Clinica Ortopedica e
Traumatologica
Università degli Studi di Pavia

Fondazione IRCCS
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Global and partial loosenings

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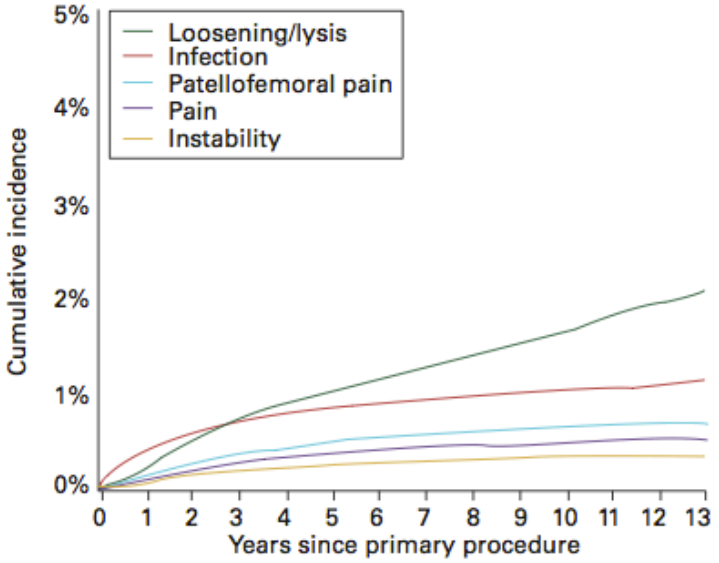
Epidemiology

- The most common indication for revision of a TKA in studies published prior to 2006 (almost 25% of all revisions)
- Advancement in surgical technique, tribology and polyethylene manufacturing reduced the incidence of early revision due to loosening (infection!!)



- It remains the most common indication for late revision

Khan et al, The epidemiology of failure in TKA, Bone Joint J, 2016.

Epidemiology

Since the National Joint Registries first began:

- Infection and pain as indications for revision have increased
- Aseptic loosening decreased

Table I. Variation trends for the indication of revision TKA for the most commonly referred to National Joint Registries (NJR)

	NJR England, Wales, and Northern Ireland		Swedish knee arthroplasty register		Australian orthopaedic association NJR	New Zealand NJR			American NJR
	1st annual report 2004[32] (%)	11th annual report 2014[26](%)	1st annual report 1999[33](%)	13th annual report 2014[29] (%)	1st annual report 2000[34](%)	14th annual report 2014 (%)	1st annual report 1999[28](%)	15th annual report 2013[28](%)	1st annual report 2013[30] (< 3 months to revision)
Aseptic loosening	*41.4*	*32.0*	*43.6*	*26.0*	*40.3*	*32.7*	*0*	*34.6*	N/a
Deep infection	*18.4*	*22.0*	*11.2*	*22.0*	*9.1*	*17.4*	*50*	*27.4*	*45.7*
Pain	*23.0*	*15.0*	n/a	n/a	*2.6*	*9.6*	*0*	*29.3*	n/a

TKA, total knee arthroplasty

Khan et al, The epidemiology of failure in TKA, Bone Joint J, 2016.

Osteolysis

- Chronologically periprosthetic osteolysis pre-dates aseptic loosening in the majority of cases
- It weakens the bone-implant interface
- It is a condition facilitating aseptic loosening

J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Basic science of osteolysis

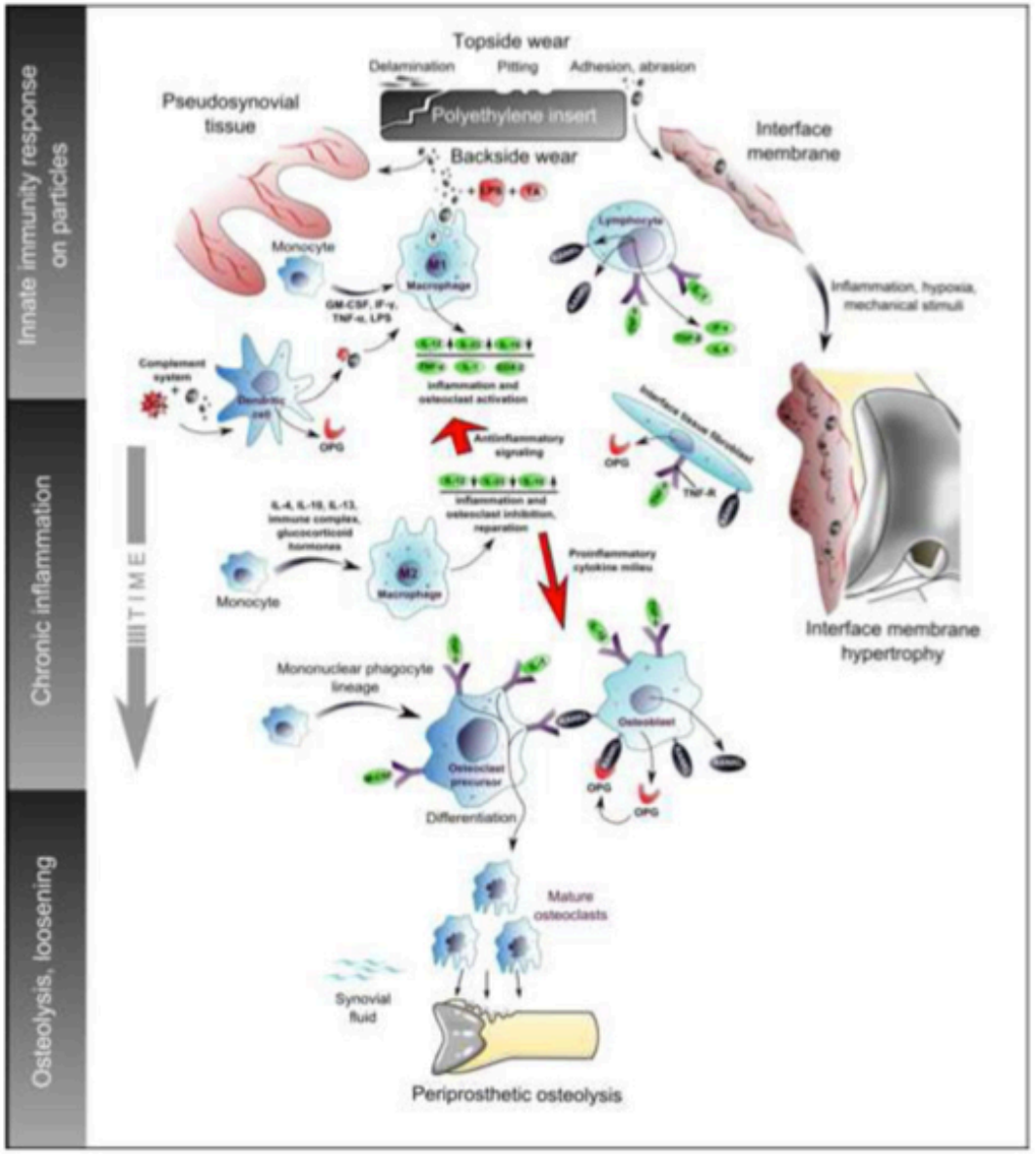
- Resorption of periprosthetic bone caused by an immune response to particulate debris:

1. Most commonly associated with polyethylene wear
2. Wear particles are phagocytized by macrophages that become activated and release inflammatory cytokines
3. Stimulation of osteoclasts
4. Bone resorption

J. Fraser et al, Wear and loosening in TKA: a quick review, J Knee Surg, 2015.

Chronic inflammation and osteolysis

- Size of osteolytic lesion and risk of aseptic loosening depend in part on the host's response to polyethylene, PMMA and metallic wear particles



J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Source and type of prosthetic particles

- Frictional forces result from a rolling/sliding motion are the main source of wear debris

- Adhesive wear
- Abrasive wear

} Smaller and more biologically active particles

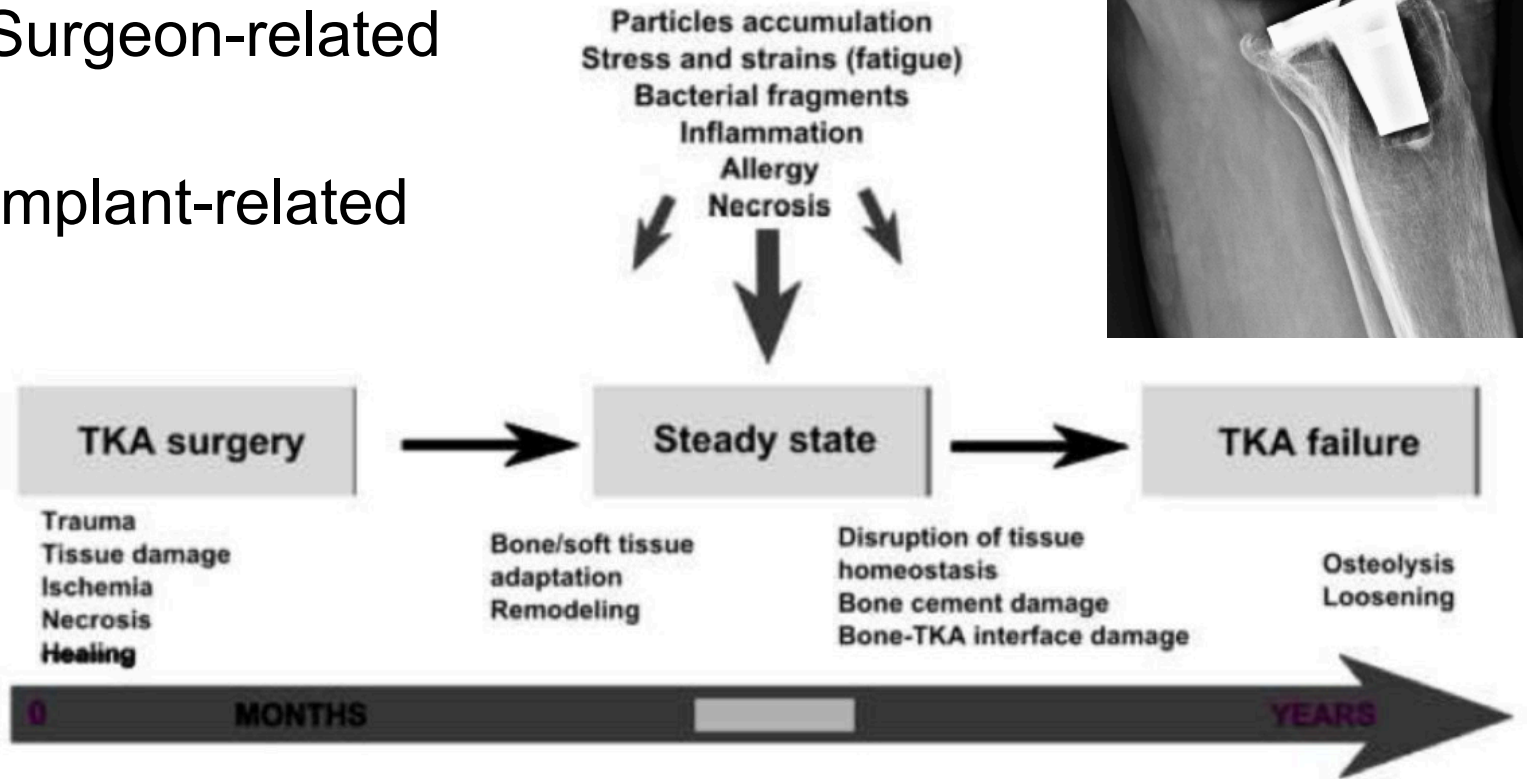
- Surface fatigue: Larger particles, delamination (flaky debris) and pitting (round debris)

- Tribo-/electrochemical wear

J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Pathogenesis of the loosening

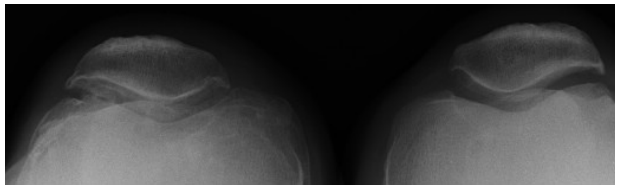
- Multifactiorial:
  - ✓ Patient-related
  - ✓ Surgeon-related
  - ✓ Implant-related



J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

CLINICAL CASE

- Male, 60 years
- Former argentinian rugby player
- Hypertrophic OA, right knee



CLINICAL CASE

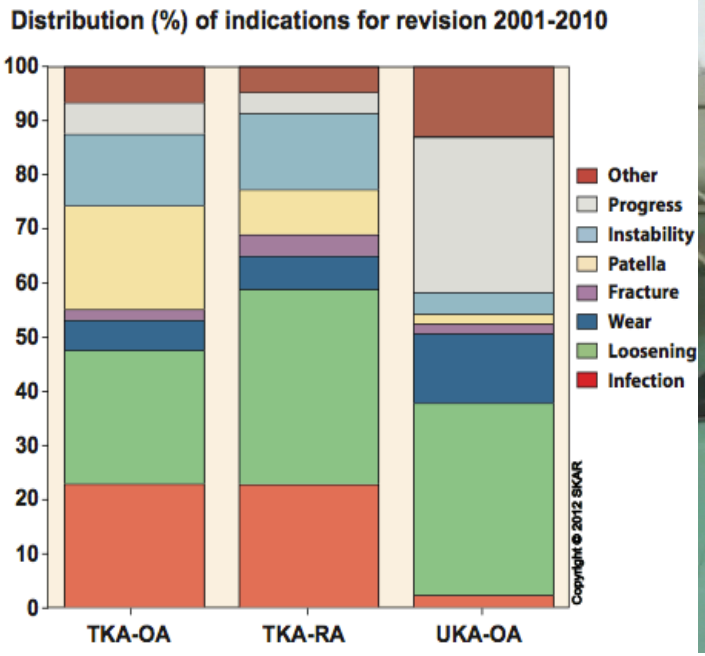
F-u at 3 months

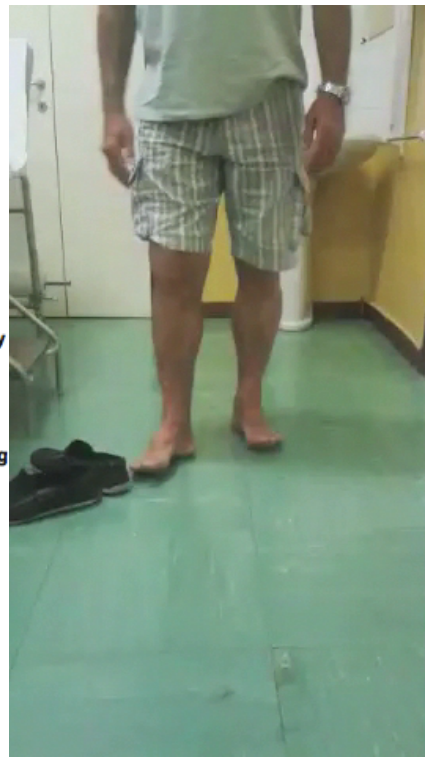
Patient-related factors

- Age: male
- Gender: younger

Higher activity

- Primary diagnosis: RA
- Individual susceptibility to osteolysis and chronic inflammation





These factors can not be influenced!

Swedish Knee Registry, Annual Report 2012.

J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Patient-related factors

- Physical activity:
  - ✓ Type
  - ✓ Extent
  - ✓ intensity

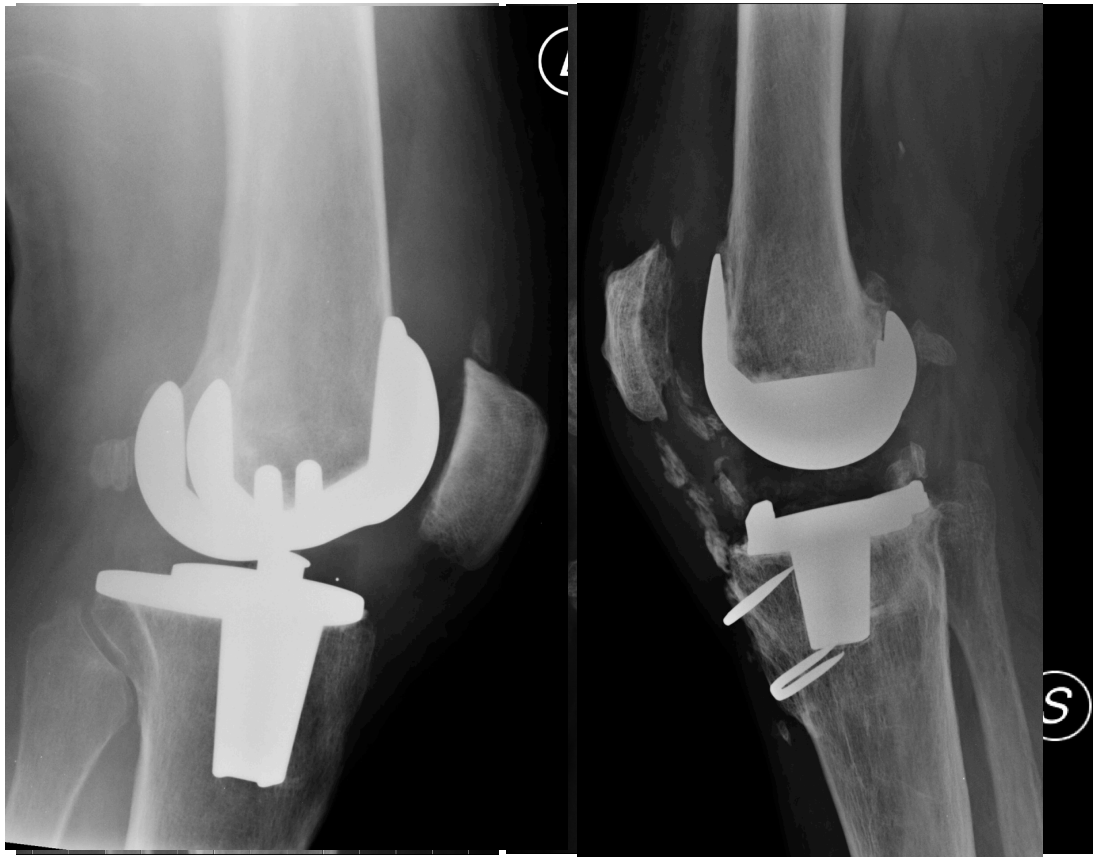
- Weight:
  - ✓ Every Kg generates up to 40 N more compression at the tibio-femoral joint
  - ✓ Higher rate of loosening in severely obese patients

These factors can be influenced!

J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Patient-related factors

- M. R.
- Male
- 65 years old
- Obese, Hypertension, Diabetes Mellitus type II
- Smoker
- osteotomy left knee (young age)
- Bilateral TKA (left 1998, right 2006)



Patient-related factors

2012, November, admission in hospital:

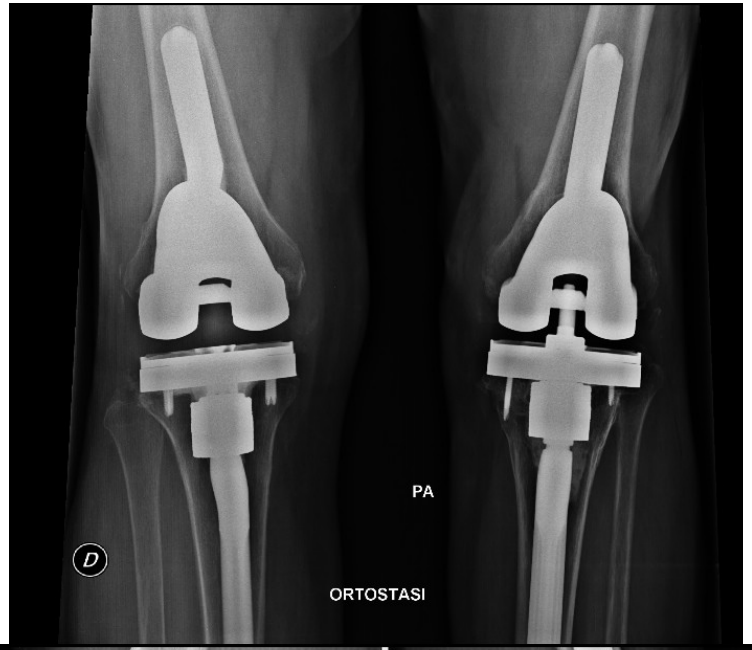
- Fever
- Neutrophilic leukocytosis, high RCP and PCTI
- Hyperglycemia
- Left knee swelling with acute pain
- After 10 days same symptoms right knee

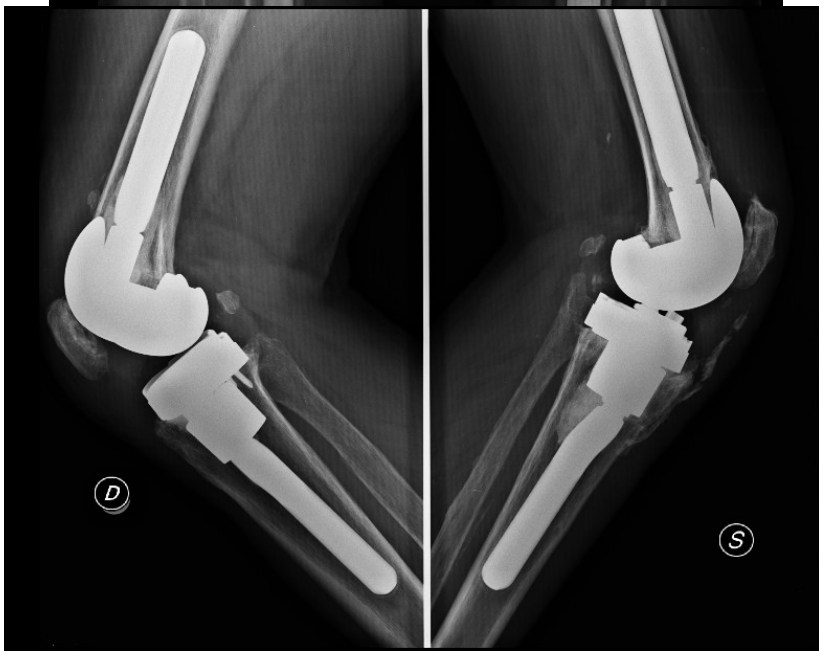
Patient-related factors

- Septic shock
- Arthrocentesis (left knee) and blood coltures: beta hemolytic streptococcus
- Synovial fluid culture (right knee): Candida Albicans

Step one: Hoffman

F-u 13 months (right),6 months (left)





Surgeon-related factors

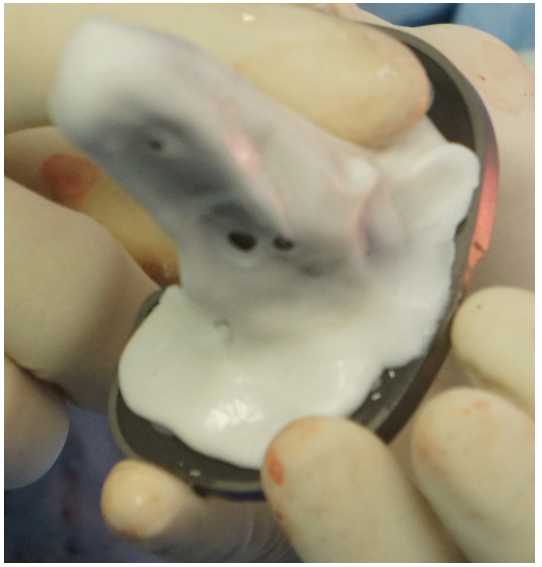
- Failure to restore of the mechanical axis of the limb
- Poor component alignment (flexion of femur, excessive posterior tibial slope, malrotation)
- Instability of TKA

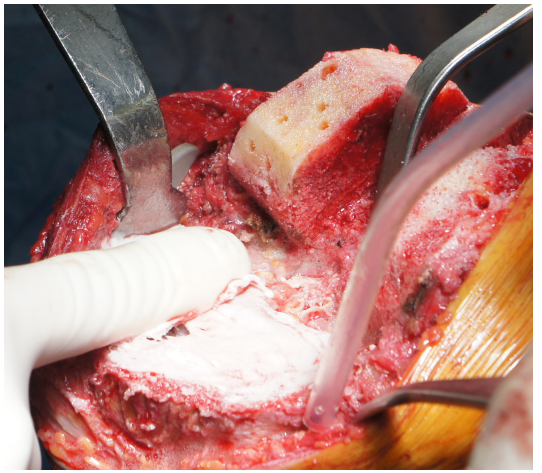
- Increased loading forces across the bone implant interface
- Polyethylene damage

J. Gallo et al, Osteolysis around TKA: a review of pathogenetic mechanism, Acta Biomaterialia, 2013.

Surgeon-related factors

- Cemented or uncemented: open discussion
- Which type of cementation:
  - ✓ Full cementation: risk of stress-shielding
  - ✓ Surface cementation: cement must be penetrate more than 3 mm in the trabecular bone



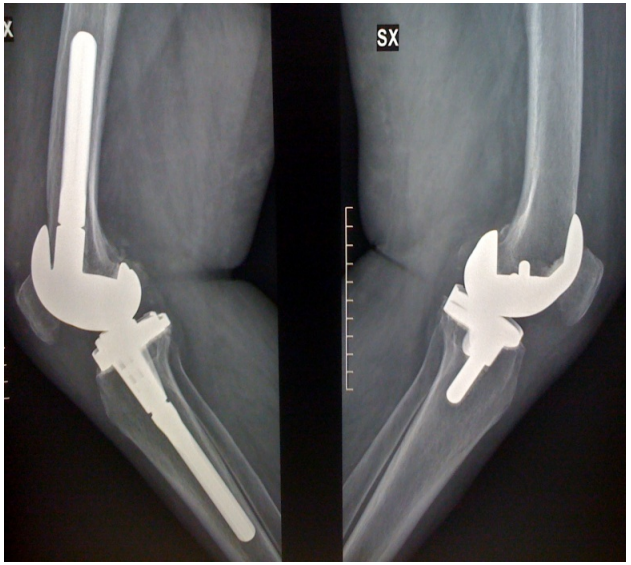


Clinical case

Clinical case

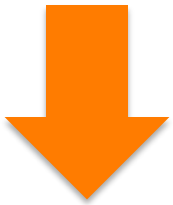
Implant-related factors

- Less conforming designs with tibial flat surface
- Level of constraint
- Method of manifacturing and sterilization of polyethylene
- Ceramic-ceramic TKA?



Early bone changes after TKA surgery

- The loss in bone density reaches up almost 23% within 1 year postoperatively
- It is the result of the surgical procedure, peri-operative inflammation and bone remodeling
- Periprosthetic bone density generally normalizes at the end of 3 years



- Early postop administration of biphosphonates could decrease the risk of aseptic loosening

Clinical history

- History of wound healing, prolonged drainage
- Fever, chills
- Night sweats
- Urinary tract infection, recent dental work

Infection

- Pain at rest → Infection, regional pain
- Late onset of pain → Loosening, instability, hematogenous infection
- Startup pain/triphasic pattern → Loosening, mechanical failure

Clinical history

Table 2 Type of pain

Night and rest pain	Infection
	Joint effusion or referred neurogenic
Pain on descending stairs and chair raising	Flexion gap instability
	Femur malrotation
Anterior knee pain	Patella maltracking
	Overuse tendinitis and neurinoma
Posterior knee pain	Posterior soft tissue tightness
	Popliteus tendinitis
Pain on full extension	Anterior soft tissue impingement
	Posterior tightness
Pain on full flexion	Post impingement (offset/osteophytes)
	Patella impingement or tightness
Starting pain	Loose components
	Tibia and/or femur forceps pain
Weight-bearing pain	Unspecific
	Mainly mechanical cause

Hoffmann et al, “The painful knee after TKA: a diagnostic algorithm for failure analysis”, Knee Surg Sports Traumatol Arthrosc (2011) .

Radiolucent lines and osteolysis

The Journal of Arthroplasty 30 (2015) 2311–2314

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

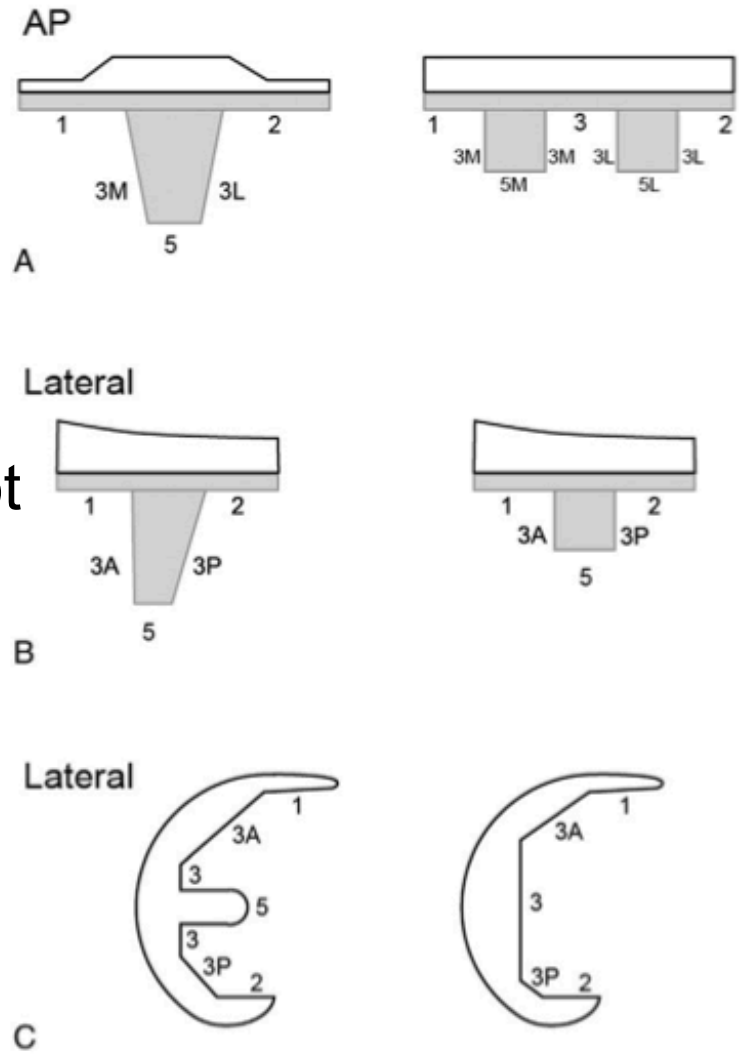
Development of a Modern Knee Society Radiographic Evaluation System and Methodology for Total Knee Arthroplasty

R. Michael Meneghini, M.D. [a], Michael A. Mont, M.D. [b], David B. Backstein, M.D. [c], Robert B. Bourne, M.D. [d], Doug A. Dennis, M.D. [e], Giles R. Scuderi, M.D. [f]

- Stable non progressive radiolucent lines are frequent in the first years after TKA
- Descriptive evaluation rather than predictive or prognostic

Radiolucent lines and osteolysis

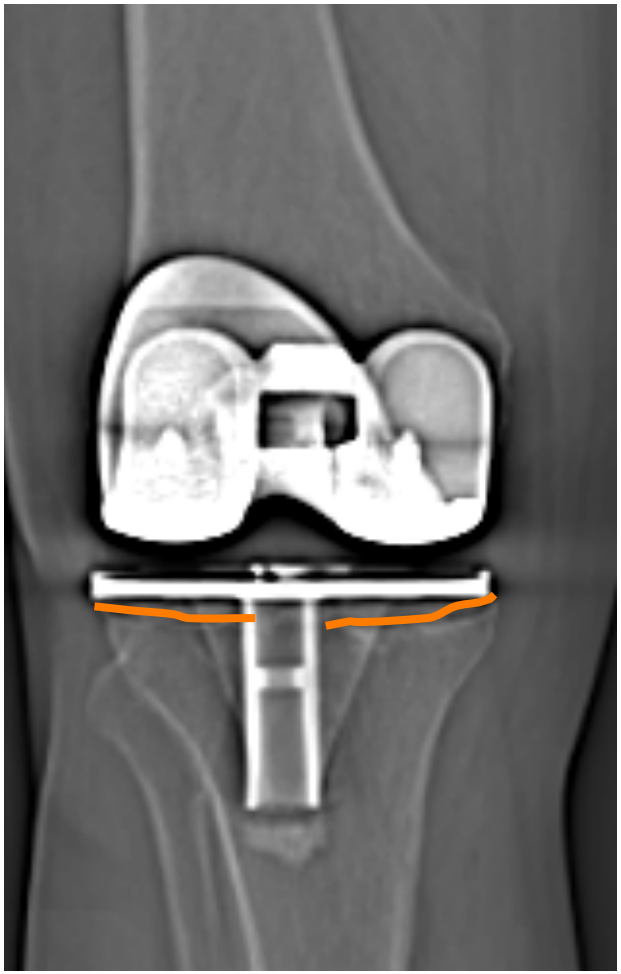
- Implant-cement and cement-bone interfaces
- Implant bone interface (uncemented)
- Complete or partial: encompass or not an entire interface surface
- Stable or progressive: serial radiographs with nearly orientation
- Millimeters

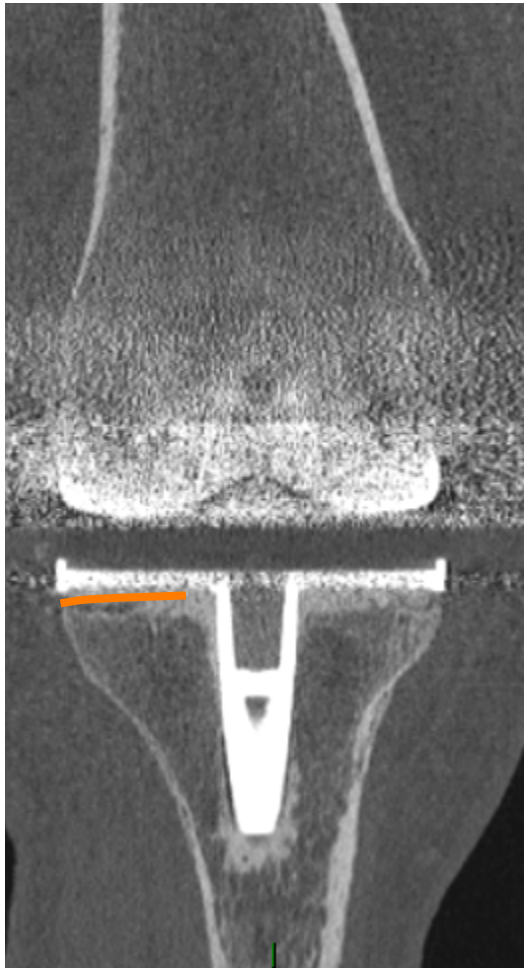


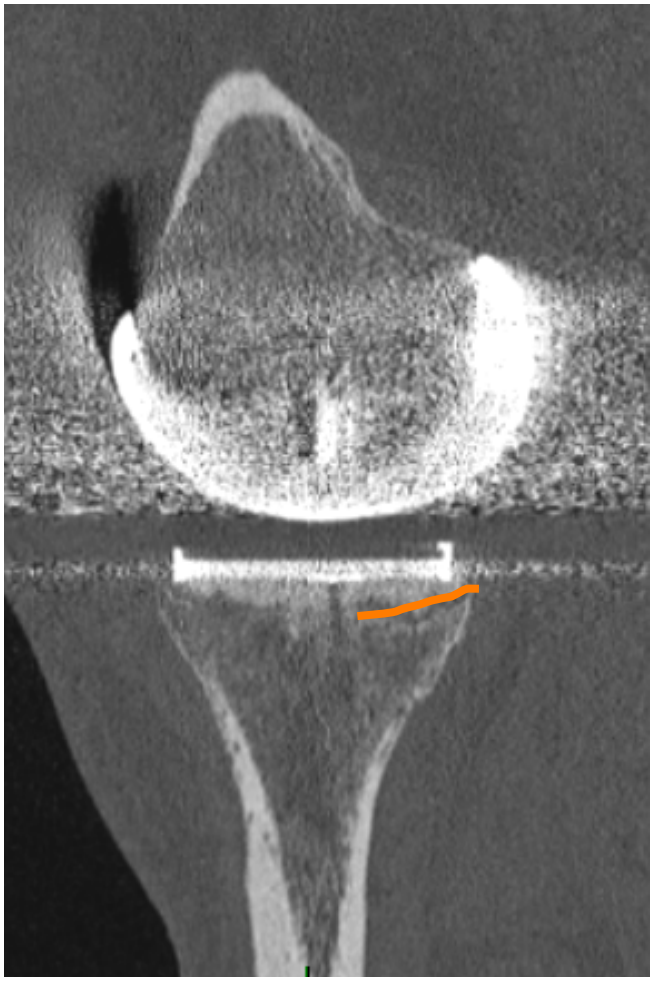
Meneghini et al, Development of a Modern Knee Society Radiographic Evaluation System and Methodology for TKA, J Arthroplasty, 2015.

Radiolucent lines

Six months after primary TKA: cementation?? Bone change??







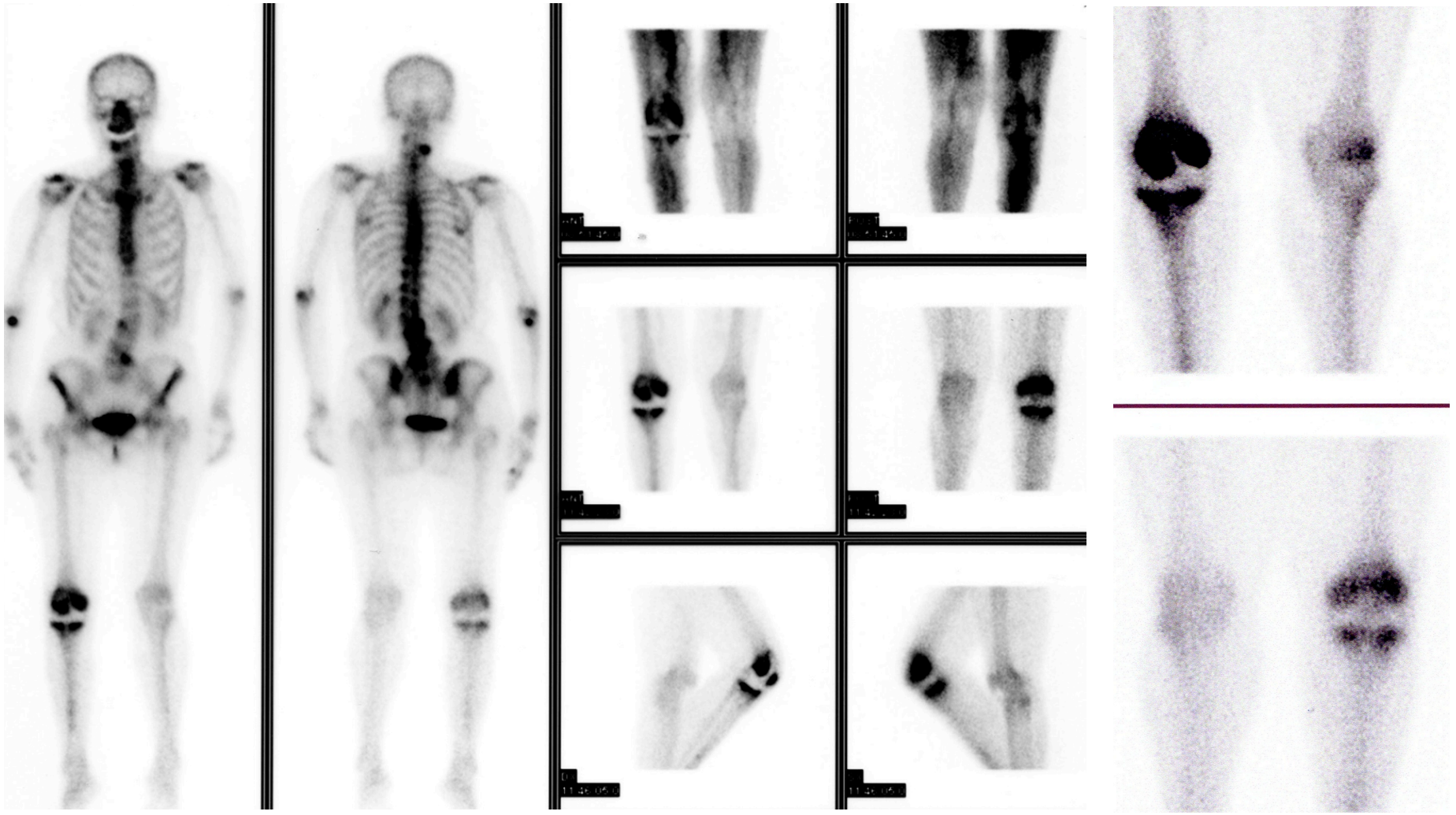
Radiological examination

CT:

- Evaluate bone loss (wear osteolysis, fracture)

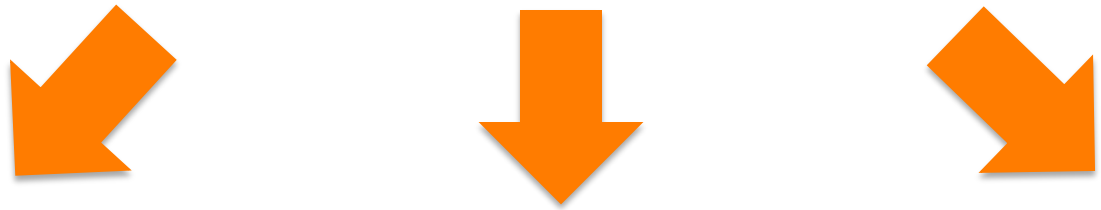
Radiological examination

Whole body bone scintigraphy 99mTc-HMDP



Treatment

- Preoperative and intraoperative are critical for the success
- Evaluate:
  - ✓ Stability of the components
  - ✓ Alignment
  - ✓ Bone loss (AORI classification)



Serial radiographs

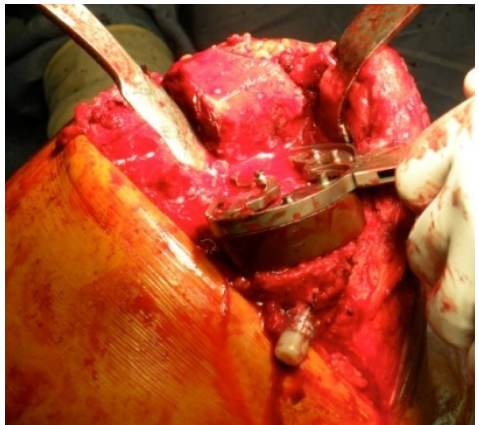
PE exchange +/- bone graft

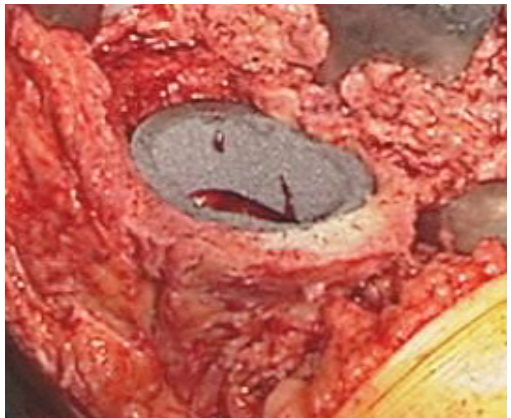
TKA revision

Bone loss management: treatment

Type 1	Type 2	Type 3
Cement	< 5 mm: cement	Unicondylar: metal augments
Morcelized bone graft	> 5 mm: metal augments	Bicondylar: • metal augments • tantalum cones • structured allografts

An implant which is supported by bone of poor quality will turn to an early failure





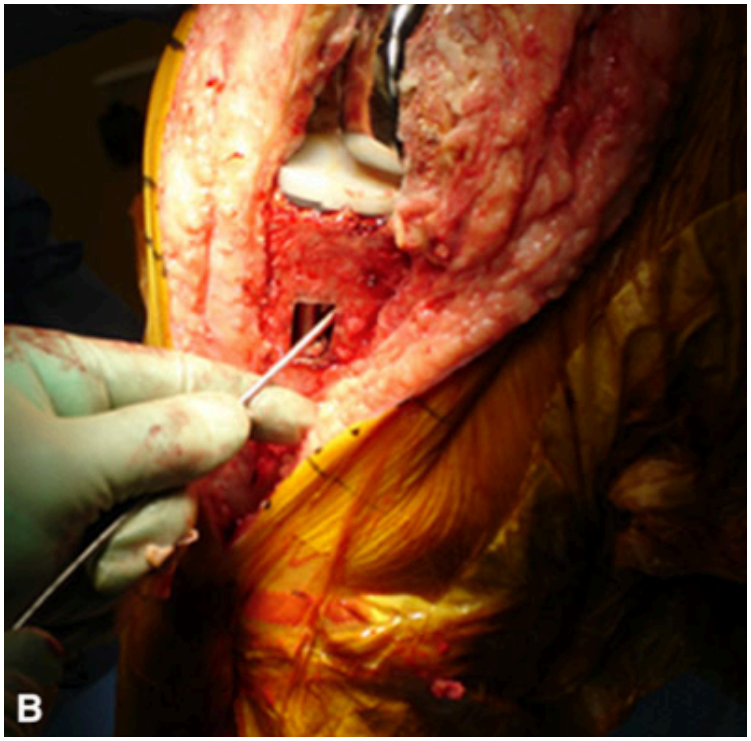
Clin Orthop Relat Res (2011) 469:154–159
DOI 10.1007/s11999-010-1521-3

SYMPOSIUM: PAPERS PRESENTED AT THE ANNUAL MEETINGS OF THE KNEE SOCIETY

Liner Exchange and Bone Grafting

Rare Option to Treat Wear & Lysis of Stable TKAs

John J. Callaghan MD, Eric R. Reynolds, Nicholas T. Ting BA, Devon D. Goetz MD, John C. Clohisy MD, William J. Maloney MD



- 22 patients (25 knees): 17 F, 5 M
- Mean area of femoral osteolysis: 21 cm^2 (a-p), 22 cm^2 (lat)
- Mean area of tibial osteolysis: 10 cm^2 (a-p), 9,3 cm^2 (lat)
- TKA well-fixed and well-aligned

Table 3. Type of graft used

Graft source	Number	Percent
Allograft	11	44
Allograft and commercial graft	8	32
Commercial graft	4	16
Allograft and methylmethacrylate	2	8

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- Mean f-u: 59 months
- 84,6% of femoral and 70% of tibial lesions showed complete or near complete graft incorporation
- One revision (of the 25 knees) for aseptic loosening

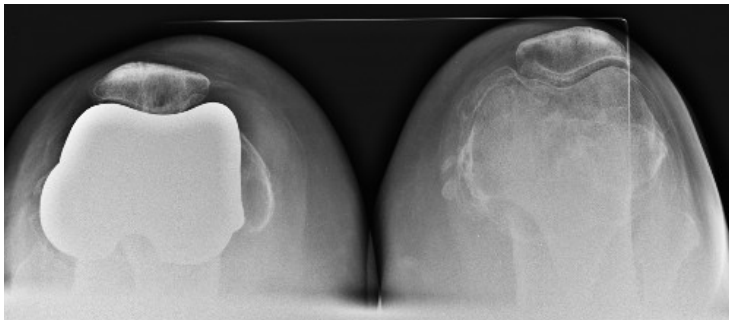
Table 4. Graft incorporation*

Lesions	Number	Percent
Femoral lesions (13)		
Fully incorporated	9	69.2%
Mostly incorporated	2	15.4%
Partially incorporated	2	15.4%
No incorporation	0	
Tibial lesions (20)		
Fully incorporated	12	60%
Mostly incorporated	2	10%
Partially incorporated	5	25%
No incorporation	1	5%

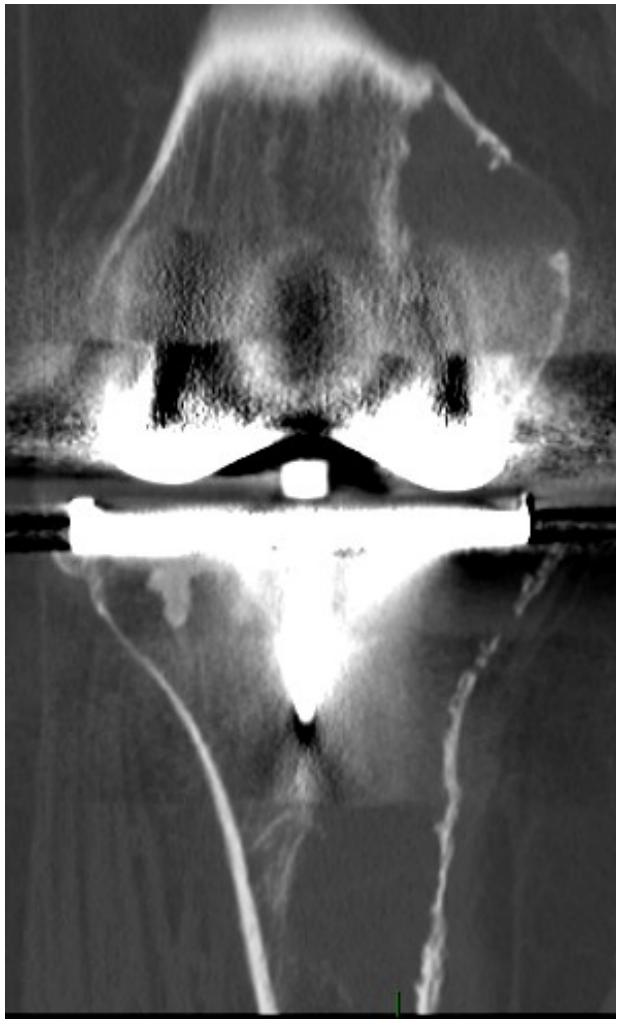
* One knee with less than 24-month radiographic followup.

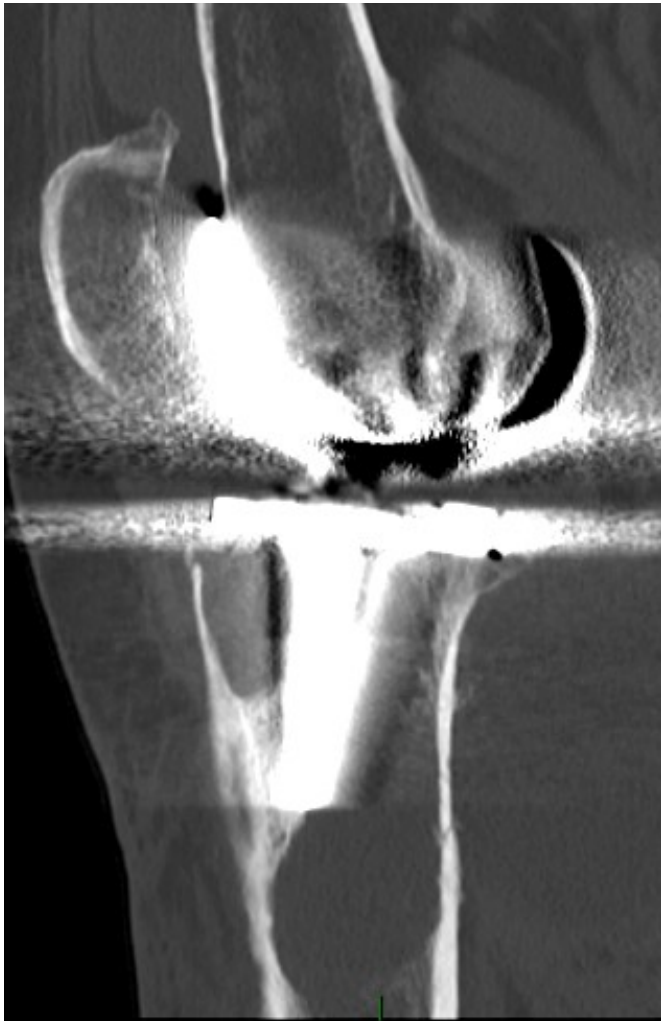
Revision TKA: clinical case

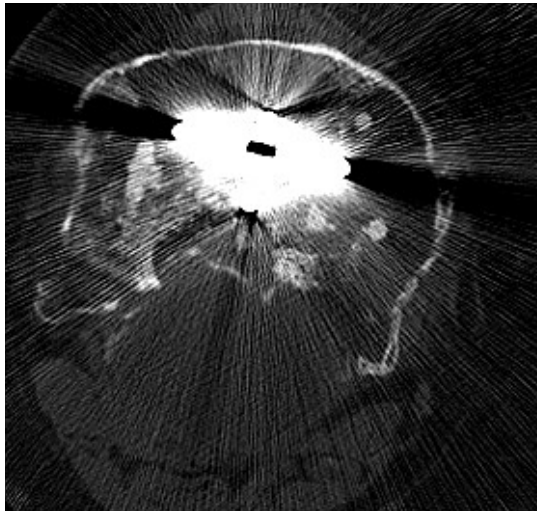
- Female
- 66 years
- TKA 13 years ago

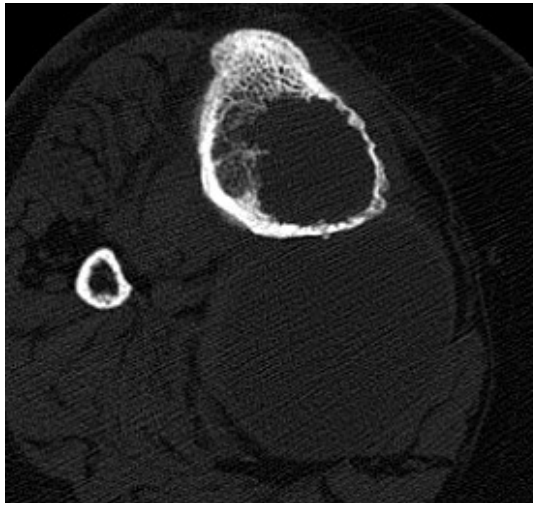


Revision TKA: clinical case

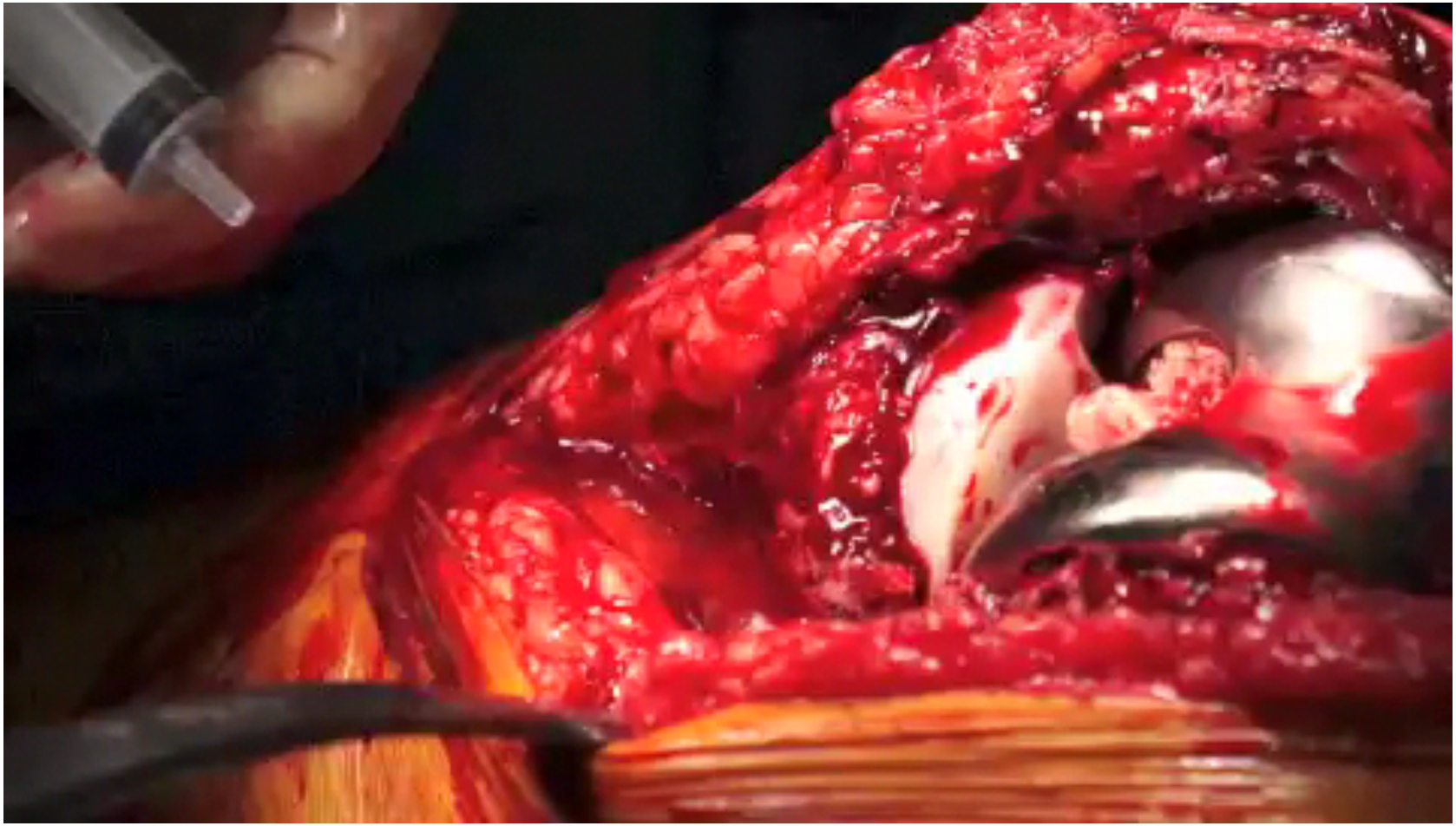




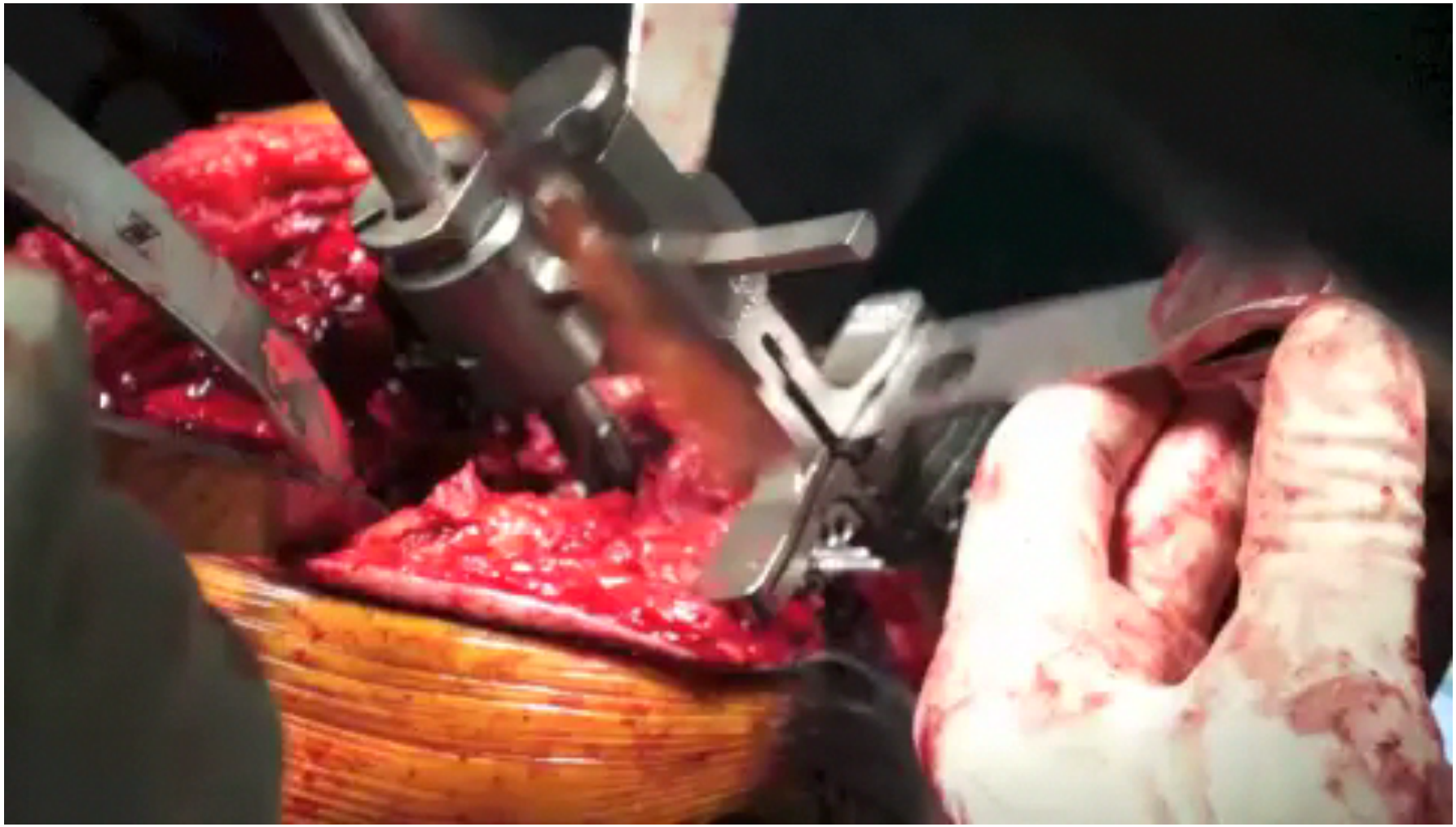




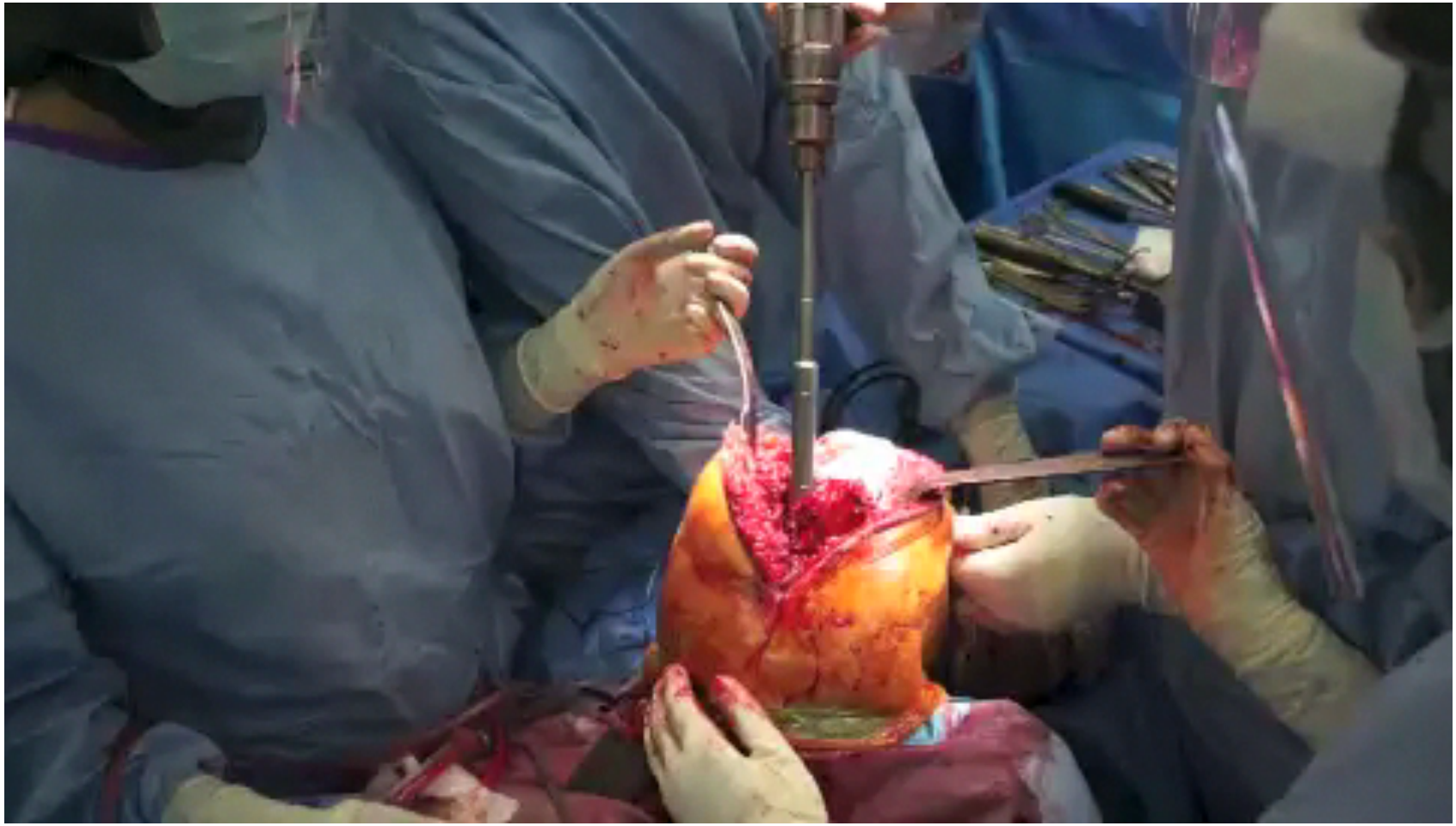
Component removal



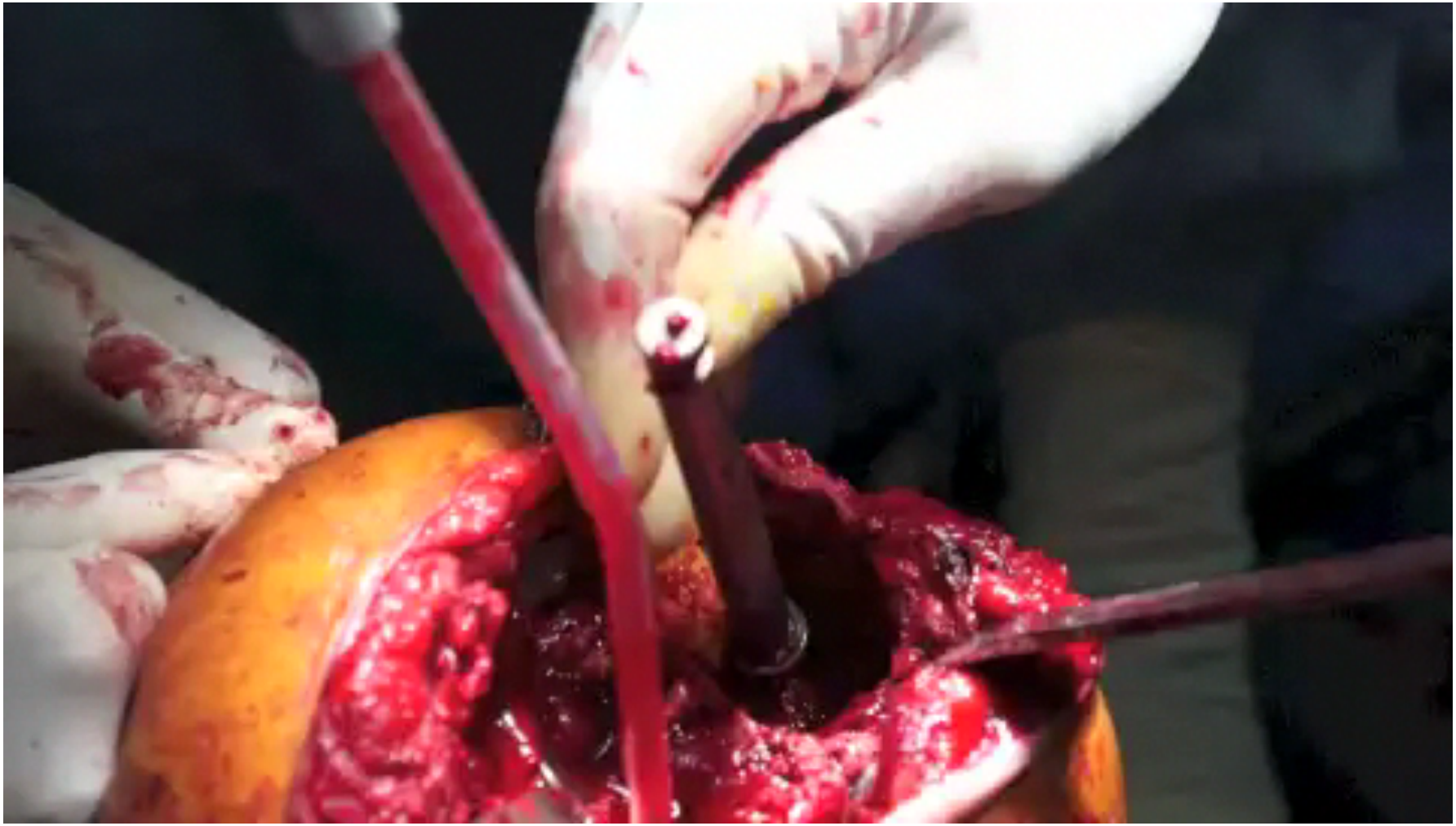
Tibia preparation



Femur preparation

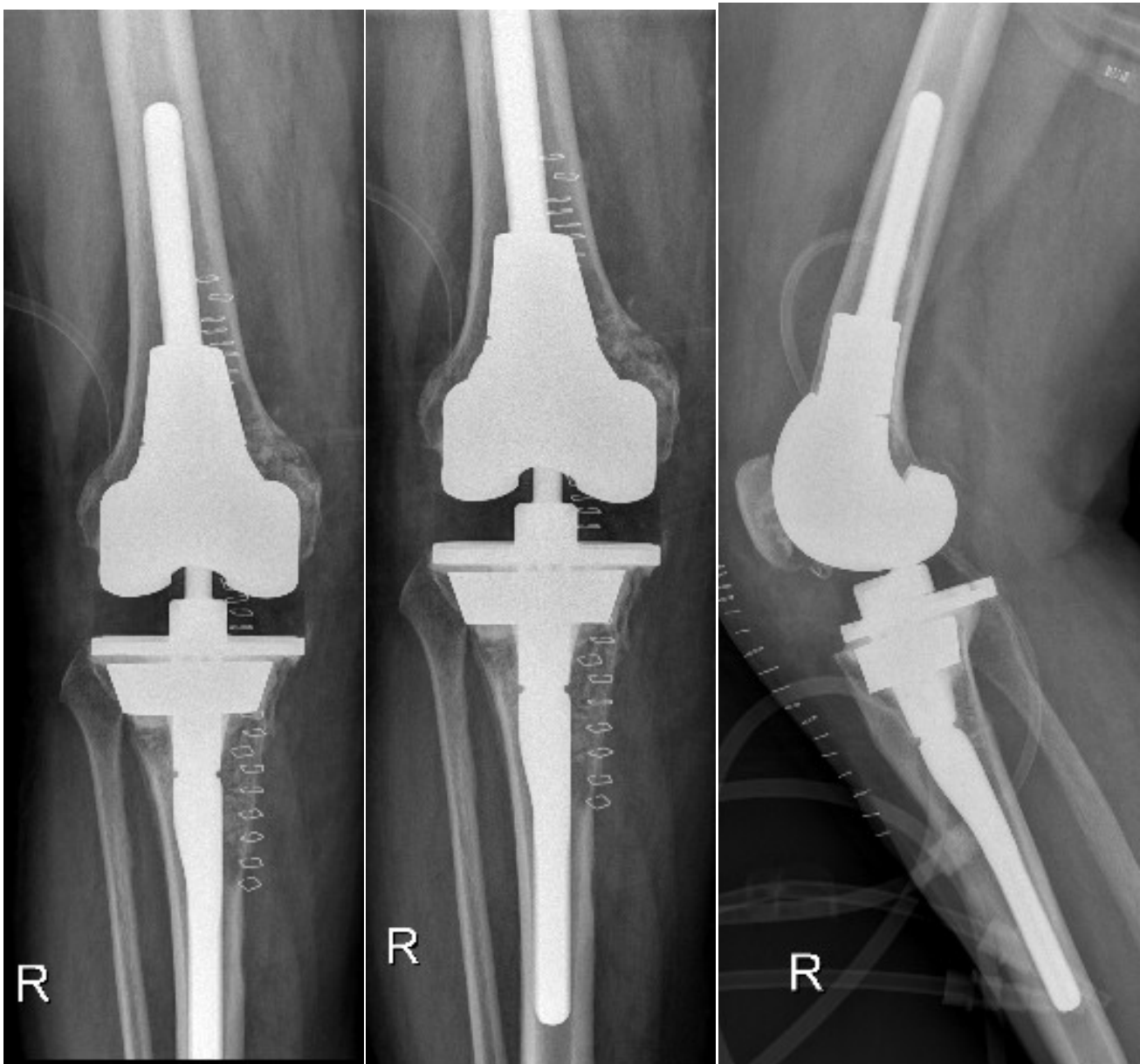


Final

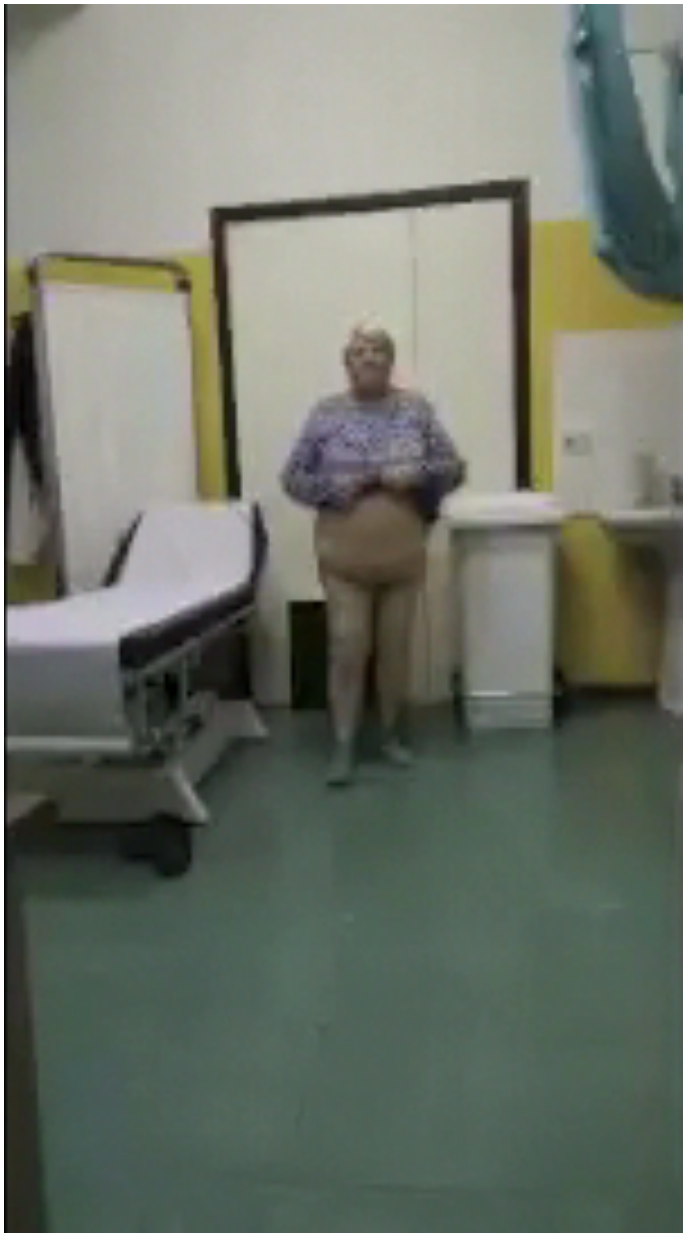


Post-operative x-rays

- LCCK
- 2 femoral cones
- 3 femoral augments
- Tibial cone



Follow-up at 2 months



Conclusions

- The most common indication for late revision
- Osteolysis pre-dates aseptic loosening in the majority of cases
- Caused by an immune response to particulate debris (PE wear)
- Multifactorial pathogenesis
- Clinical and radiological history (exclude infection!)
- If TKA stable: serial x-rays or PE exchange and graft
- If TKA unstable: revision TKA
- Address properly the bone loss to avoid further revision!