

Orthopedic Management of Skeletal Metastases

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General

- Approximately 1.4 million new cancer patients diagnosed each year
- Incidence of skeletal metastases varies: 12-70%
- Bone---3rd most common organ involved by mets, behind lung and liver (In breast cancer it is the second most common site)
- Autopsy studies of breast cancer patients have demonstrated skeletal metastases in 90% of patients
- The quality of life of patients with skeletal metastases is compromised by pain, forced immobilization and pathological fractures

General

- Most skeletal mets involve the axial skeleton and lower extremities (More heavily vascularized parts of skeleton)
 - Thoracolumbar spine
 - Pelvis
 - Proximal femur/lower limb
 - Skull
 - Upper extremities 10-15 % of skeletal metastases

General

- 7-10% of patients with skeletal metastases develop pathological fractures
- Pathological fracture may be the first sign of disease
- When the primary site is unknown the most likely origin of the metastasis is from the lung or kidney
- The primary site is not discovered in 3-4% of patients who present with a pathological fracture

Most Common Metastases to Bone

- Myeloma
- Breast
- Lung
- Prostate
- Kidney
- Lymphoma
- Thyroid
- GI tract
- Melanoma

Presentation

- Pain, usually localized and intermittent at first; progressive increase in intensity over time
 - (Mechanical Pain and Biological Pain from cytokines and chemical mediators)
- Pain at Night
- Rotator cuff symptoms or frozen shoulder with shoulder girdle mets
- Referred pain, motor weakness, sensory deficits or bowel and bladder dysfunction from spine mets

Evaluation

■ Laboratory Studies

- CBC—anemia, bone marrow suppression, neutropenia
- Chemistries—hypercalcemia, elevated alkaline phosphatase
- PT/PTT, LFTs
- Serum Protein Electrophoresis (SPEP)
- Urinalysis
- PSA, CEA (GI Cancer), CA129 (breast)

■ Radiological Studies

- Plain Radiographs
- Bone Scan
- MRI/CT Scan
- PET Scan

Radiographic Studies

- Identify site of disease and extent of local disease
- Amount of bone involved
- Multiple lesions in a bone
- Presence of soft tissue component
- Other sites of disease (precautions during surgery)
- Important to determine optimal surgical approach, amount of tumor to be removed and method of reconstruction

X-Ray

- First test ordered for evaluating bone pain
- Usually permeative, sometimes geographic or well circumscribed
- Lytic, Blastic, Mixed
- Prostate Mets---blastic
- Breast Mets---usually mixed
- Lung Mets---usually lytic
- Renal cell and Thyroid---lytic, expansile

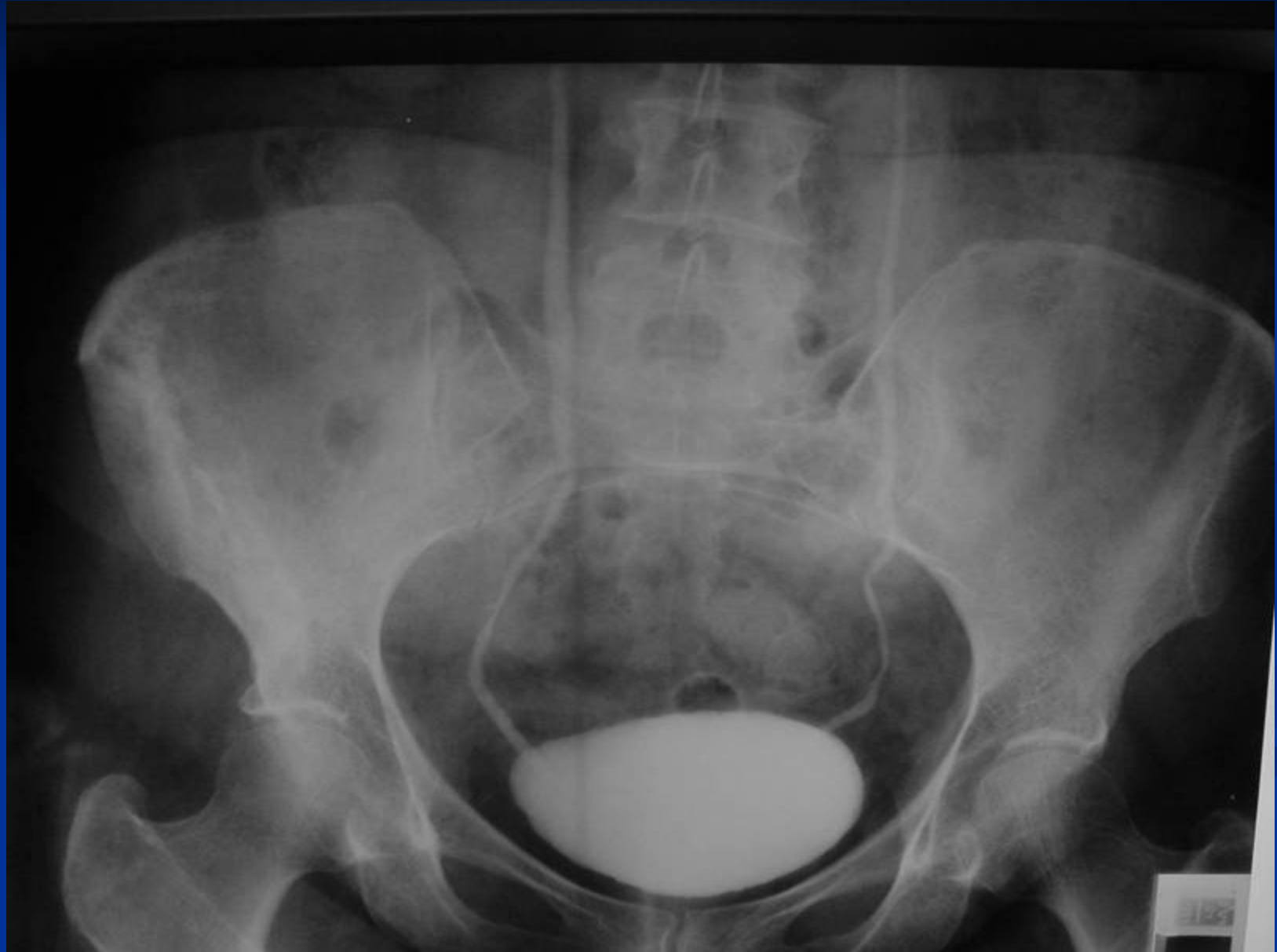
X-Ray

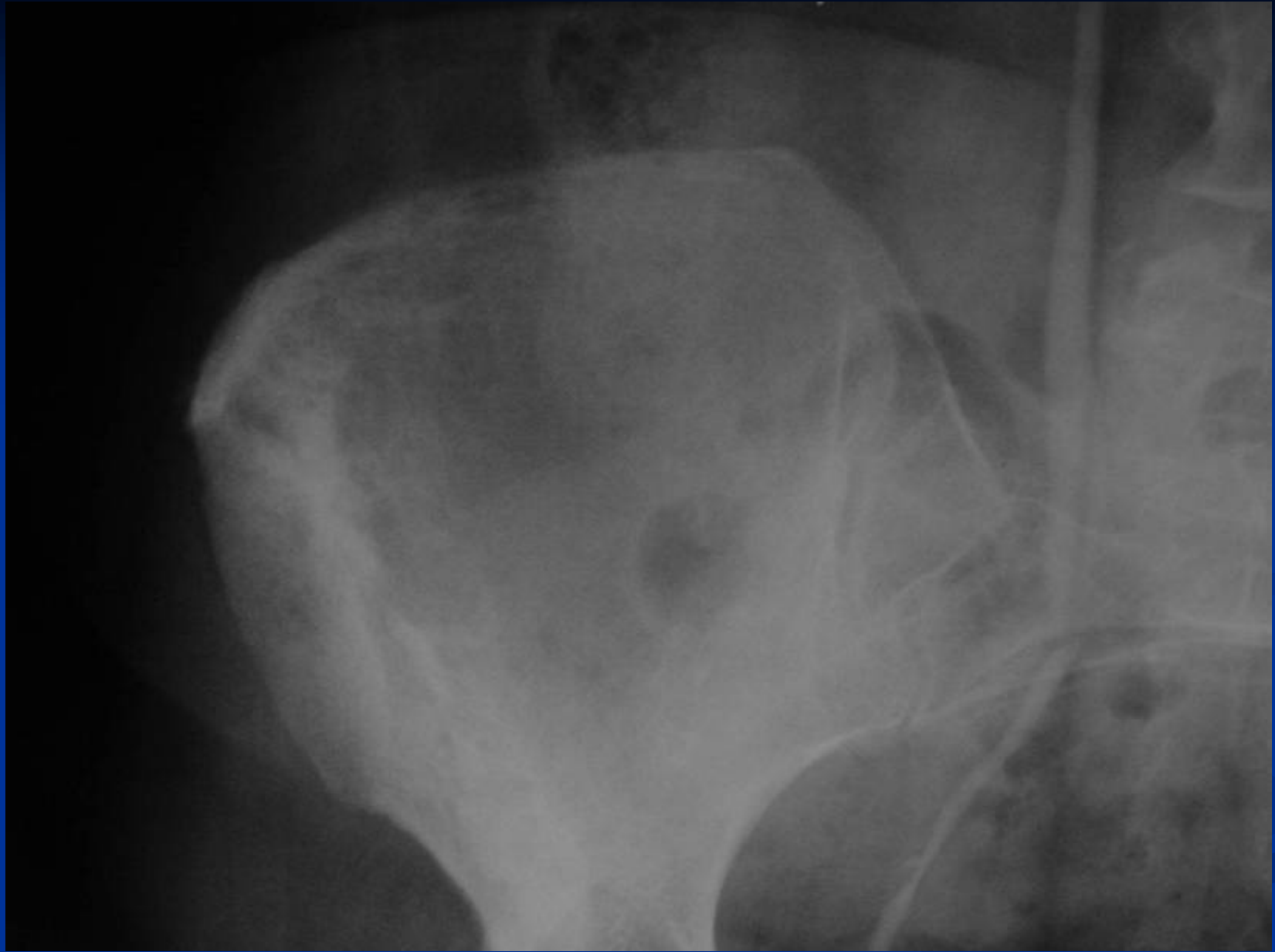
- Evaluate overall bony quality, structure
- Entire bone is radiographed so that all lesions can be identified and addressed during the same surgery
- Monitoring response to treatment, disease progression and local recurrence
- Skeletal survey for tumors that may not be detected on bone scan (multiple myeloma, renal cell carcinoma)
- 30% of bone must be destroyed in order for a lytic lesion to be evident on a plain x-ray

Breast --Mixed



Breast---Mixed

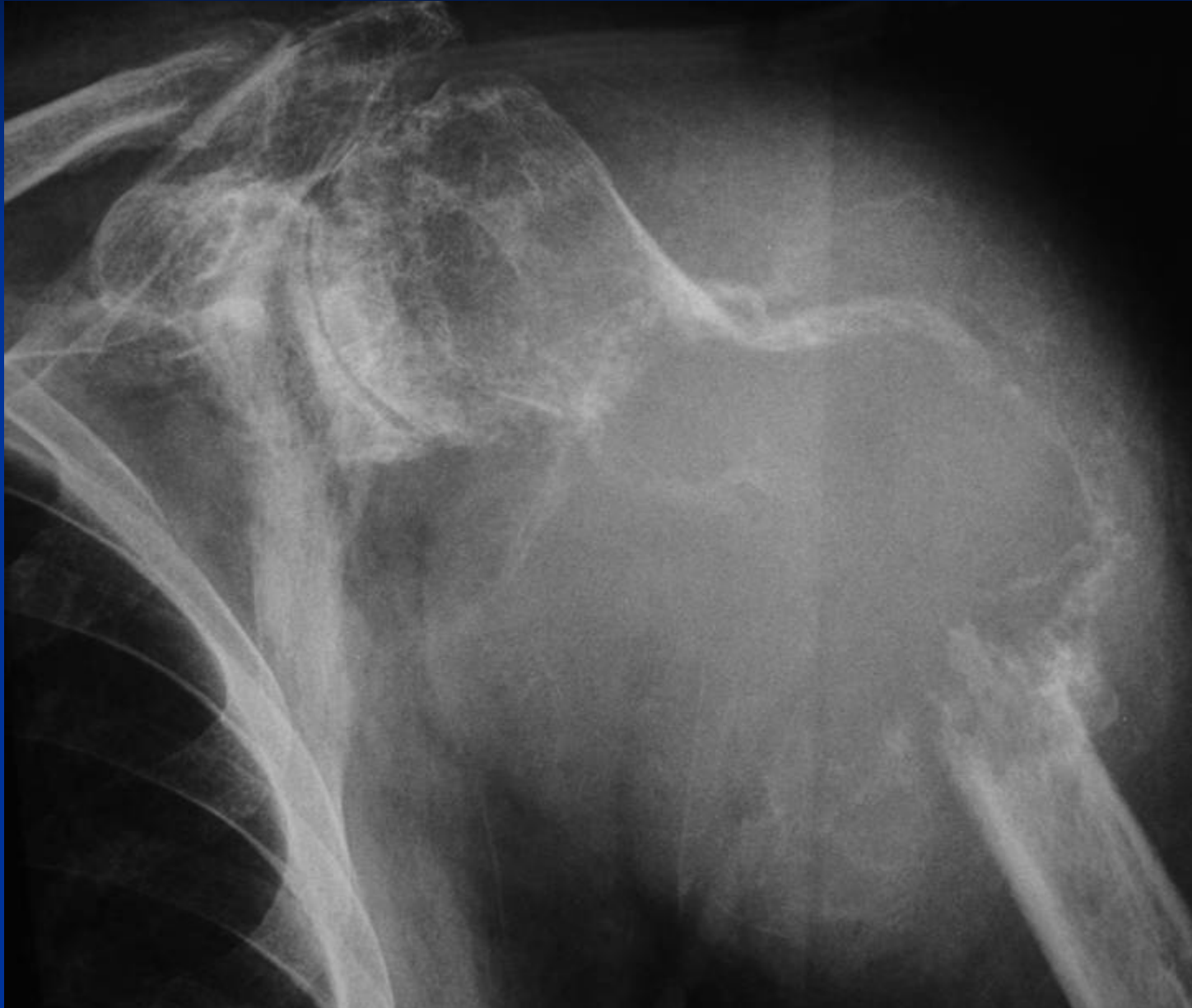




Renal Cell—Permeative, Lytic



Renal Cell—Expansile, Geographic



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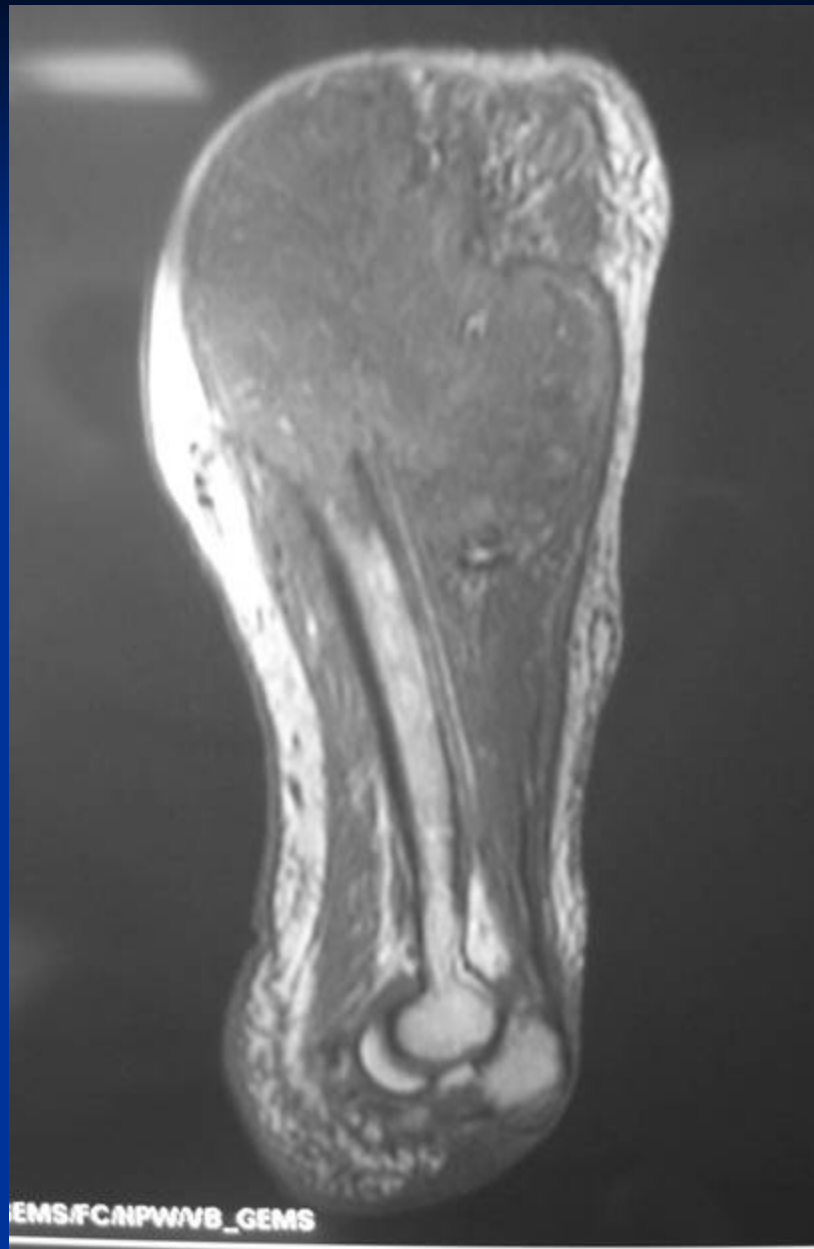
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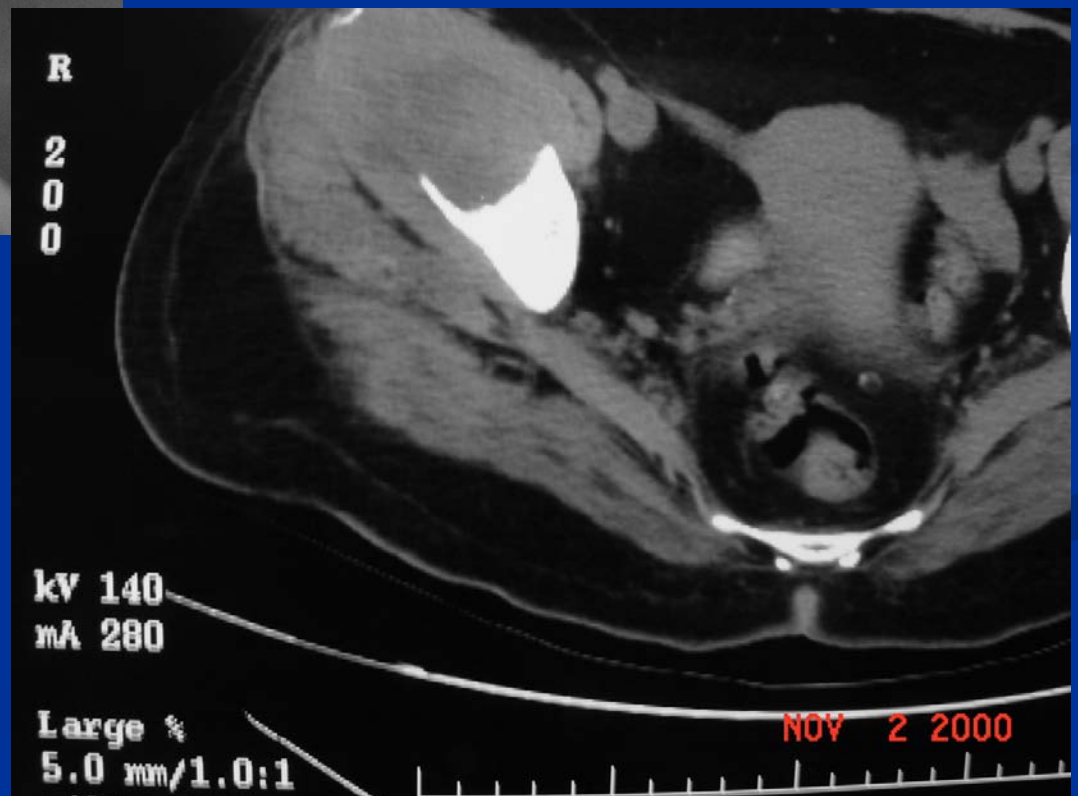
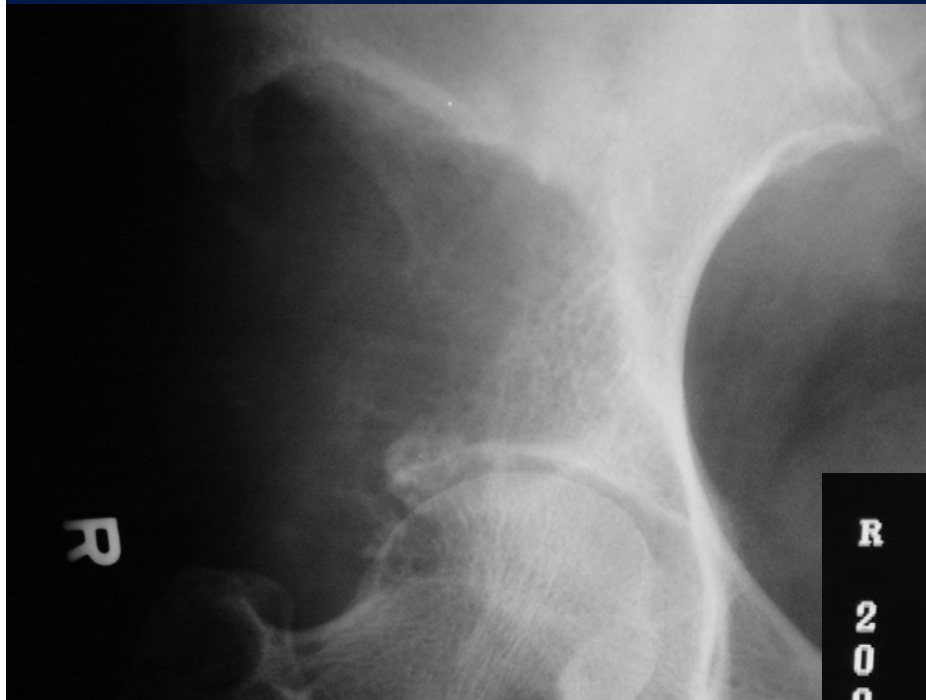
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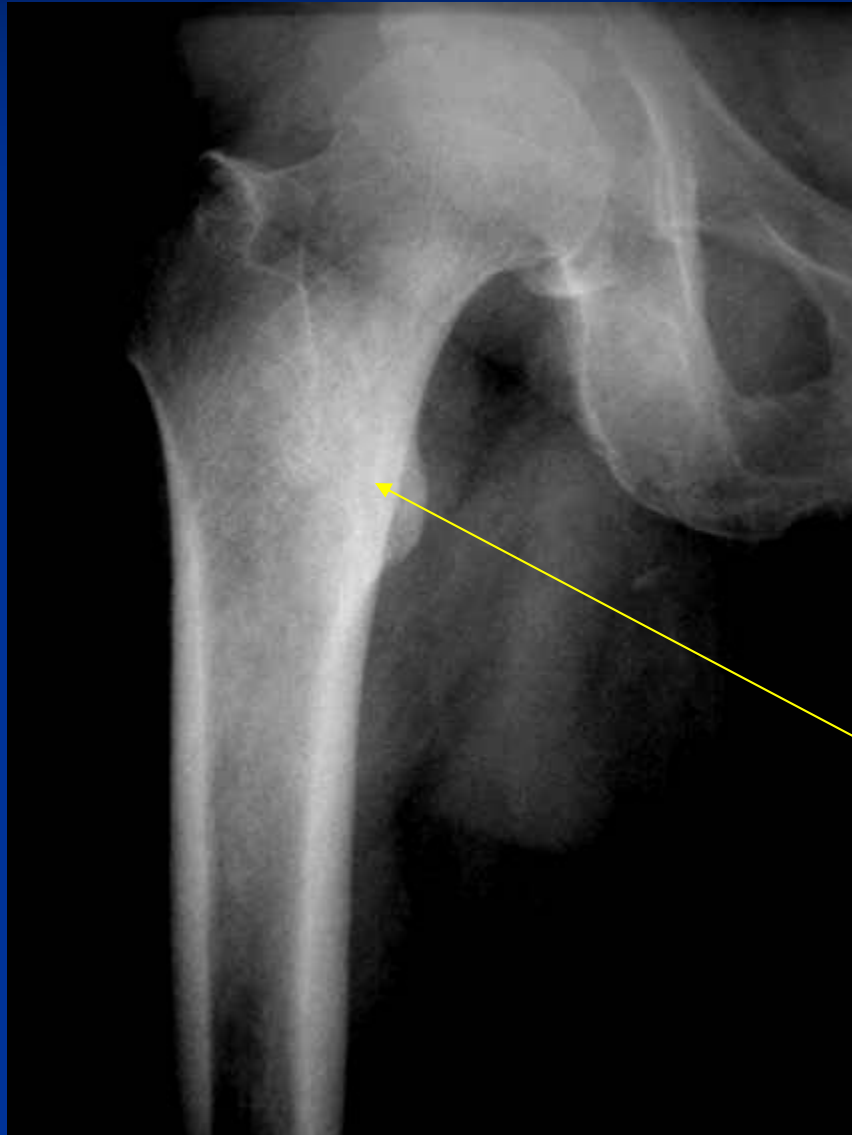
Lung--Lytic



Thyroid—Lytic, Geographic, Blown Out

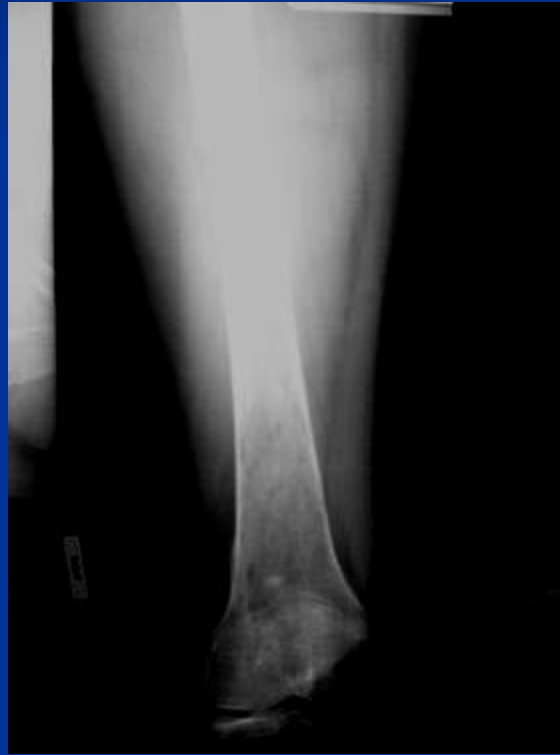


Prostate---Blastic



Myeloma





Bone Scan

- Demonstrates skeletal involvement much earlier than plain radiographs
- Occult bone lesions and metastatic disease
- Does not tell anything about the specific anatomic characteristics of a lesion (bony integrity)
- Monitoring response to treatment and disease progression
- Flare phenomenon occurs in 15% of patients
 - Initial increase in radioisotope uptake with treatment
 - Reflects new bone formation in response to treatment

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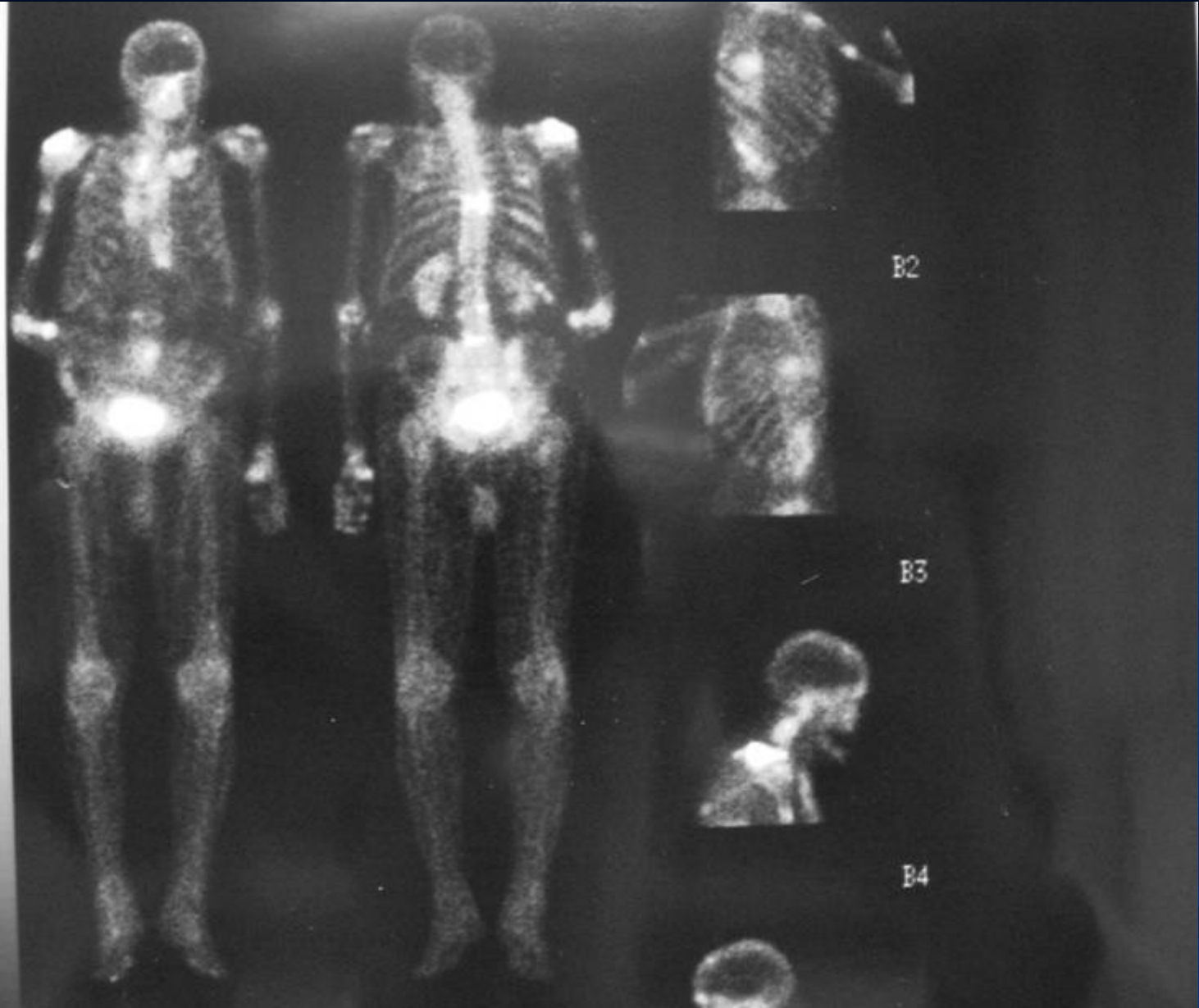
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CT Scan

- Confirm presence of metastatic disease especially when a patient presents with a pathological fracture as the initial presentation (r/o pseudopathologic fracture)
- Bony integrity/ cortical details
- Evaluating pelvis, shoulder girdle and spine that are often not well visualized on x-rays





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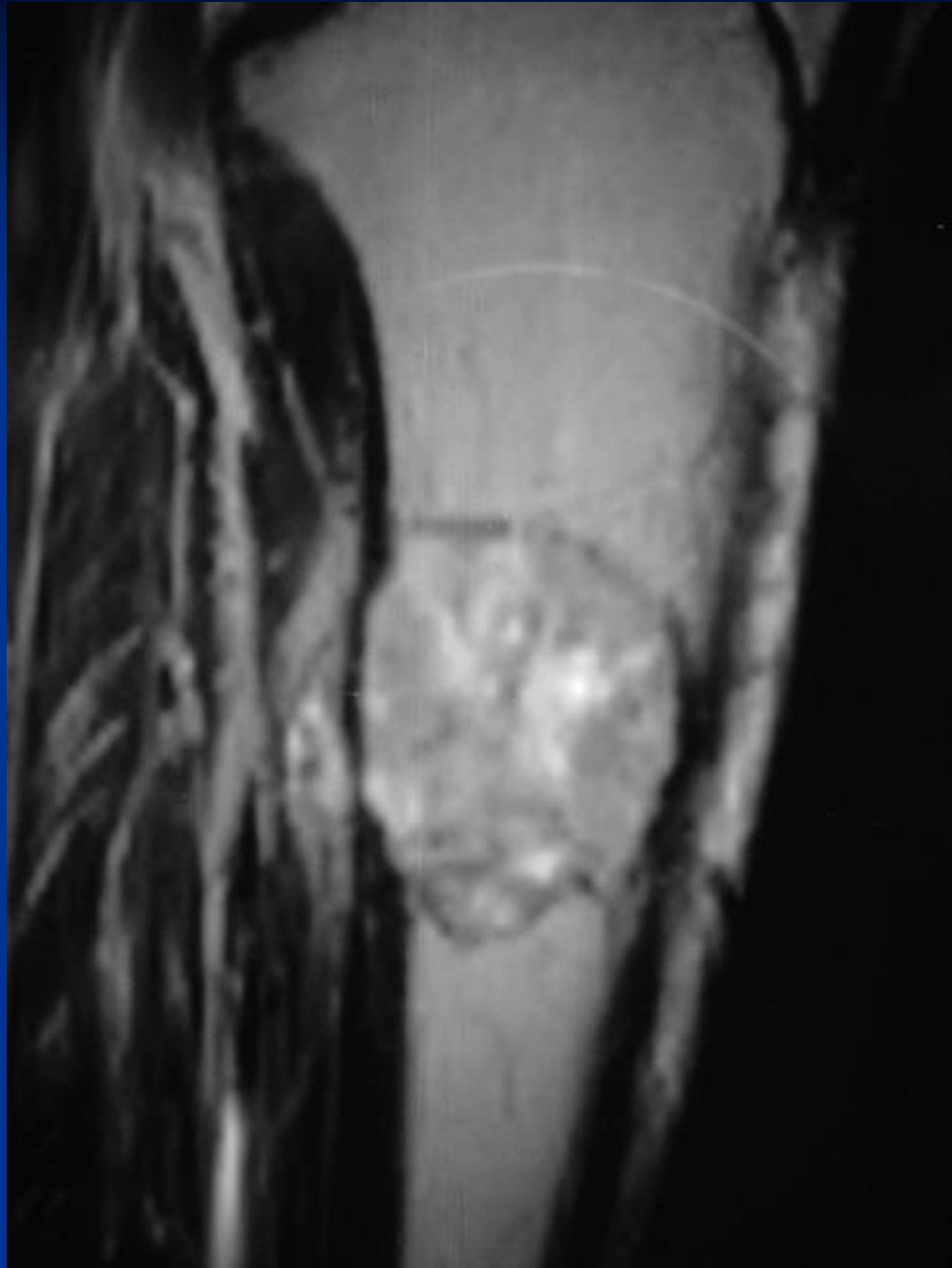
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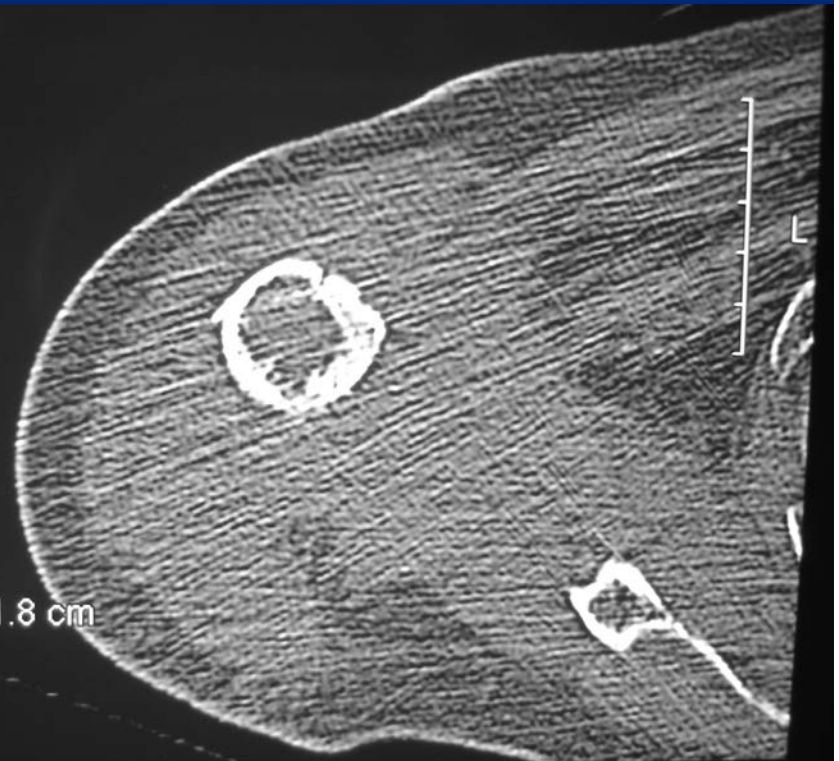






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Nassau Radiological Group

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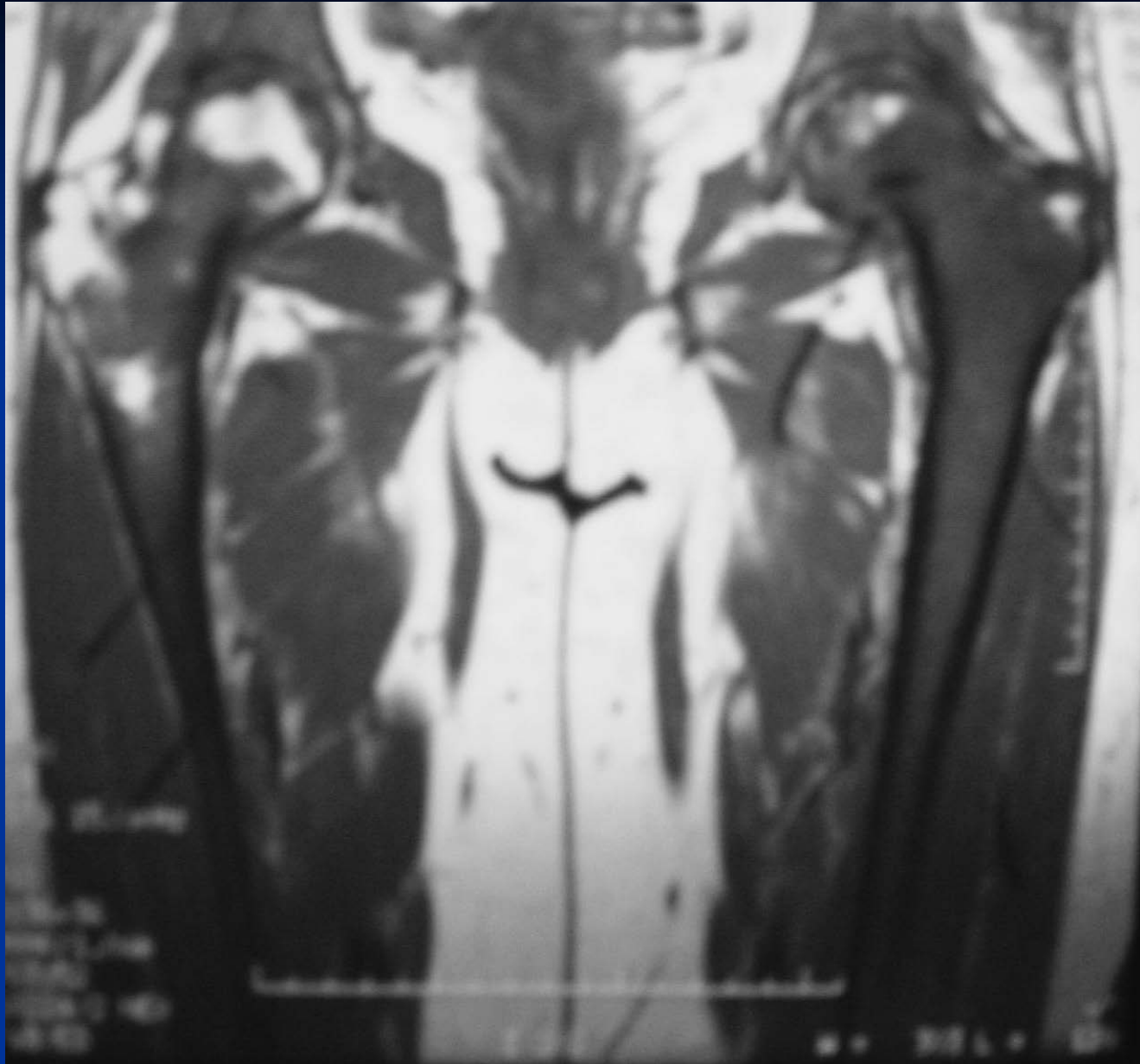
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MRI

- Extent of intramedullary and marrow involvement
- Extraosseous component
- Spine involvement and epidural extension, spinal cord compression
- Pathological fracture through neoplasm vs. osteoporotic bone vs. infection
- Evaluating adjacent joints/ other pathology causing pain











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Summary/3D Postp







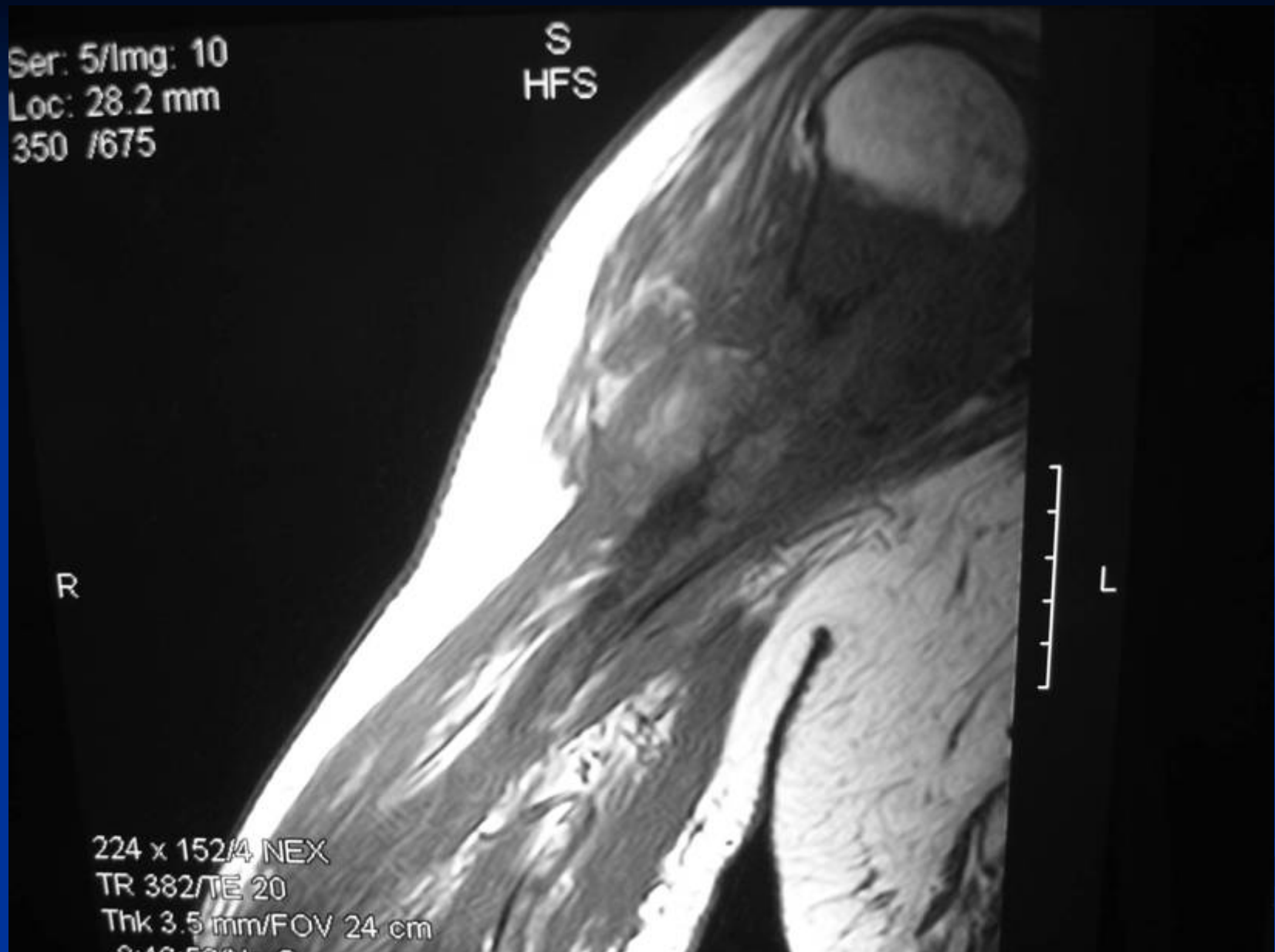
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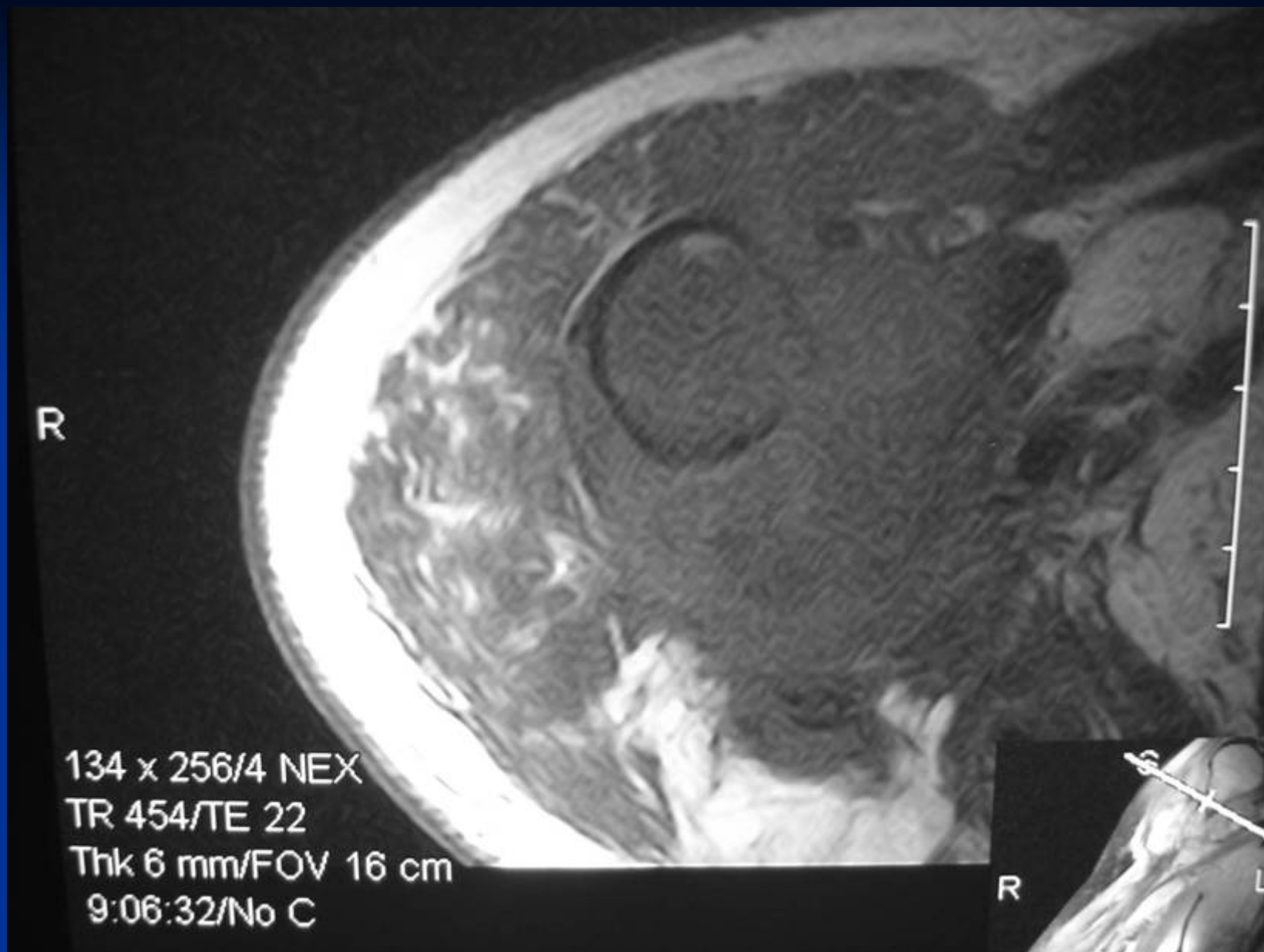


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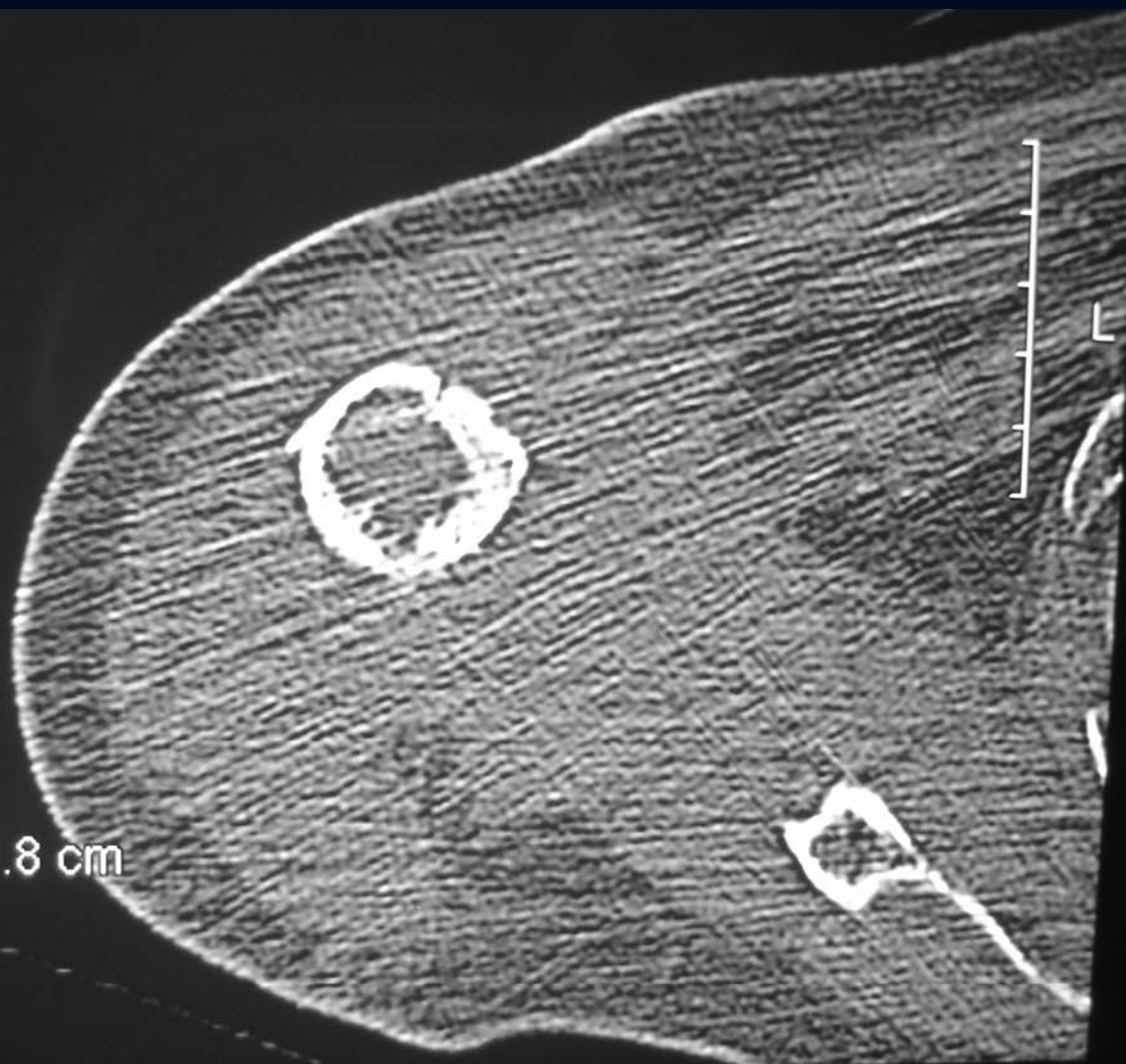
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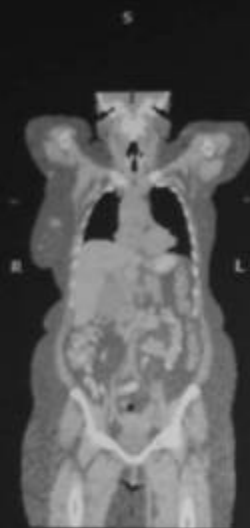
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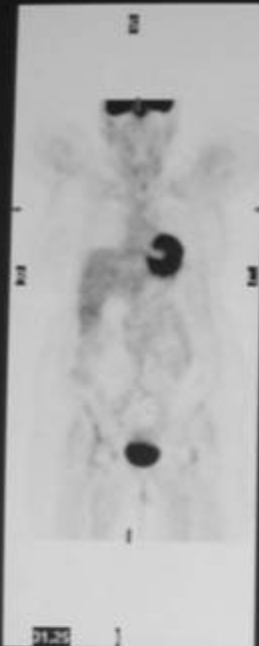
Nassau Radiological Group

PET Scan

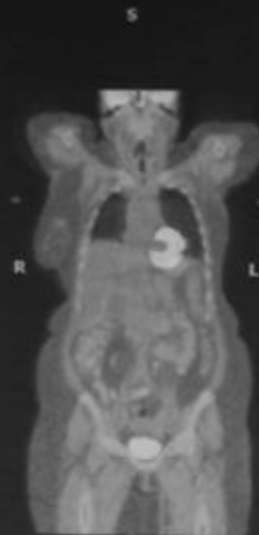
- New Tool
- (18F)fluorodeoxyglucose---radiolabeled glucose
- Identifies metabolically active areas
- Nonspecific
- Must correlate with other studies
- May be useful for monitoring response to treatment



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CT Coronals



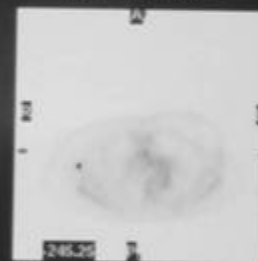
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PET Coronals



31.25 I
Fused Coronals



CT Transaxials



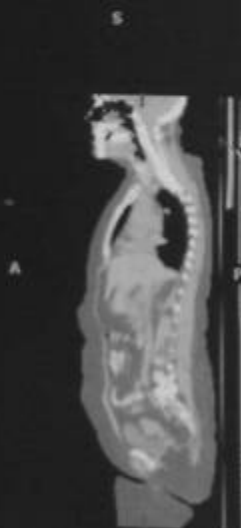
PET Transaxials



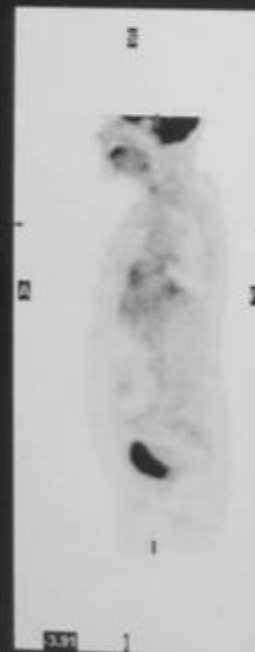
Fused Transaxials



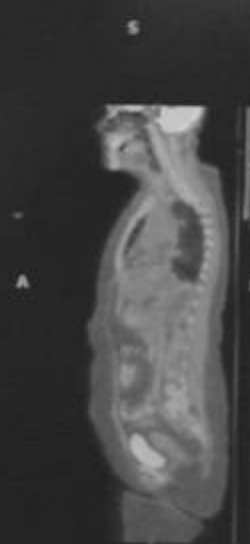
Scout View



-3.91 I
CT Sagittals



-3.91 I



-3.91 I



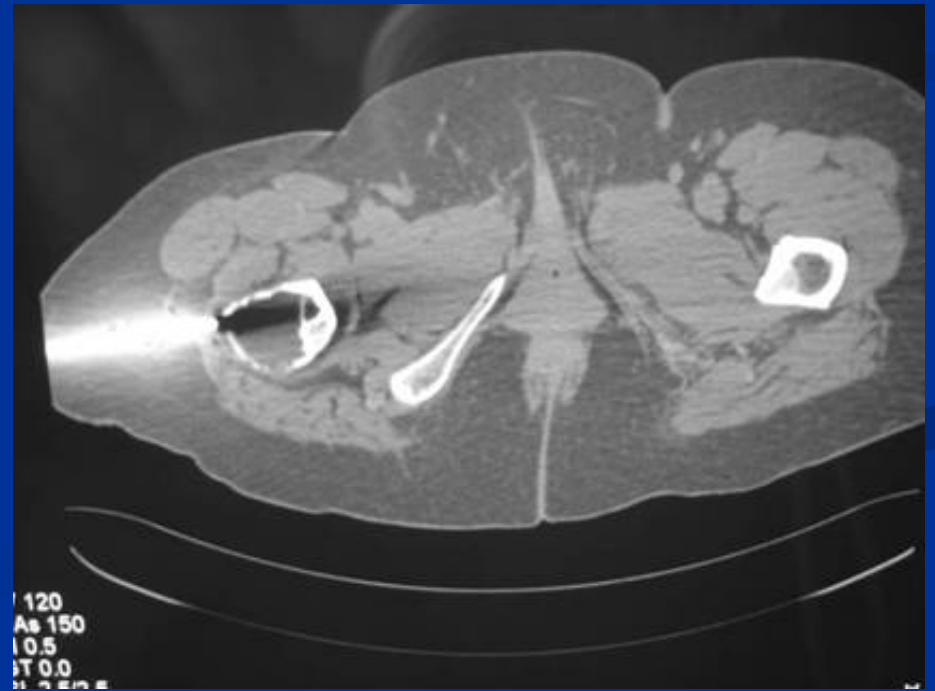


Biopsy Indications

- Confirm metastatic disease in a patient with a known primary
- Solitary or multiple bone lesions in a patient without a known primary tumor (rule out sarcoma, dedifferentiated chondrosarcoma, paget's disease, metabolic bone disease, brown tumor of hyperparathyroidism)
- Disease progression
- Hormonal/immunohistochemical studies

Types of Biopsies

- CT guided core needle biopsy
 - Preferred method; Minimally invasive; Less risk of infection and hematoma; Less soft tissue contamination
 - Diagnostic accuracy up to 90% (same as open biopsy when performed by experienced radiologist and pathologist)
 - Biopsy site in line with incision for definitive procedure
 - Needle directed to portion of lesion most likely to yield diagnostic tissue
 - Especially useful for pelvic and spine lesions



Types of Biopsies

- Fine needle aspiration (FNA)
 - Confirm presence of metastatic carcinoma in a patient with known metastatic disease (Not for solitary tumor)
- Open biopsy
 - At time of surgery, confirm metastatic carcinoma in pt with known mets
 - Failed CT guided biopsies

Nonsurgical Management

- Hormonal Therapy—Prostate and Breast Cancer
- Chemotherapy/Immunotherapy
- Bisphosphonates--pamidronate
- Radiation
- Radiopharmaceuticals (Strontium 89, Iodine 131)---
end stage diffuse painful bone mets

Surgery

- Surgical intervention must be undertaken with the intention of avoiding future surgery and complications (poor medical condition and limited life expectancy of patients)
- Most patients without a fracture do not require surgery however fractures are best treated by operative internal fixation

Goals of Surgery

- Pain relief
- Preservation and maintenance of function
- Facilitation of nursing and custodial care
- Local tumor control
- Skeletal stabilization
 - Immediate weight bearing and return to activity
 - Do not rely on fracture healing
 - Presence of tumor negatively affects the ability of a fracture to heal

Principles of Surgical Management

- Preoperative embolization of suspected vascular lesions
- Administration of perioperative antibiotics
- Correction of hypercalcemia
- Transfusion to correct preexisting anemia, thrombocytopenia and coagulopathy
- Modify surgical approach to avoid previously irradiated fields and ensure adequate soft tissue coverage
- Curettage to remove all gross tumor

Principles of Surgical Management

- Immediate rigid internal fixation supplemented with PMMA or cemented prosthetic replacement
- Filling defects with PMMA
- Postoperative nutritional supplementation to promote wound healing
- Adjuvant radiotherapy and/or chemotherapy

Tumor Excision

- Biological Control
- Curettage if sufficient bone remaining for reconstruction with PMMA
- Resection for total bone loss or if single isolated metastasis
- Patients with an isolated bone met may be rarely cured or rendered with prolonged disease free survival following resection

Composite Osteosynthesis

- Internal fixation devices usually combined with PMMA
- Use of PMMA to fill the defect reduces risk of fixation failure
- Fixation of impending and pathological fractures of the shaft of long bones (humerus and femur)
- Fix and protect entire bone when feasible
- Intramedullary rods have lower rates of failure than plates
- Intramedullary rods may be impossible with extensively sclerotic lesions—like drilling cement





Joint Replacement

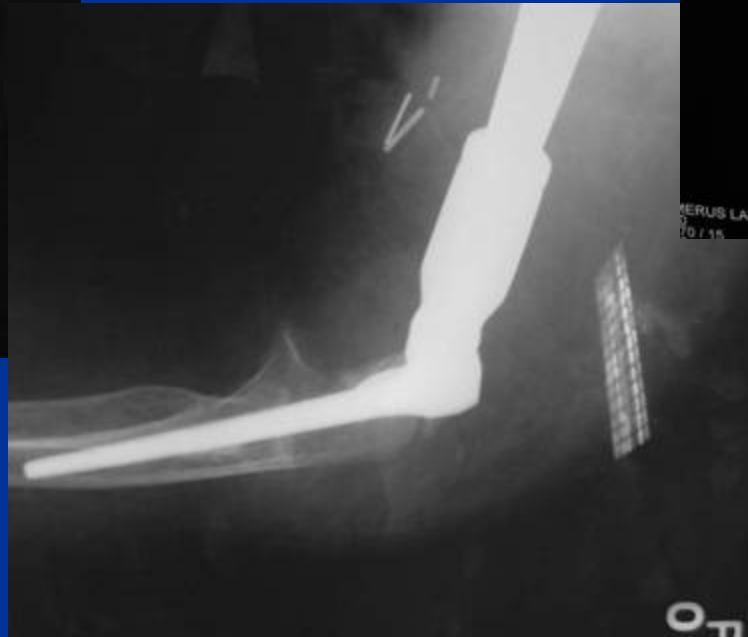
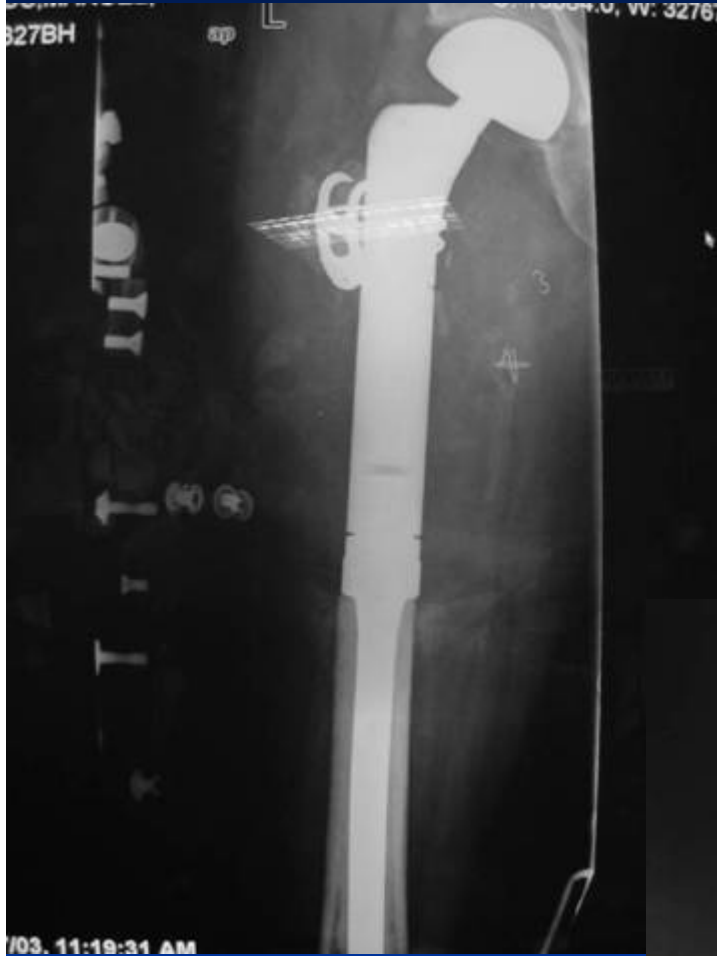
- Resection and reconstruction of a joint using a prosthesis combined with cement
- Most commonly used around the hip and shoulder
- Long stem prosthesis often utilized
- Tumor prostheses for extensively destructive lesions or for a single bone metastasis



Long Stem Cemented Hemiarthroplasty



Segmental Prosthetic Replacements



Cryosurgery

- Use of liquid nitrogen as an adjunct to surgical curettage to freeze and destroy any residual microscopic cells
- Indications
 - Failed radiation treatment
 - Hypernephromas, Metastatic Thyroid
 - Tumors in difficult anatomic locations or where XRT may cause problems





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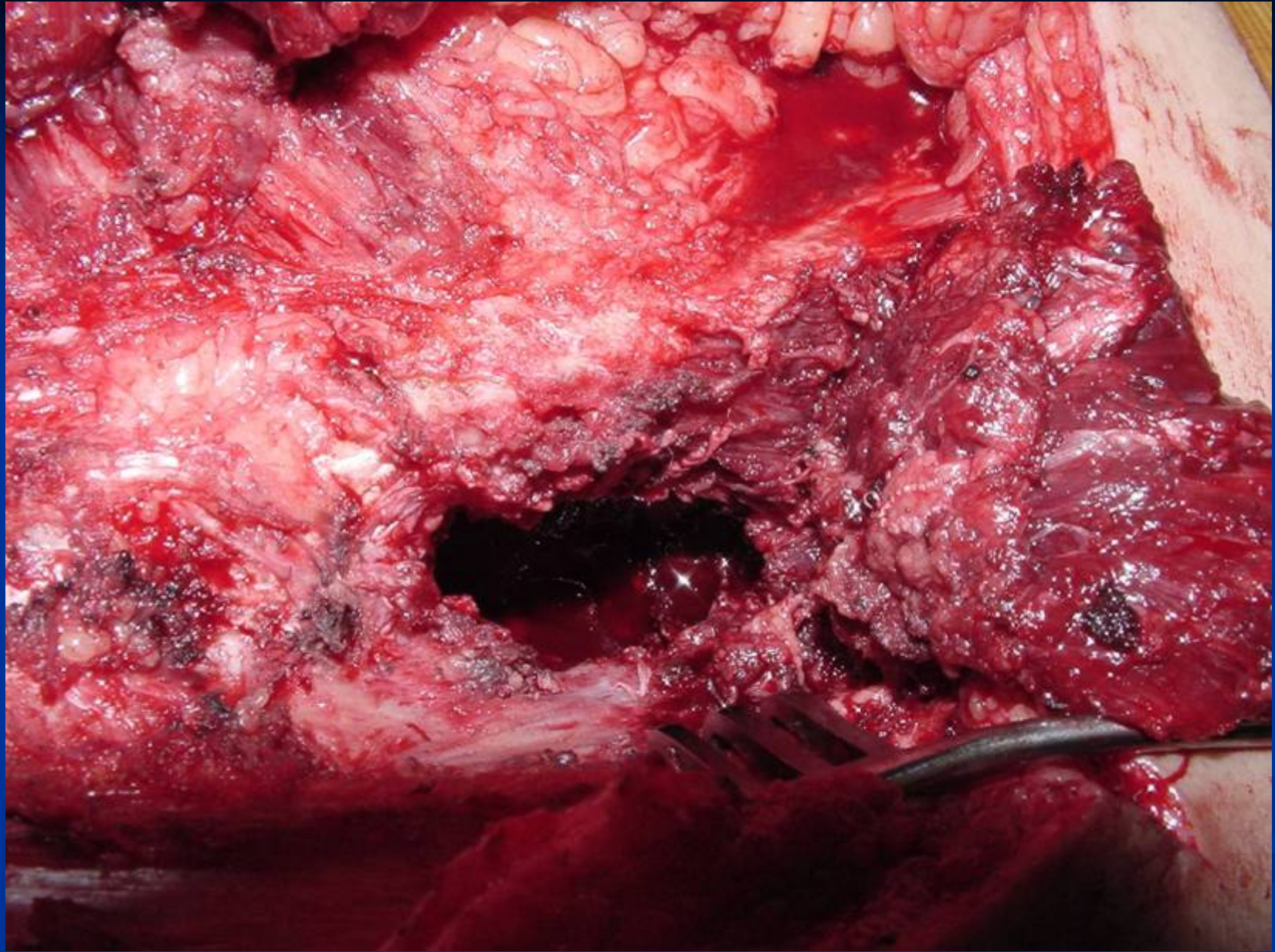
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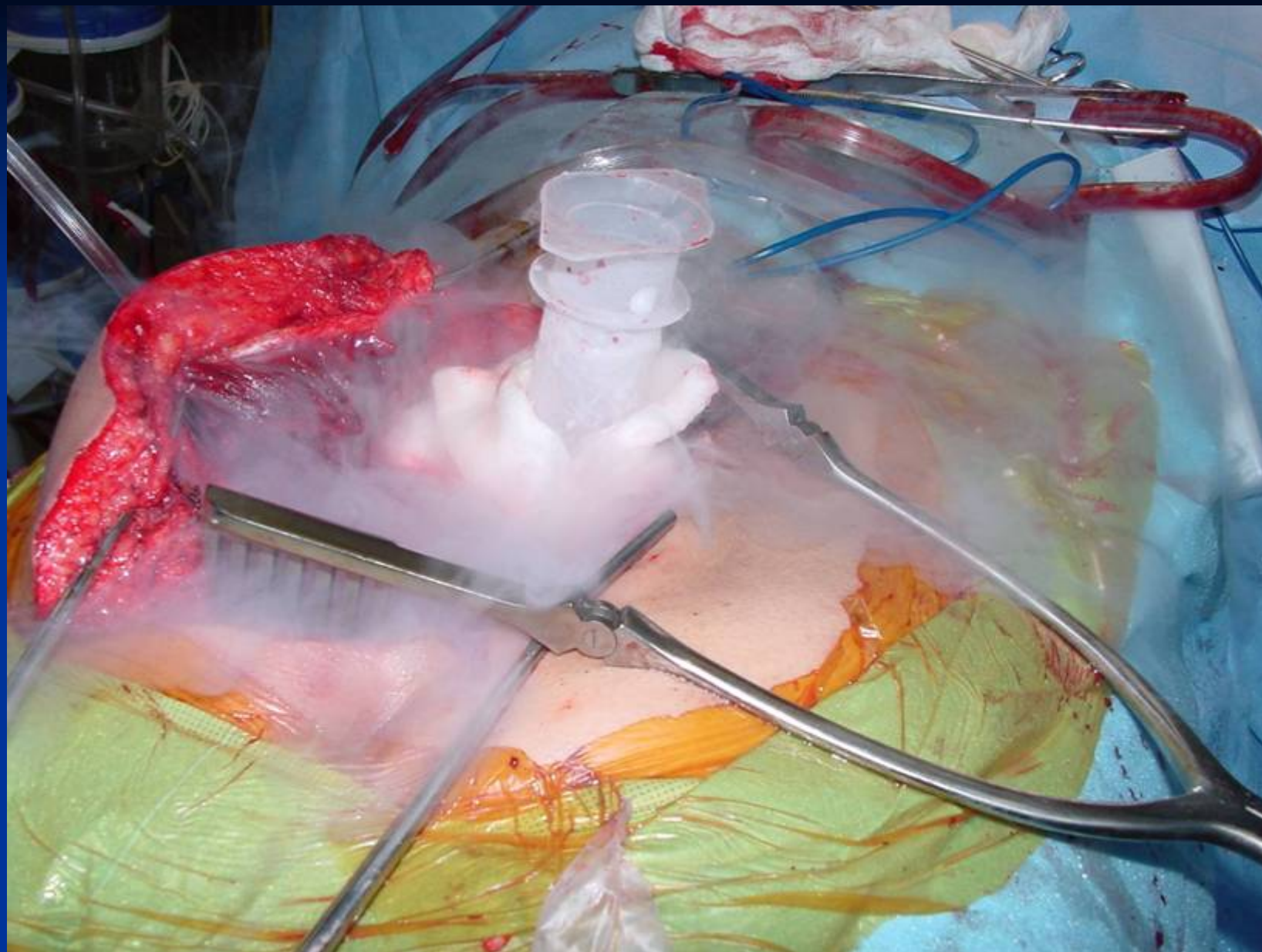
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Amputation

- Limited role in treatment of metastatic carcinoma
- Advanced cancer results in uncontrollable, intractable pain, a functionless extremity, tumor fungation, venous gangrene, sepsis or uncontrollable hemorrhage
- Can improve a patient's quality of life and provide palliation

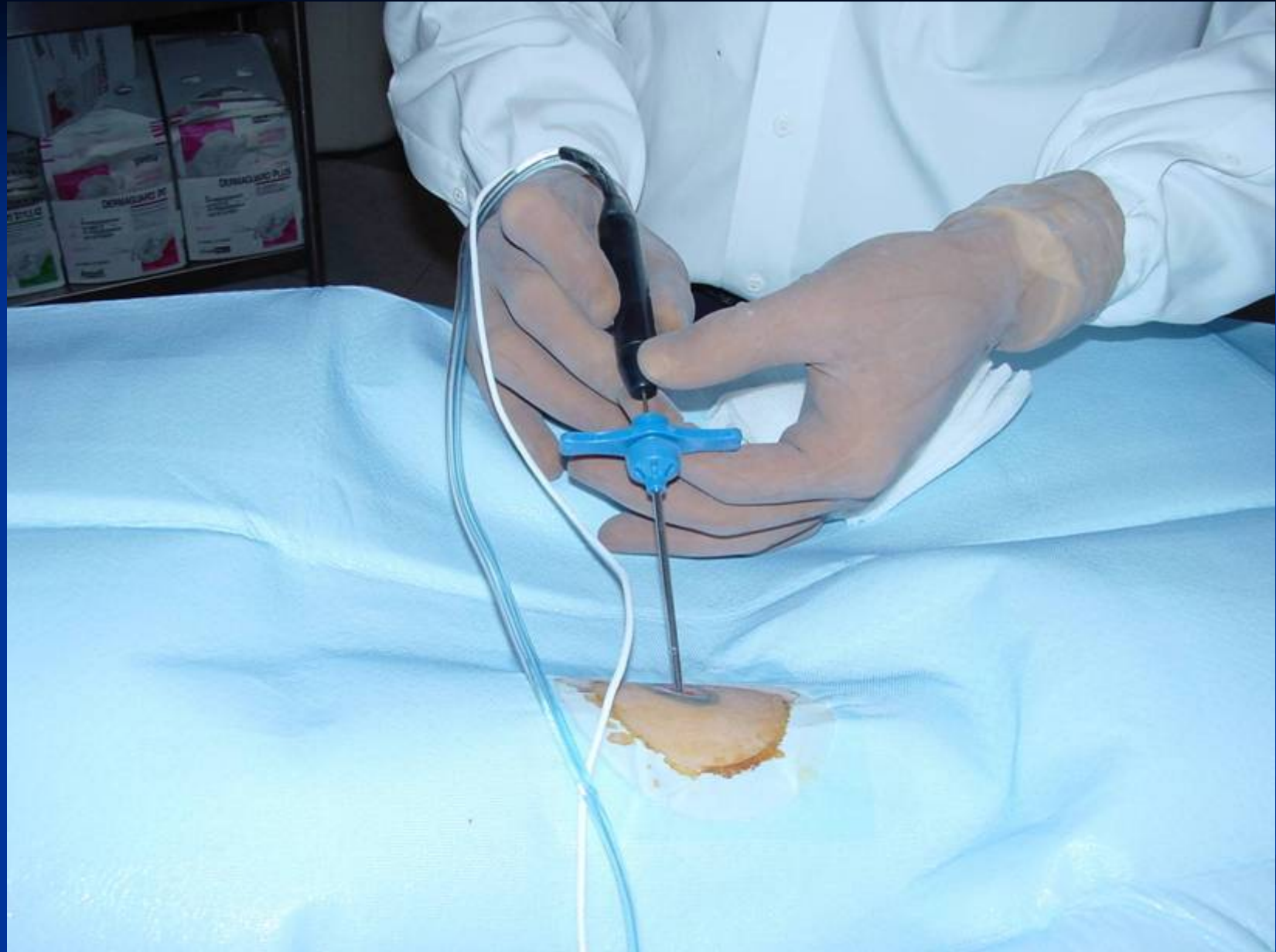
Radiofrequency Ablation (RFA)

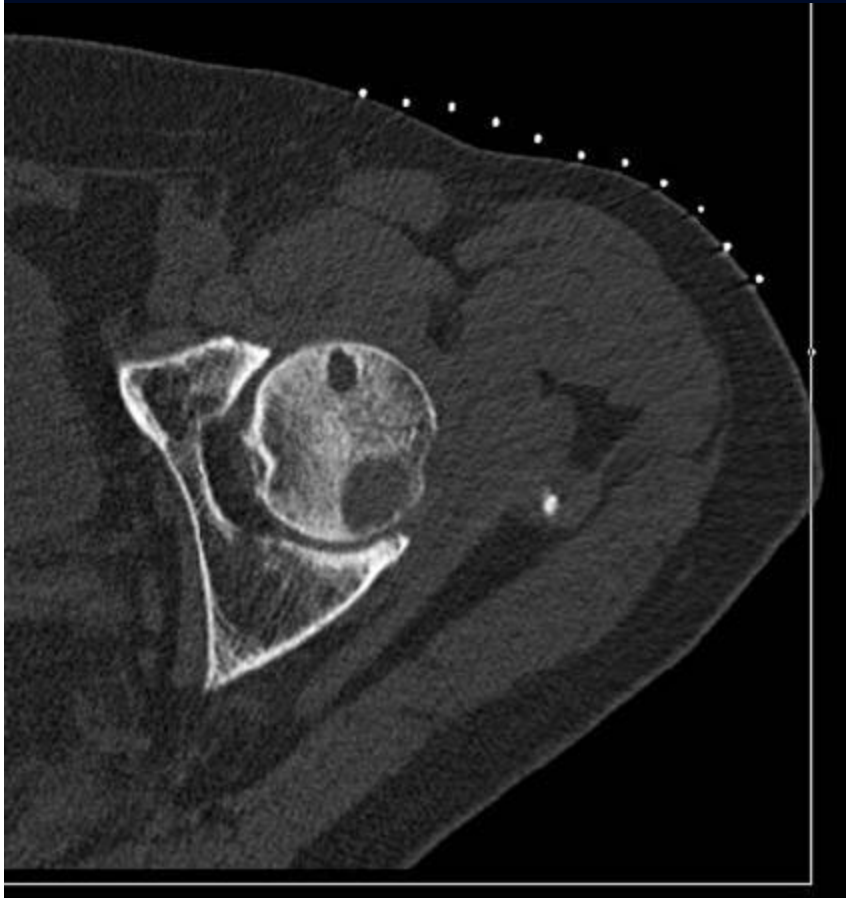
- Minimally invasive procedure
- CAT Scan guidance by a musculoskeletal radiologist.
- Needle or probe into lesion and destroying it with the use of heat.
- Outpatient procedure with the patient returning home the same day.

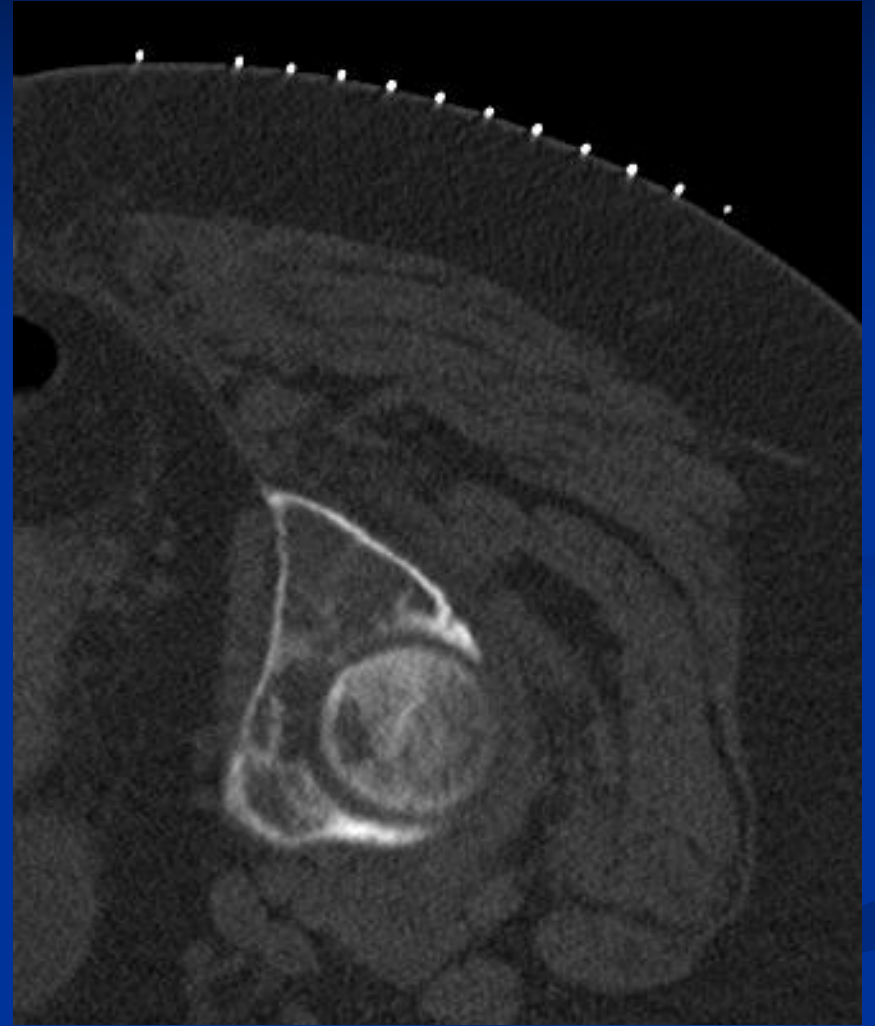
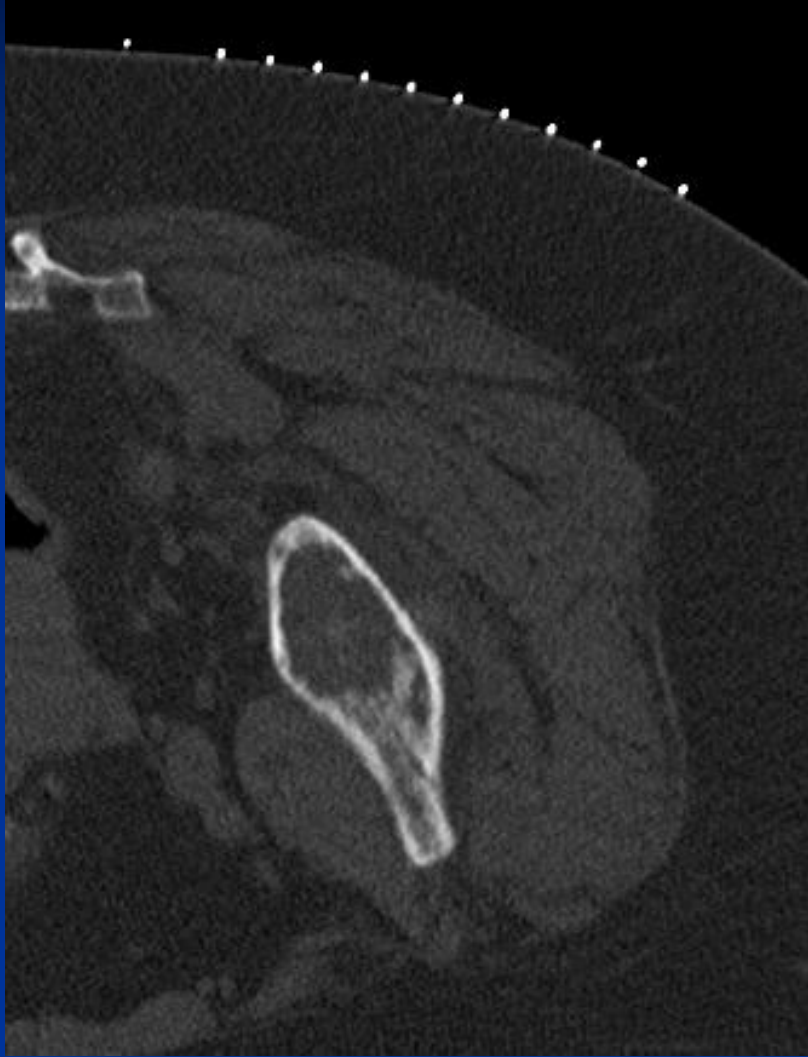
Radiofrequency Ablation (RFA)

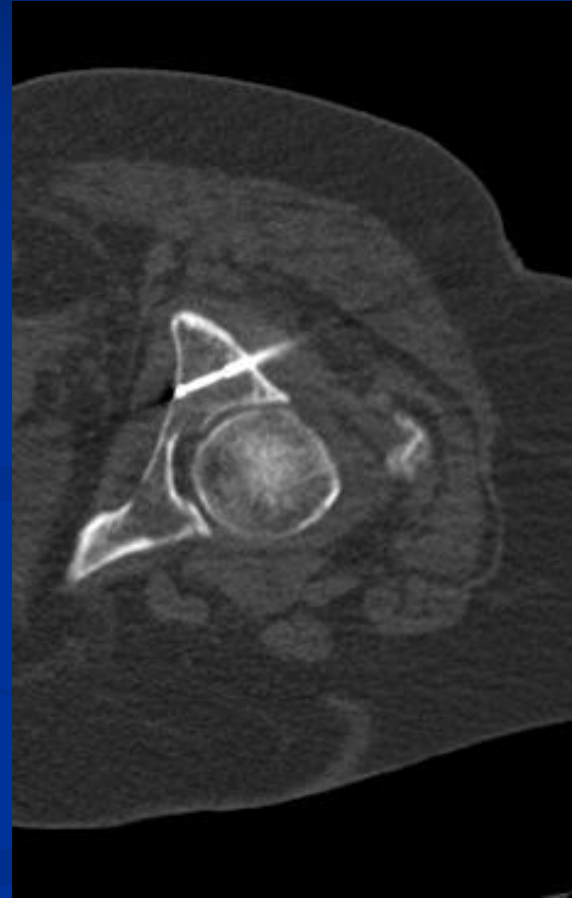
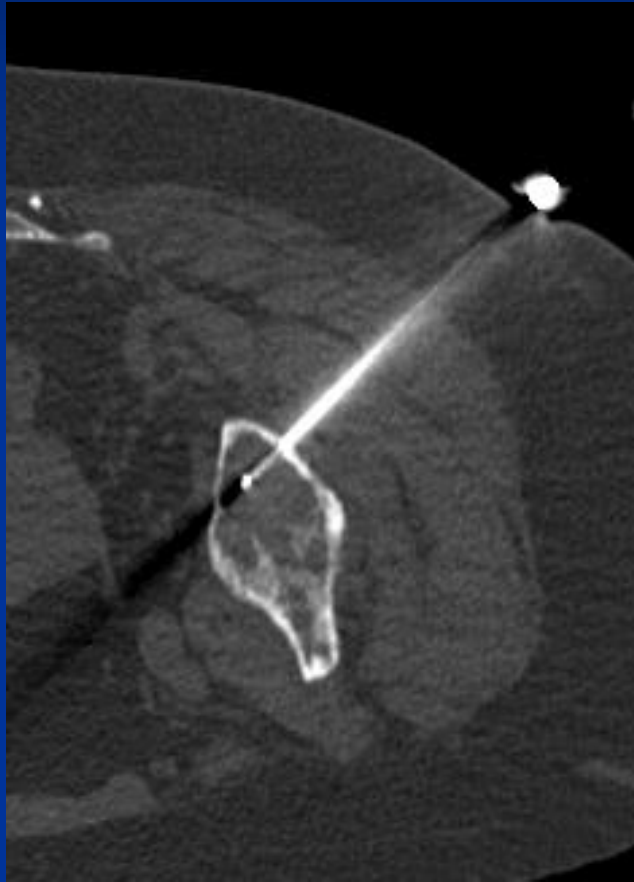
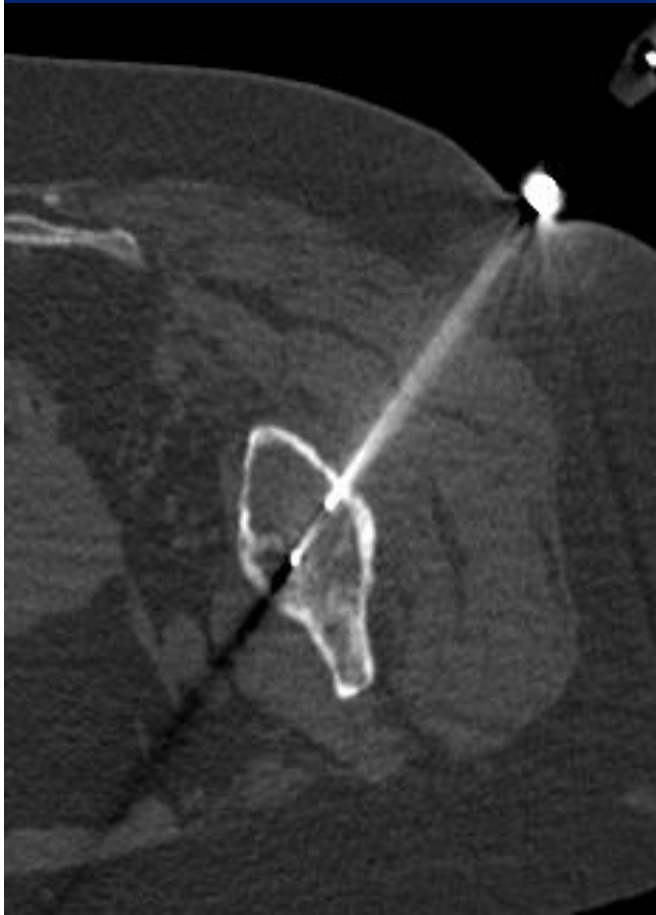
- Indications (not well defined)
 - Small painful lesion with low risk of pathological fracture
 - At risk lesion; small lesion if progresses will place patient at risk of a pathological fracture
 - Failed radiation treatment
 - Tumor in area where it may be preferable to avoid XRT (ie pelvis because of bone marrow suppression and need to get chemotherapy)











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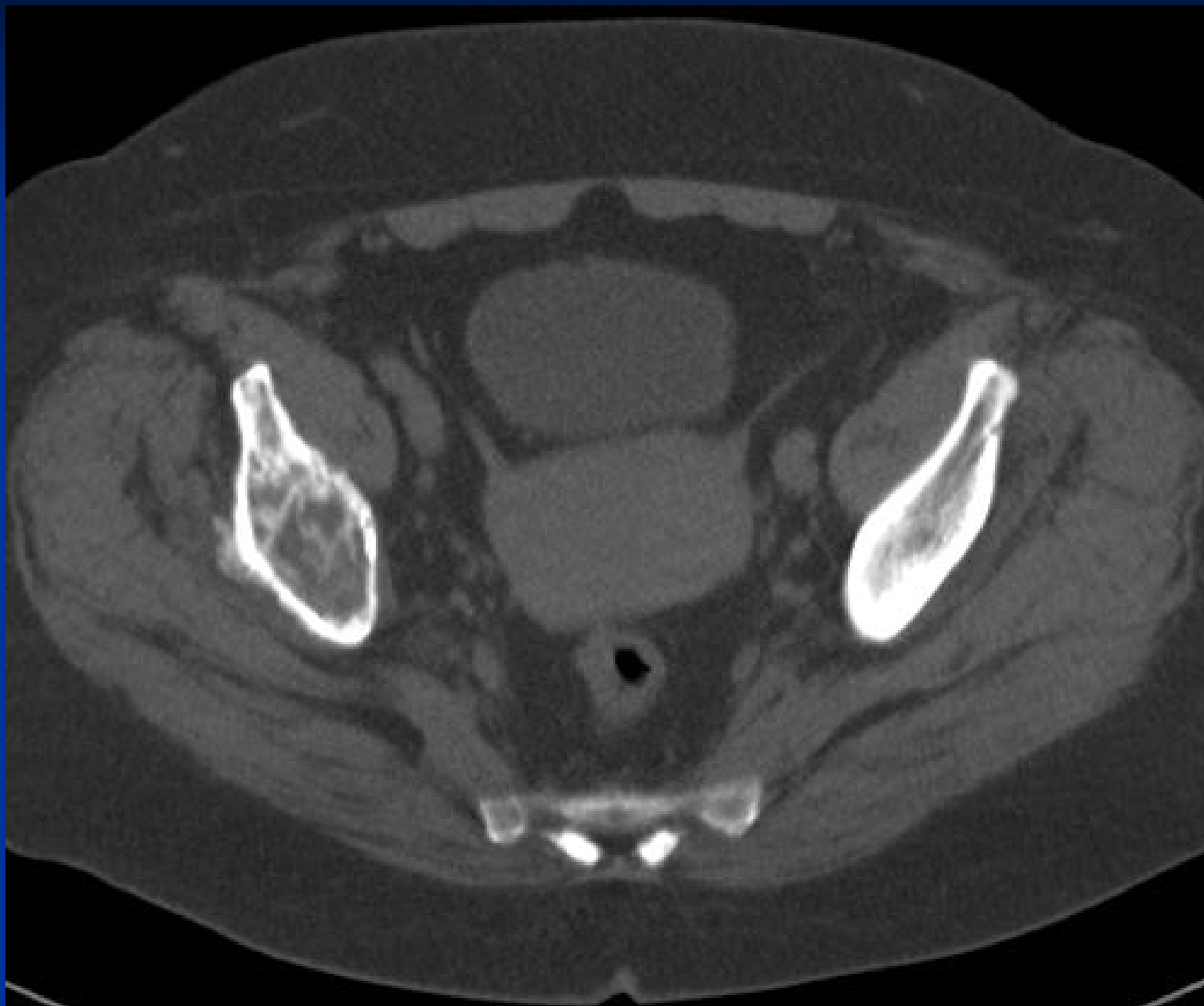
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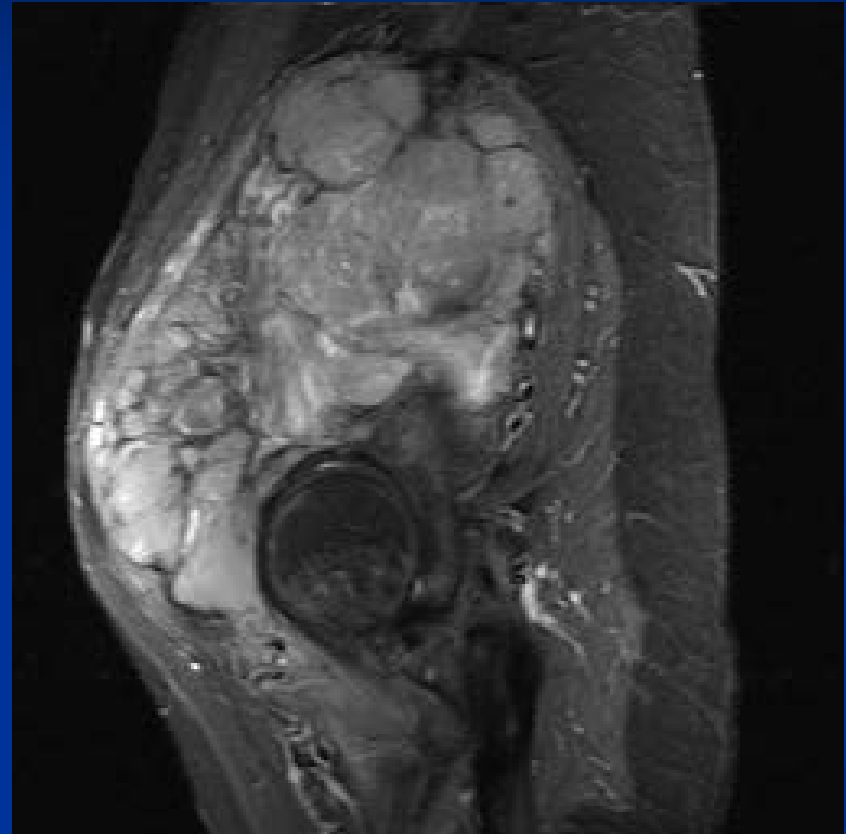
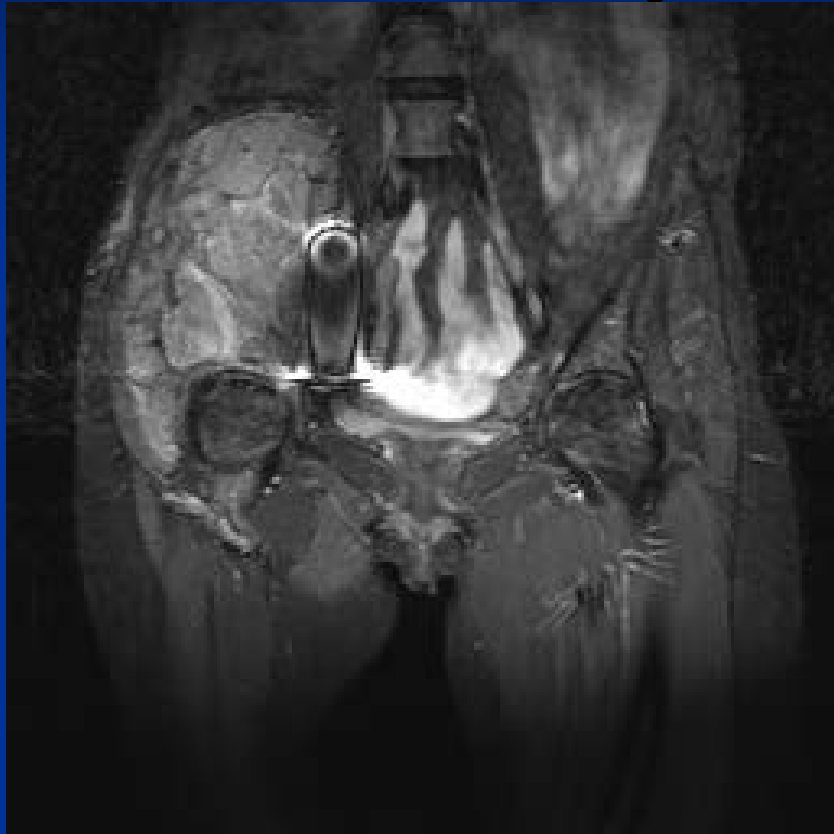


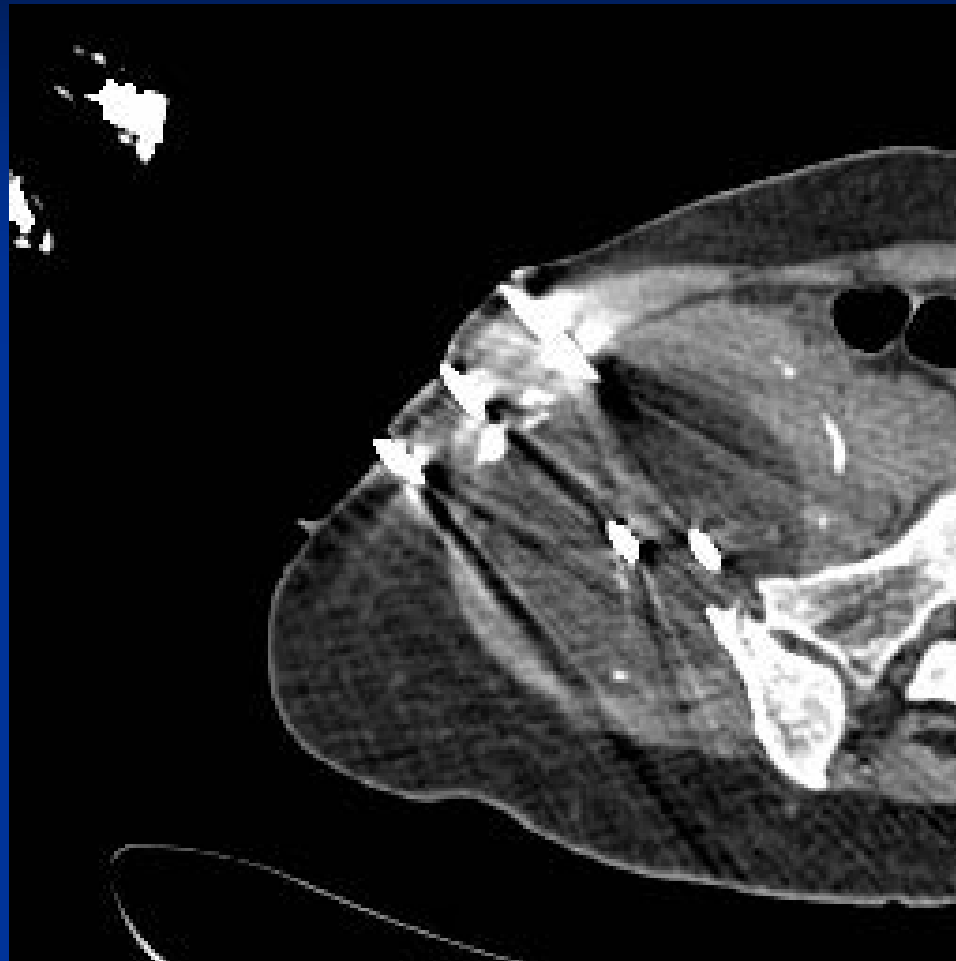


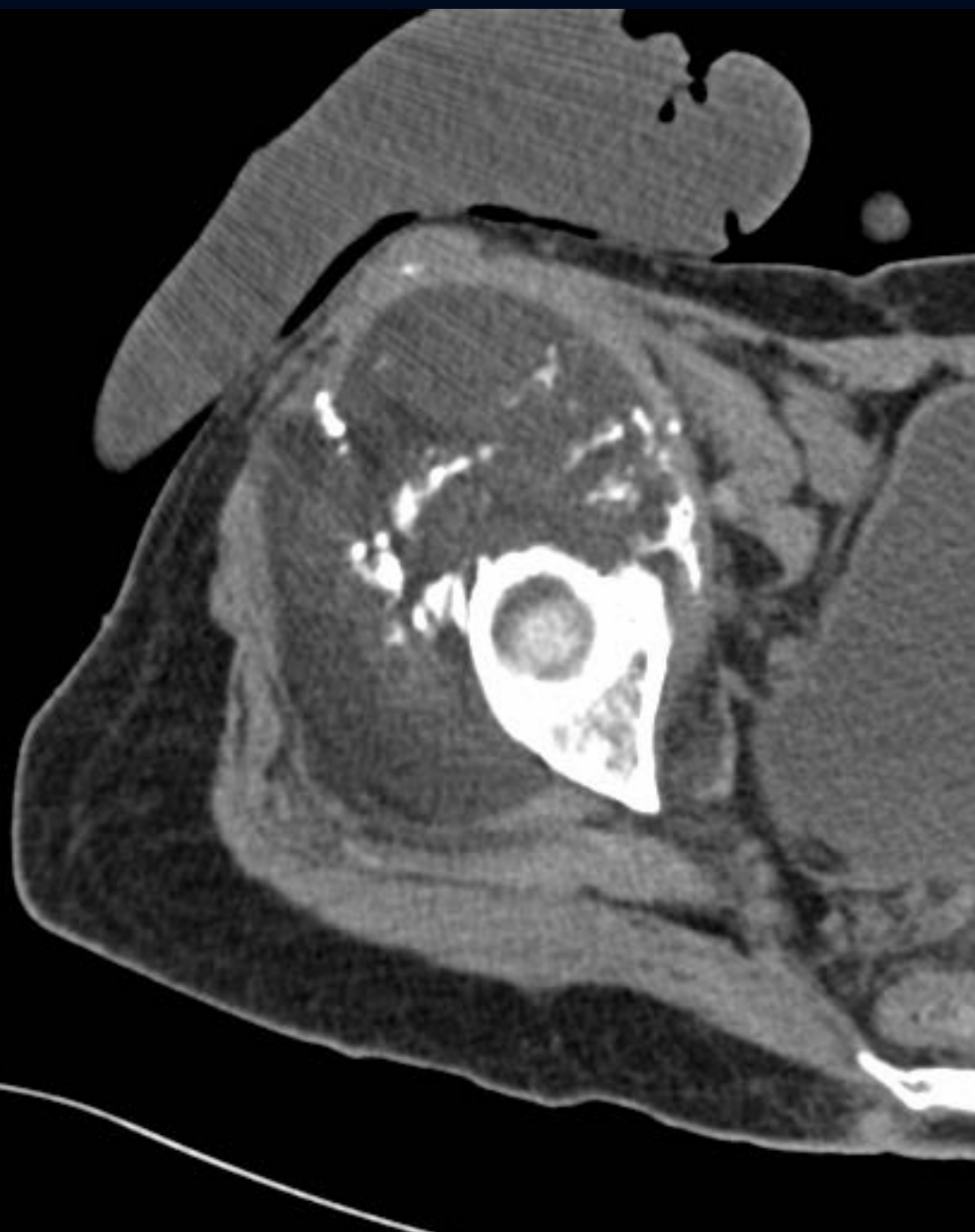
Percutaneous CT guided Cryoablation

- Minimally invasive treatment of a lesion with use of argon probes that directly freeze the lesion to subzero temperatures
- Preoperative planning for probe placement
- Ice ball is observed under CT
- Indications are poorly defined

Percutaneous CT Guided Cryoablation



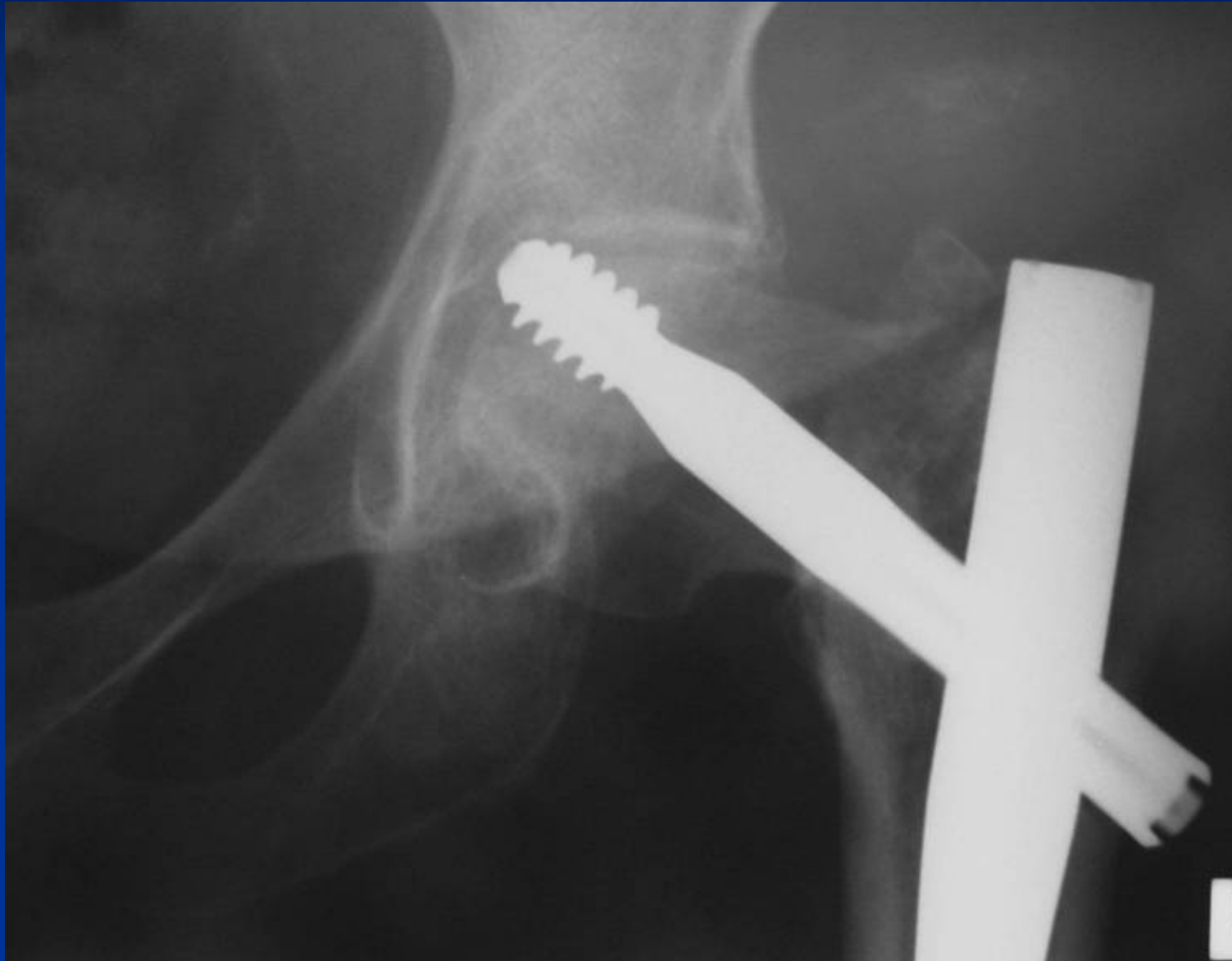




Pitfalls



Path Fx of Femoral Neck Breast Cancer



Metastatic Renal Cell Carcinoma of Pelvis





Metastatic Renal Cell





Surgical Indications

- Pathological Fracture
- Impending Pathological Fracture
 - Pain
 - Location of lesion (weight bearing, pelvis/spine); Number of Lesions
 - Size of lesion
 - Medullary and/or cortical involvement
 - Primary tumor type and responsiveness to radiation
 - Undergoing chemotherapy?? Will systemic treatment be interrupted
 - Age
 - Health Status
 - Activity level; Weight of patient
 - Prognosis
 - Patient's acceptance of risking a pathological fracture with nonoperative treatment

Prophylactic Fixation

- Many studies designed to assess risk of actually fracturing
- Can not accurately assess the risk of fracturing because of many confounding variables
- Endosteal resorption of $\frac{1}{2}$ cortical thickness reduces bone strength by 70%

Prophylactic Fixation

- Pain
- Site of lesion
- Blastic or lytic
- Size
- Medullary and /or cortical

Prophylactic Fixation

- Painful medullary lytic lesion resulting in 50% endosteal resorption of cortex
- Painful lytic lesion involving cortex that is more than 2.5 cm long or larger than the cross sectional diameter of the bone
- Lesion producing functional pain after radiation therapy
- Using these criteria, during surgical exploration the bone is found to be practically fractured





Conservative Management

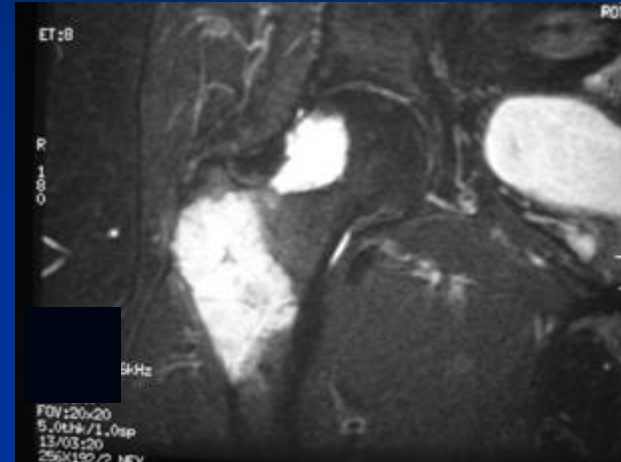
- Braces
- Wheel chair
- Radiation
- RF Ablation
- Cryoablation

Type of Surgery/Fixation Method

- Depends on Site and Extent of Disease
 - Epiphyseal
 - Metaphyseal
 - Diaphyseal

Epiphyseal Fractures

- Arthroplasty-cemented
- Stem length chosen to treat existing or potential lesions in the same bone
- Usually Long Stem



Metaphyseal Fractures

- Prosthetic replacement
 - Can be difficult if bone is actually fractured and there is extensive bony destruction
 - Much easier for impending fractures
- Intramedullary rods
 - May not adequately control the proximal fragment
 - At risk for failure if tumor progresses proximally or does not respond to radiation
 - At risk for failure if fracture does not heal—augment with PMMA
- Plate and screw combinations
 - Does not fix entire bone
 - More prone to failure than intramedullary rods
 - Mostly for metaphyseal fractures with densely sclerotic bone

Diaphyseal Fractures

- Cephalomedullary intramedullary rods
 - Fixes entire bone
- Rush rods with cement
 - May be good for humerus if want to avoid shoulder pain/rotator cuff
- Flexible nails

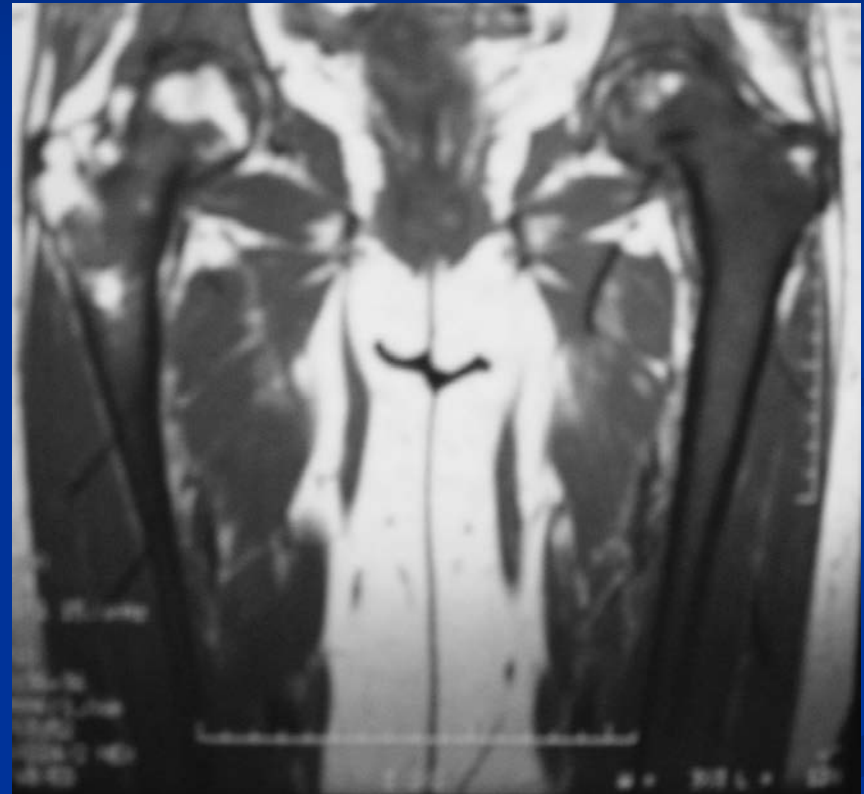


Specific Anatomic Sites

Proximal Femur

- Long stem cemented hemiarthroplasty
 - Femoral Neck, Intertrochanteric, Subtrochanteric
- Cephalomedullary nail
- Compression screw and side plate
- Cannulated screws

Proximal Femur







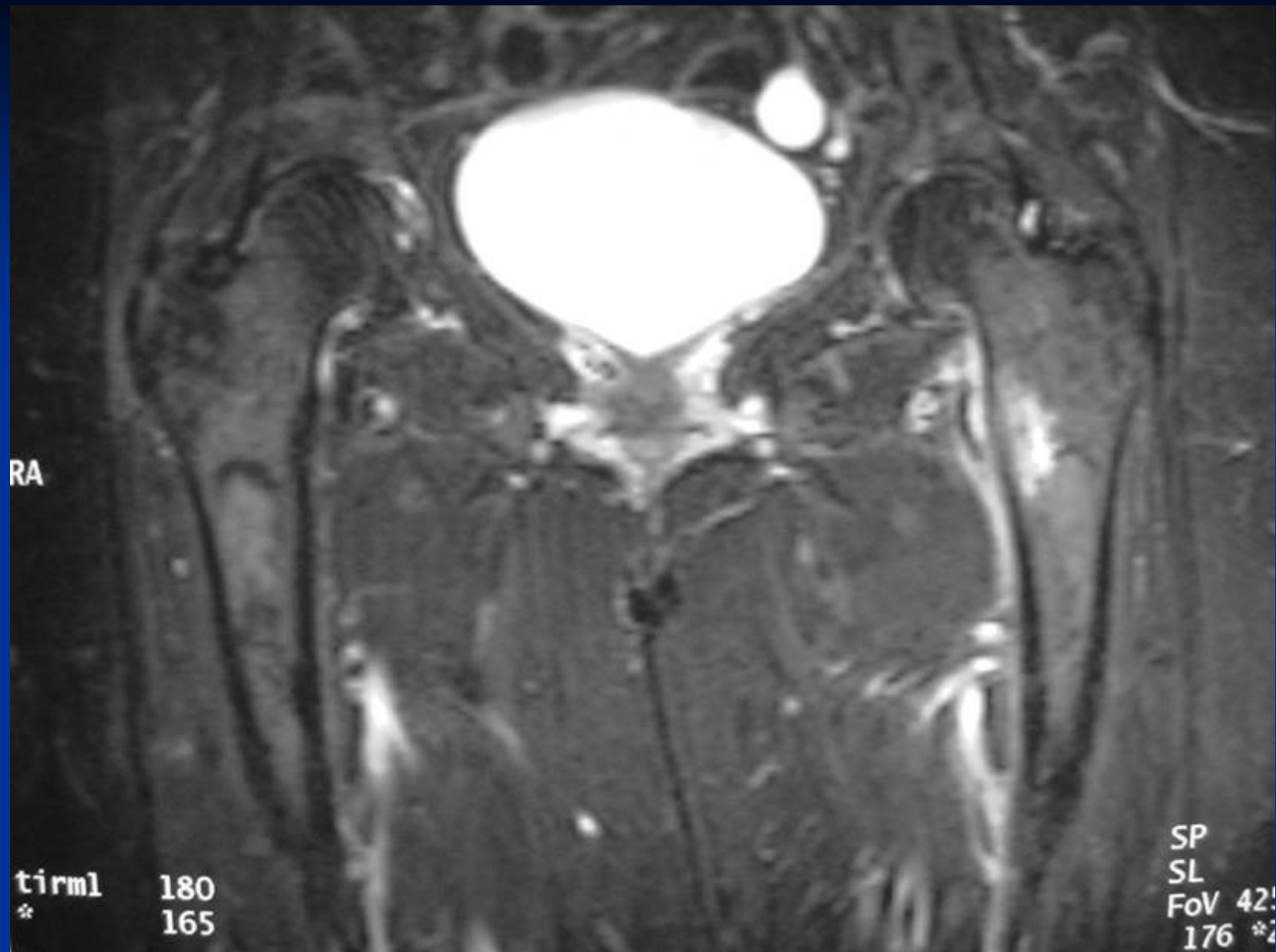














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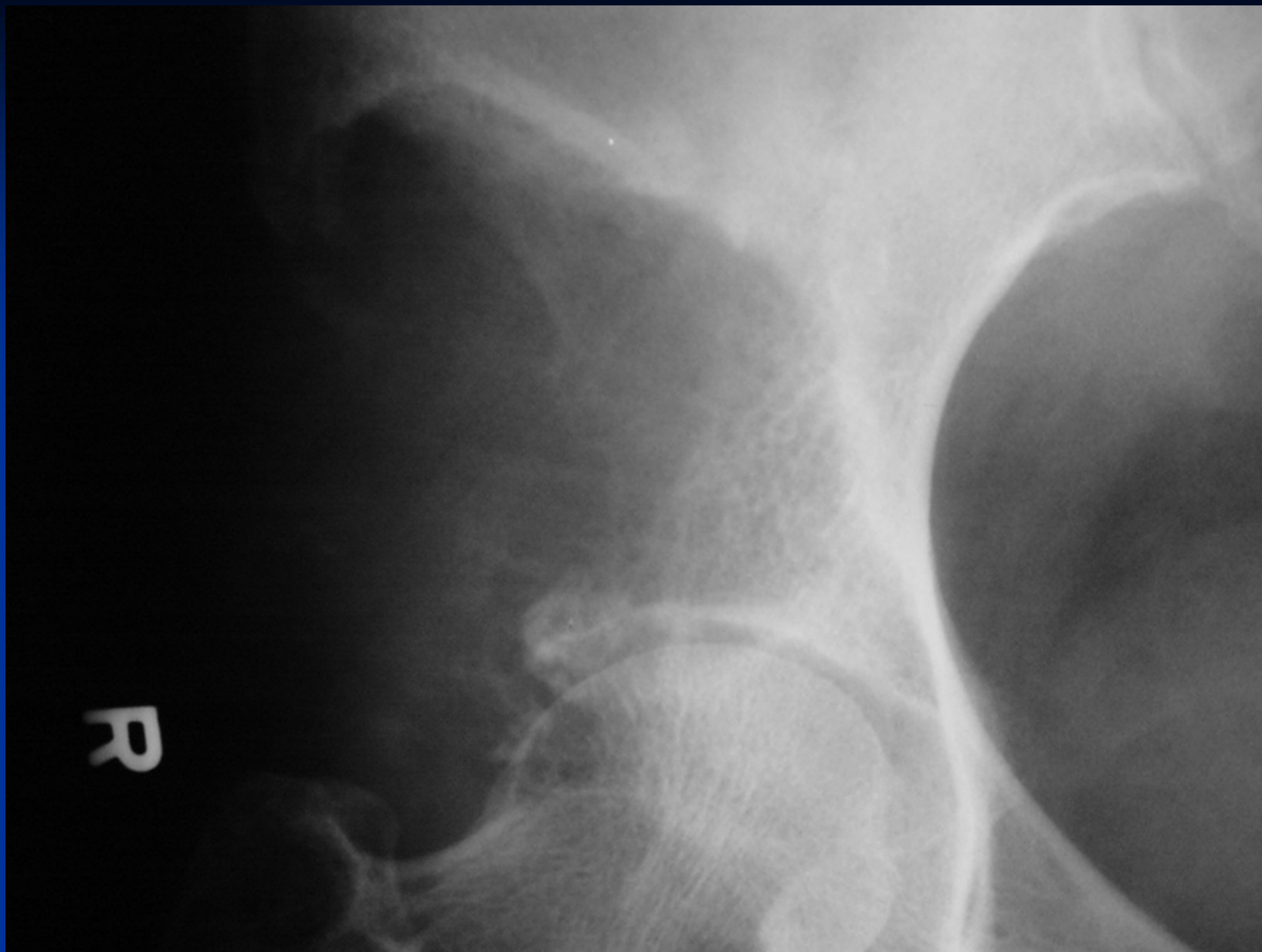
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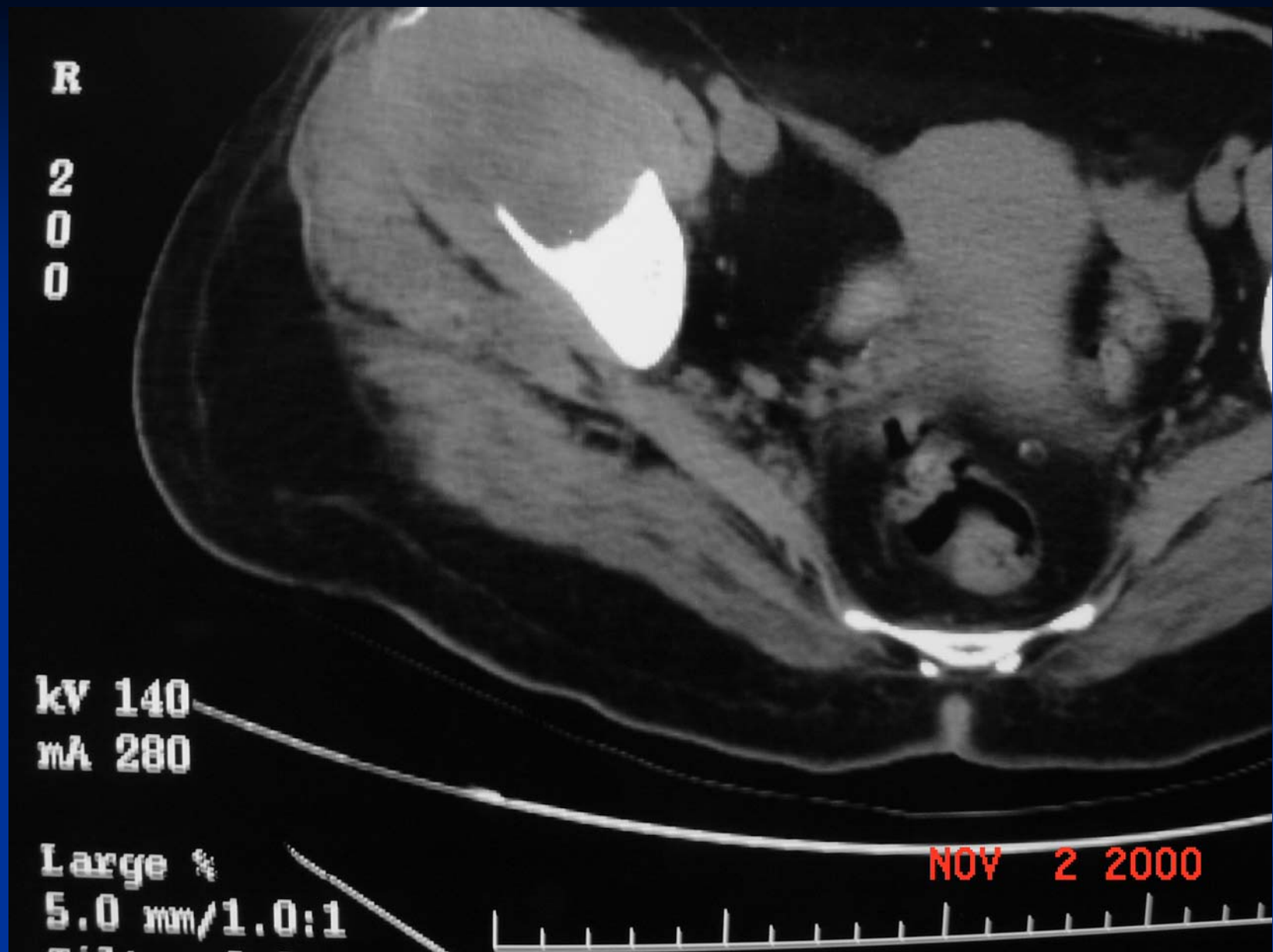
Acetabulum

- Polyethylene Spacer, cement, threaded steinman pins
- Acetabular cage, total hip replacement, cement, steinman pins
- Saddle prosthesis

Acetabulum









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Washington Hospital Center

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MASK IMAGE
2 9



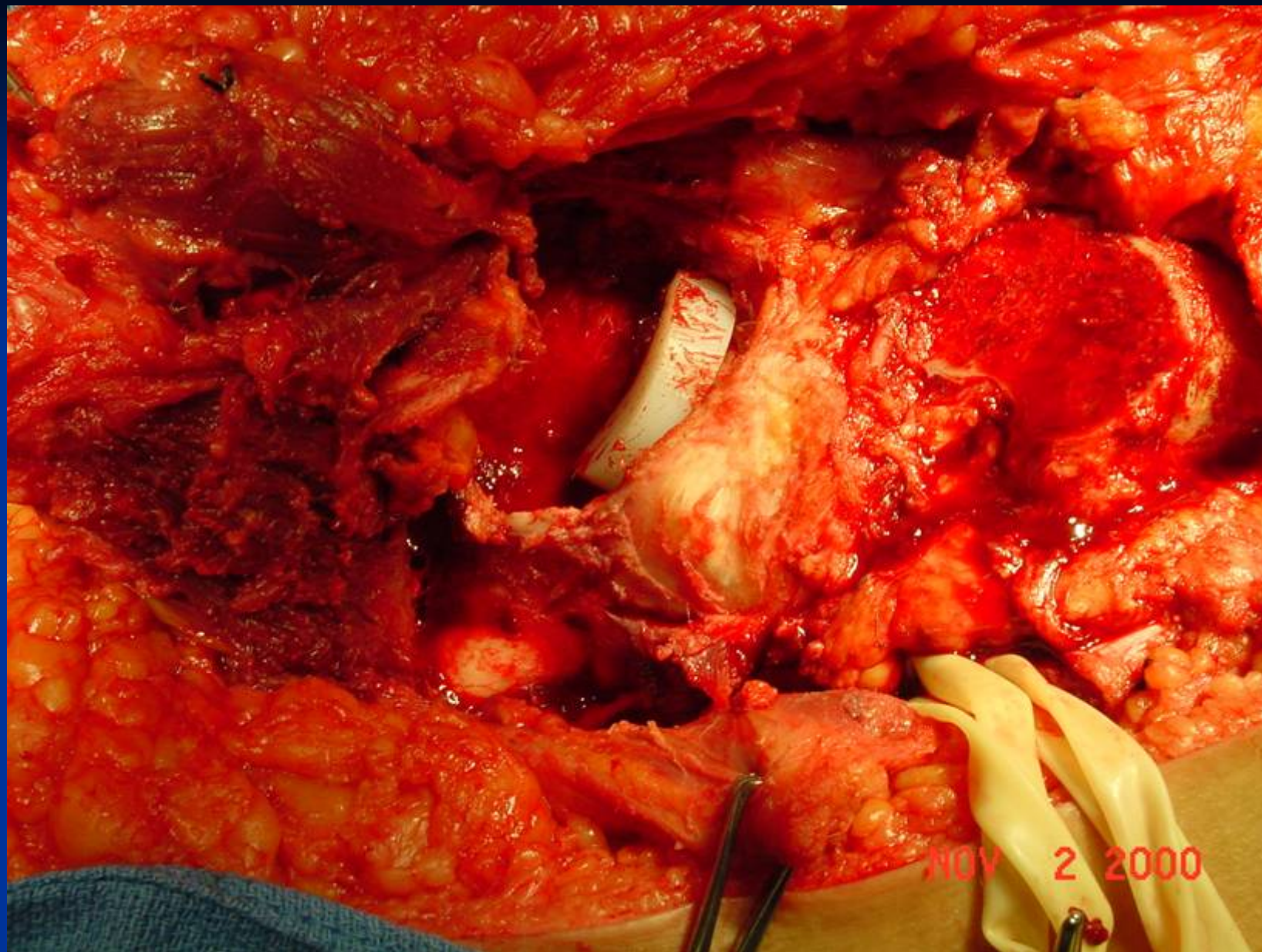








IMAGE 181
SER 1-11

↑ : F

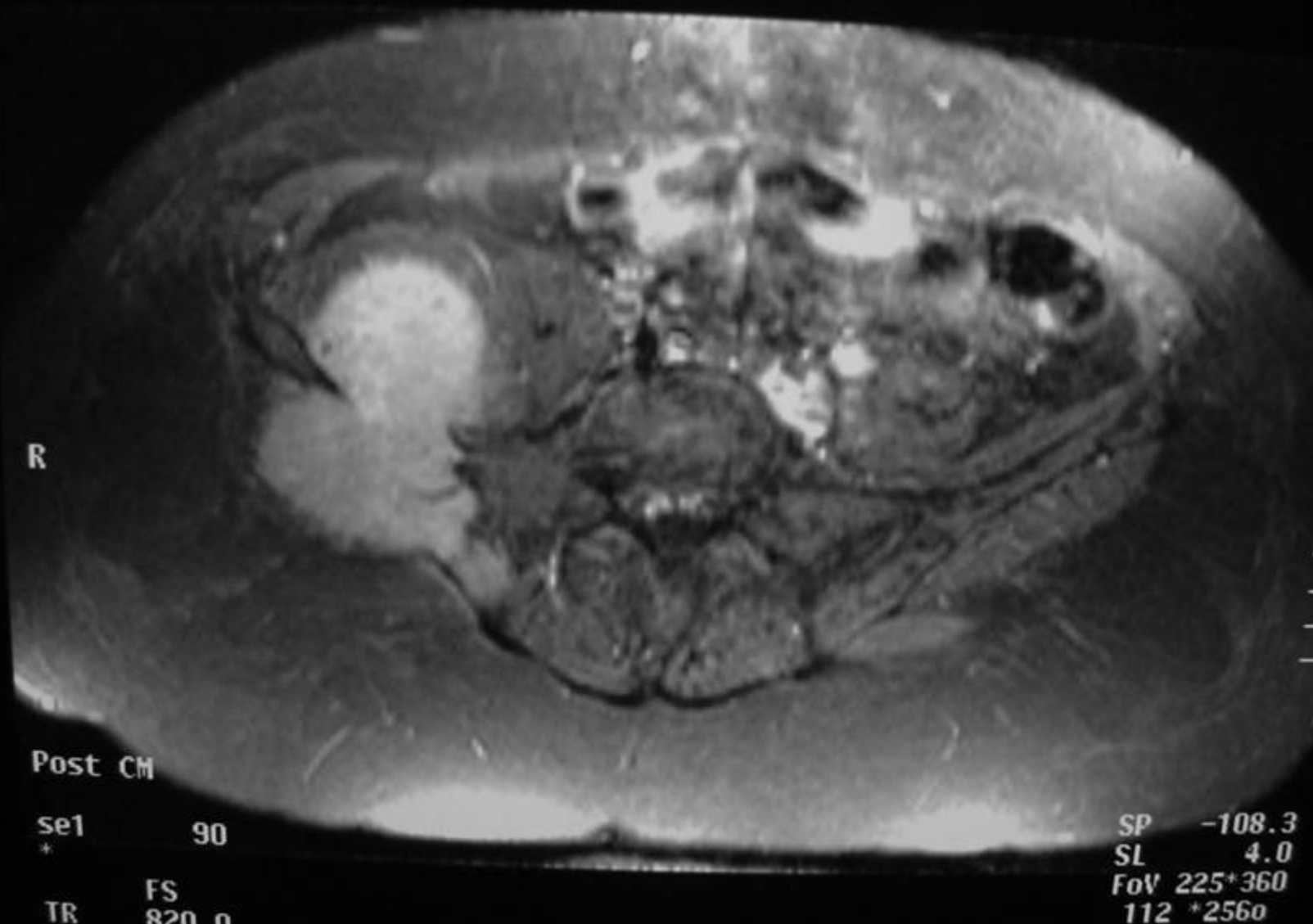
R

Post CM

se1 90
*

TR FS
820 0

SP -108.3
SL 4.0
FoV 225*360
112 *2560



Gantry: 0°

FoV: 376 mm

Time: ms

Slice: 5 mm

Pos: 181

FFS

F: B

250 mA

120 kV

Image no: 18



PRE EMBO.

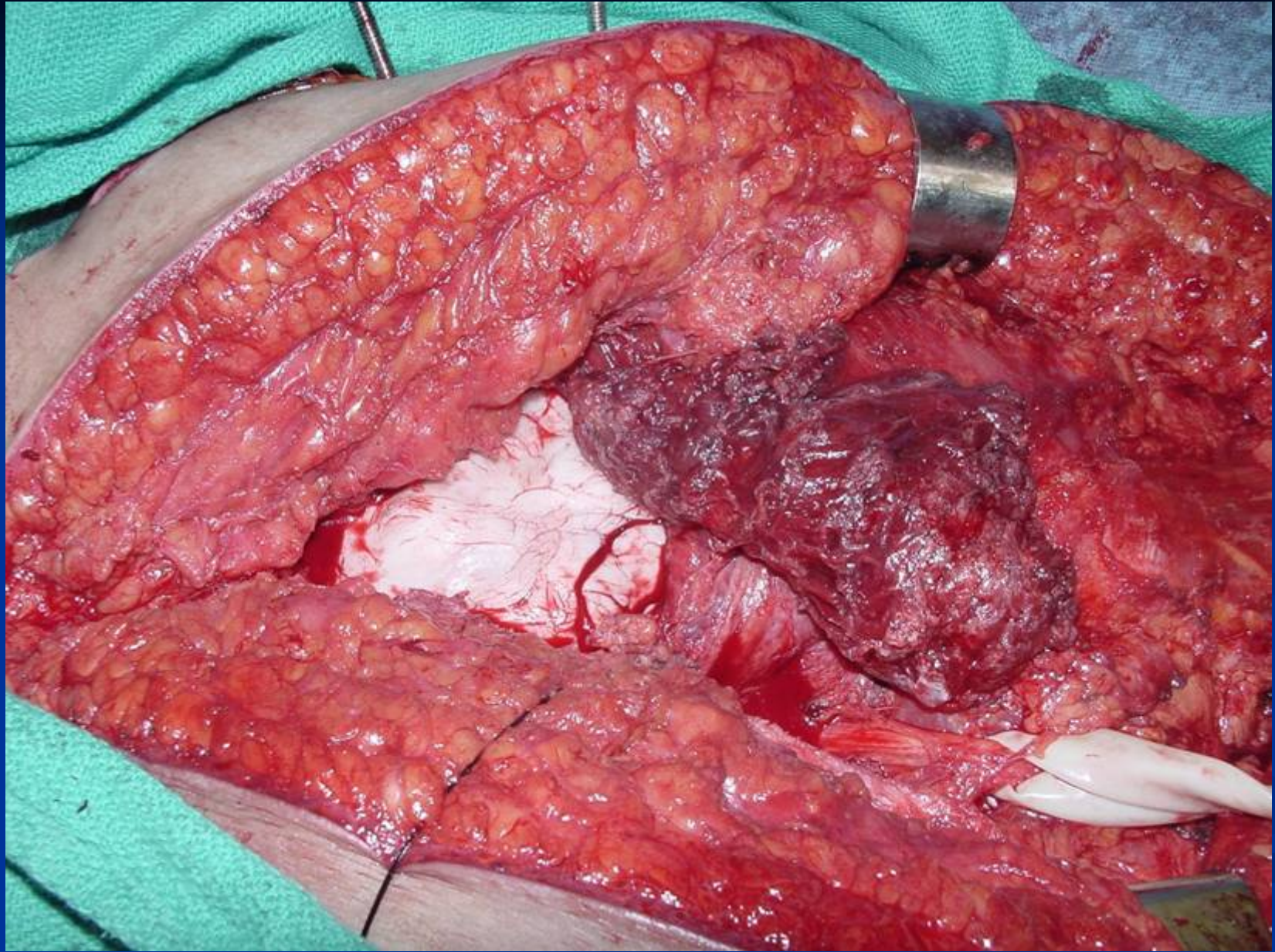


POST EMBO.

10:38:20
: 0.50
e: 2.50

MASK
2





872966BH
15



5/12/2004, 1:55:26 PM





DFOV 36.0cm
BONE

Aug 19 2003
512
MF:1.1

DFOV
BON

FLI:e3

R
1
6
4

L
1
6
4

R
1
6
4

kV 120
mA 320

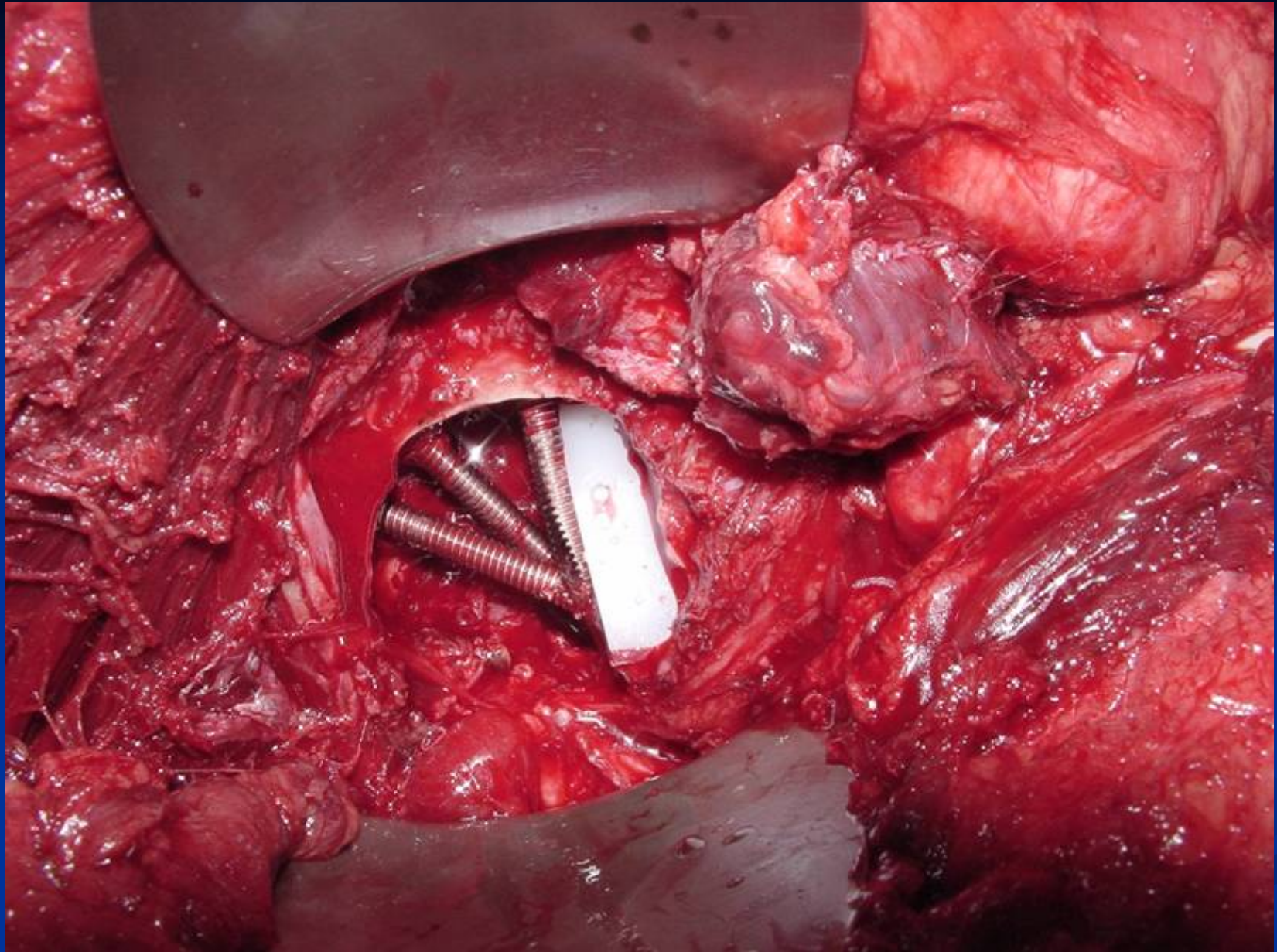
kV 1
mA 3

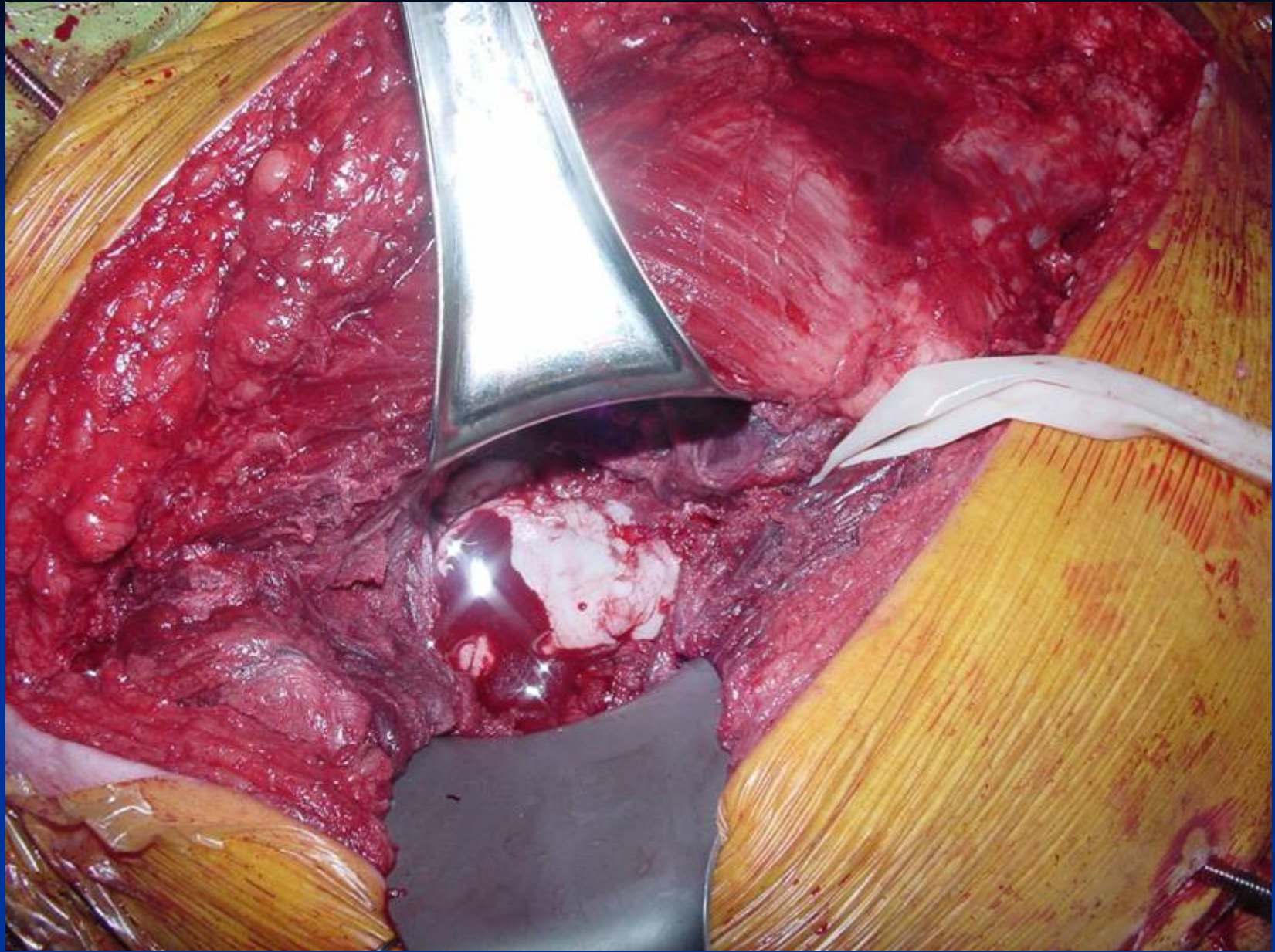
Large
5.000mm/7.50 0.75:1
Tilt: 0.0
0.8s /HE 09:11:01 AM/12 22

Large
5.00
Tilt
0.8s
0.206











Se: 9
In: 6
QAx S270.4

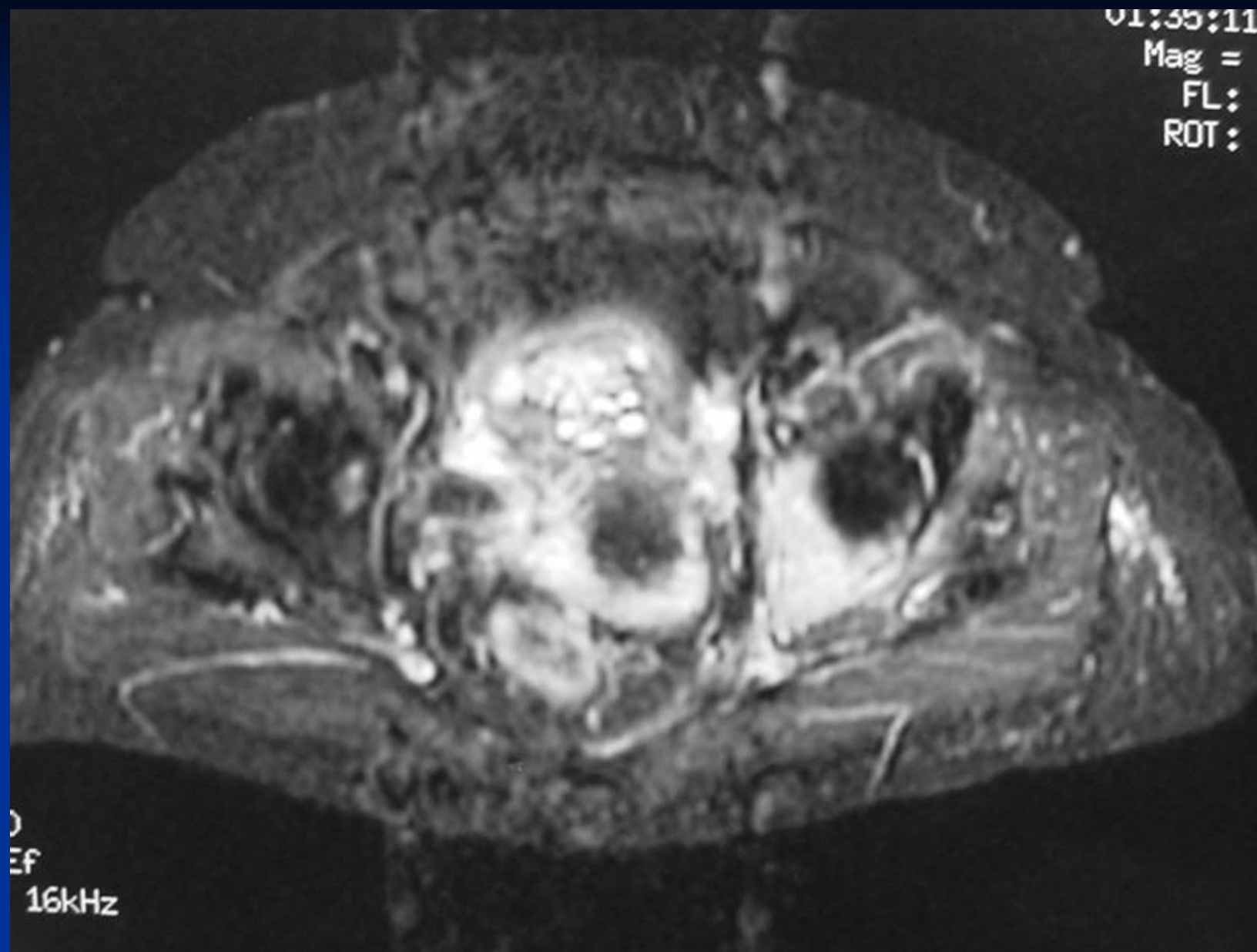
ET:15

R
I

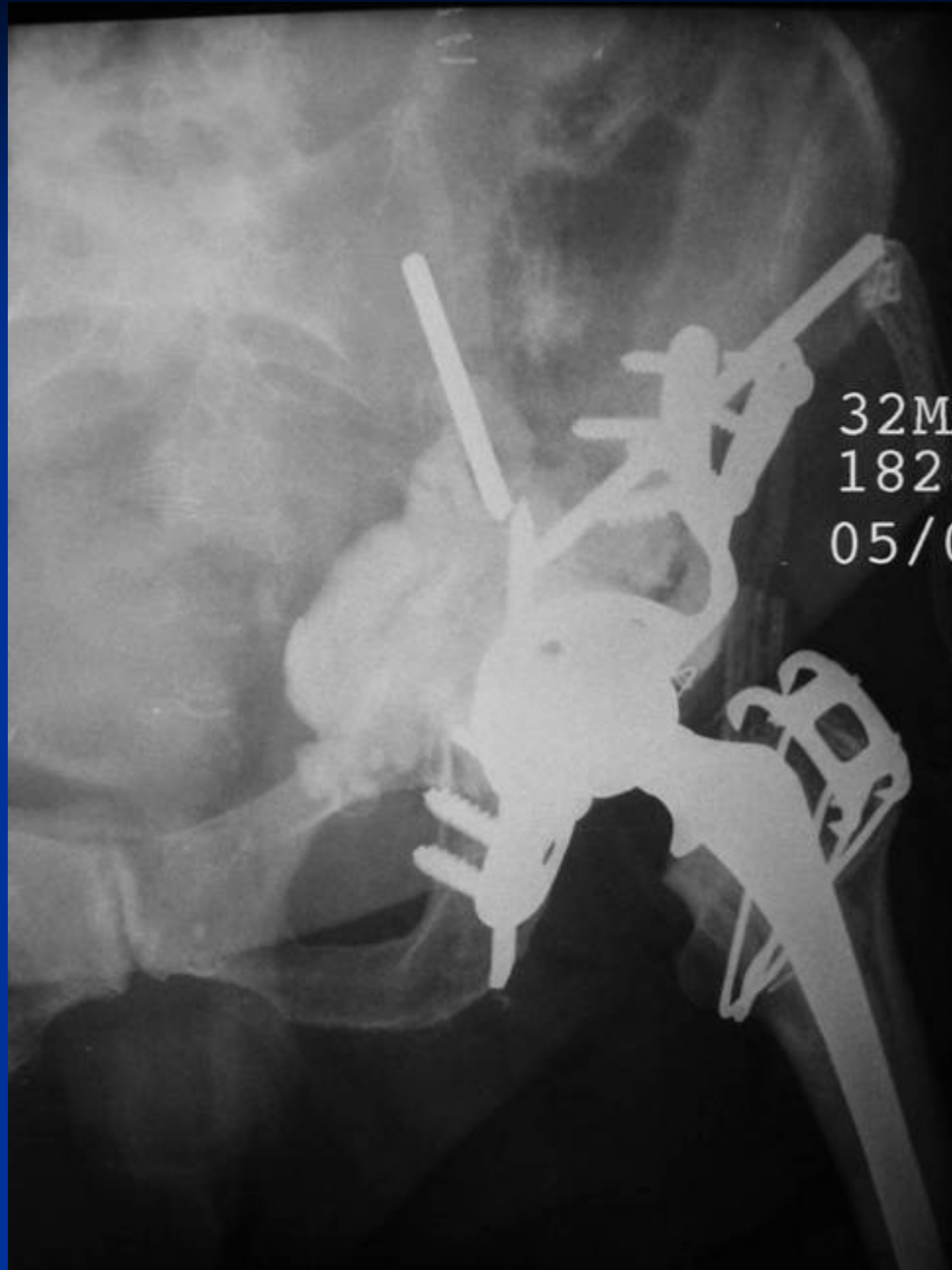
L
S

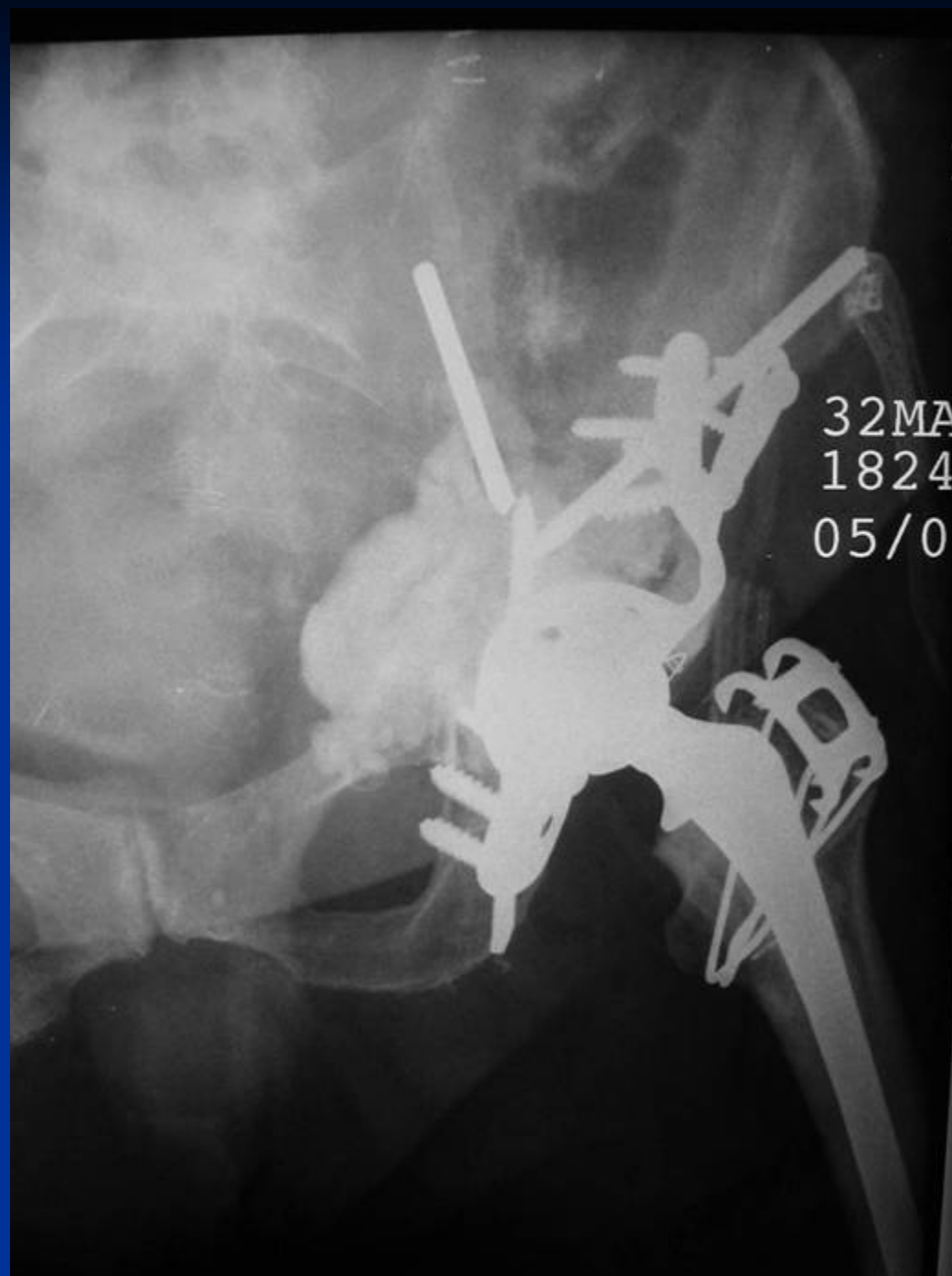
0
TE:48/EF
EC:1/1 16kHz
TI:150
BODY
FOV:46x34
7.0thk/2.0sp
27/04:25
256X192/2 NEX
St:si /SO

W = 386 L = 187
v>







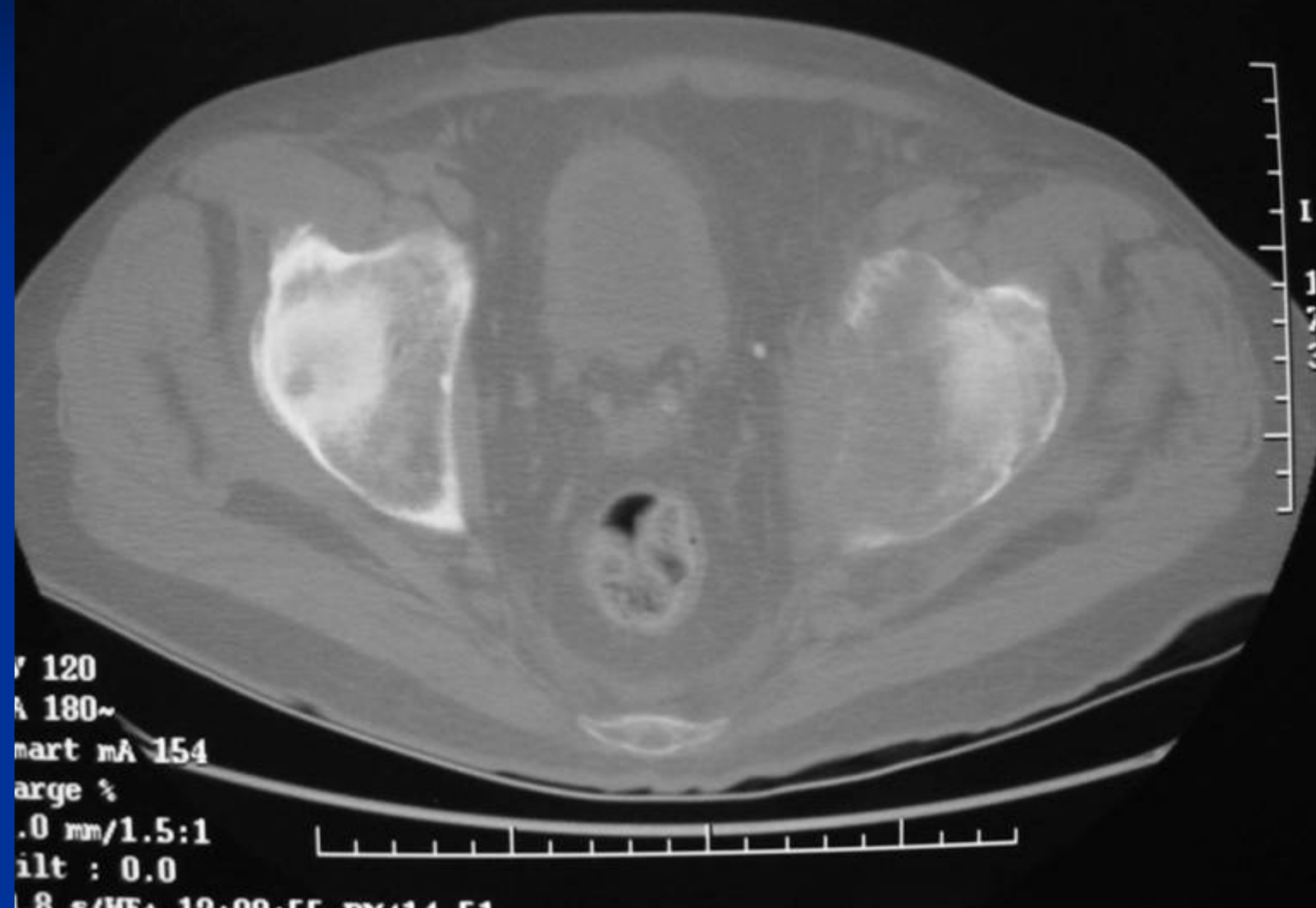






DFOV 36.0cm
BONE/+

500 31 01
512



DFOV 36.0cm
BONE/+

Dec 31 01
512

R
1
8
7

I
1
8
7

kV 120
mA 180~
Smart mA 154

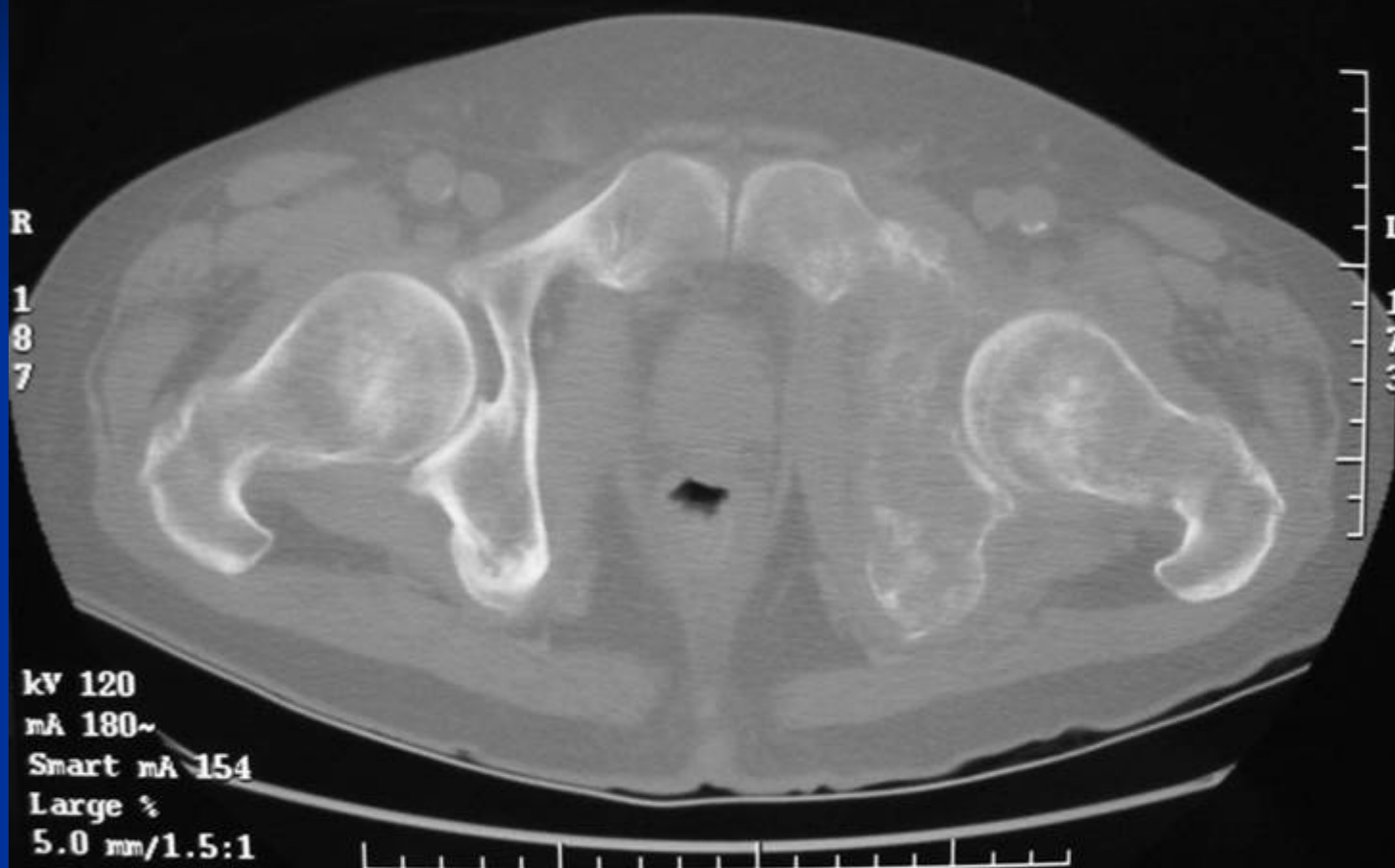
Large %
5.0 mm/1.5:1

Tilt : 0.0

0.8 s/HE+ 12:08:55 PM/17.92

W:2500 L:150

P 180





3 Months After Saddle Prosthesis



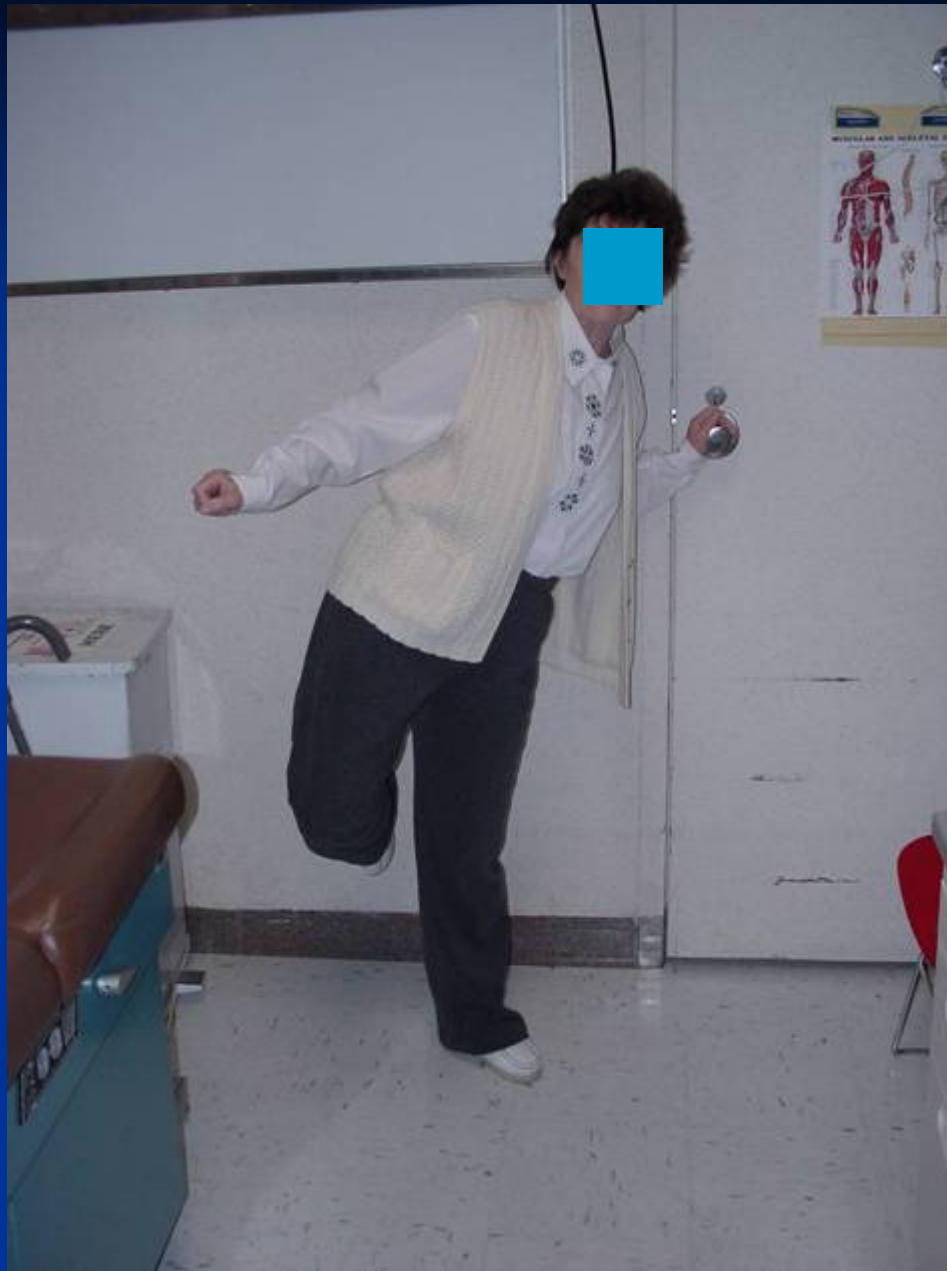






9 Months Postop







Femoral Shaft

- Cephalomedullary nail (gamma nail)
- Flexible nails and cement





53
36
04
80
20

VA47
F-S

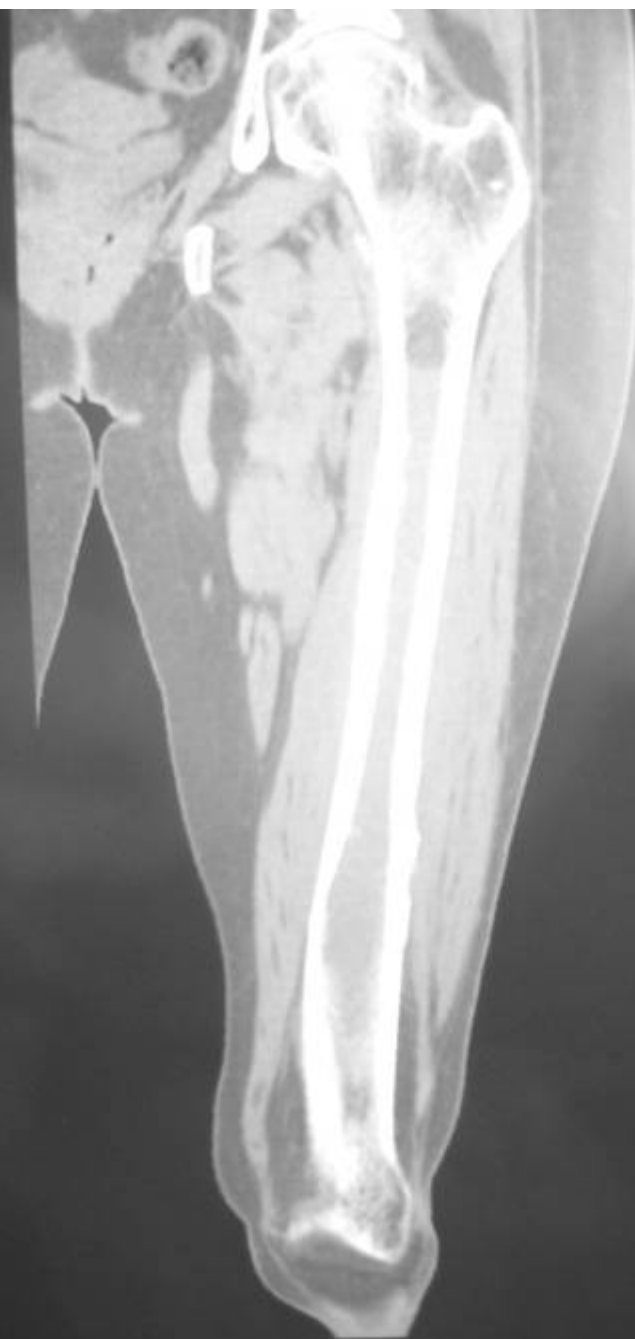
Spin: -0
Tilt: 0

10cm

A

W 1500
C 450

10
0.0
2.5
s





Distal Femur

- Cephalomedullary nails
- Retrograde femoral nail
- Flexible nails, Rush rods

Proximal Humerus

- Long stem hemiarthroplasty
- Cephalomedullary nail
 - No Distal Interlocking Screw
- Rush rods



FOV 37.8cm

STND/+

NOV 10 2003

512



kv 120

mA 280

Large

5.000mm/13.50 1.35:1

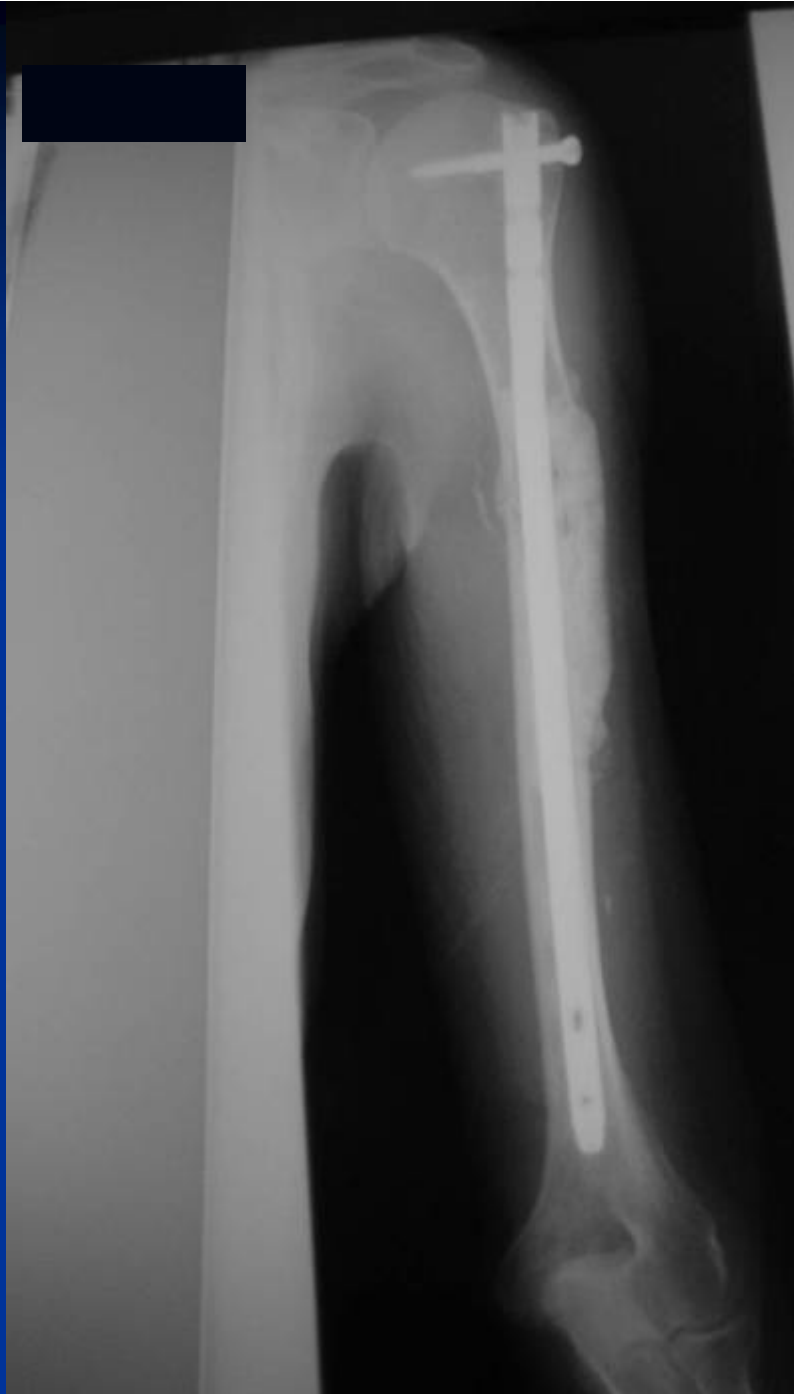
Tilt: 0.0



Humeral Shaft

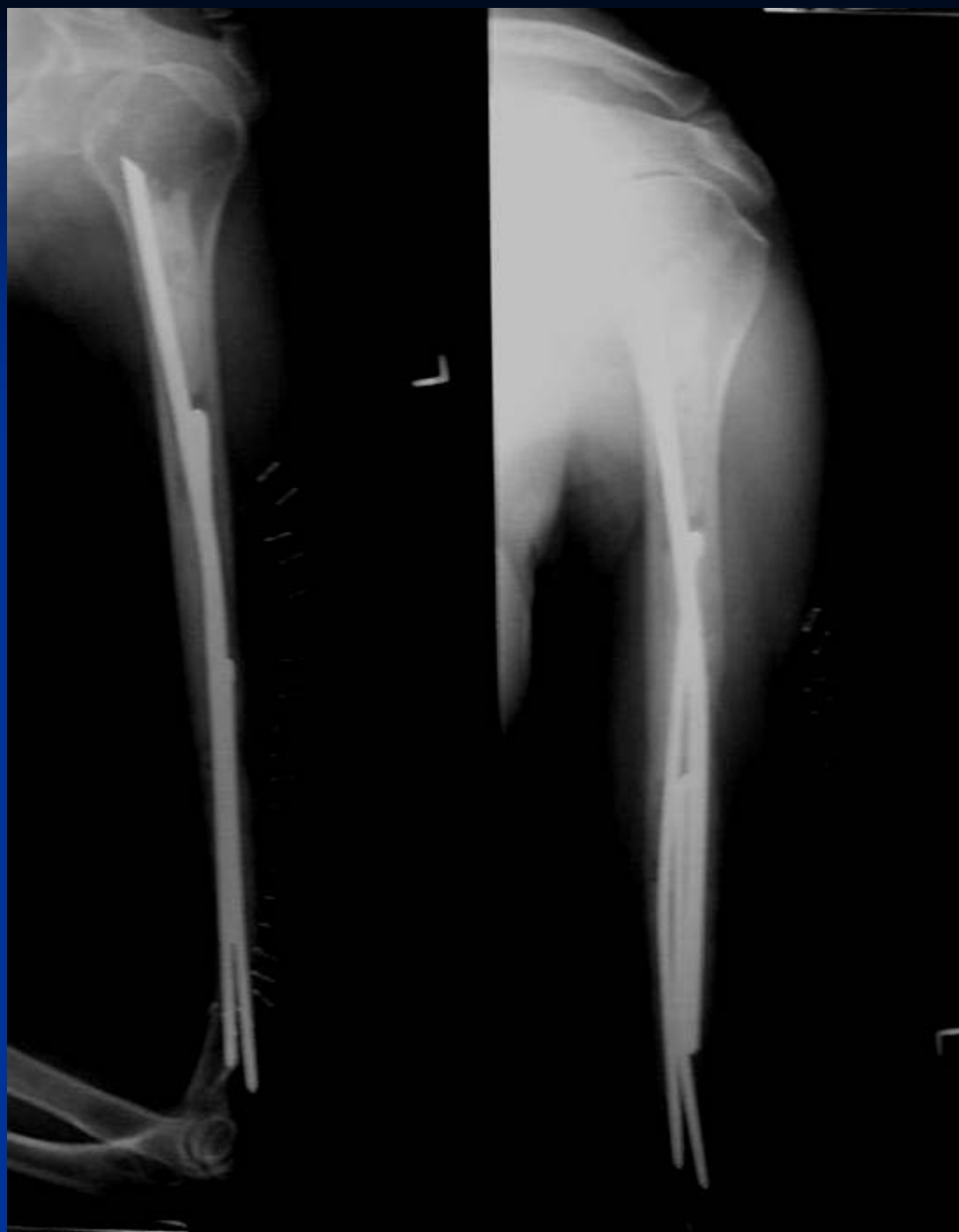
- Intramedullary (cephalomedullary) nail
 - Cemented
 - No distal interlocking screw
- Rush rods











Elbow/Distal Humerus

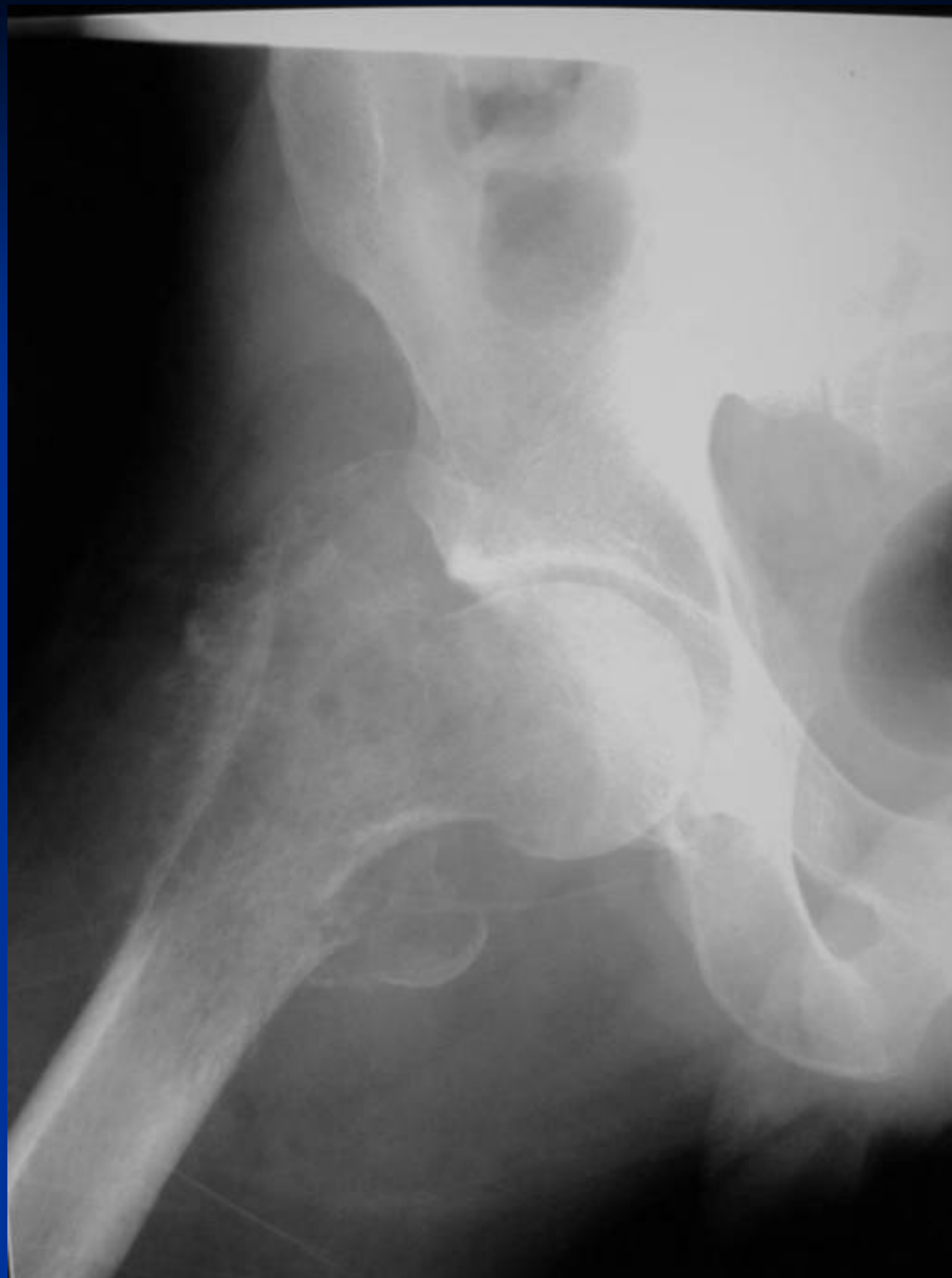
- IM Nail
- Rush Rods/Flexible Nails

Tibia

- Intramedullary rods
- Rush rods

Segmental Prostheses

Hip/Proximal Femur



31-DEC-2002
IMAGE 355
SER 1-23

RH

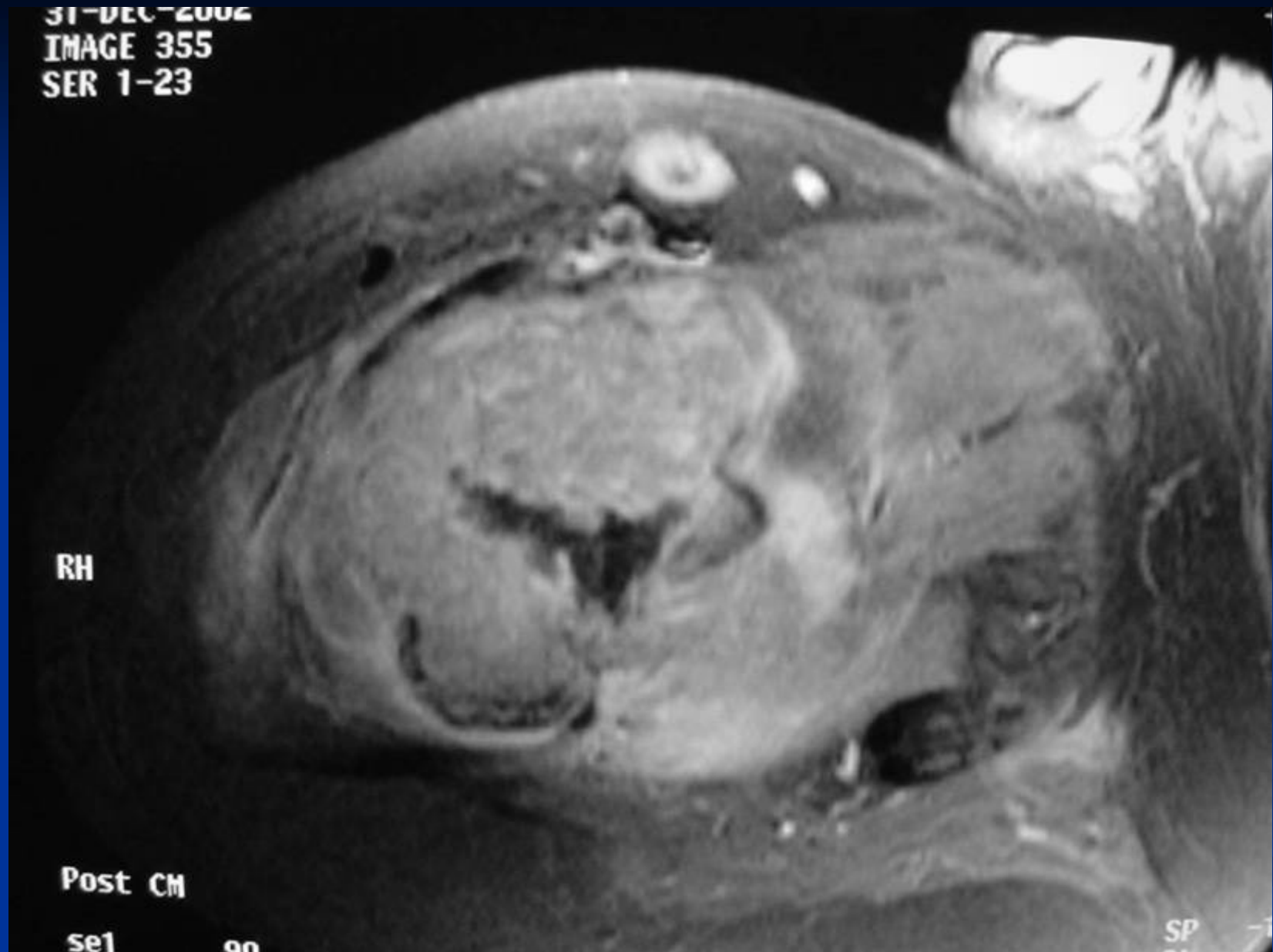
Post CM

se1

90

SP

-1



FoV: 360 mm

Tid: 1782 ms

Snitt: 2 mm

Pos:

F: BONE

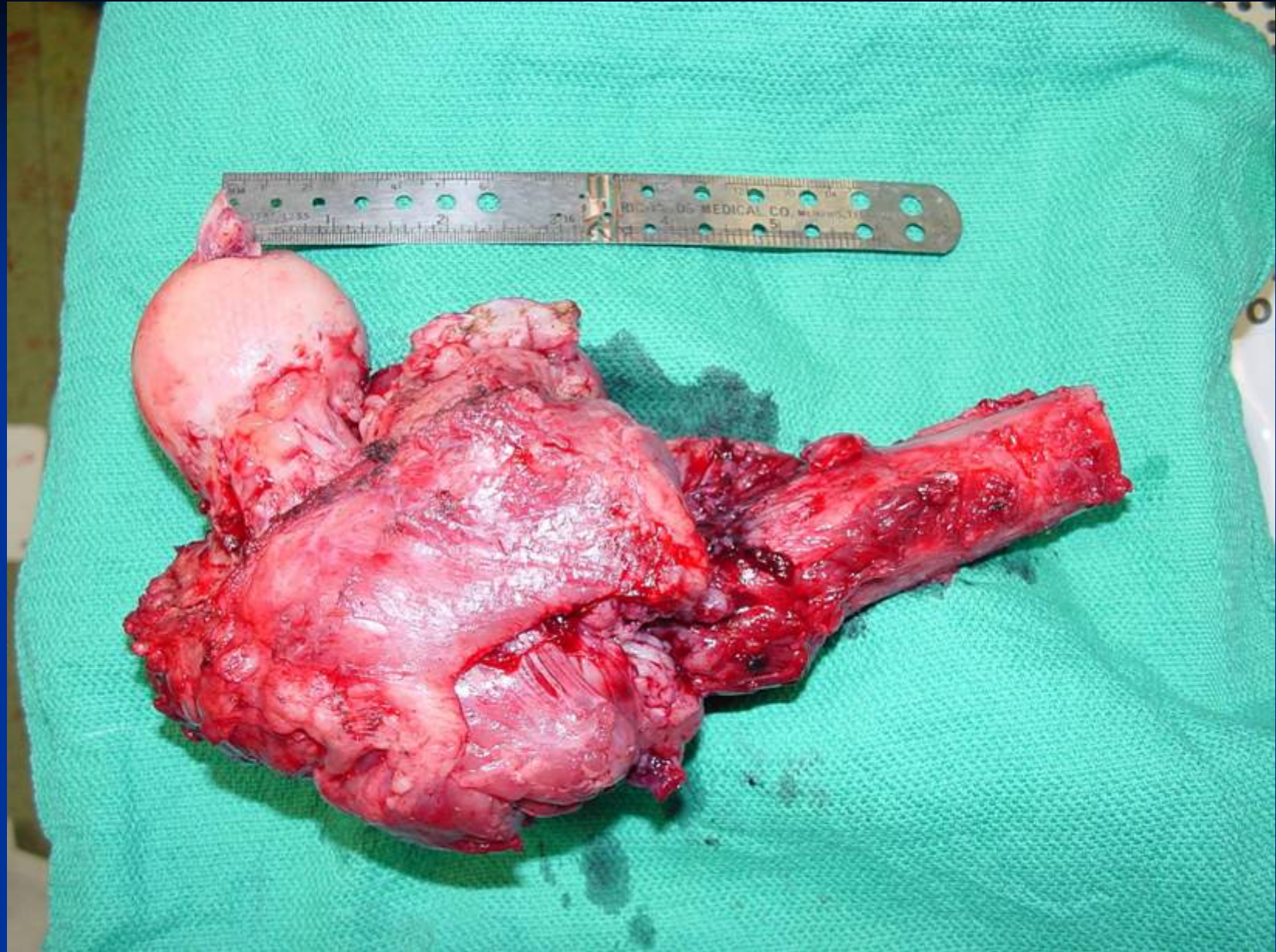
320 mA

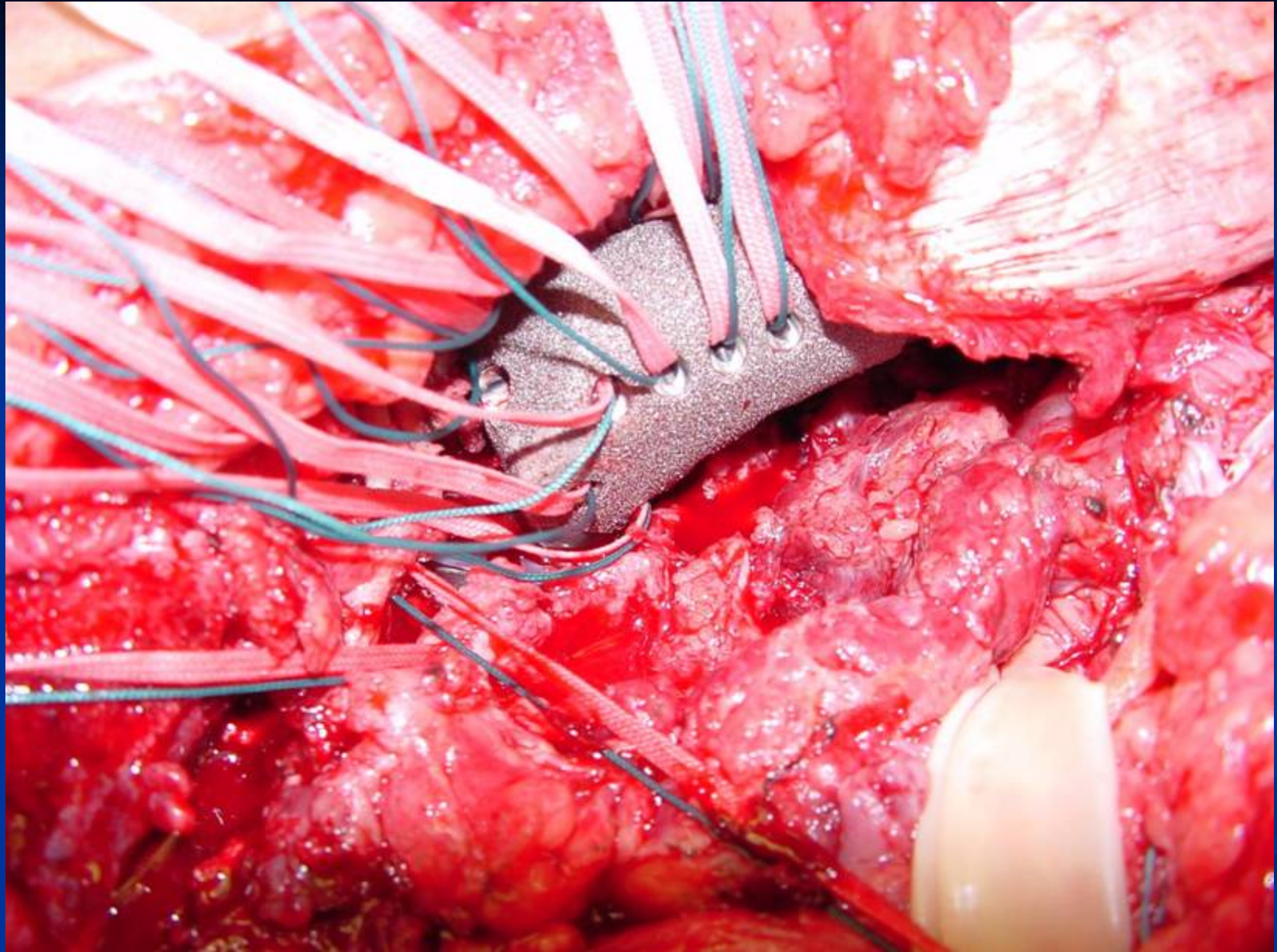
20 kV

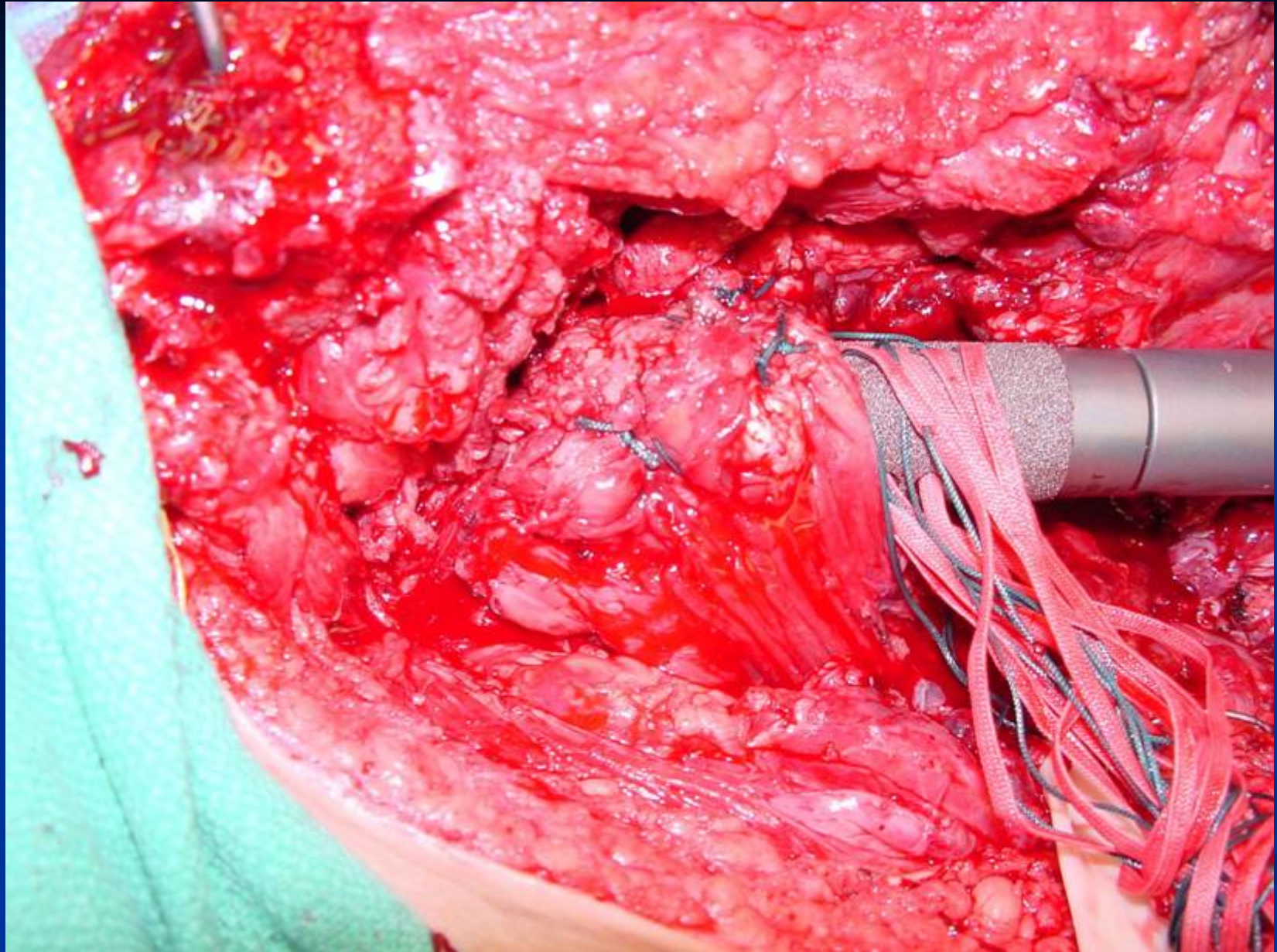
image no: 4

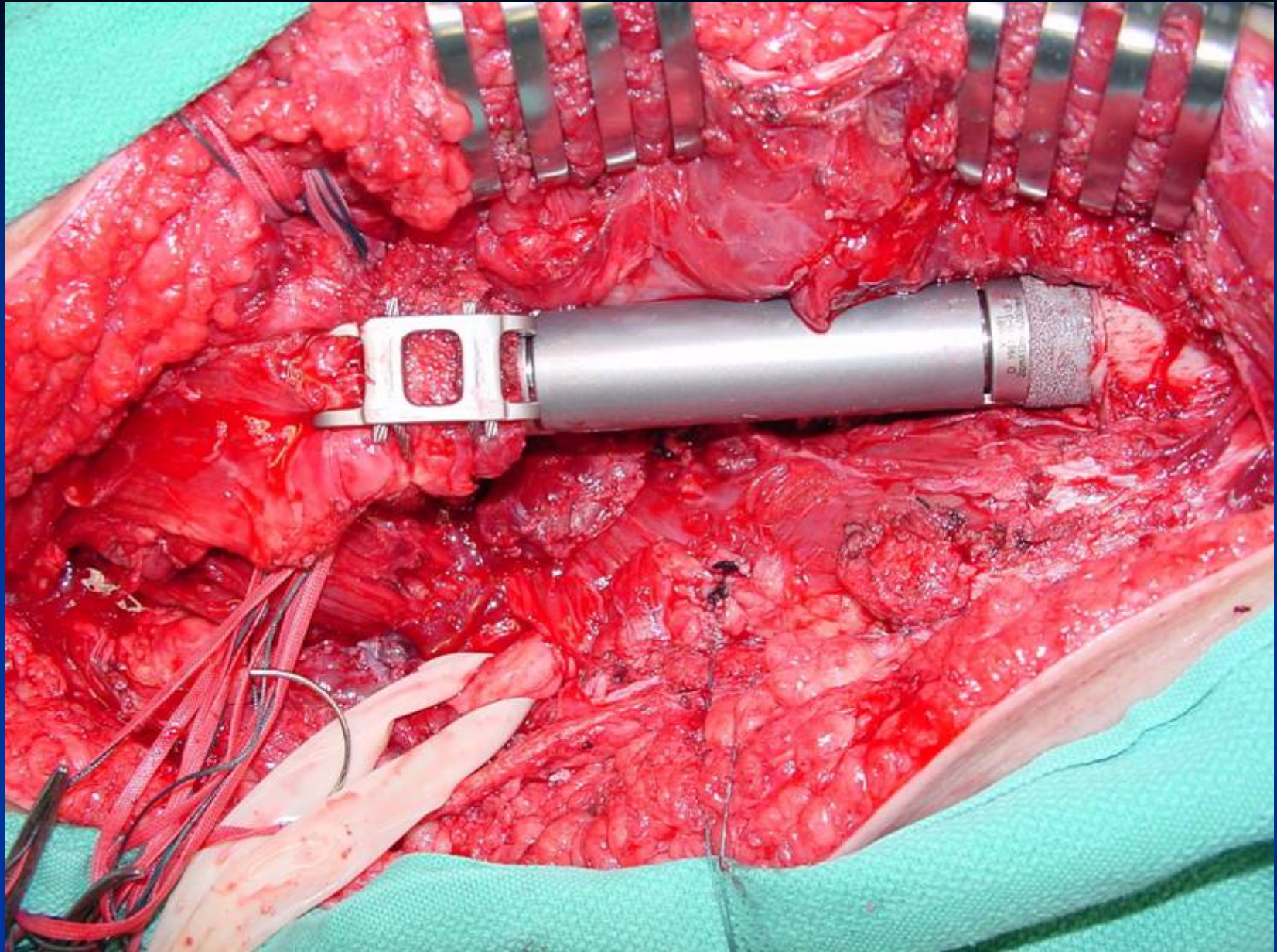
image 64 of 106

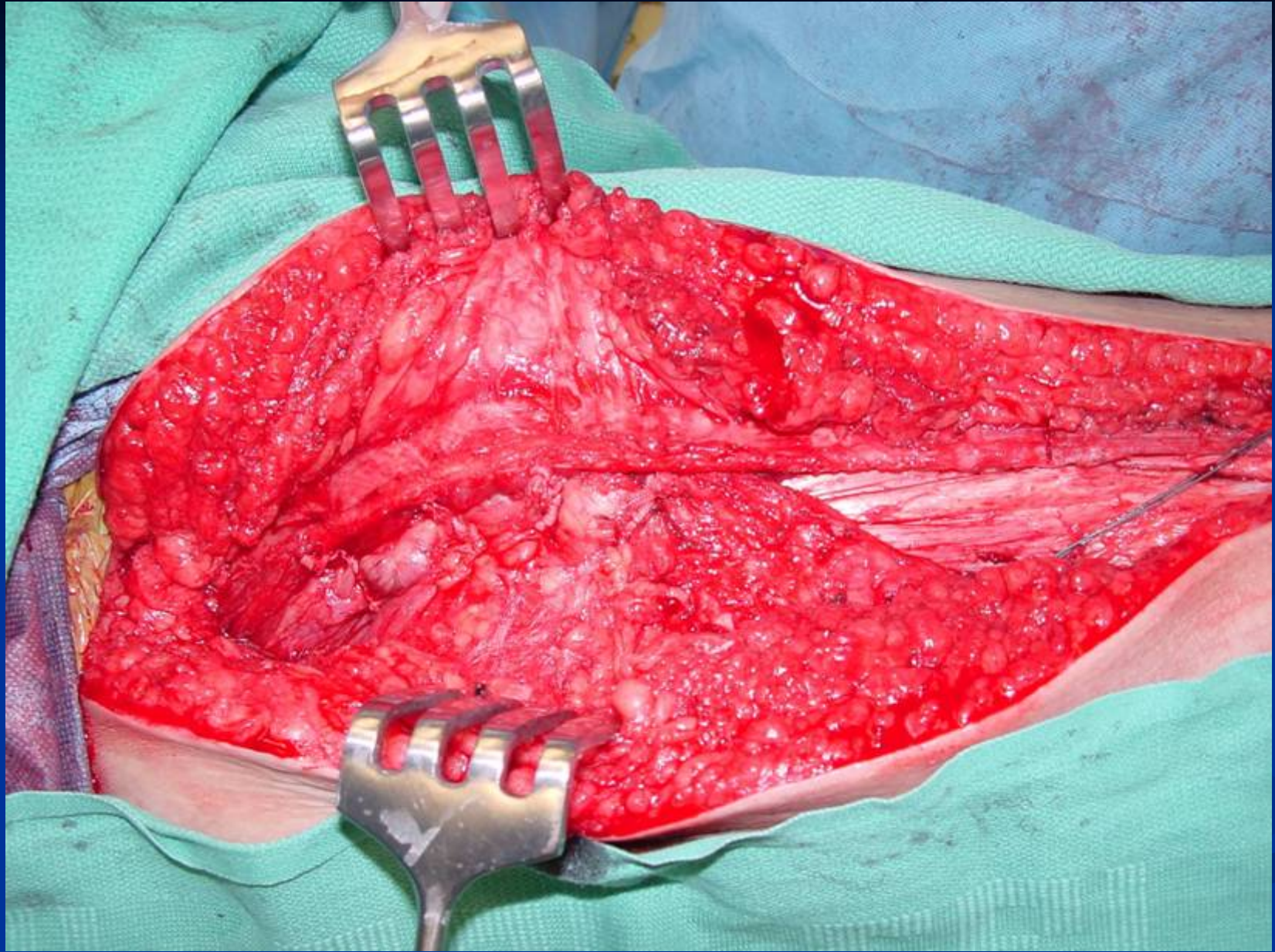


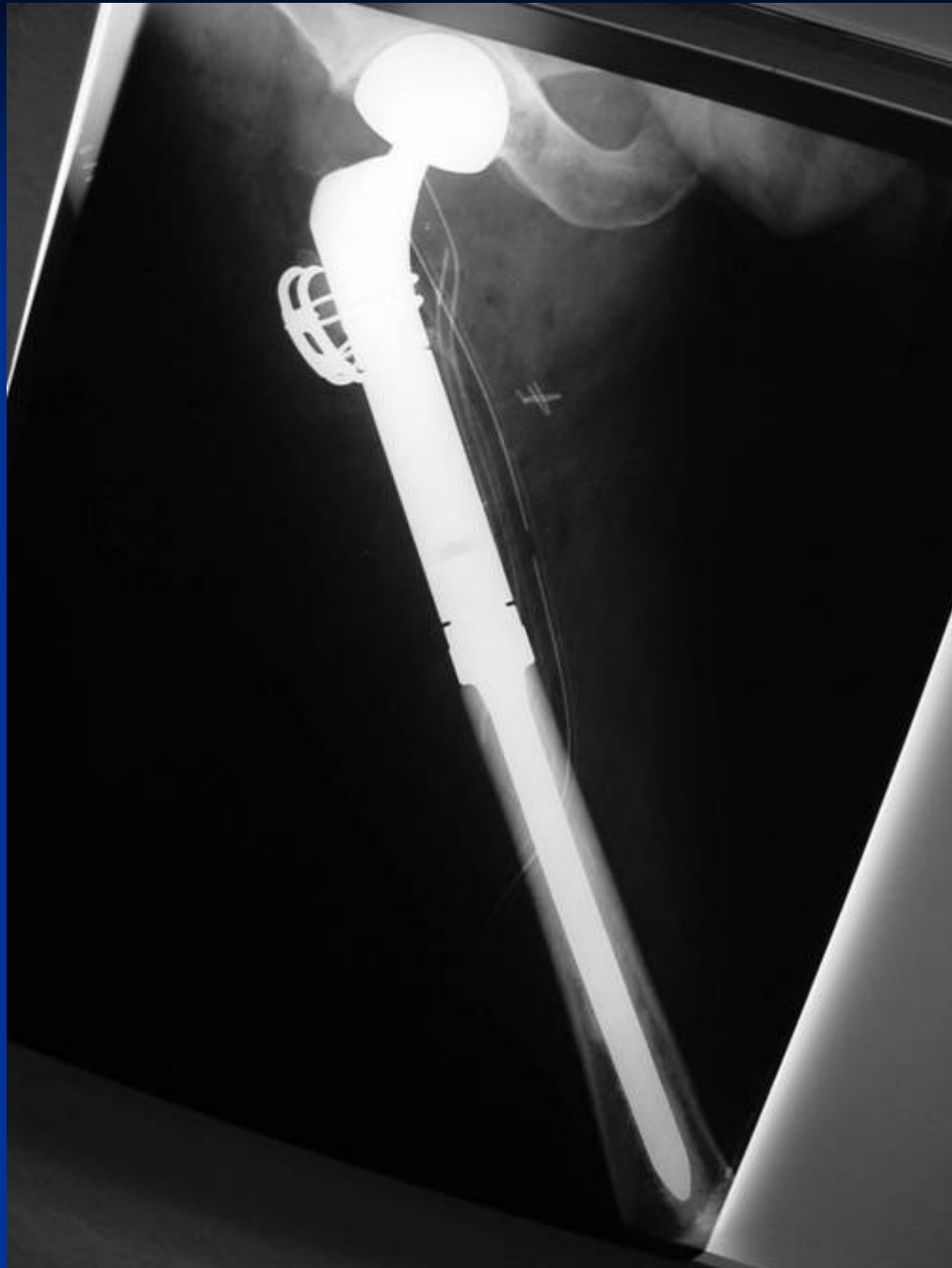












3 Months Postop









1 Year Postop

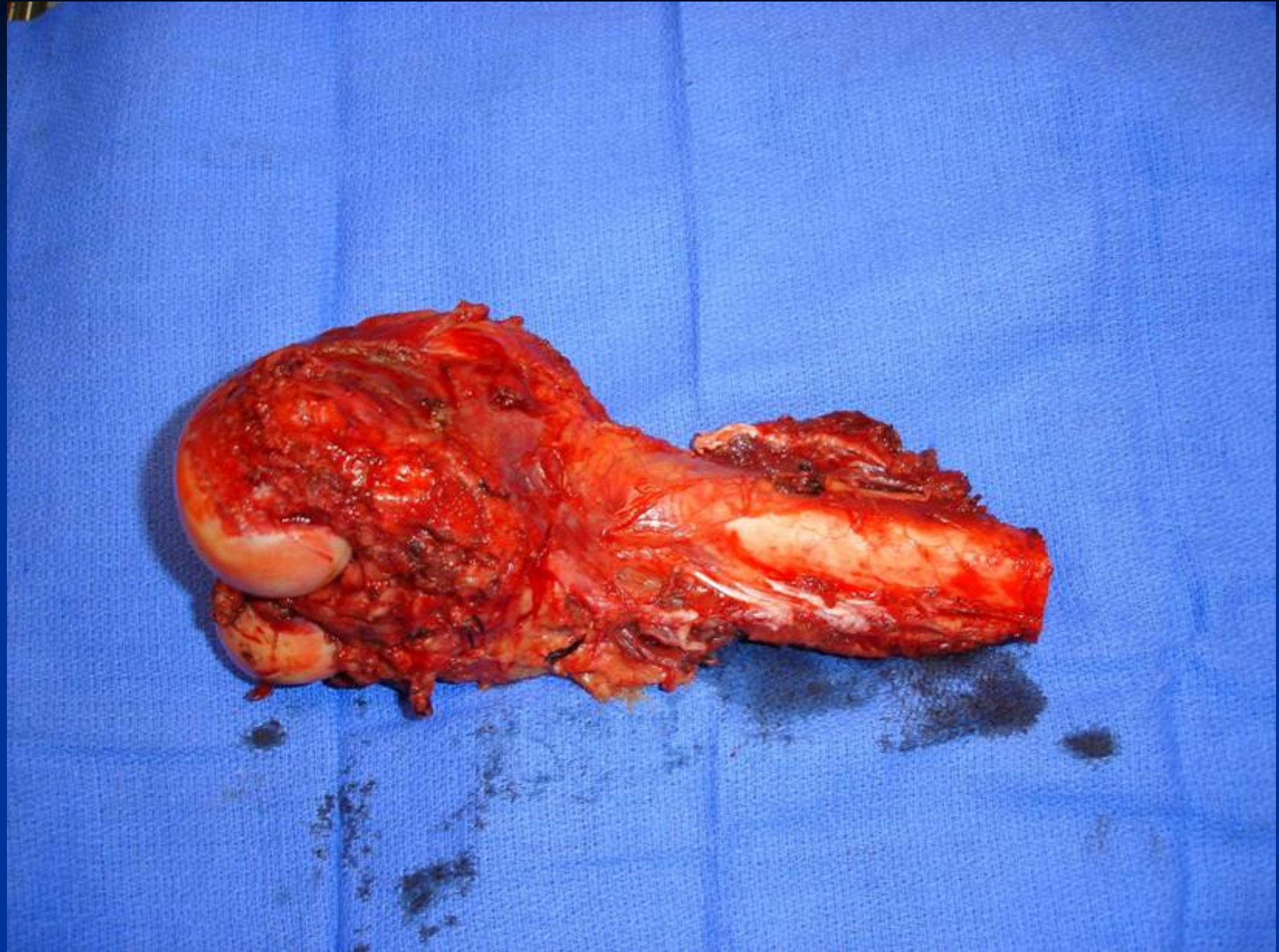


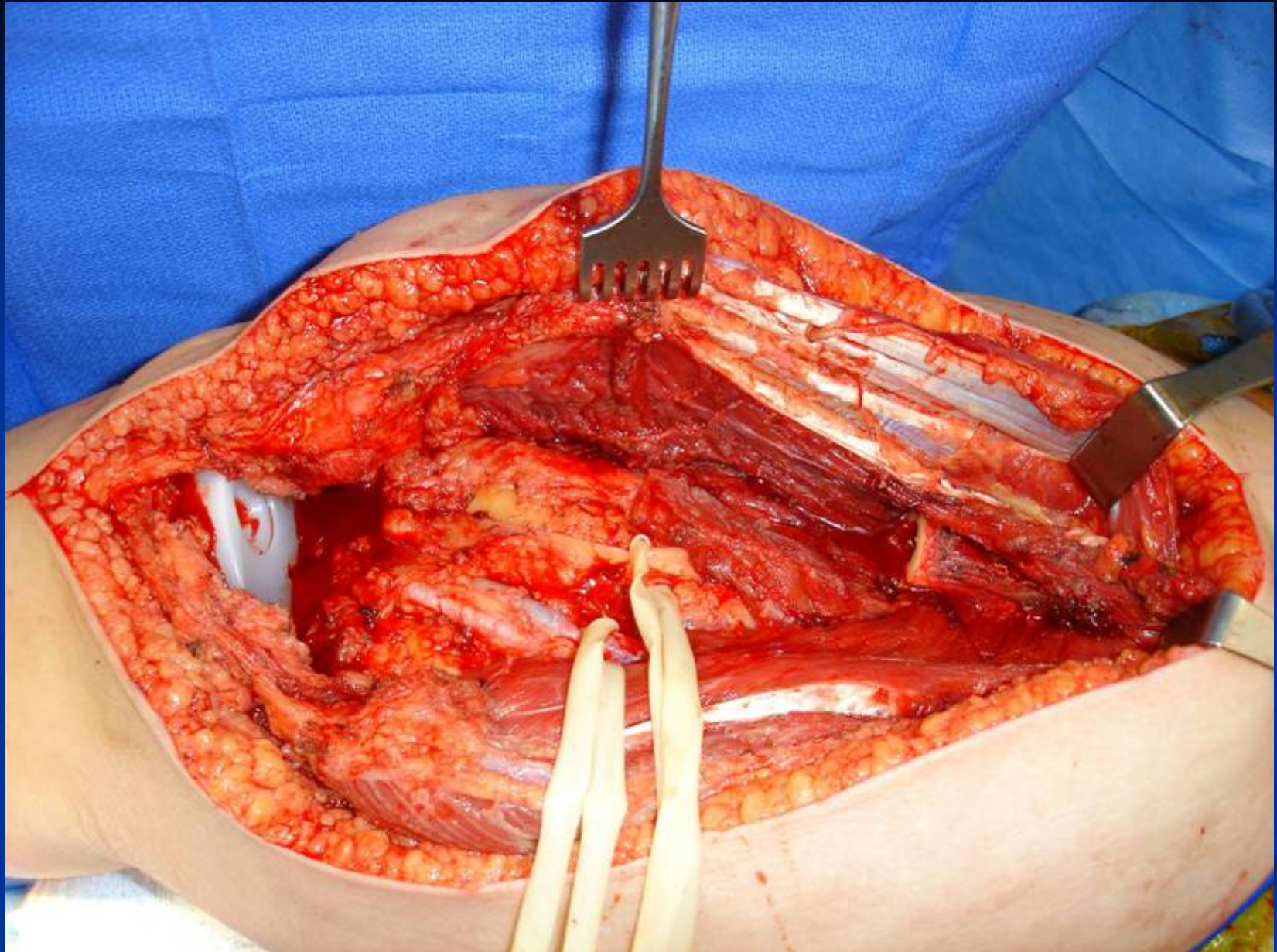
Distal Femur

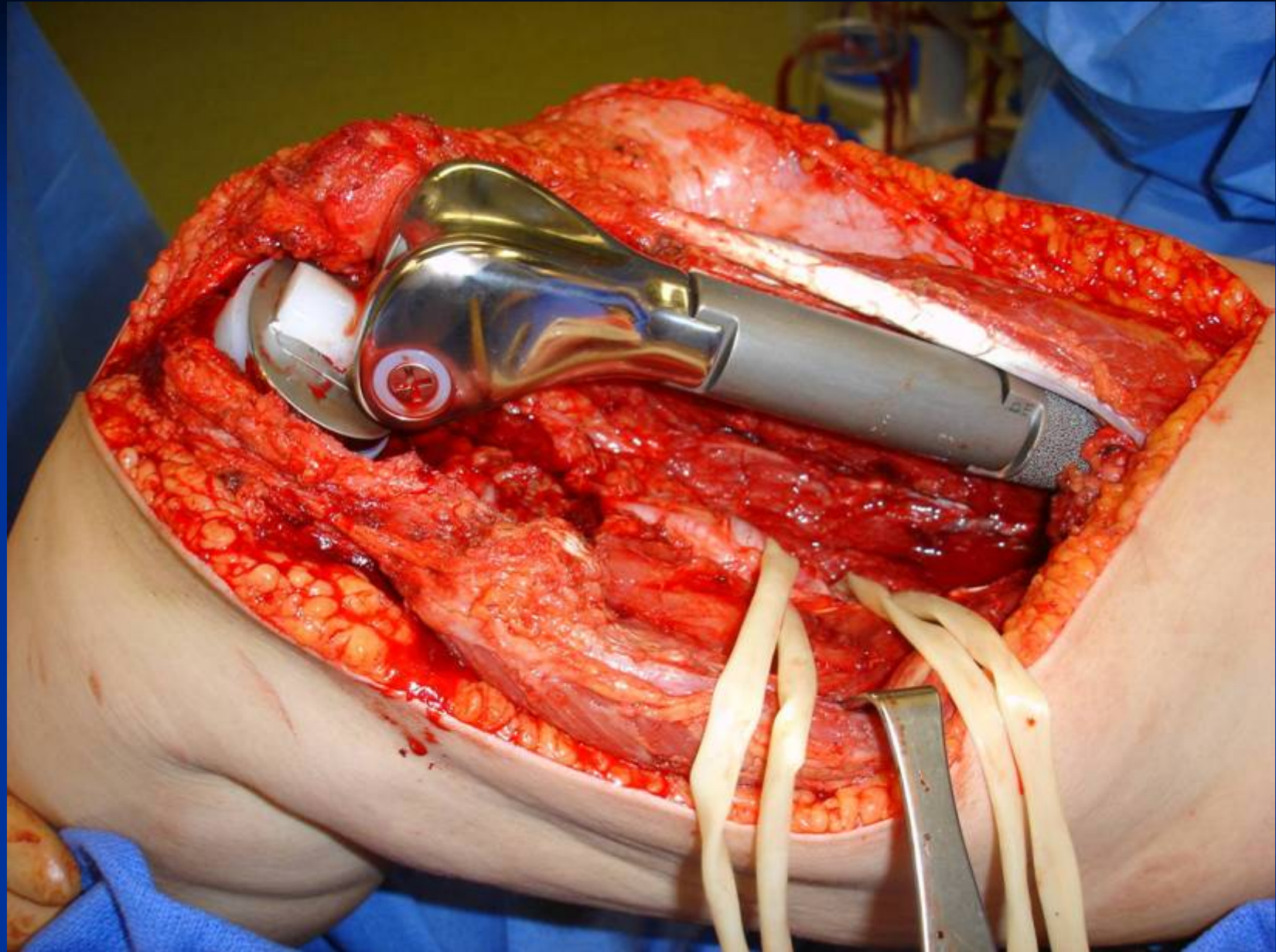


23:20 PM









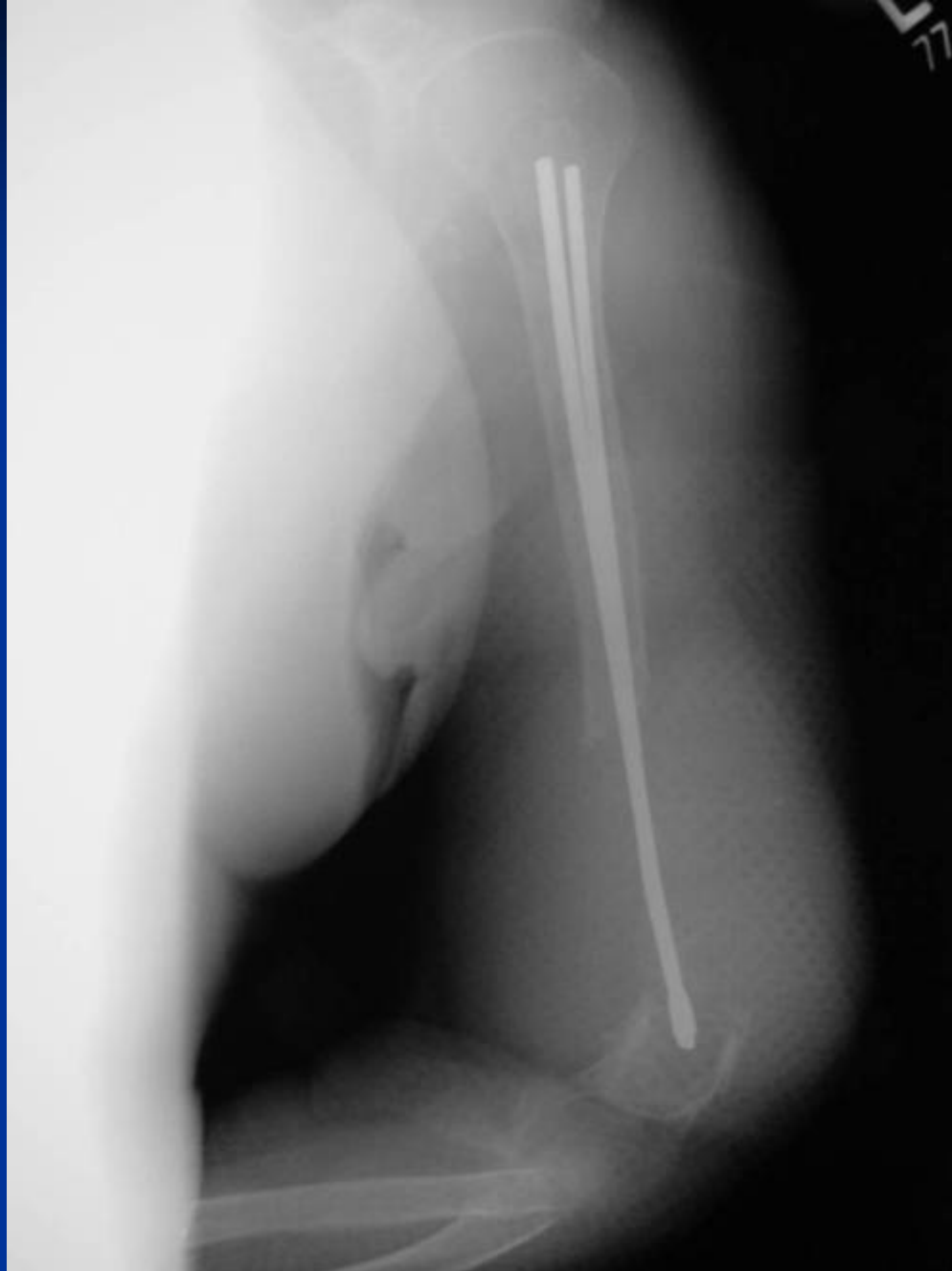


Elbow





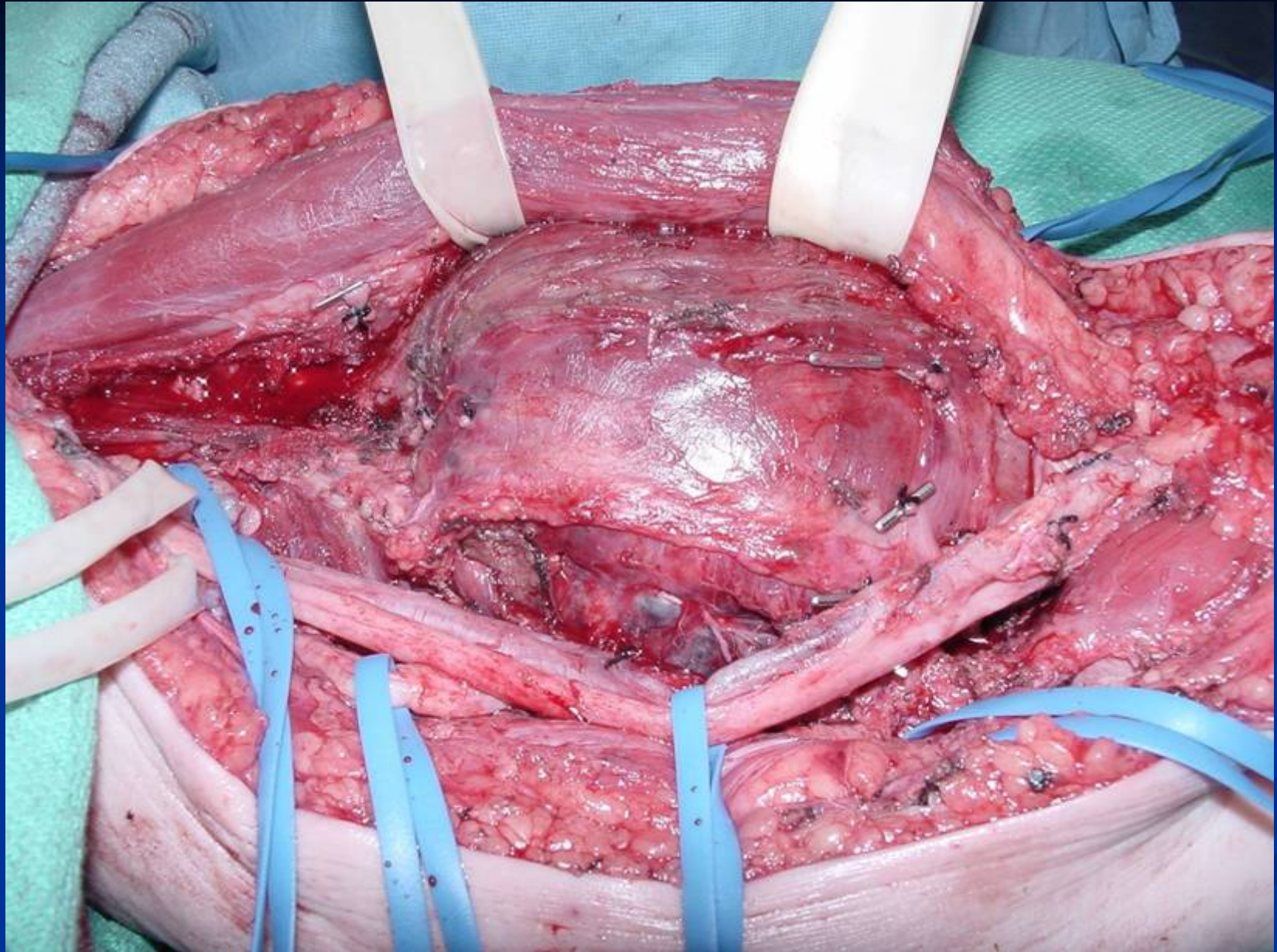


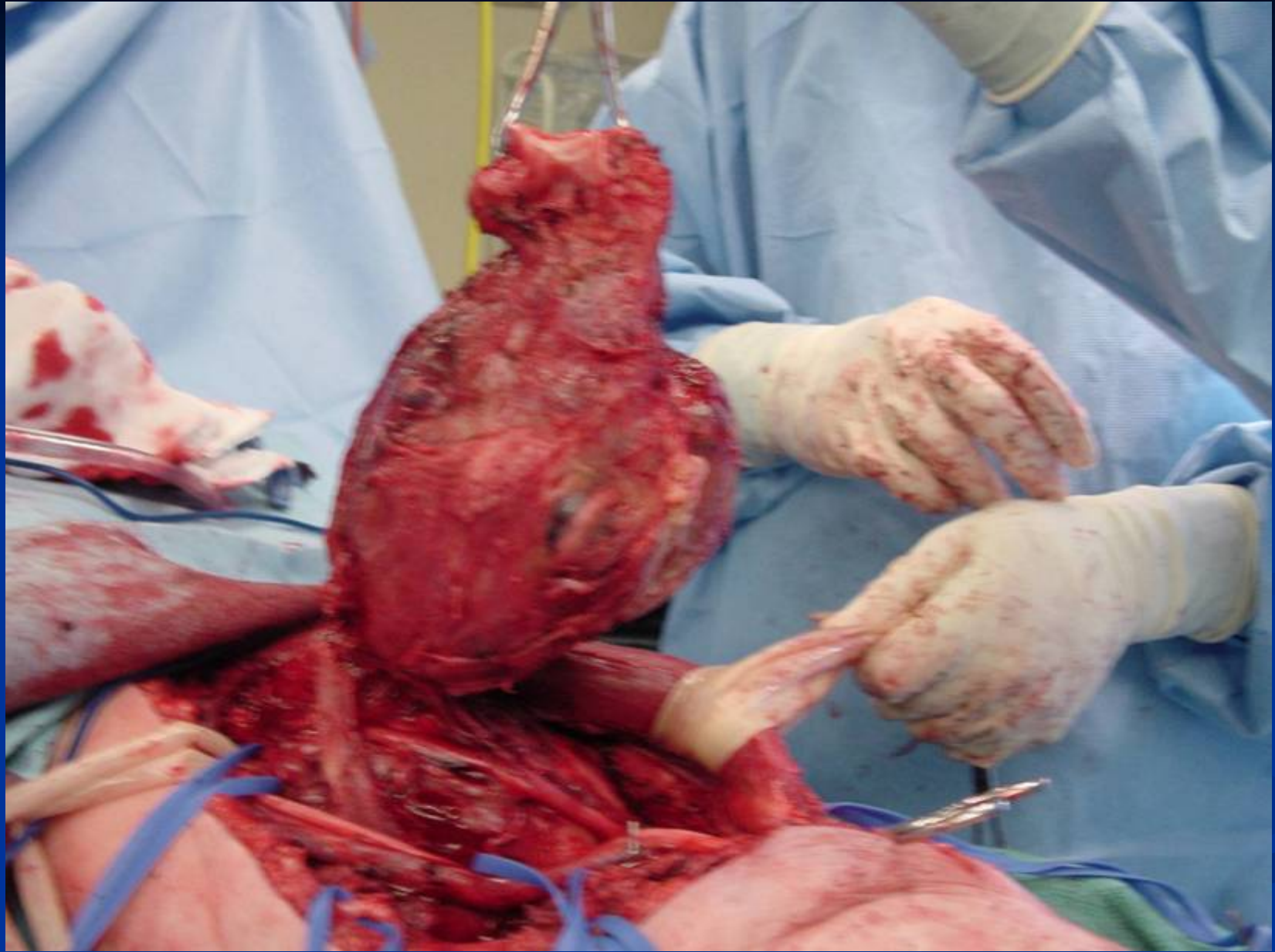


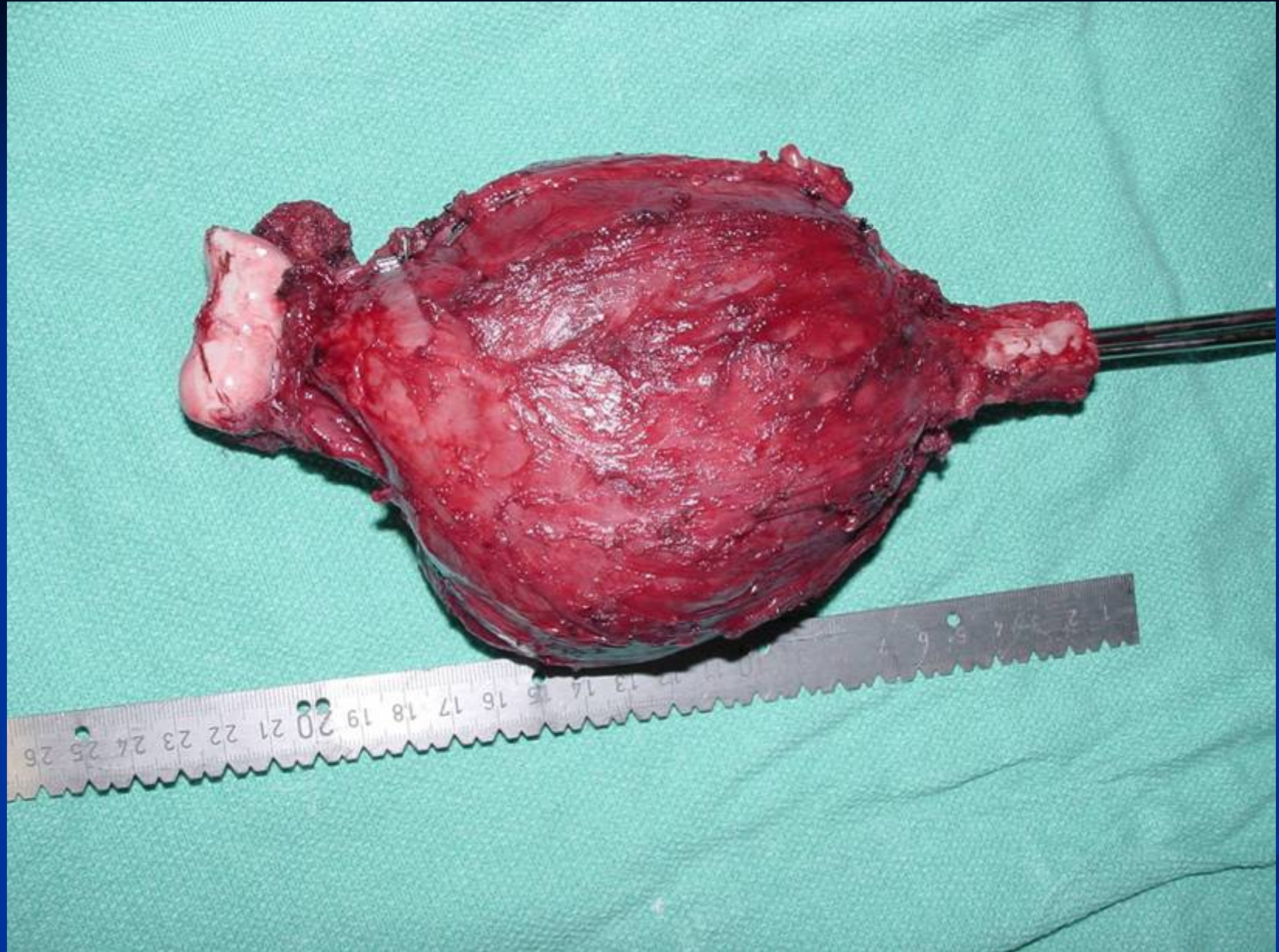


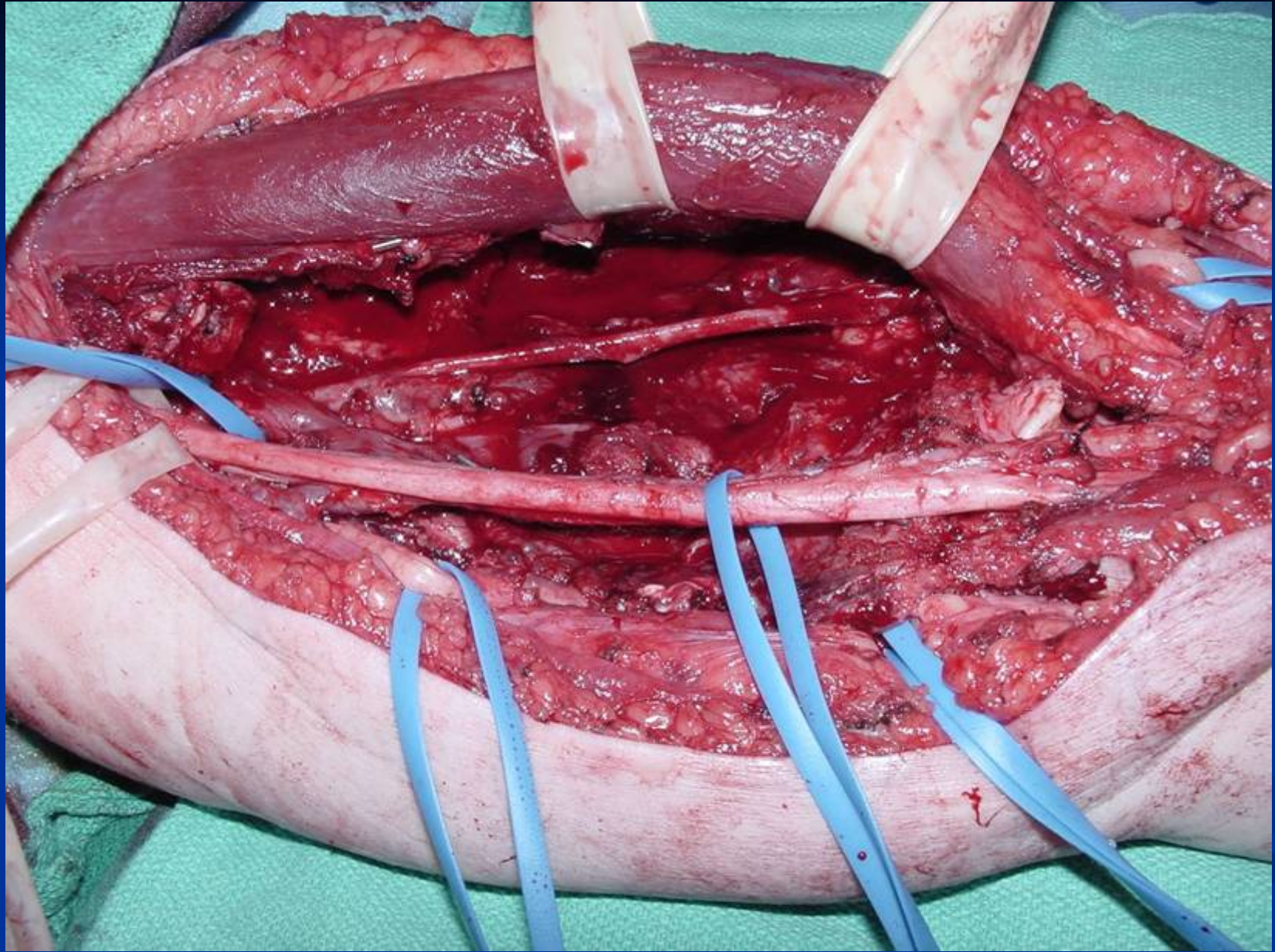


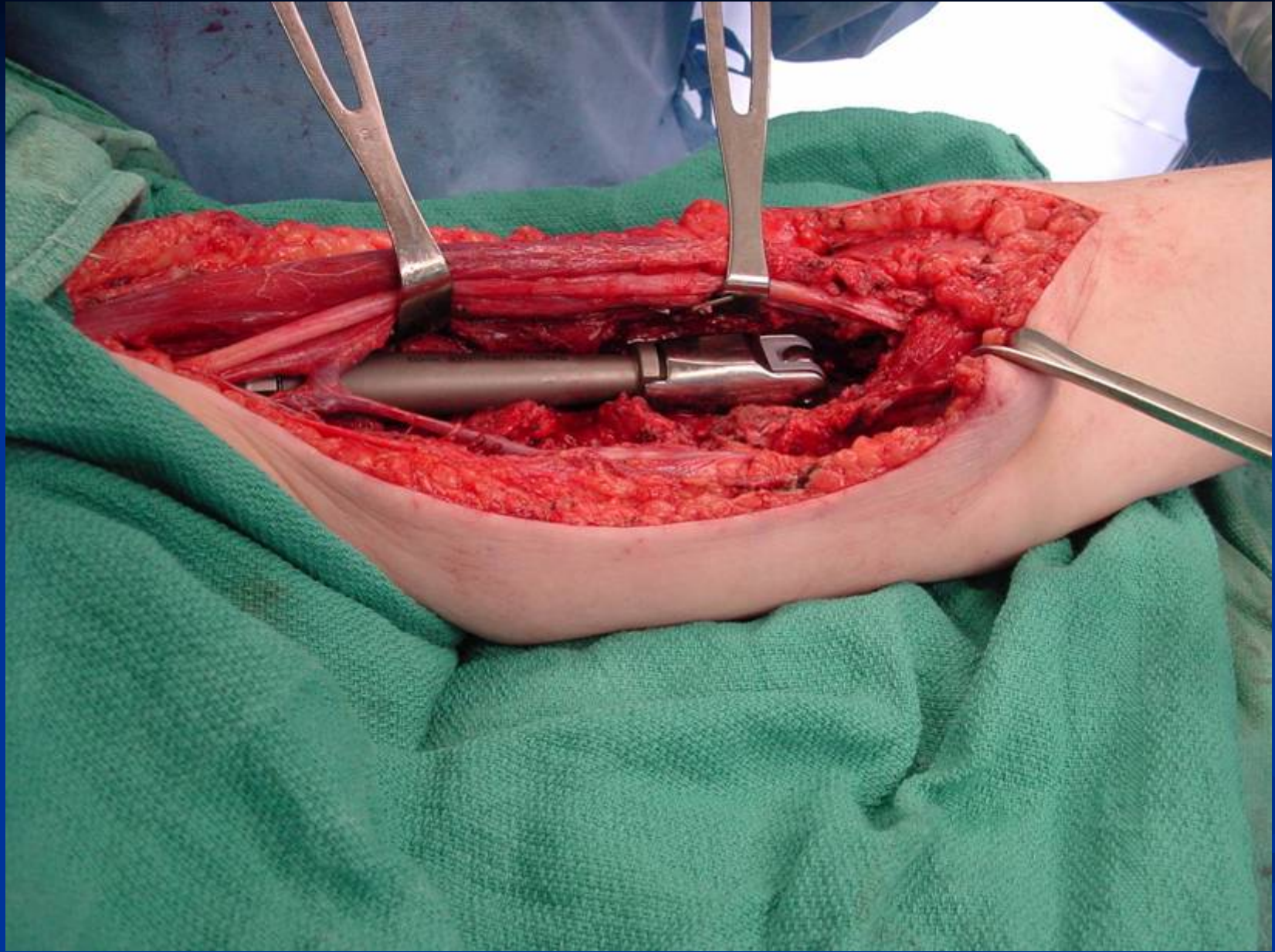


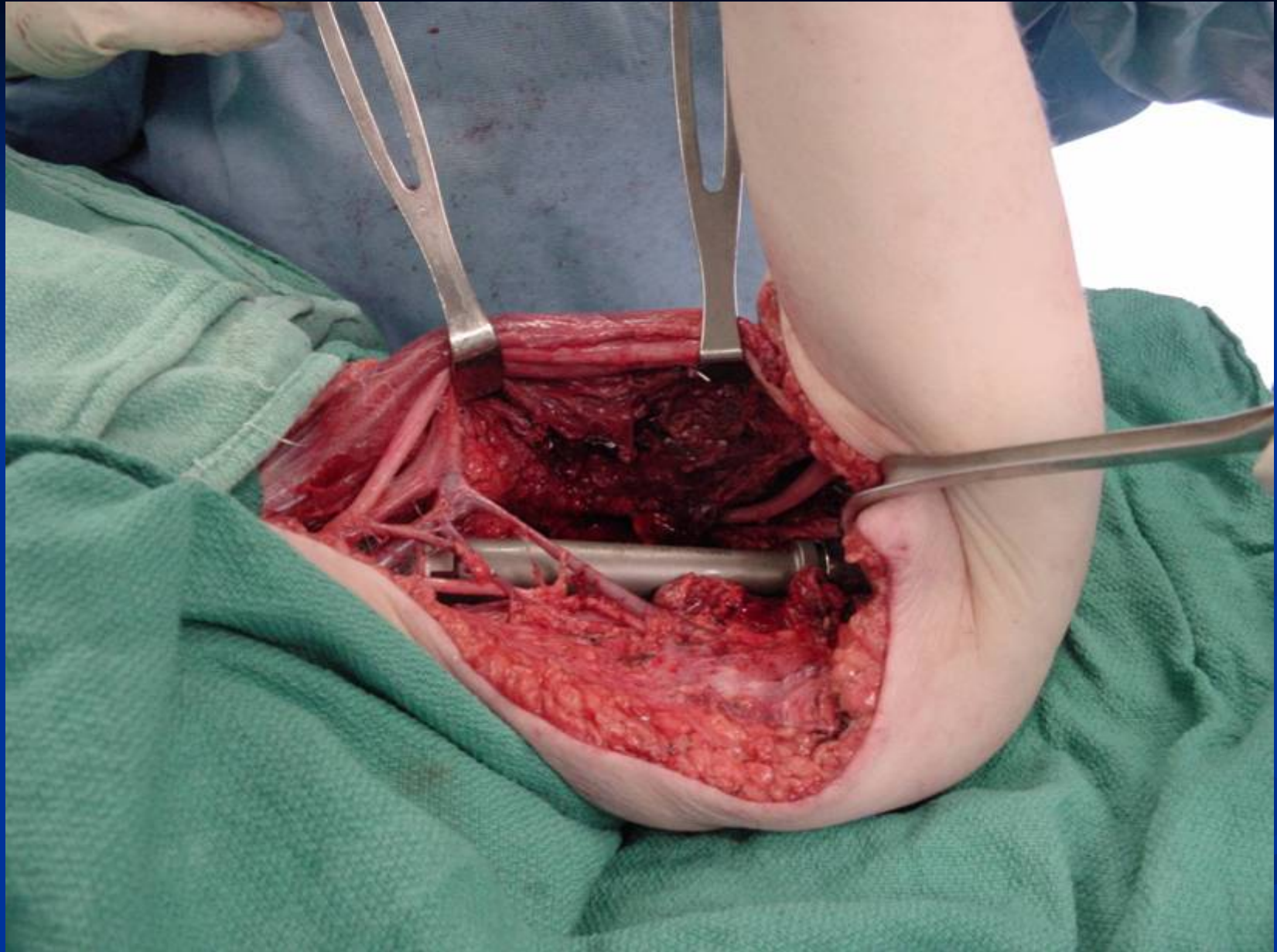












12 Weeks Postop







15:44
12-AUG-2003
IMAGE 638
SER 1-31

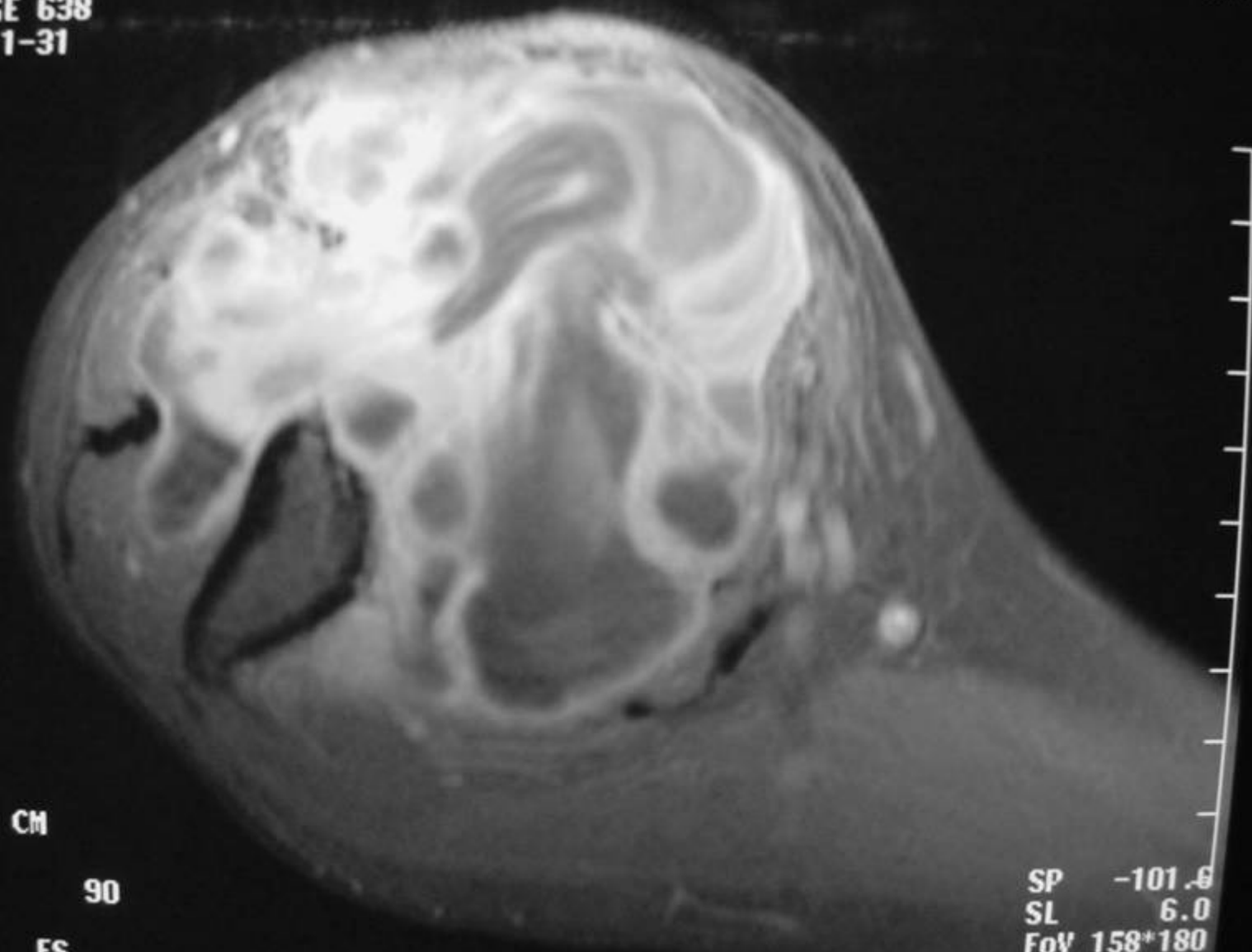
VR33G
+ : F A L

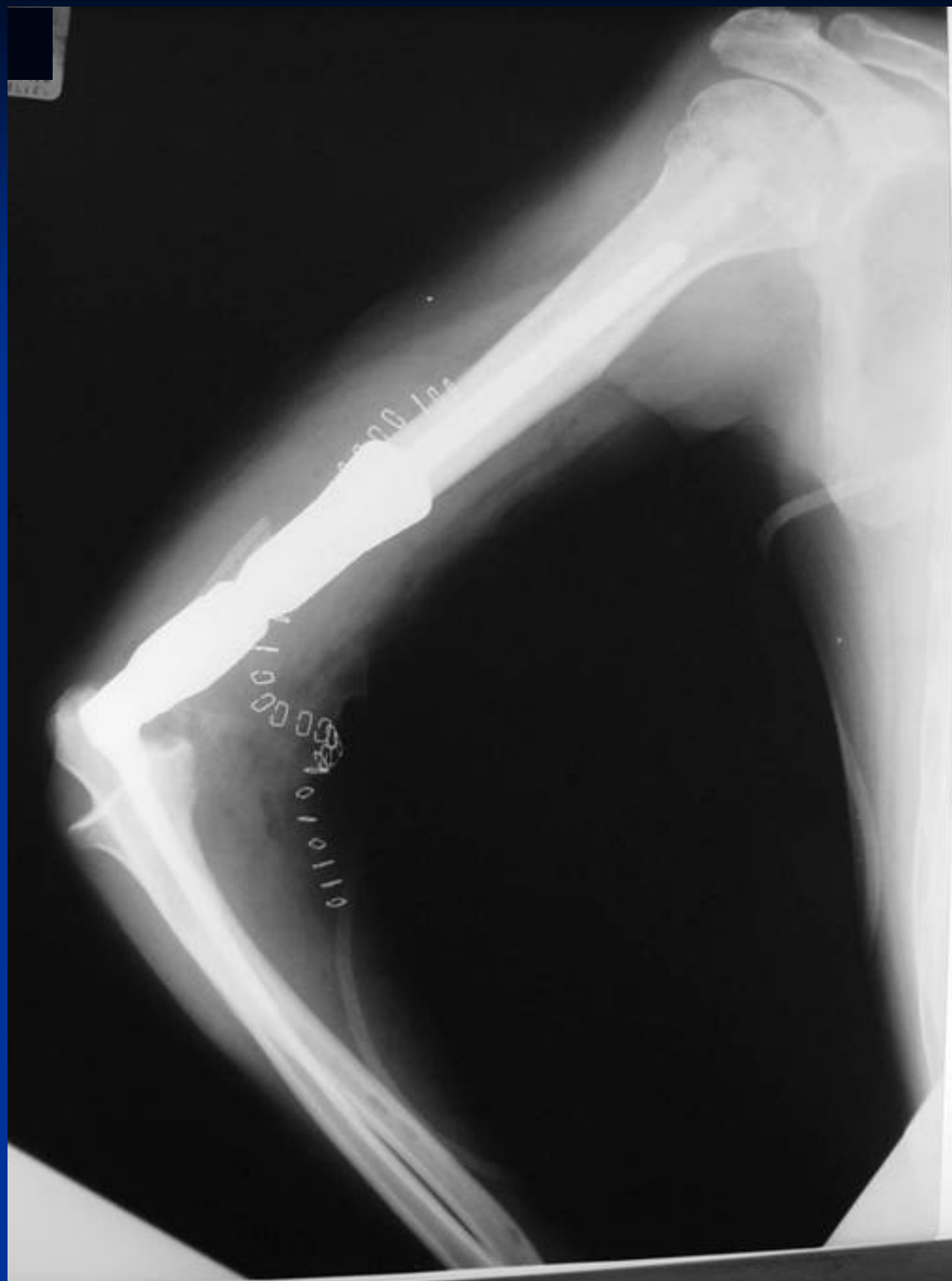
RFP

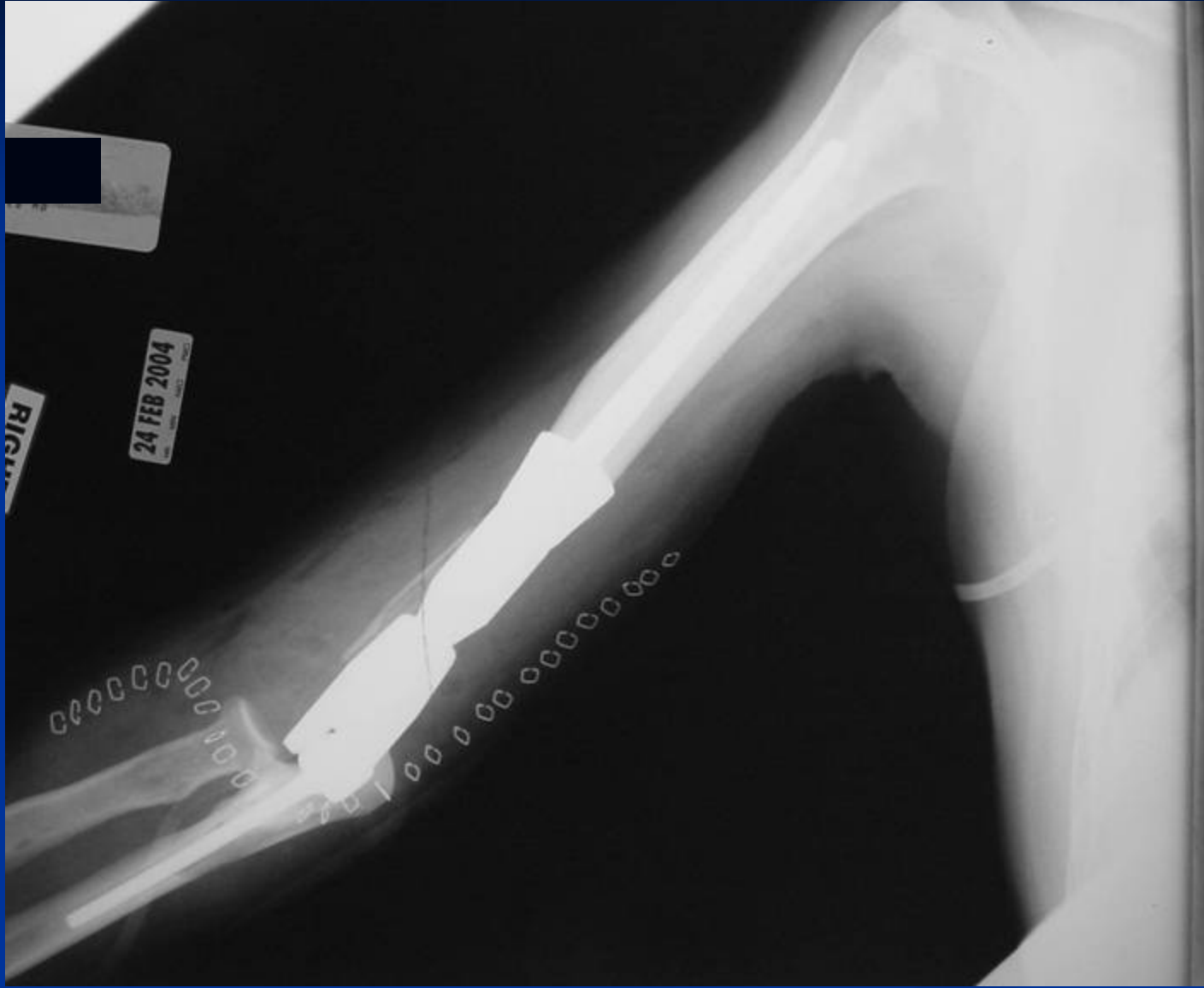
Post CM

se1 90
*R
FS

SP -101.6
SL 6.0
FoV 158*180







12 Weeks Postop







Proximal Humerus



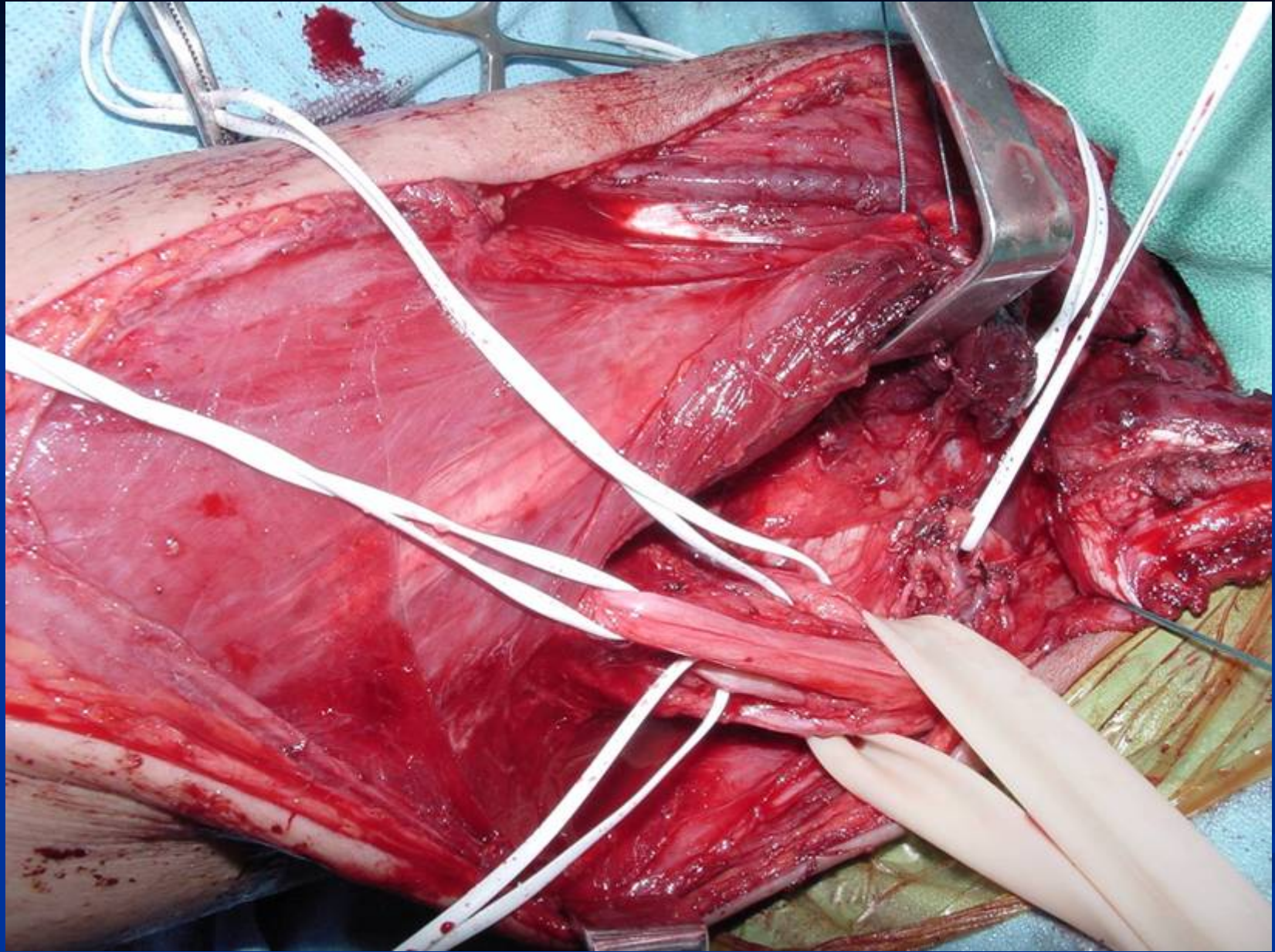
003

RIGHT

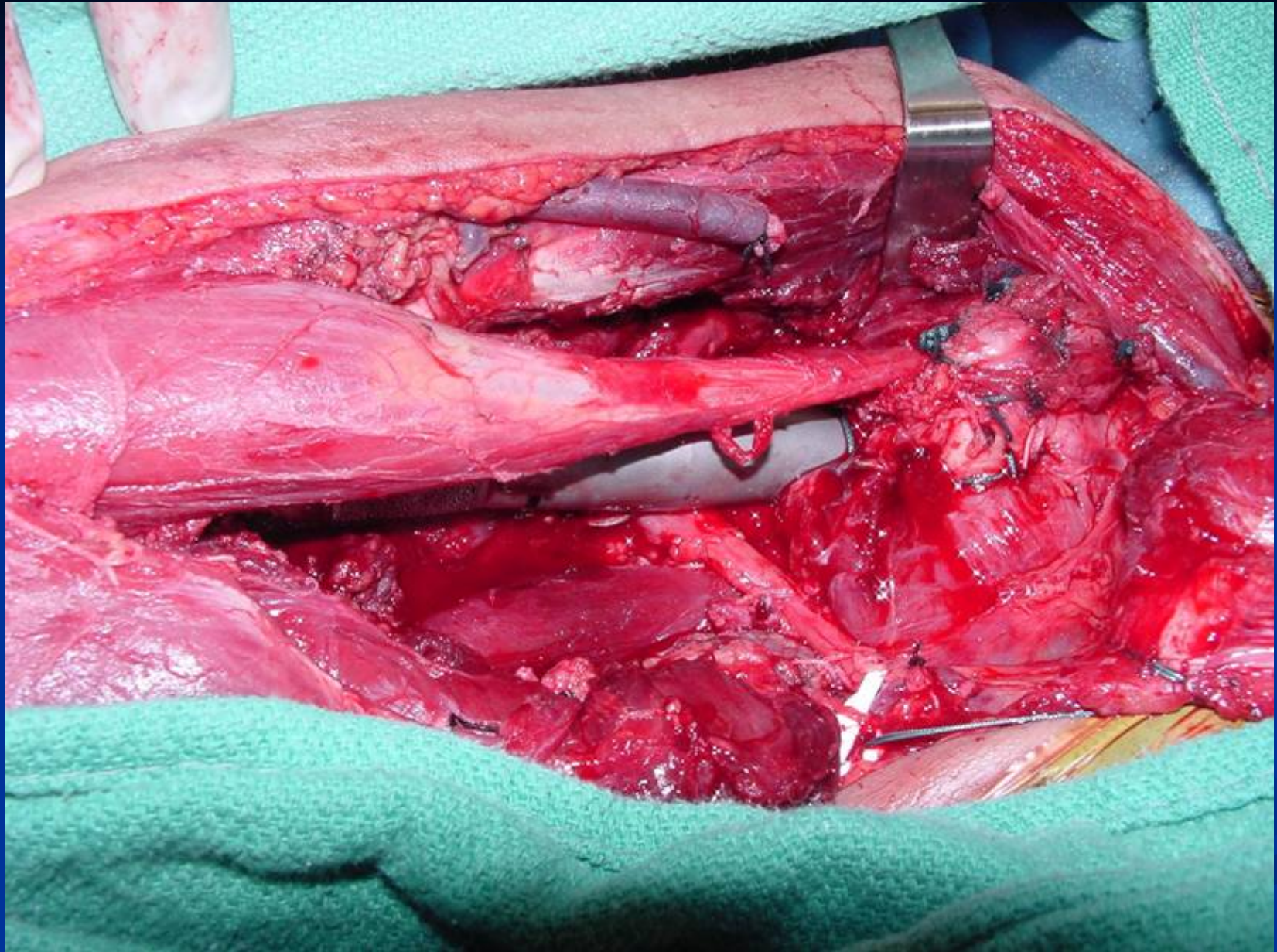
un: 14:05:39
ask: 0.33
mage: 2.33













3 Weeks Postop







Rehabilitation

- Important to restore function and improve mobility as soon as possible
- Important for patient to gain independence

Thank You!!