

# ALLOGRAFT SKELETAL RECONSTRUCTION: APPLICATIONS AND CHALLENGES

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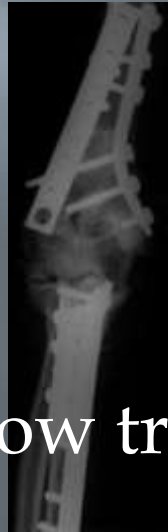
# Disclosures

- ▣ Chair elect Physicians Council AATB
- ▣ Biologics Committee AAOS
- ▣ Medical Director The Denver Clinic for Extremities at Risk
- ▣ President The Limb Preservation Foundation
- ▣ Adjunct Faculty Animal Cancer Center Colorado State University
- ▣ Reviewer for JBJS and CORR
- ▣ Consultant Wright Medical Technologies

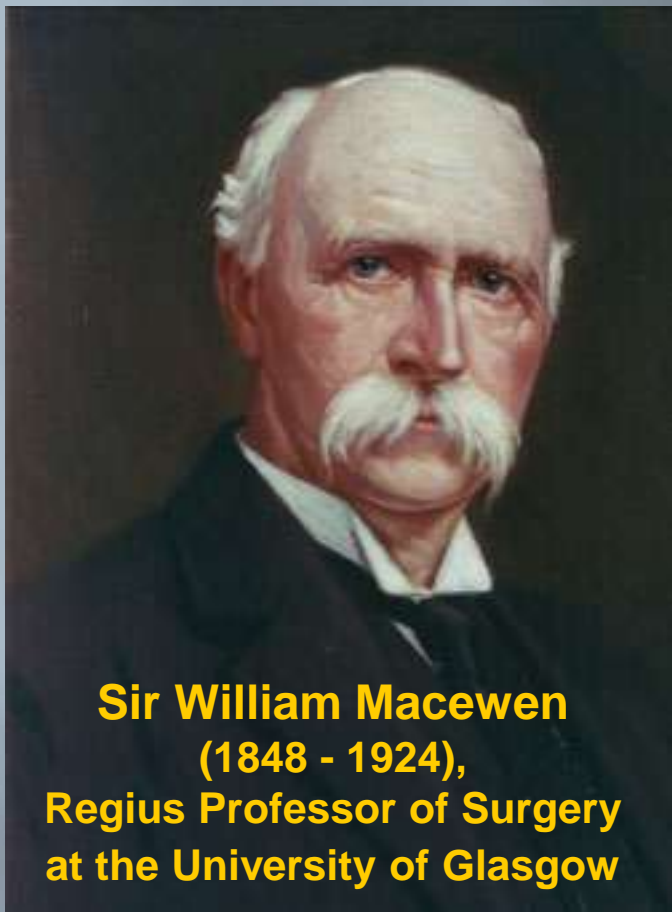
# Allografts

- ▣ Types
- ▣ Safety
- ▣ Utility
- ▣ Complications
- ▣ Solutions
- ▣ Future applications
- ▣ Case study

# History of Bone/Tissue Transplantation



Osteoarticular elbow transplant



**Sir William Macewen**  
(1848 - 1924),  
Regius Professor of Surgery  
at the University of Glasgow

## **First successful bone allograft transplant**

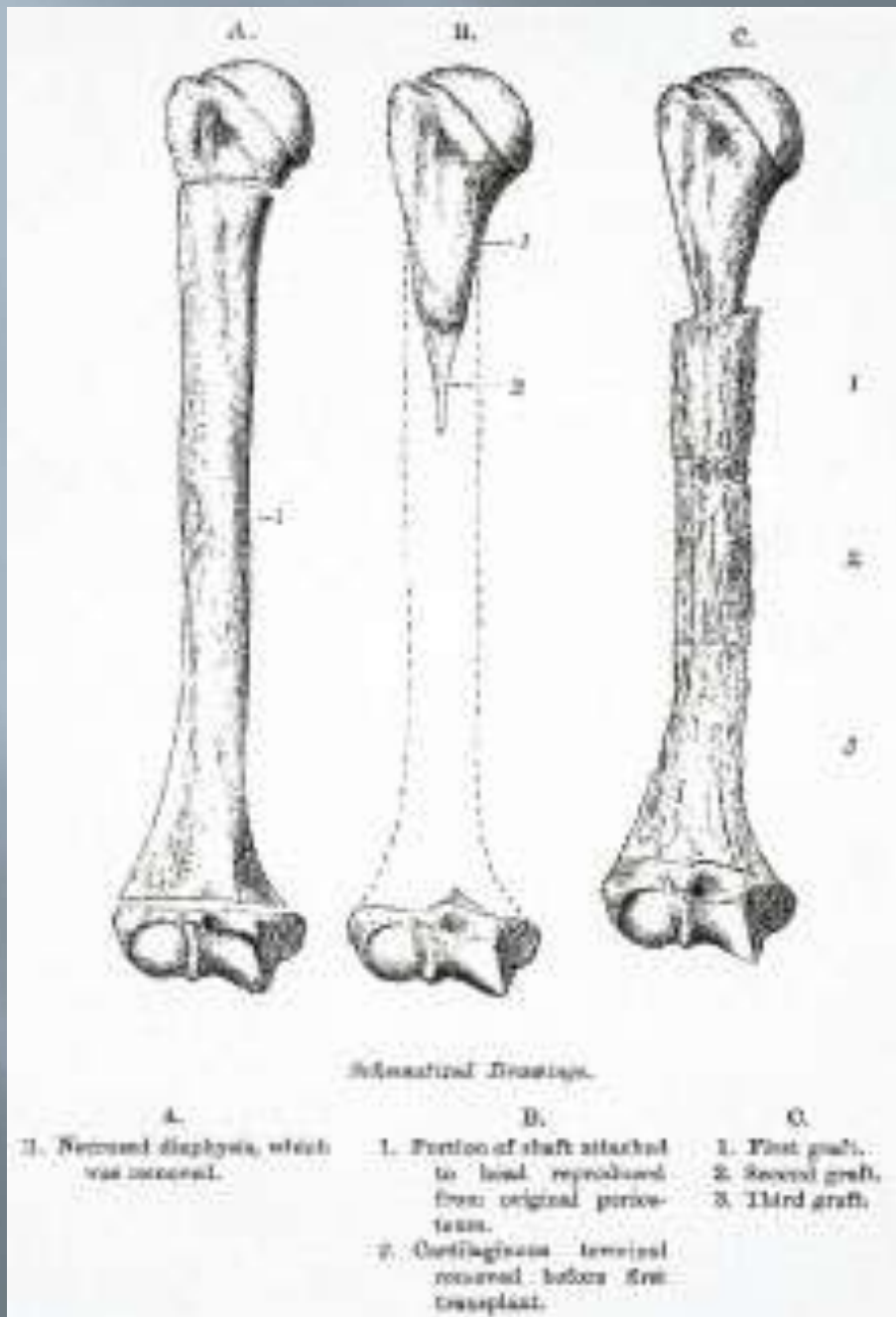
**Glasgow, 1878. Dr Macewen, age 32, had a 3 yr old emaciated boy with osteomyelitis, necrosis, right humerus mid-shaft,**

**chronic pus draining  
Humerus shaft removed, healed**

**15 mo later: no bone regrowth, limb useless and parents request amputation**

**. Macewen W. Observations concerning transplantation of bone, illustrated by a case of interhuman osseous transplantation, whereby two-thirds of the shaft of a humerus was restored.**

**Proc Roy Soc Lond 1881; 32: 232-47**



**30 YR LATER**  
**Limb functions,**

Macewen W. The Growth of Bone. Observations on Osteogenesis. An Experimental Enquiry into the Development and Reproduction of Diaphyseal Bone. James Maclellan and Sons: Glasgow; 1912

# Allografts

- ▣ Traditional
  - Cancellous
  - Cortical
- ▣ DBM
- ▣ Sports
  - Ligaments
  - Tendons
- ▣ Osteoarticular
  - Cryopreserved
  - Fresh

# Allografts in the United States

- ▣ 2012 – 1 Million allografts
- ▣ Less than 50% use of autografts  
Morbidity..Cost
- ▣ **Why structural?**  
Strongest material for it's size and weight  
Used to replace bone loss for trauma,  
tumor, infection and osteolysis where the  
only other alternative may be limb loss.



# CASE PRESENTATIONS

7 yo female w/ sarcoma left  
femur



Se: 3  
In: 13  
QCor P41.9

F 7 01-265730345

Sep 12 00  
04:10:55 PM  
Mag = 1.2  
FL:  
ROT:

ET:8

R  
P

A  
L

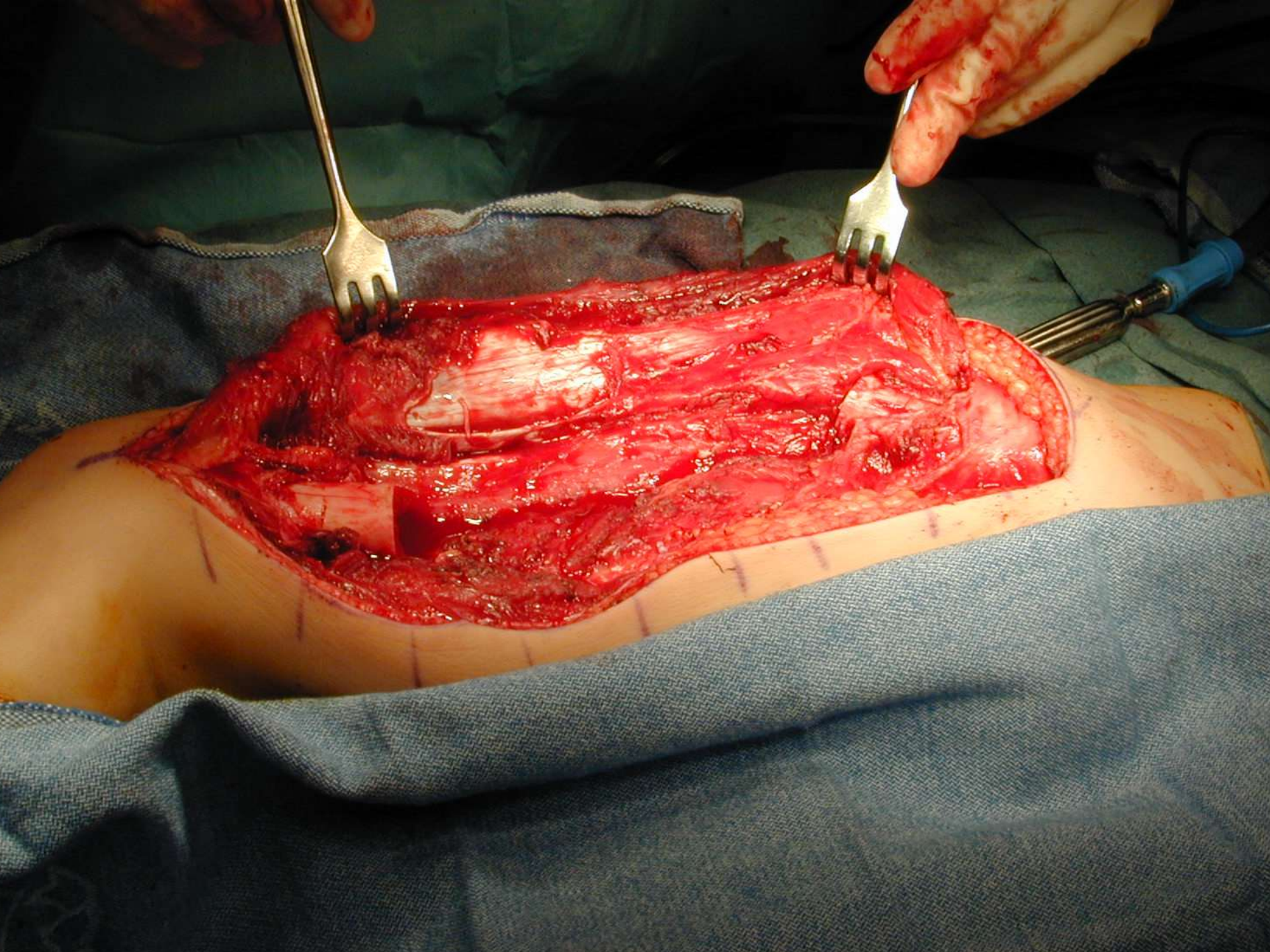
FSEC/90  
TR:3200  
TE:84/EF  
EC:1/1 15.6kHz

BODY  
FOV:40x40  
4.0thk/1.0sp  
20/03:57  
256X192/3 NEX  
SISIF/NP/VB/EO/TRF/Z512

I 203

W = 356 L = 175



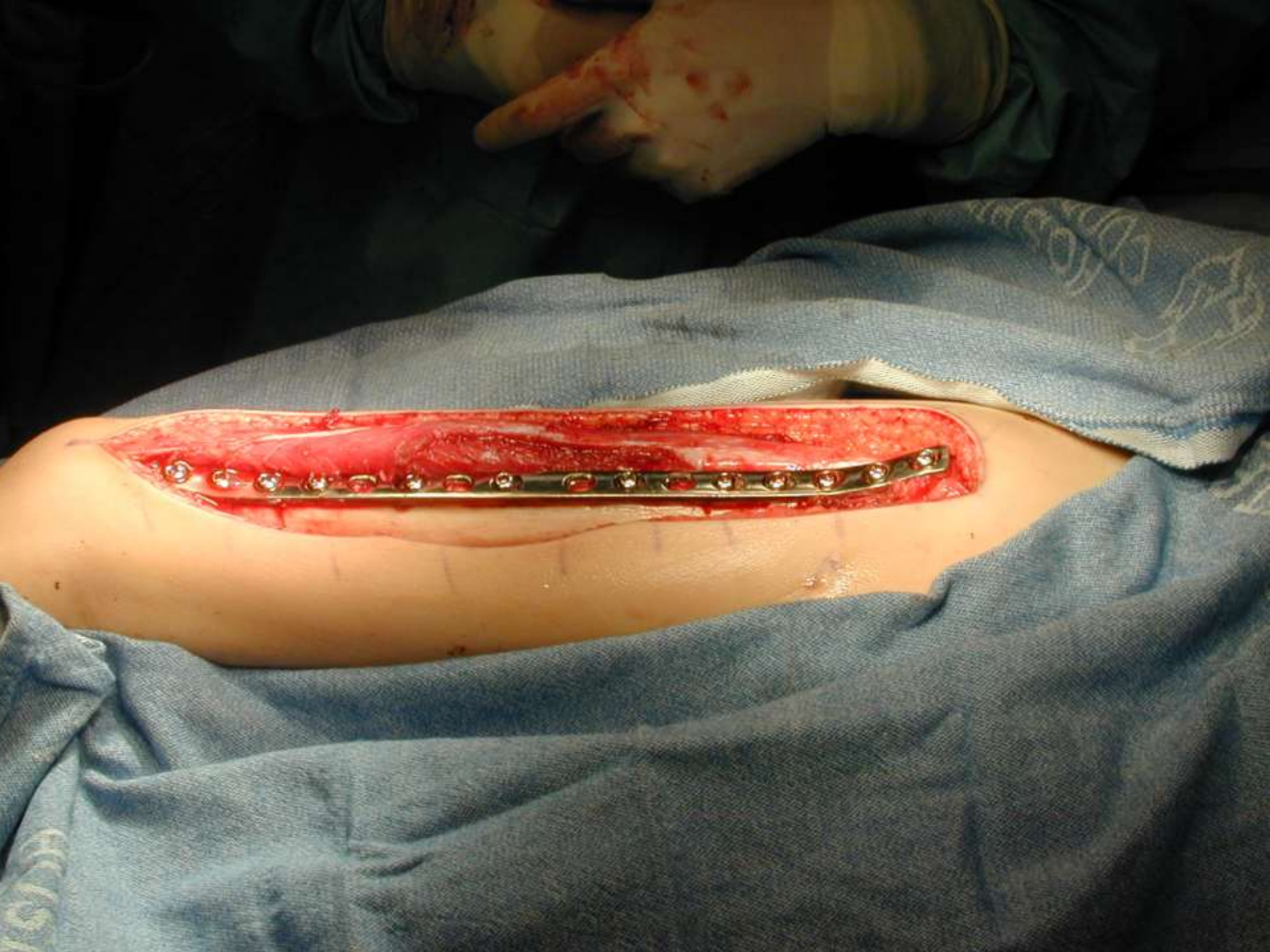


















HK  
10/1/09

Ross Wilkins, MD

# History

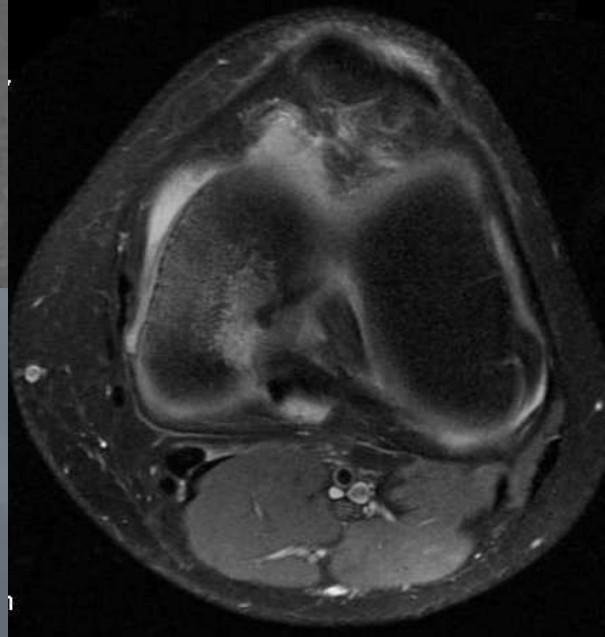
- ▣ 13 yo female w/ hx Juvenile OCD
- ▣ Cheerleader
- ▣ OCD lesion R knee '07- improved w/ rest x 3 mos
- ▣ Developed L knee pain 10/08 and rested as she did w/ R knee
- ▣ Returned to cheerleading gradually and developed signif pain
- ▣ L knee scope at Children's Hosp → large OCD lesion L MFC 8/24/09
- ▣ Did well w/ PT and resumed high level tumbling/cheerleading

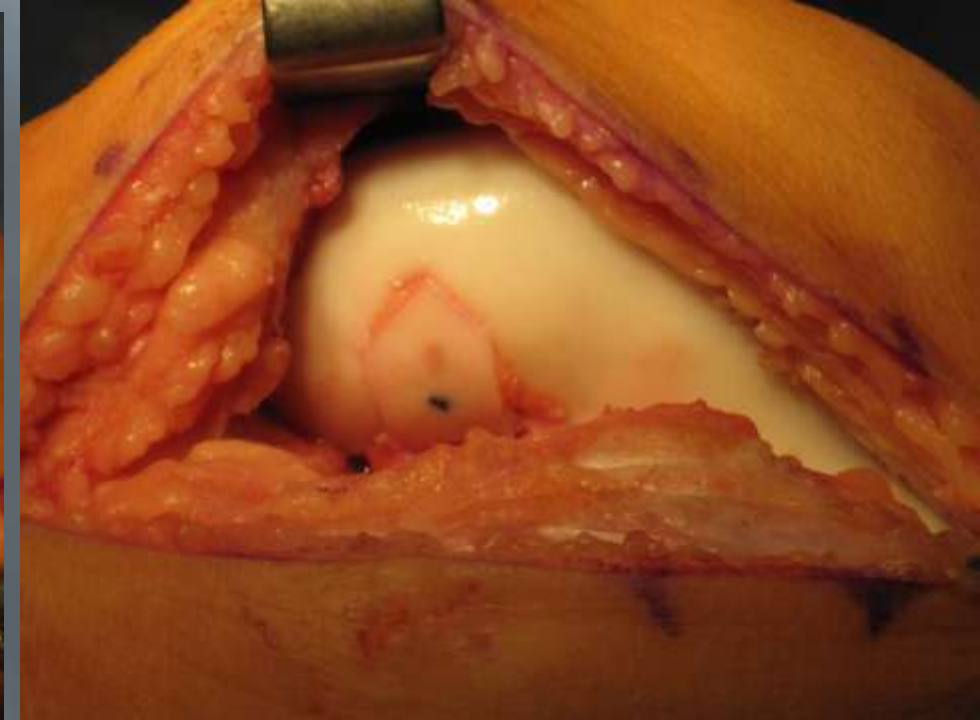
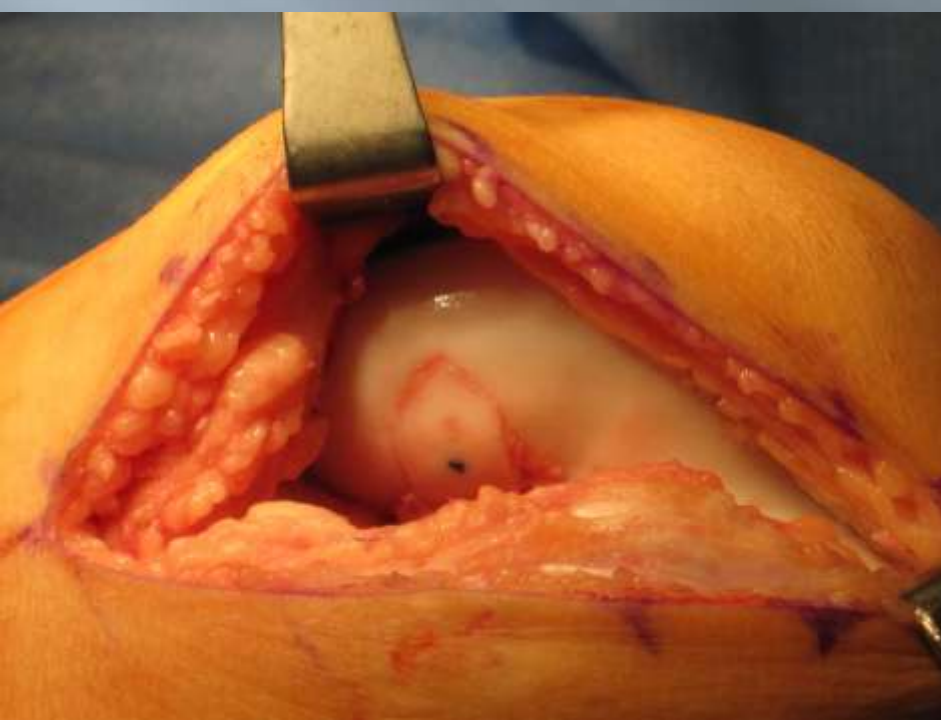
8/3/09





# MRI 9/2/09







# 18 yo OCD Femoral condyle 6mos PO





18 yo college tennis player  
osteosarcoma tibia





Back playing  
competitive tennis

17 YOU FEMALE  
CHAMPIONSHIP  
BASKETBALL PLAYER  
LOW GRADE OGS





Returned to competition

# Clinical Cases

- ▣ 22 yo... 150,000 volt injury...bilateral UE and LE amputations.  
Right AE with only humeral head present....











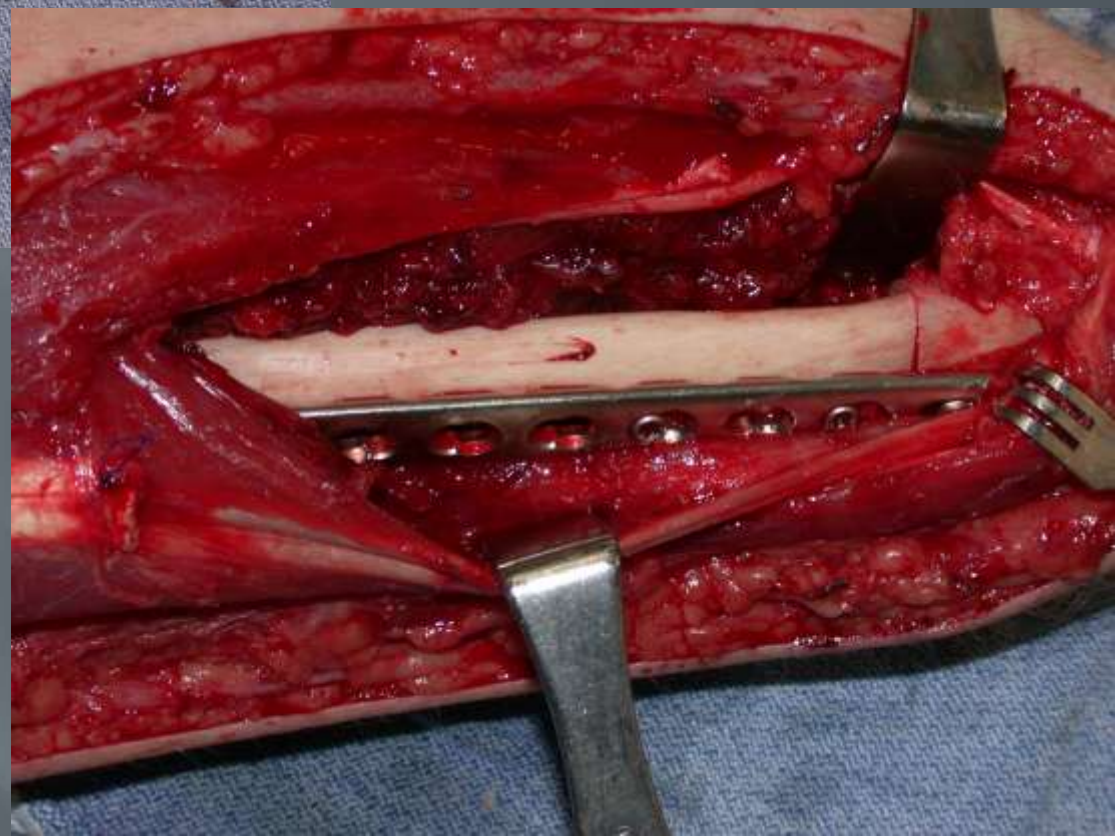






18 yo male lacrosse  
player  
ogs ulna











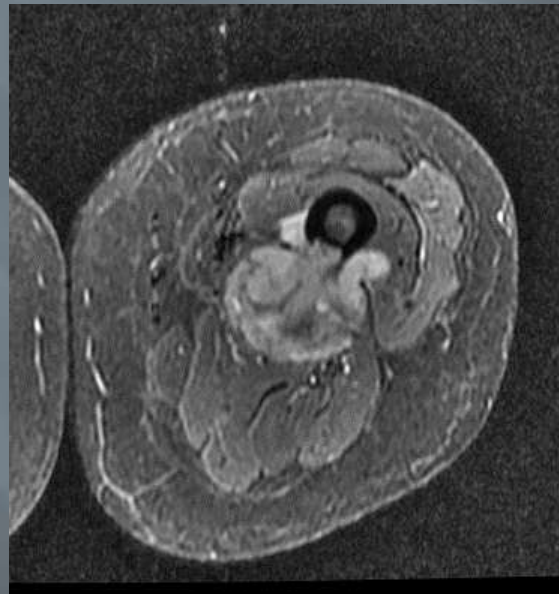
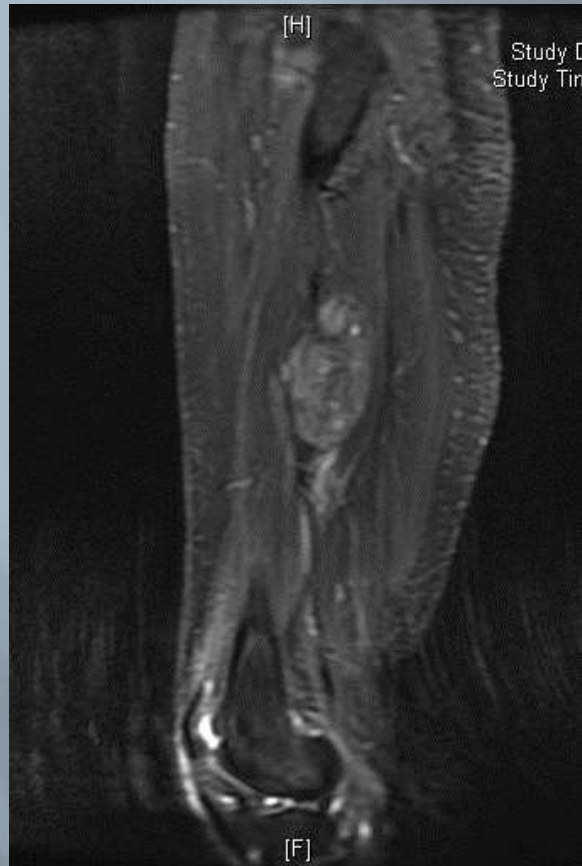




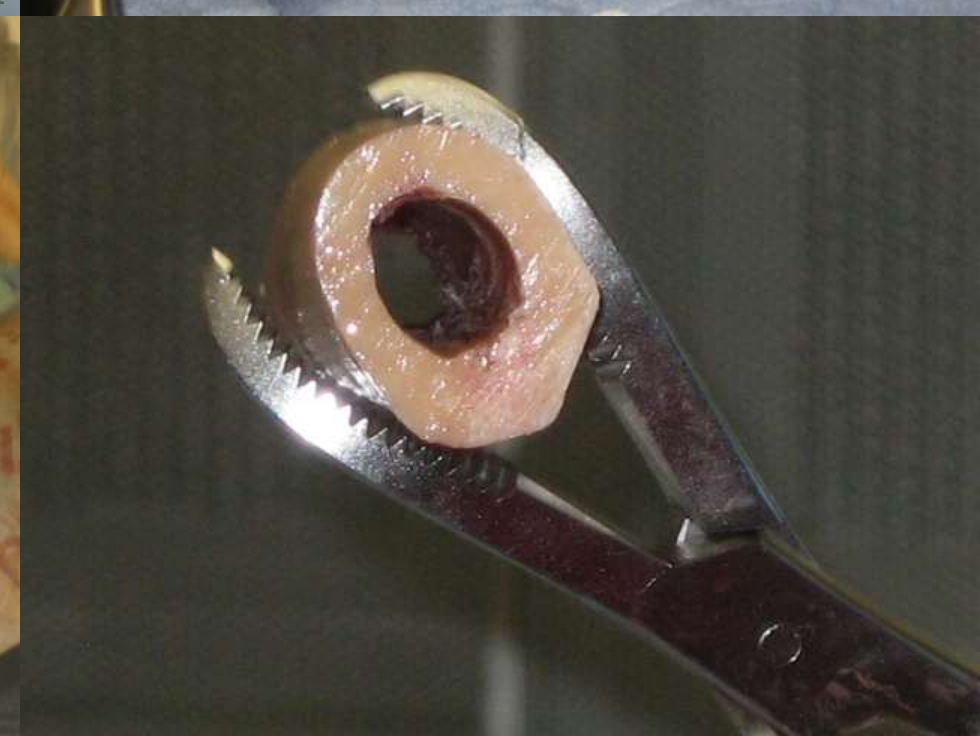
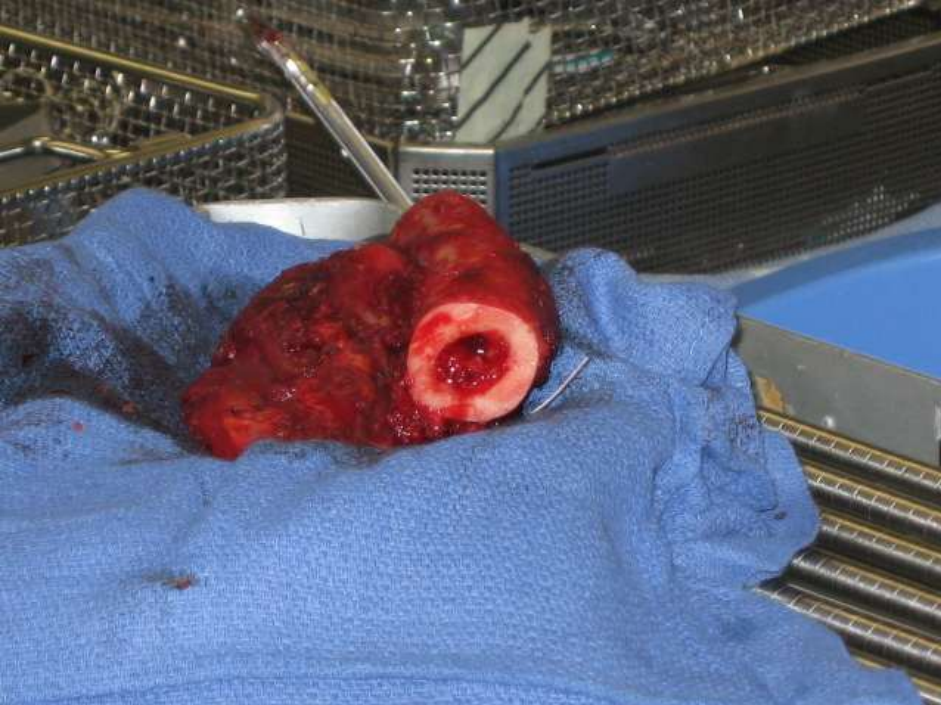
30 yo female small  
cell OGS femur



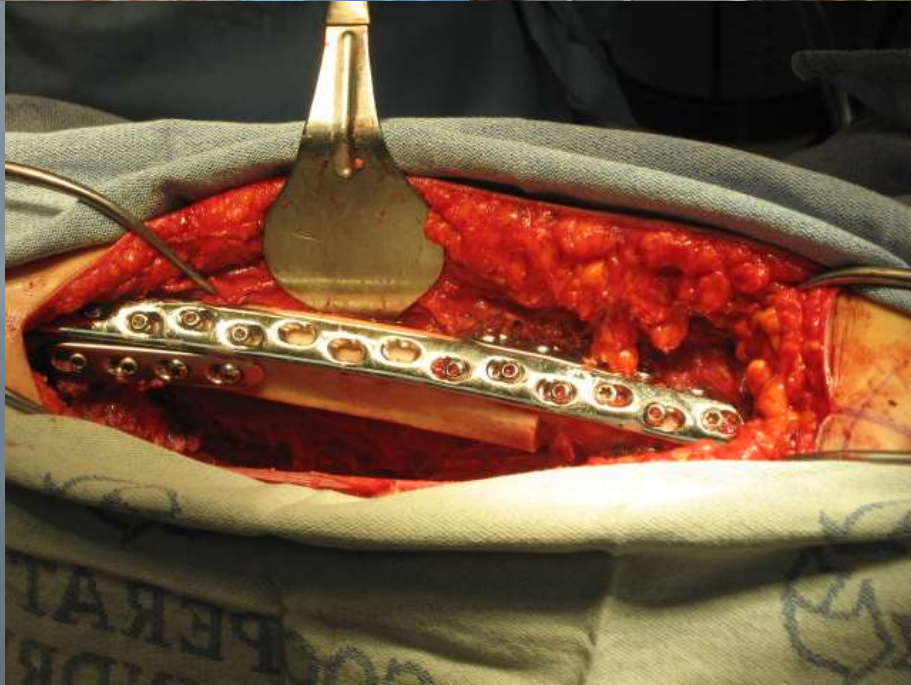
# MRI 5/19/09



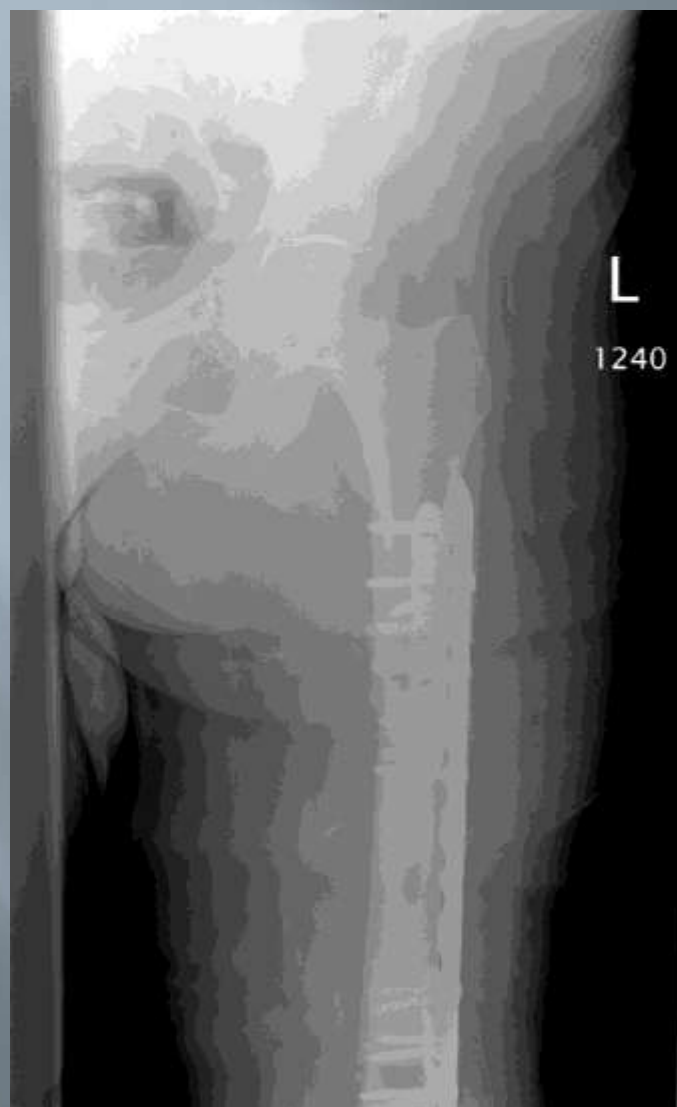


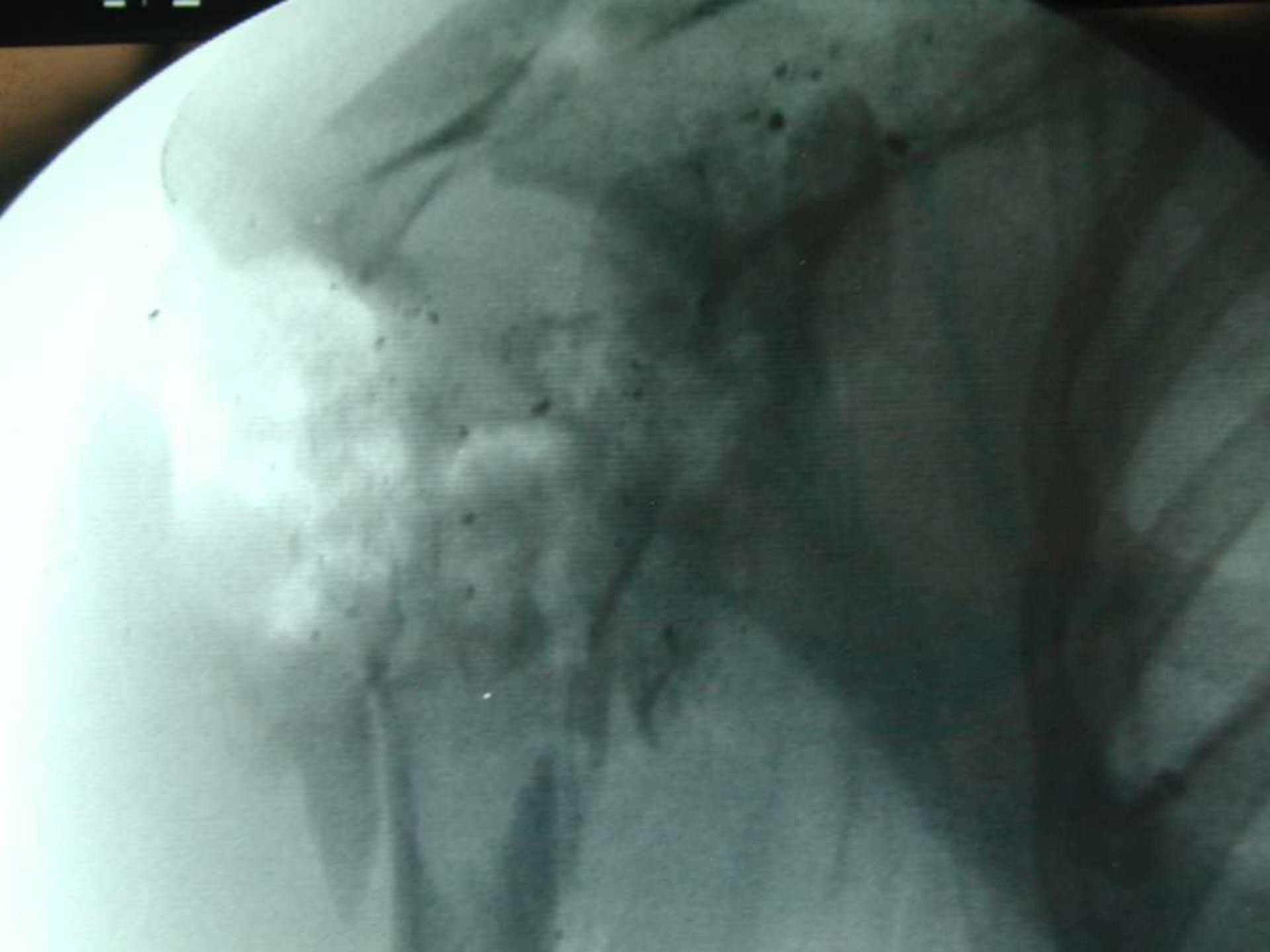






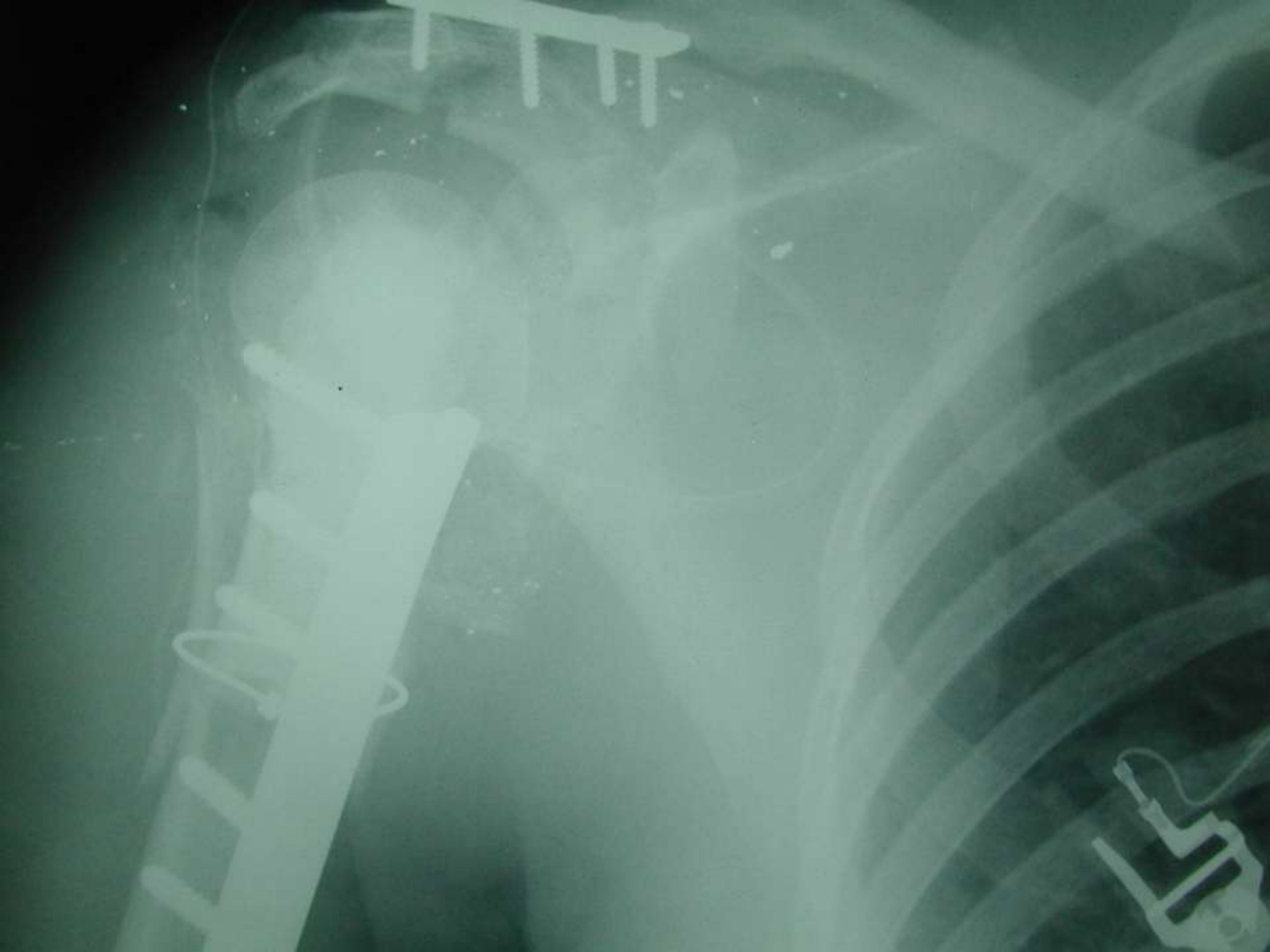
# Post-op 6/17/09





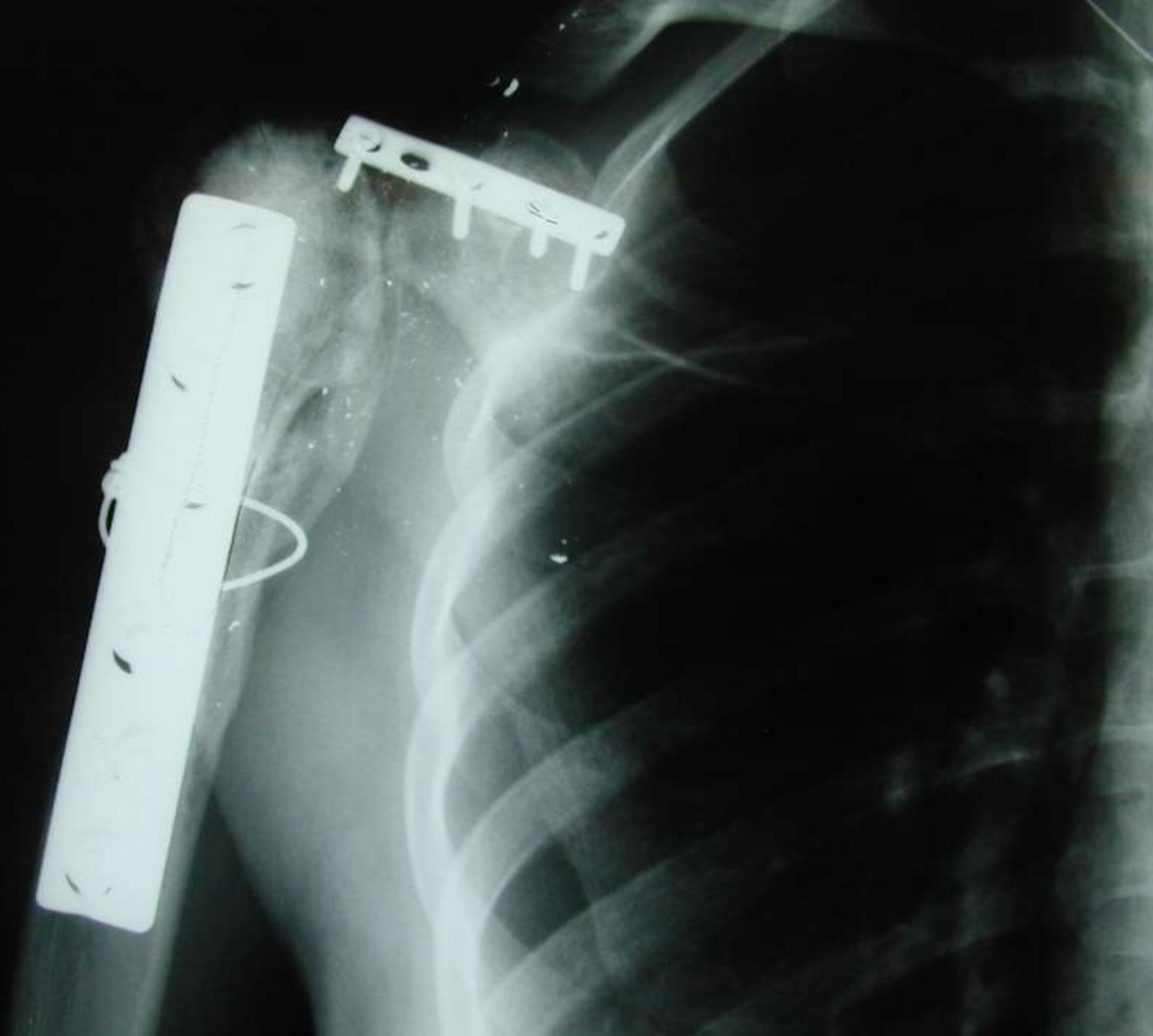




















# Thank you

▣ Questions?

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# So...that's the good news..

## Allograft Complications

- ▣ 1990
- ▣ Combined – MGH – 50% (80%)
- ▣ Infection –4-30%
- ▣ Non-union – 8-14%
- ▣ Fracture – 5-18%

How do we justify doing an operation that has a 50%+ complication rate?

- ▣ **Have we improved?**
- ▣ **New techniques    DETAILS, DETAILS DETAILS**

# Infection

- Why?

Compromised local bed

Compromised immune system

Poor soft tissue coverage

Nutrition

Multiple operations

Hematoma

Dead tissue



# Clinical Infection Prevention

- ▣ Antibiotics
- ▣ Meticulous technique
- ▣ Avoid hematoma
- ▣ Use local/free flaps
- ▣ ANC (>500)
- ▣ Toe nail hygiene

# Non-unions

## ▣ WHY?

Nutrition

Chemotherapy/radiation

NSAIDS

Smoking

Lack of RIGID fixation

Poor local blood supply

Poor graft fit

Infection





# Non-union Prevention

- ▣ Nutrition
- ▣ Avoid NSAIDS/smoking
- ▣ Graft junction sites initially
- ▣ Graft delayed unions early
- ▣ RIGID fixation
- ▣ Perfect fit
- ▣ Ultrasonic stimulation (?)

# Fracture

- ▣ WHY?  
Bone dissolution
- ▣  
Lack of mechanical support  
along entire graft
- ▣ Granulation tissue/cortical perforations
- ▣ Non-unions/loss of fixation

# Fracture Prevention

- ▣ Bridge entire graft with hardware
- ▣ Graft initially and early if delayed union
- ▣ Avoid cortical perforations (holes for sutures)
- ▣ Avoid excessive activities



# Prevention of Allograft Complications

- ▣ **Antibiotic cement loaded allografts**
  - Removes marrow/blood elements
  - Serves as reservoir for antibiotic
  - Strengthens graft overall
  - Allows for more rigid fixation

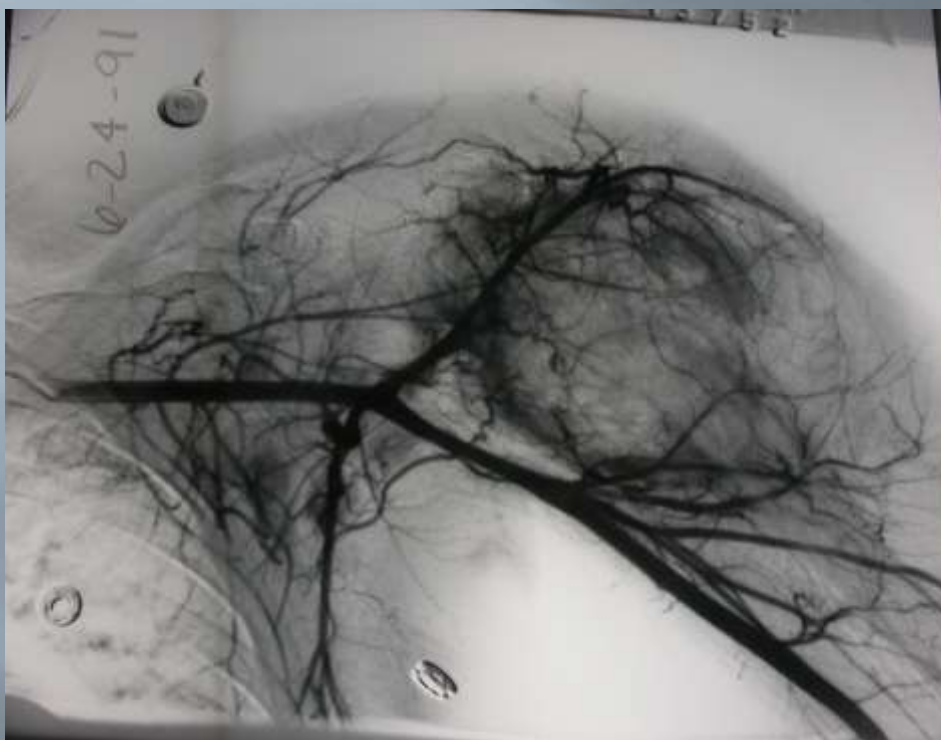
# Cemented Allografts

- ▣ Dog studies
  - Did not interfere with healing/strength
  - Reduces complications 50%
- ▣ Human studies (Toronto/Denver)
  - Reduced complications 30% (Primarily infection and non-union)

10 yo male OGS proximal  
humerus









- ▣ Now a professional guitar
- ▣ player

15 years post op



# History

- ▣ 50 yo male dx w/ osteosarcoma of L distal femur 1990
- ▣ Chemo-4 rounds of Adriamycin and cisplatin pre-op and 4 rounds post-op
- ▣ Resection w/ fem allograft in Michigan 4/91
- ▣ L TKA 4/06
- ▣ Met lung CA w/ more chemo → renal insuff
- ▣ Mult thoracotomies '92-'97 – CTs neg now
- ▣ Developed hip and knee pain 11/09



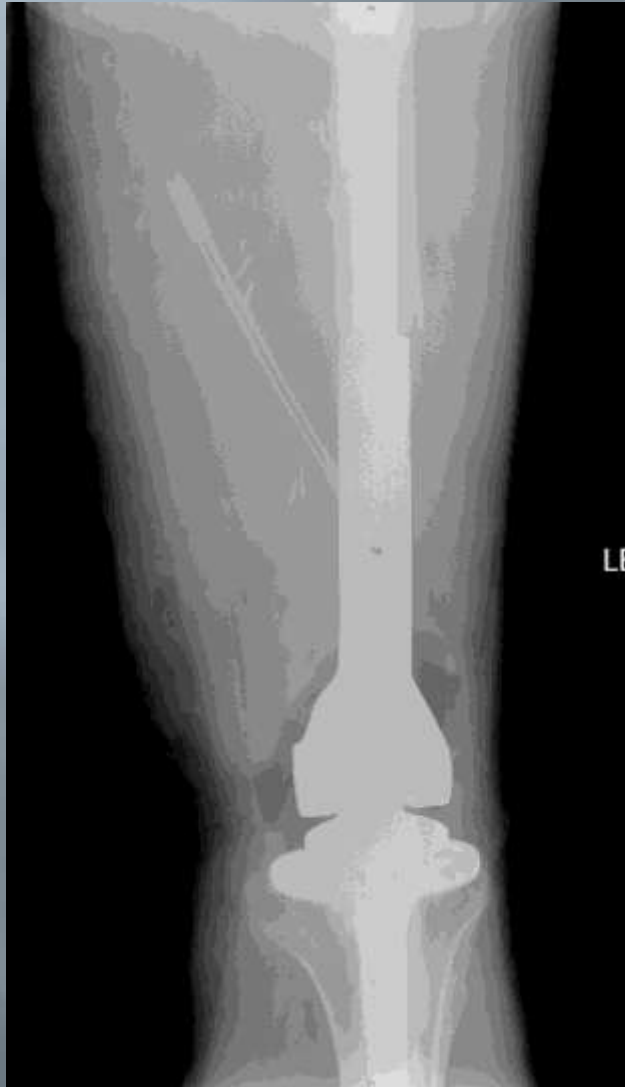
# XRAY 12/10/09



CT 12/17/09



DFR 1/27/10



# History 20 year follow up

- ▣ 46 yo female s/p rad resect L tibia w/allograft recon w/intercalary allograft and gastroc flap for osteosarcoma – 1992
- ▣ Back to normal activities
- ▣ Now needs knee replacement on other knee



# Post-op screw removal





10/25/11





20 years post op



# Allografts for Skeletal Reconstruction: Summary

- ▣ Anatomically replaces resected tissue
- ▣ Best grafts are cortical/intercalary
- ▣ Allograft prosthetic composites for periarticular areas
- ▣ Safe in regards to disease transmission
- ▣ Complications can be avoided
- ▣ Successful grafts will last the lifetime of the patient

# ALLOGRAFT SAFETY: WHAT ABOUT INFECTION: VIRAL AND BACTERIAL

Ross M Wilkins MD MS

# Allografts: Safety

- ▣ AATB Inspected and accredited
- ▣ Serology Hepatitis/HIV (PCR)
- ▣ Medical Director Review
- ▣ Pre-processing cultures
- ▣ Post processing destructive cultures
- ▣ Extraction

When in doubt, throw it out!

# Recent Publicity Re: Bacterial Infection

- ▣ Fresh graft
- ▣ No pre-processing cultures
- ▣ Put into cell culture media w/o culture
- ▣ Pt developed acute knee infection post op  
Clostr. Sordelli



# Magnitude of Problem?

- ▣ CDC – 41 cases of post op infection involving allograft cases
- ▣ 750,000 aliquots/pieces of allograft used 2001

Still not clear.....

# Where do these bugs come from?

- ▣ Donor
  - Time of death
  - Post mortem bacterial growth
- ▣ Procurement
  - Skin contamination
  - Break in sterile technique
  - Bowel contamination
- ▣ Processing
  - Environmental
  - Break in technique
  - Cross contamination
- ▣ OR 1% of all procedures

# Culturing.....

- ▣ Traditional swabbing  
Used for years – tissue banking and clinical medicine, ? False negatives?  
May not be sensitive enough!
- ▣ Extraction method – immersion/agitation  
May be more sensitive, less false negatives

# Current Practice

- ▣ Highest risk graft – Fresh  
Procured, wrapped, iced, shipped.  
Upon arrival processing commences..  
Grafts cultured, companion tissue used for  
destruction/culture, grafts re-cultured just  
before insertion into cell culture media.  
Extraction

MINIMUM FIVE CULTURES PER GRAFT



Know where your  
grafts come from,  
what they are  
tested for, how  
they are treated  
and who screens  
the donor.

# History

- ▣ 42 yo female diagnosed w/ osteosarcoma of L distal femur at age 19 in 1988
- ▣ Underwent resection, placement of allograft bone, and fusion w/ a rod 11/15/88 in Tampa, FL
- ▣ Doing well until Jan '11 when she stopped abruptly to avoid running into someone
- ▣ Noted a loud pop followed by L distal femur pain

W Knee a.p. \*  
Se: 2/2  
Im: 1/1

1968 Nov 18 F 000592026  
Acc: 6007316  
2011 Apr 07  
Acq Tm: 15:37:24.000000

W Knee lat \*  
Se: 3/2  
Im: 1/1

1968 Nov 18 F 000592026  
Acc: 6007316  
2011 Apr 07  
Acq Tm: 15:38:16.000000

L  
JH

Id:DCM / Lin:DCM / Id:ID  
W:2982 L:2605

STANDING

L  
JH

Id:DCM / Lin:DCM / Id:ID  
W:2614 L:1760

LT CORONAL  
Se: 602/8  
Im: 22/51  
Cor: A139.0 (COI)

1968 Nov 18 F 396097  
Acc:  
2011 Apr 27  
Acq Tm: 08:21:45.550000

LT CORONAL 3X3  
512x512  
U75u

R<sub>F</sub>

L<sub>H</sub>

120.0 kV  
0.0 mA  
Tilt: 0.0  
0.0 s

Lin:DCM / Lin:DCM / Id:ID  
WINDOW1 W:2000 L:400



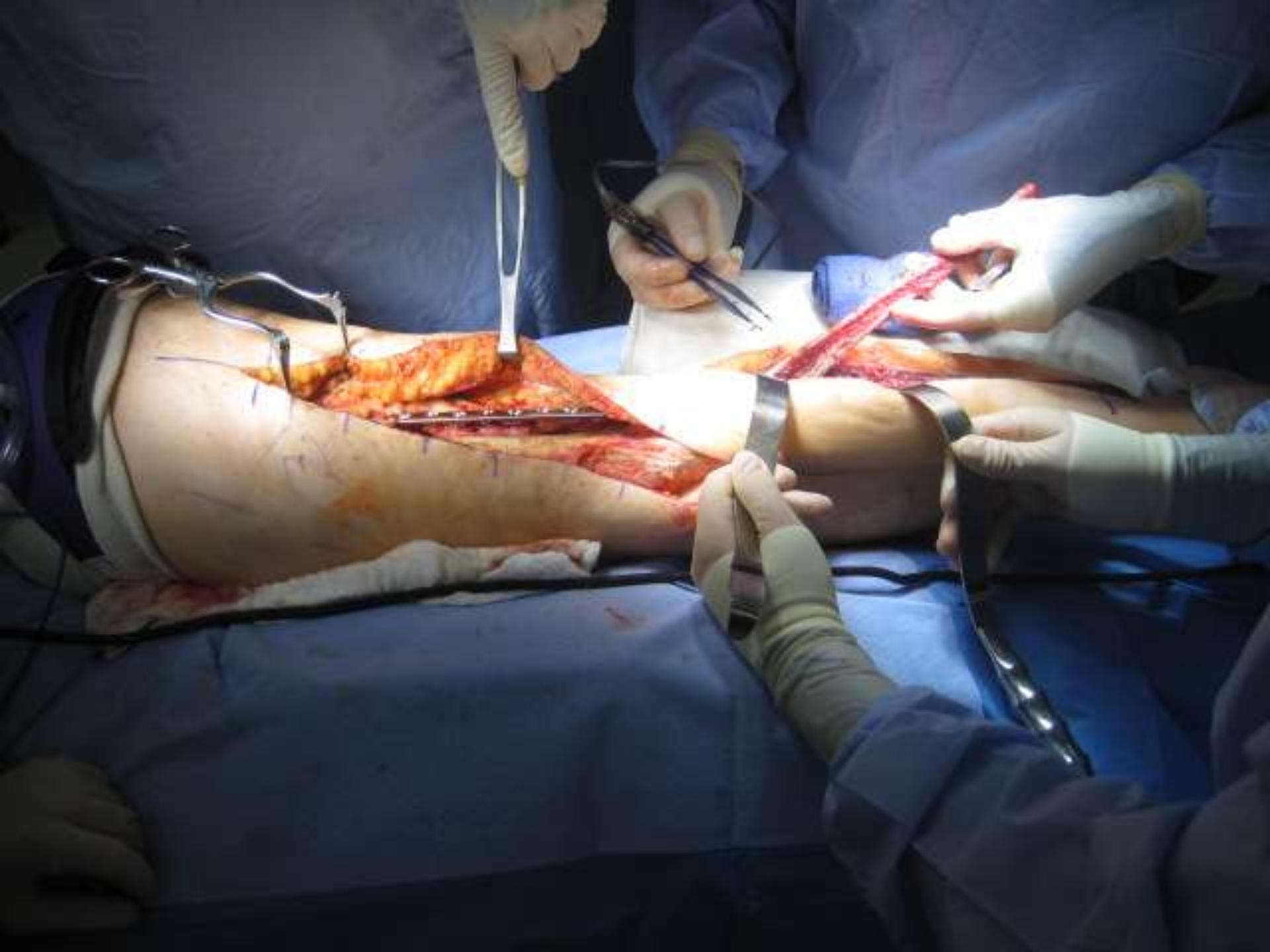
F<sub>p</sub>

DFOV: 25.0 x 25.0cm



# Procedure

- ▣ To OR 7/21/11 for bridging compression plate, a vascularized free fibular flap, and stem cell allograft





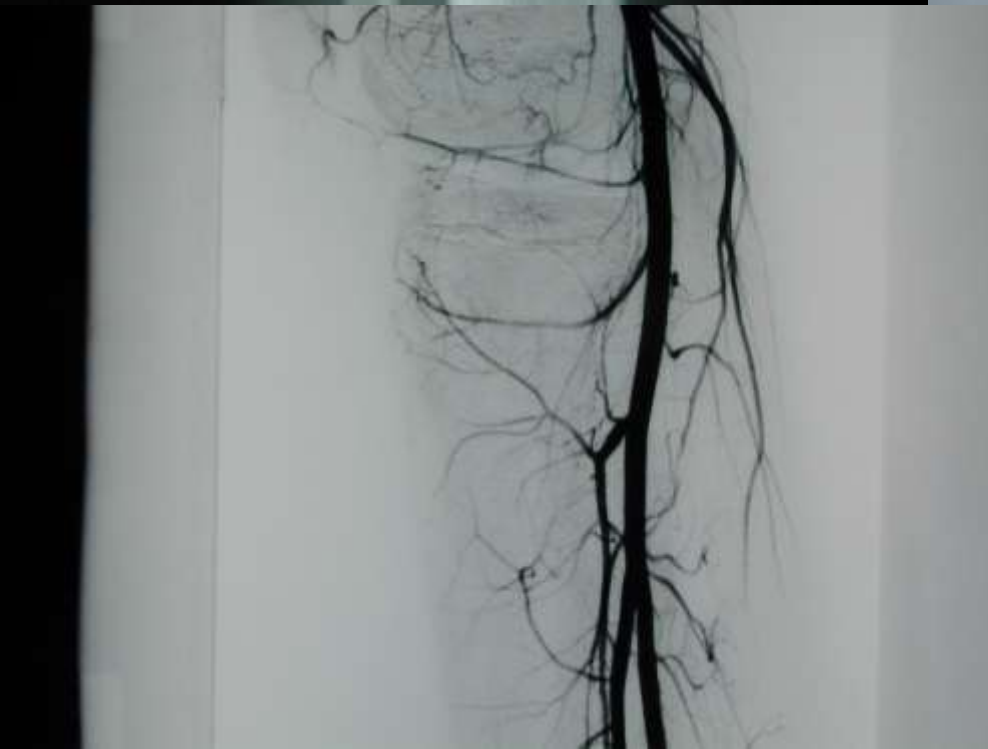
Special Case....  
Special Person!!







17 YO FEMALE  
OSTEOSARCOMA PROXIMAL  
TIBIA





# 30 YO TRAUMATIC LOSS DISTAL TIBIA





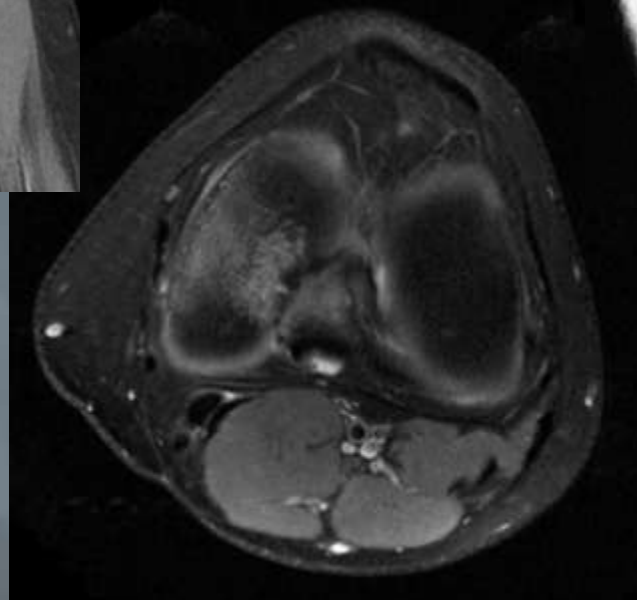


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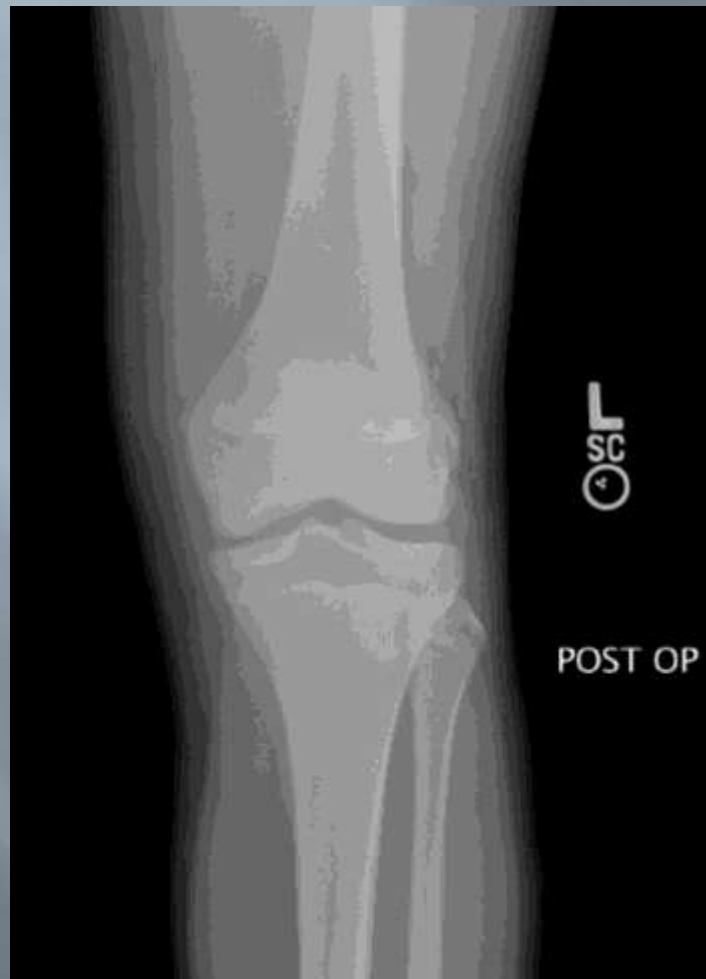




MRI 7/29/09



# Post-op 9/30/09 Osteochondral Allograft to MFC



4/20/10



# Human Allograft Skin

## Traditional Indications for Use

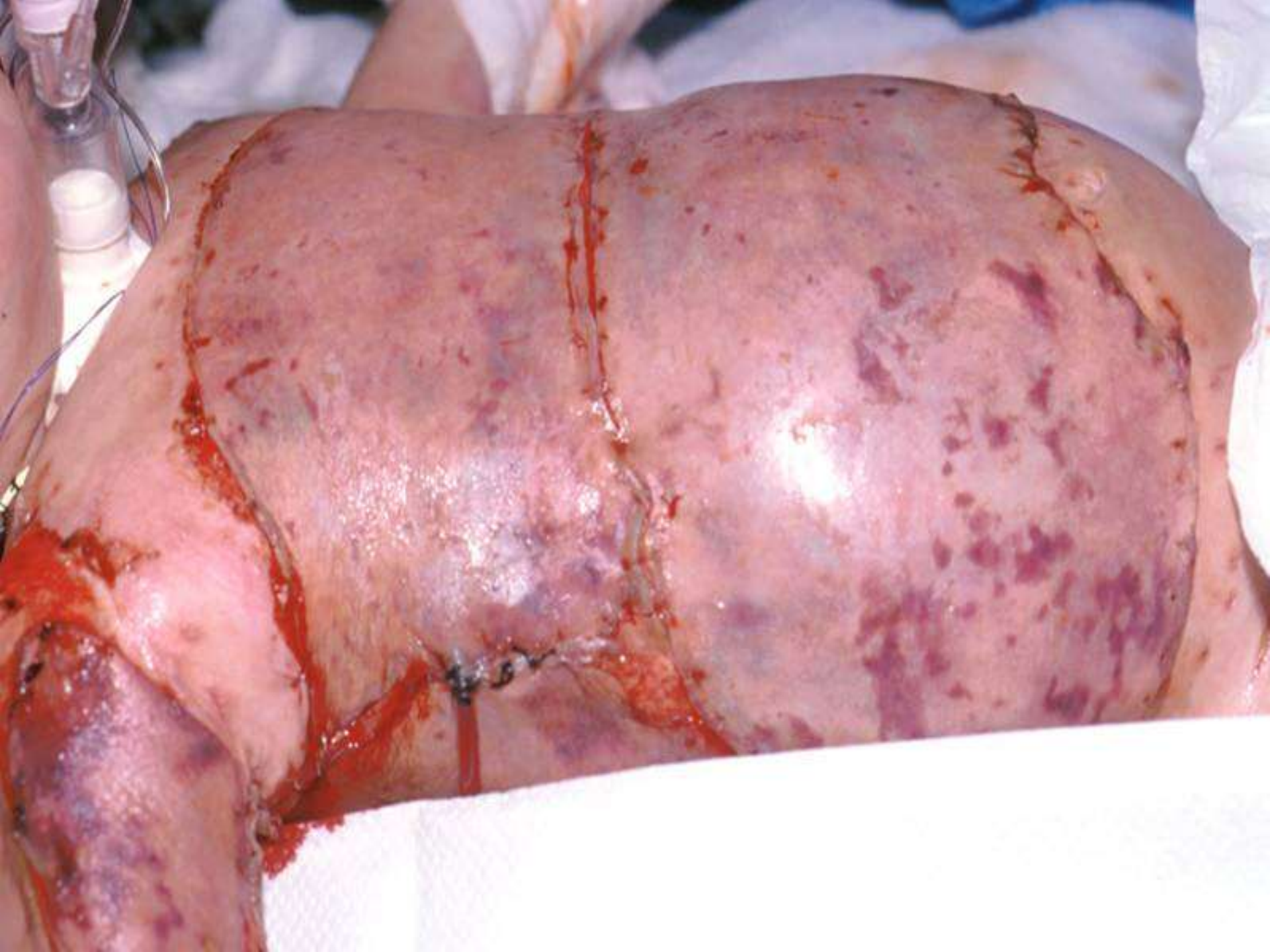
- ♦ **Excised burn wounds**
- ♦ Coverage of widely expanded autograft
- ♦ Exfoliative skin disorders
- ♦ Testing the wound bed for autografting
- ♦ Dermal template for cultured skin
- ♦ Necrotizing wound infections, degloving injuries & chronic wounds

















24 yo osteonecrosis humeral  
head due to high dose steroids  
for a closed head injury









# 22 yo female, shot in leg while watching television

- ▣ Entrance medially
- ▣ Exit anteriorly
- ▣ No N/V damage!
- ▣ Initial I & D



1.0 s/HE 17:58:22/07.00  
W:1499 L:301

P 34

HiSpeed CT/i SYS#CT01  
Ex: 804  
Se: 2  
JT S66.0  
In: 26

A 89

Medical Center of Arkansas South  
R 08538  
GI DAY  
1296  
DOB 1970  
May 02 01  
512

DFOV 13.1cm  
BONE

FLT:e2

L  
5  
7

R  
7  
1

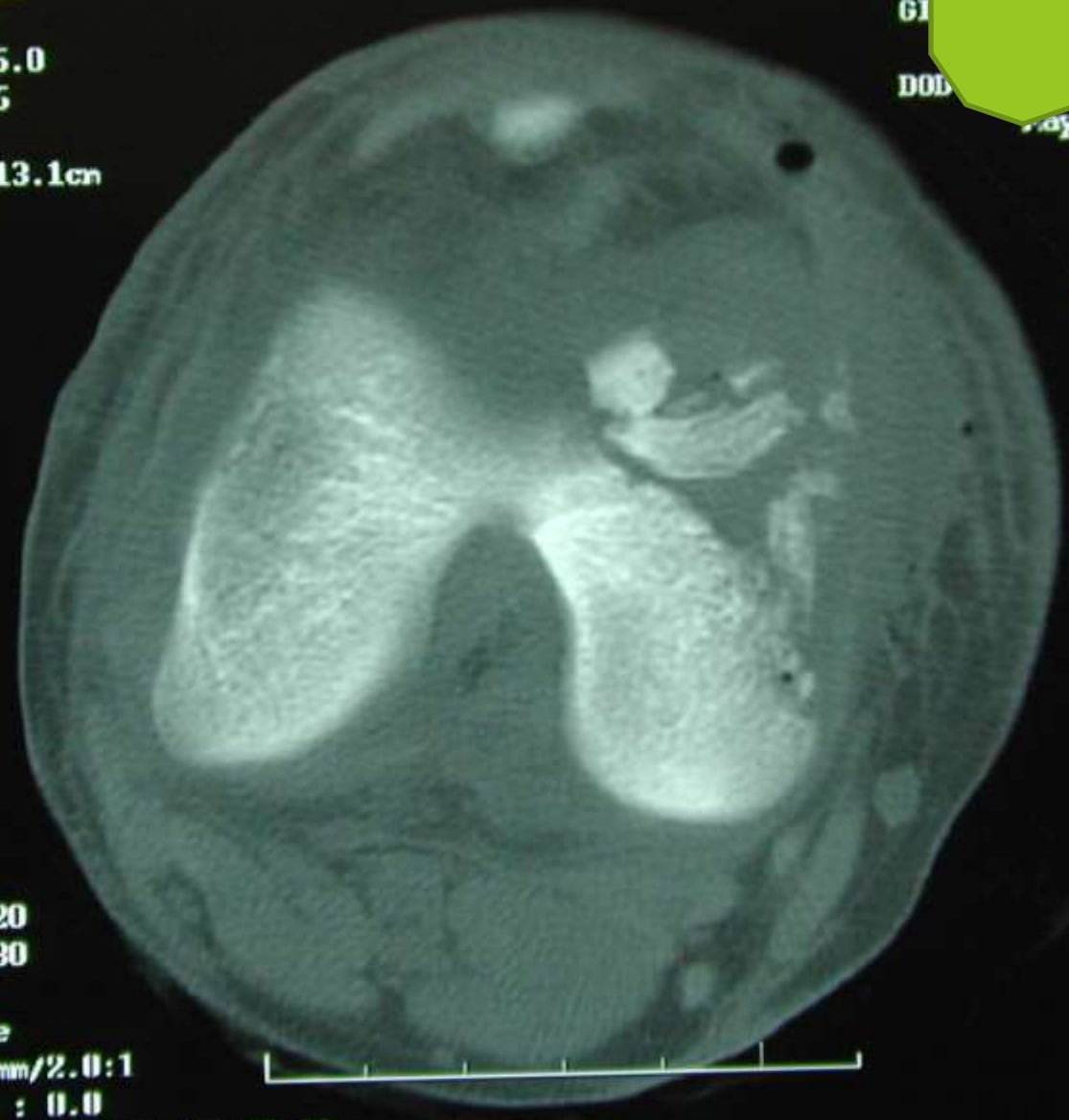
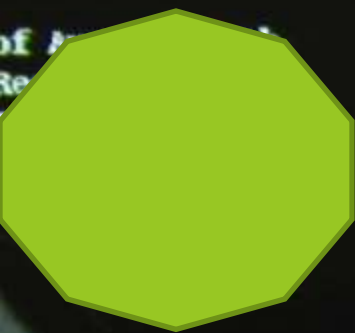
FLT:e2

L  
5  
7

kV 120  
mA 280

Large  
3.0 mm/2.0:1  
Tilt : 0.0  
1.0 s/HE 17:58:22/08.33  
W:1499 L:301

P 34



a South  
E608538  
THURSDAY  
X171296  
11 1978  
y 02 01  
512

HiSpeed CT/i SYS#CT01  
Ex: 804  
Se: 2  
JT S74.0  
In: 22  
DFOV 13.1cm  
BONE

A 89

Medical Center of South  
08538  
G [REDACTED] THURSDAY  
71296  
DOB: 11 1978  
May 02 01  
512

HiS  
Ex:  
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JT  
In:  
DFO  
BON

FLT:e2

FLT:e2

L  
5  
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L  
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kV 120  
mA 280

Large  
3.0 mm/2.0:1  
Tilt : 0.0  
1.0 s/HE 17:58:22/07.00  
V:1499 L:301

P 34

kV  
mA  
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Hi





19 =

620  
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101

