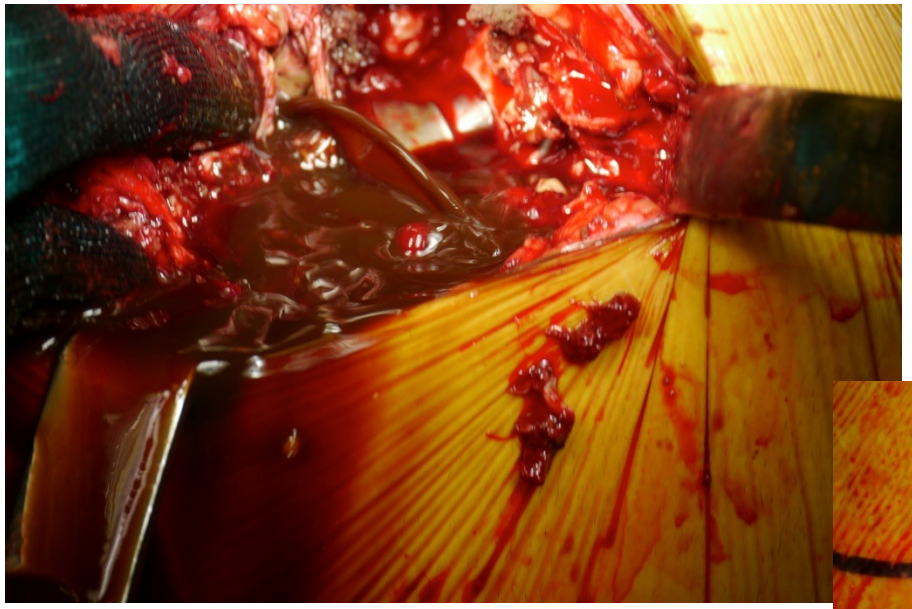

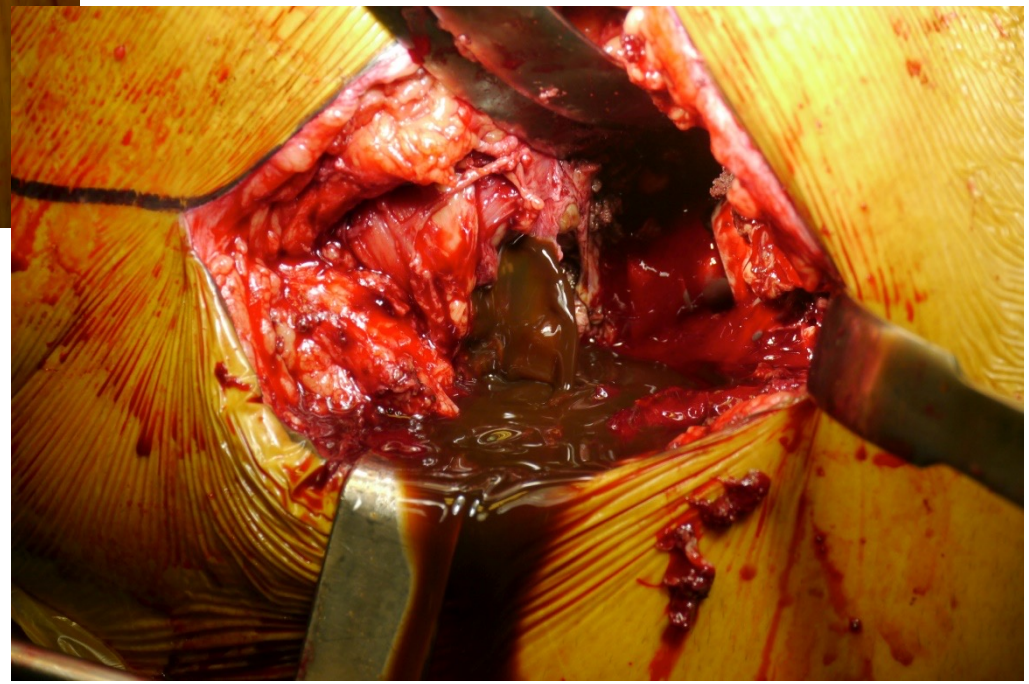

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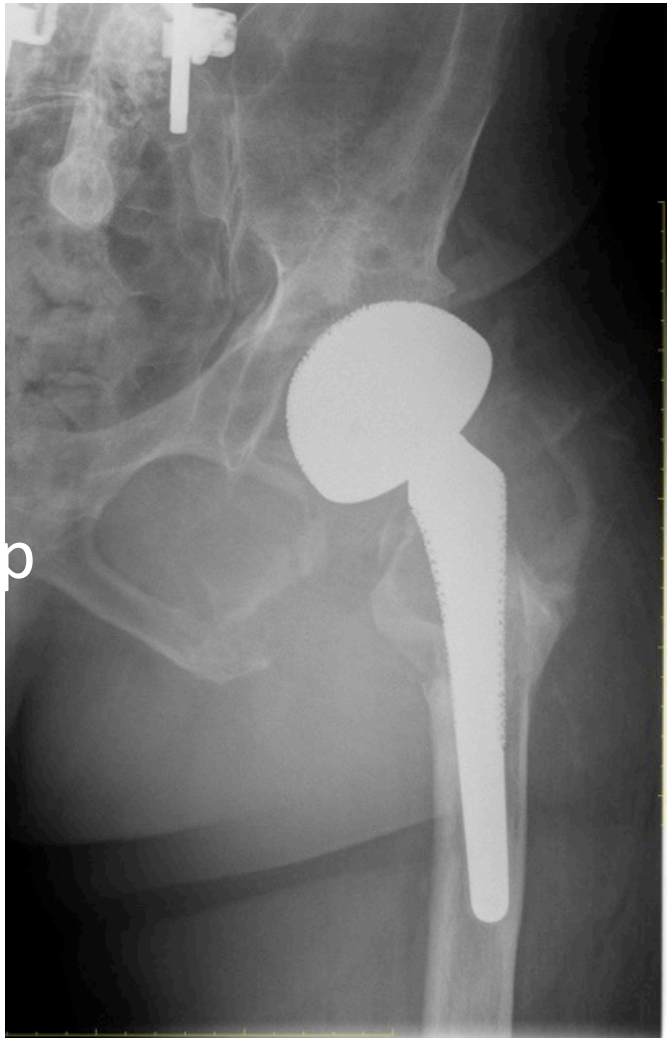

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Acetabular revision with bone loss in all sectors or pelvic discontinuity

SPACER DISLOCATION

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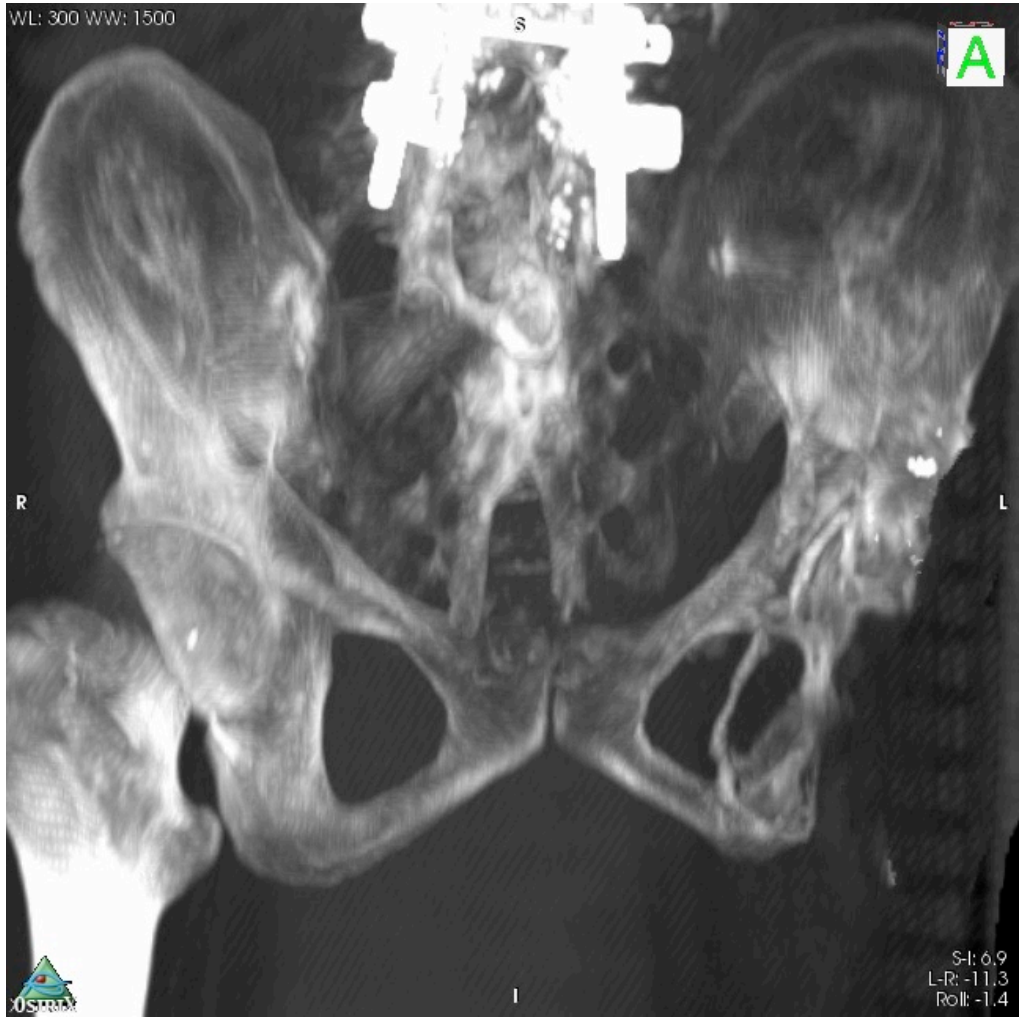

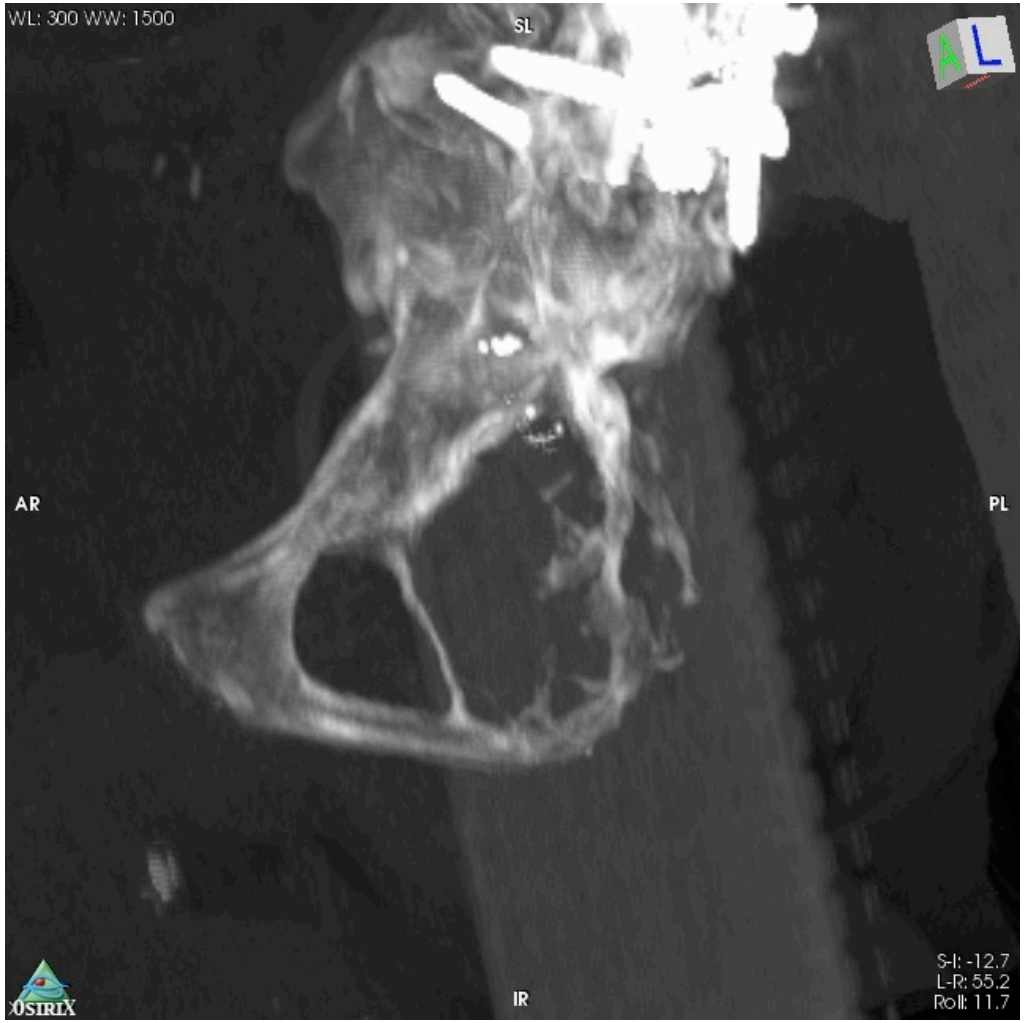

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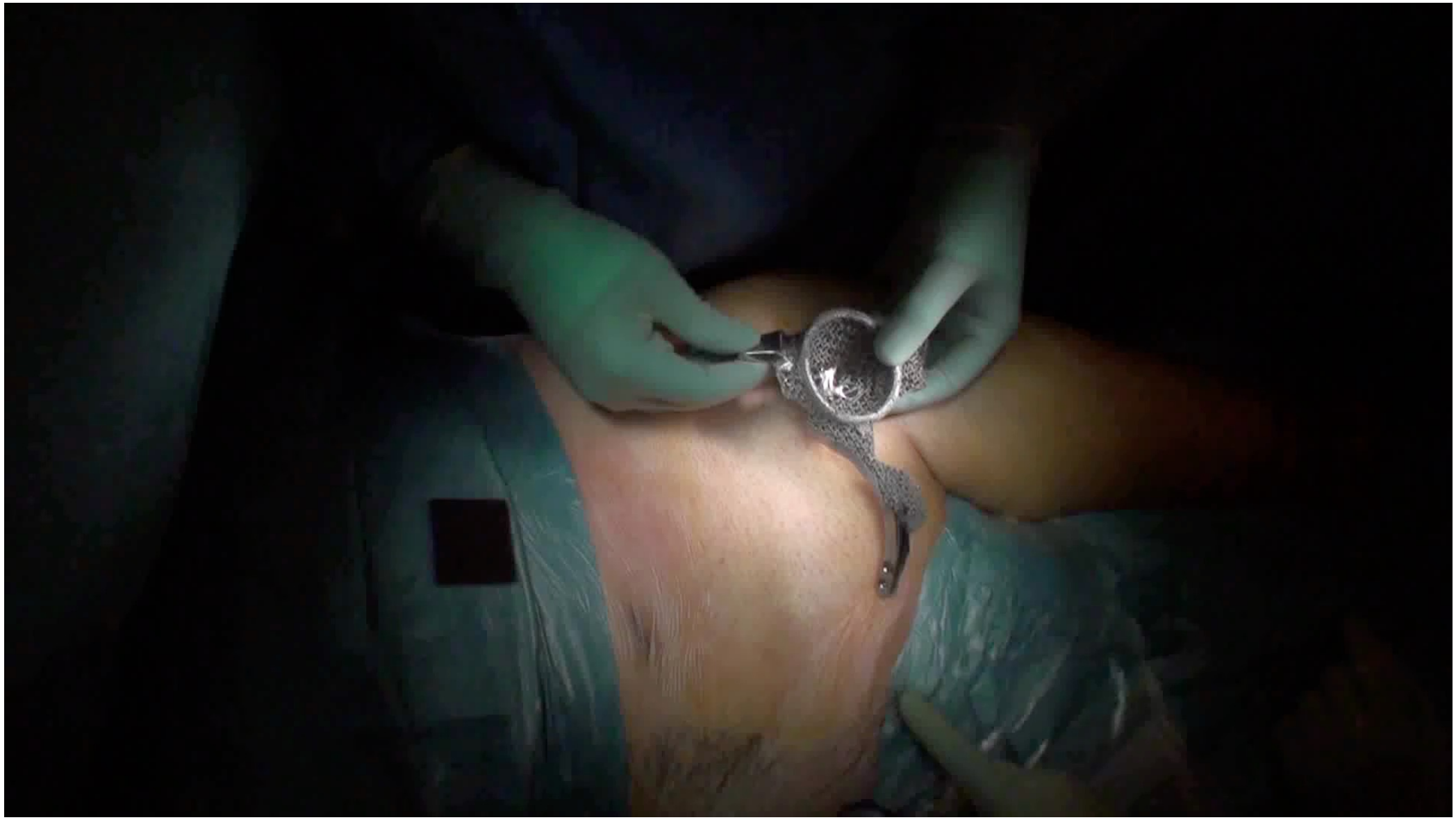

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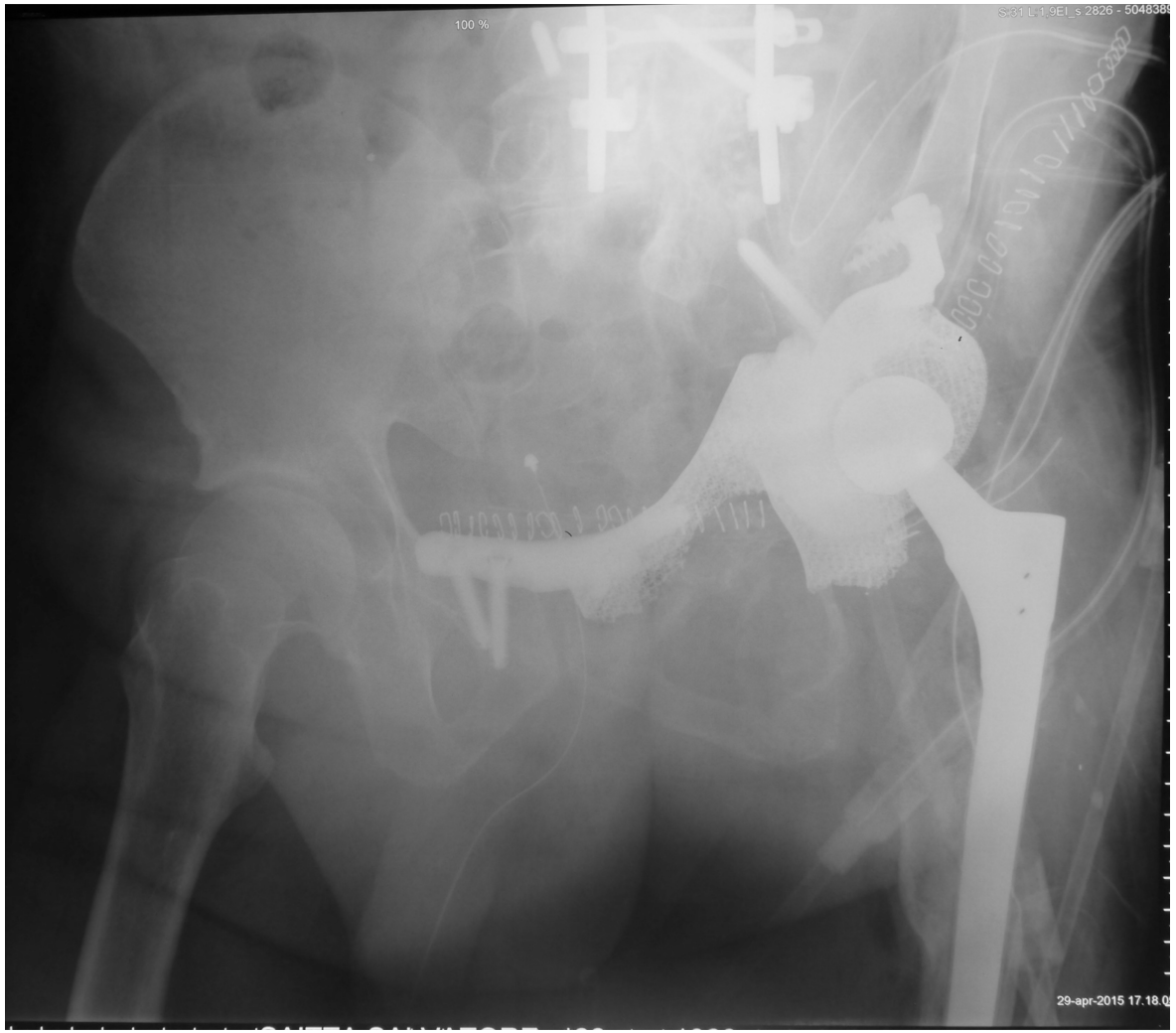

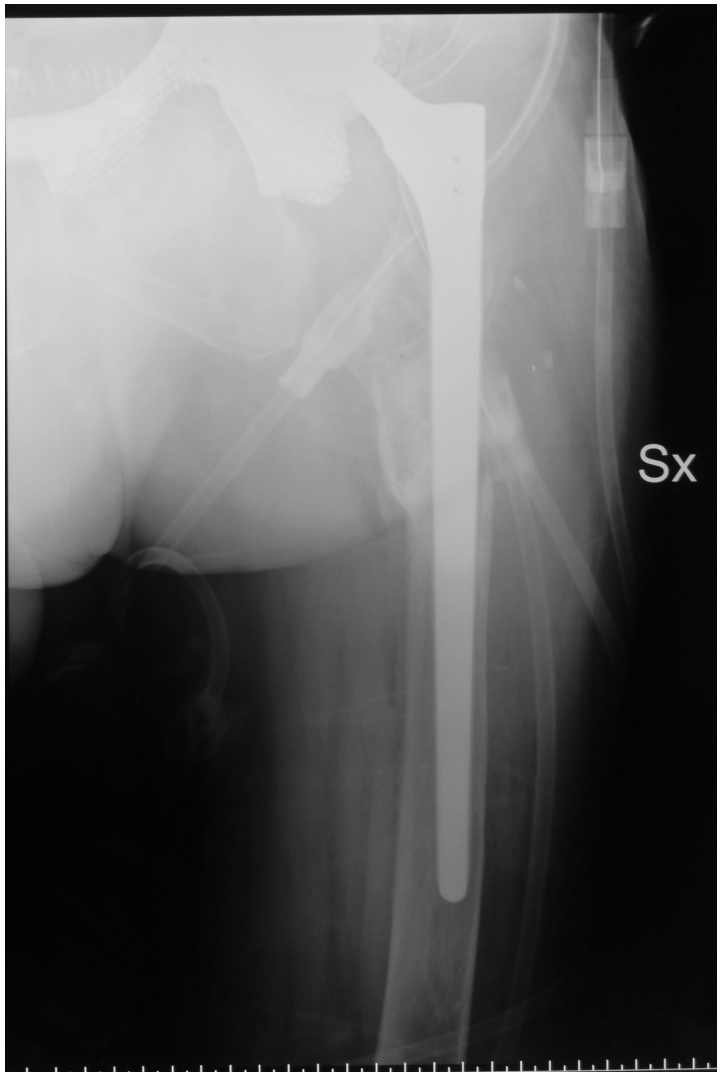

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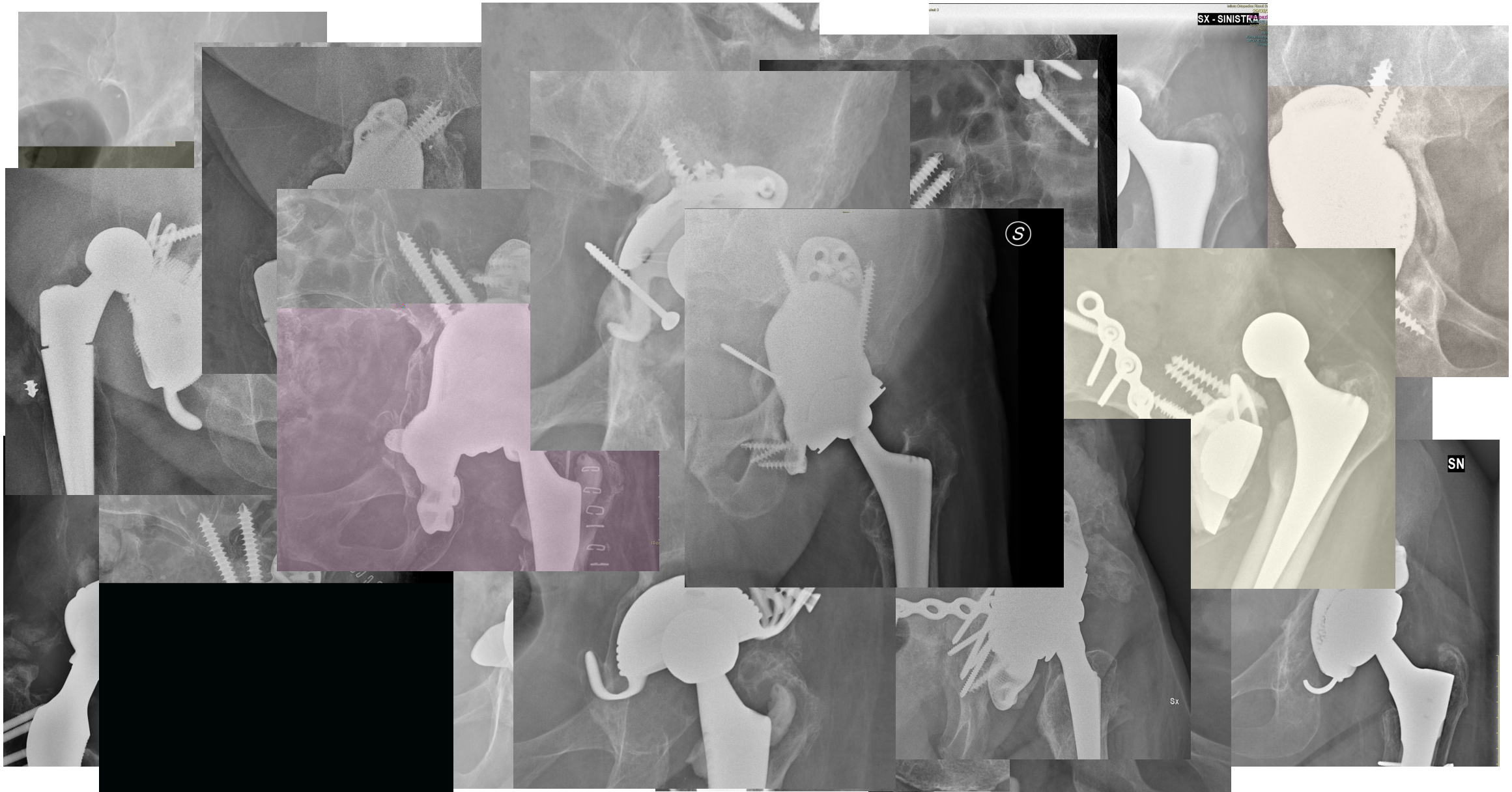
Acetabular revision with custom made prostheses



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Review of our first series: Objectives

- Investigate the clinical and radiographic outcomes of a consecutive series of CMAI implanted for a posterior wall disruption (min follow up 12 months).
- Only non-oncological reasons for revision were admitted.
- Using a 3D printing technique, a specific component was produced from a titanium alloy powder, using the powder technology.
- The final component was made in titanium alloy, with ultraporous surfaces, a series of screw options and a dual mobility bearing surfaces.

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Our experience: Results

19 CMAI were identified.

All the cases were performed for cup loosening and osteolysis.

At a mean follow up of 12.3±4.2 months, none of the CMAI was removed.

In one case, the component migrated after one month, but a subsequent stabilization occurred.

Two cases required a DAIR procedure for early signs periprosthetic infection.

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Final remarks

- Bone loss is the real problem in acetabular (& femoral) revisions
- A quantitative and topographic classification is useful
- Modular systems are reliable with correct indications
- Custom made prostheses simplify the surgery with huge bone loss

- But...

- A good understanding of the pathological anatomy shown at a CT scan

- It requires a careful preop plan and a good relationship with the engineers in charge to finalize the spacemen

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Thank you