DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

Allograft Skeletal Reconstruction: Applications and Challenges

Ross M Wilkins MD
Senior Medical Director
AlloSource
Medical Director
The Joint Restoration Foundation

2013 Western Colorado DONATION SUMMIT

Disclosures

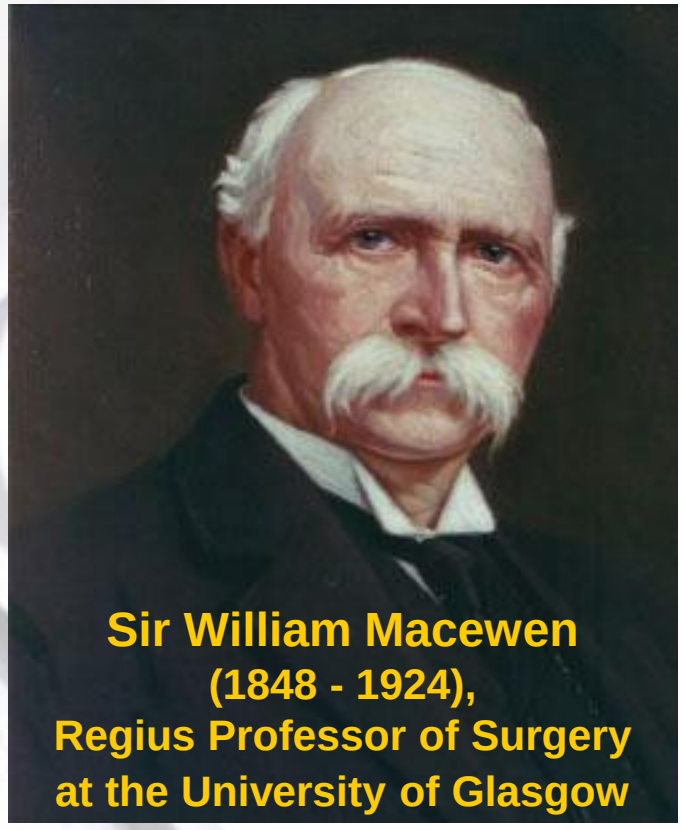
- Chair elect Physicians Council AATB
- Biologics Committee AAOS
- Medical Director The Denver Clinic for Extremities at Risk
- President The Limb Preservation Foundation
- Adjunct Faculty Animal Cancer Center Colorado State University
- Reviewer for JBJS and CORR
- Consultant Wright Medical Technologies

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

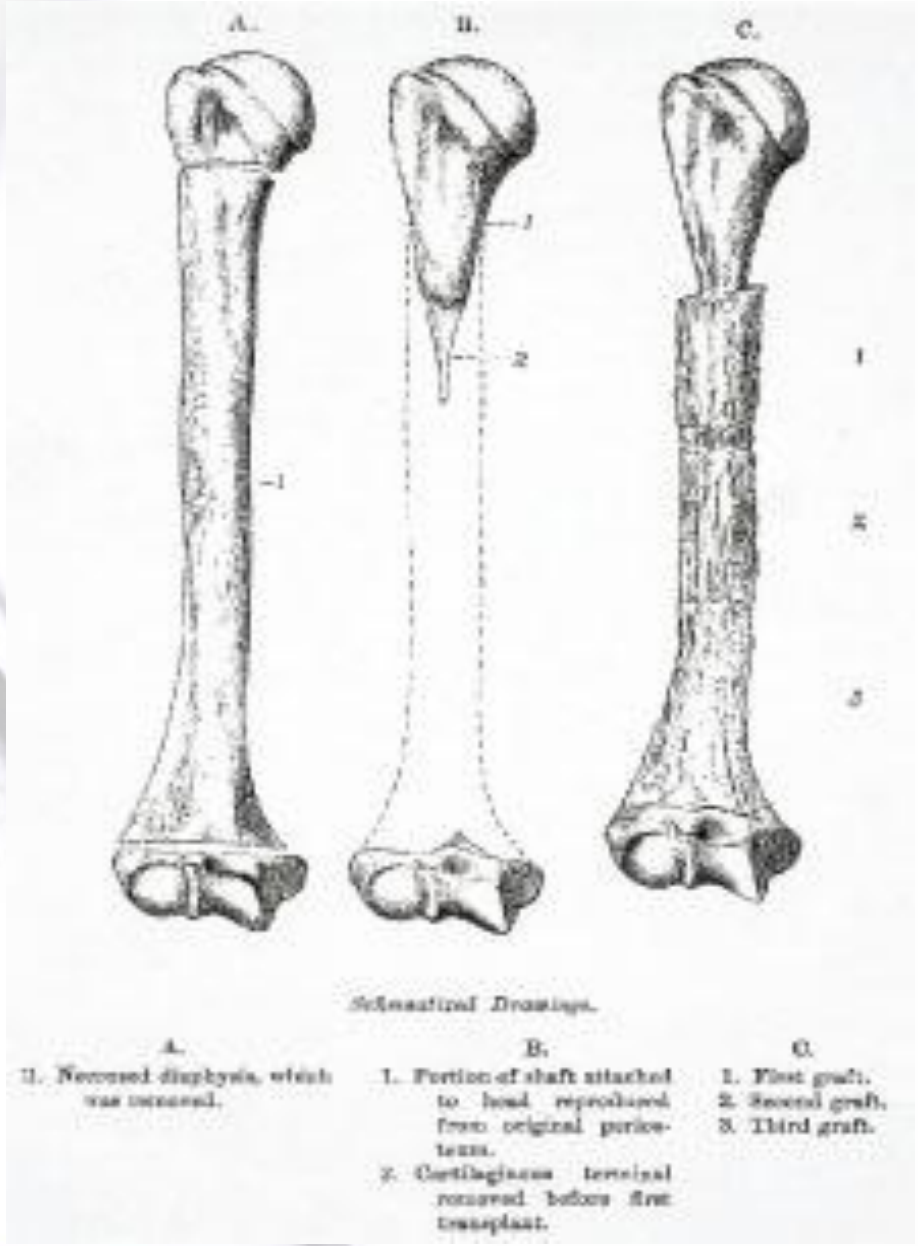
. Macewen W. Observations concerning transplantation of bone, illustrated by a case of interhuman osseous transplantation, whereby two-thirds of the shaft of a humerus was restored.
Proc Roy Soc Lond 1881; 32: 232-47

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



Schematical Drawings.

A.
1. Necrosed diaphysis, which was removed.

B.
1. Portion of shaft attached to head reproduced from original periosteum.
2. Cartilaginous terminal removed before first transplant.

C.
1. First graft.
2. Second graft.
3. Third graft.

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 Maclehose and Sons: Glasgow; 1912

DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

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.

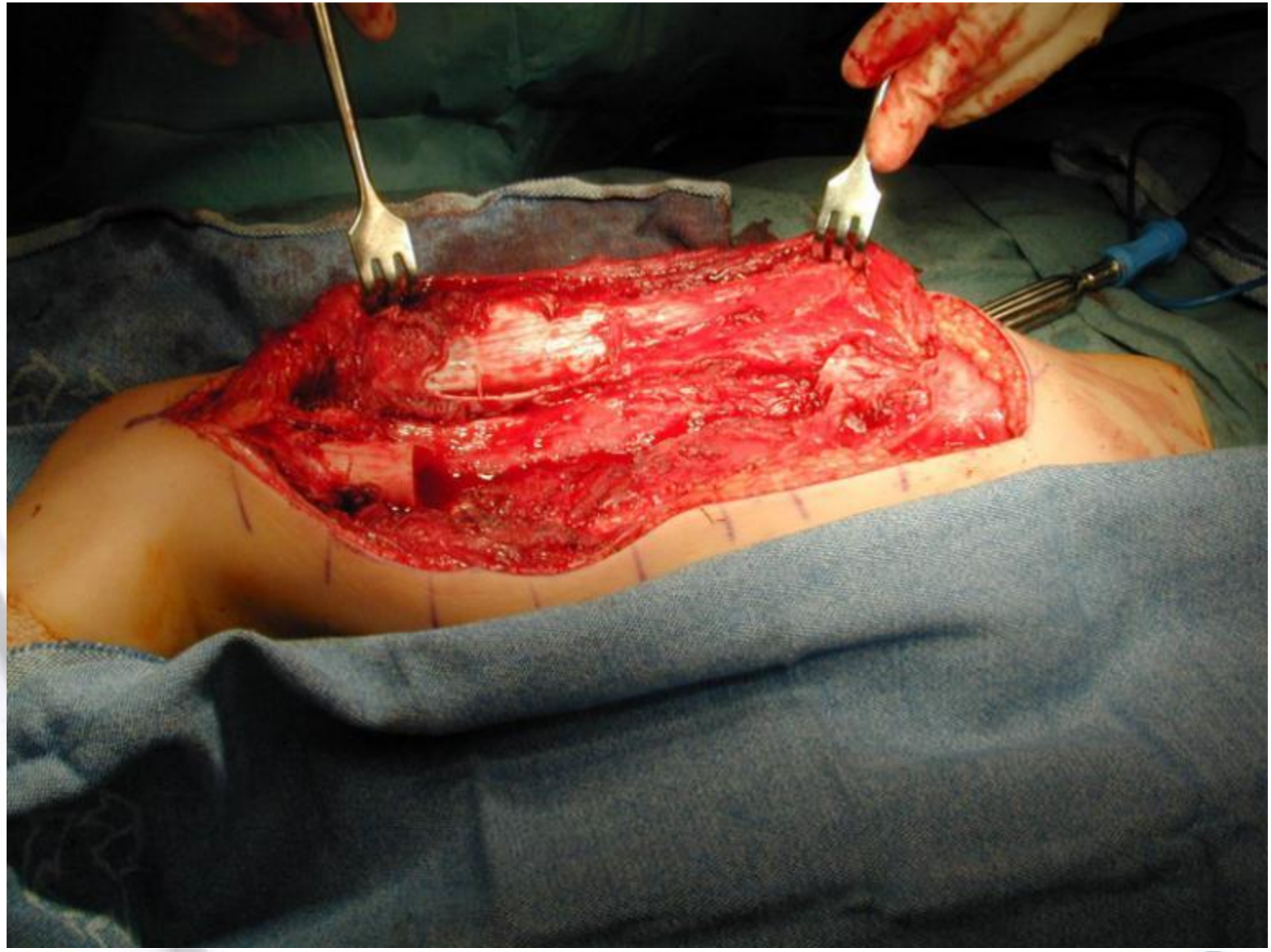
DONOR ALLIANCE
Organ & Tissue Donation

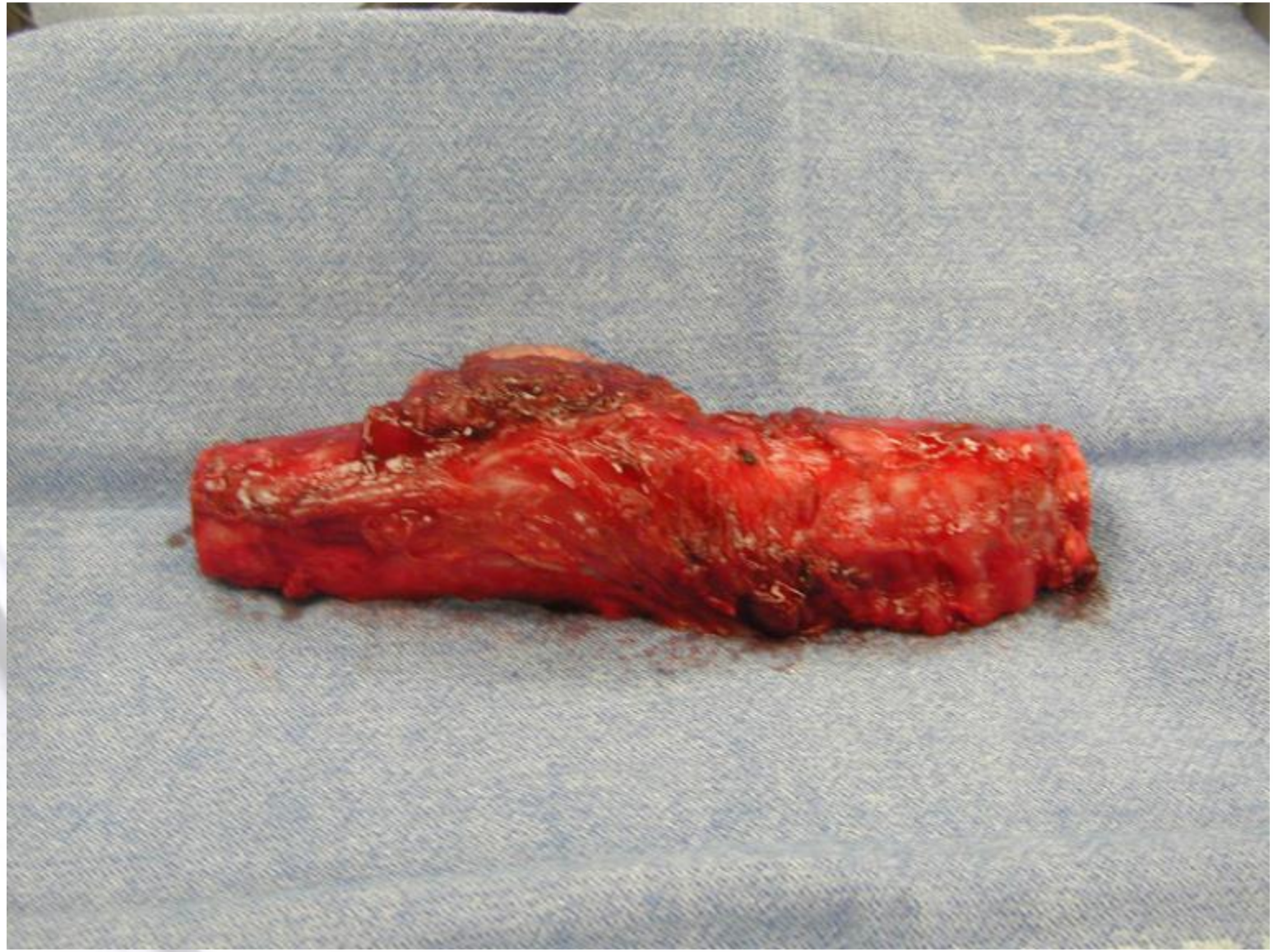
Case Presentations

2013 Western Colorado DONATION SUMMIT

7 yo female w/ sarcoma left femur

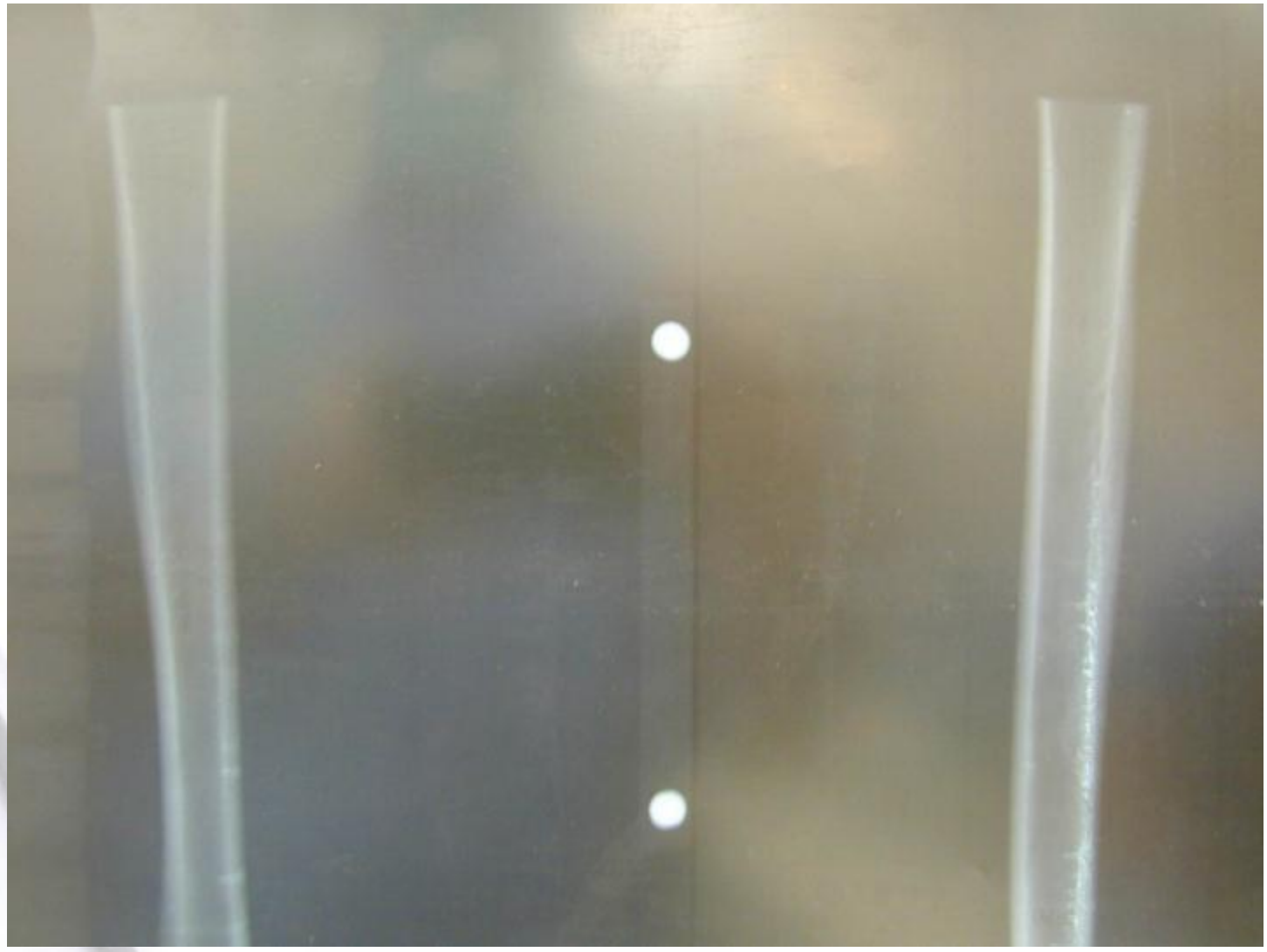

Se: 3
In: 13
OCor P41.9
F 7 01-265730345
Sep 12 00
04:10:55 PM
Mag = 1.2
FL:
ROT:
ET:8
R
P
L
A
FSEC/90
TR:3200
TE:84/Ef
EC:1/1 15.6kHz
BODY
FOV:40x40
4.0thk/1.0sp
20/03:57
256X192/3 NEX
SI:SIF/NP/VB/E0/TRF/Z512
I 203
W = 356 L = 175

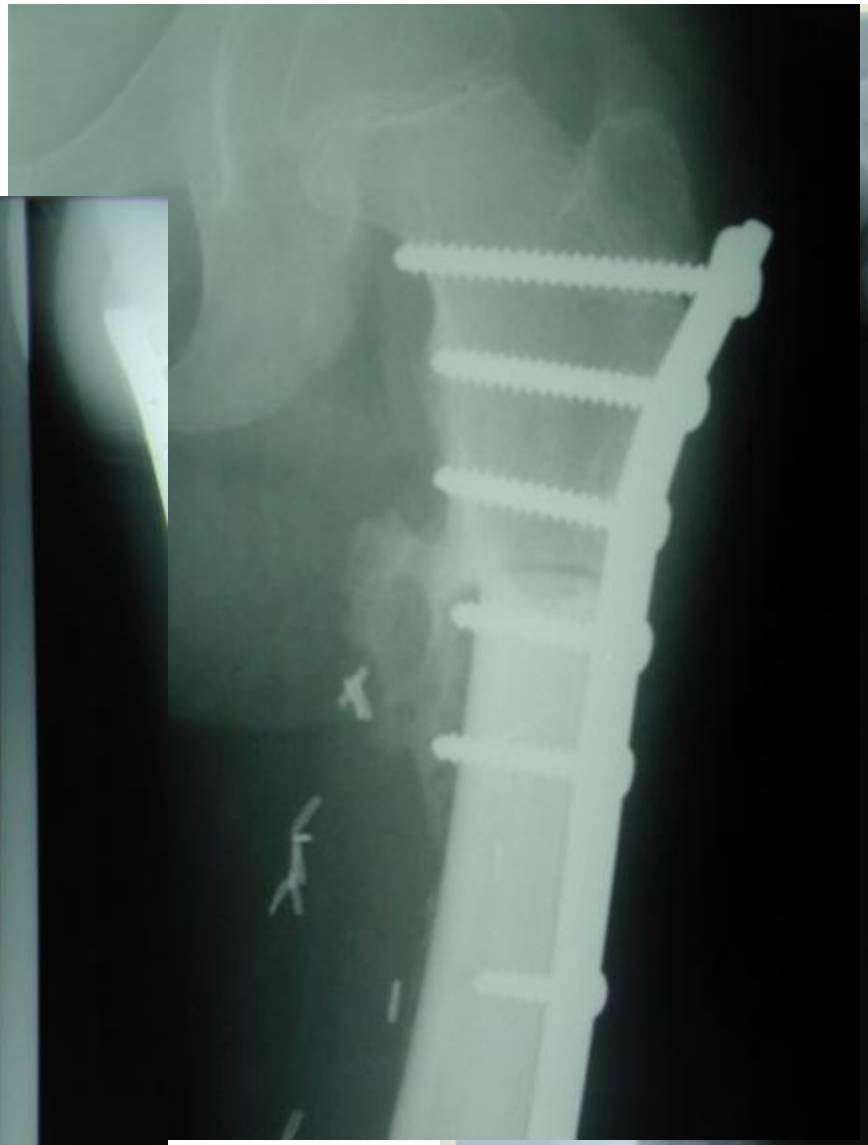




DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT




L
TS



DONOR ALLIANCE
Organ & Tissue Donation

DONOR ALLIANCE
Organ & Tissue Donation

HK
10/1/09

Ross Wilkins, MD

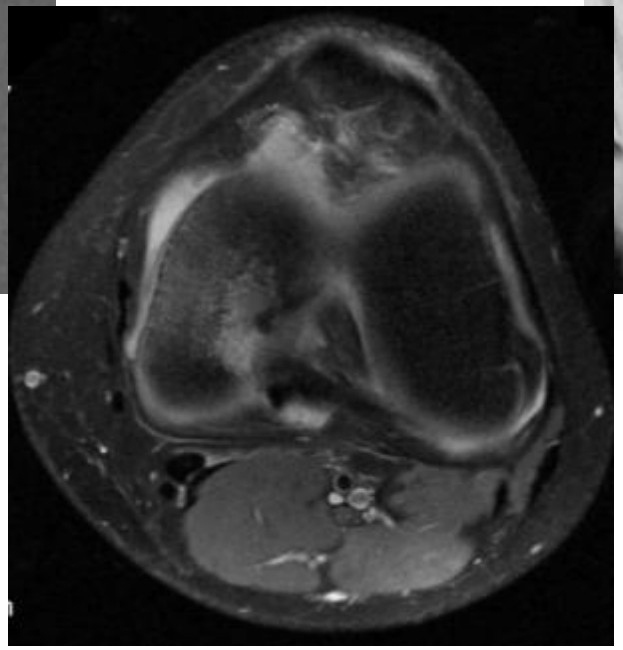
2013 Western Colorado DONATION SUMMIT

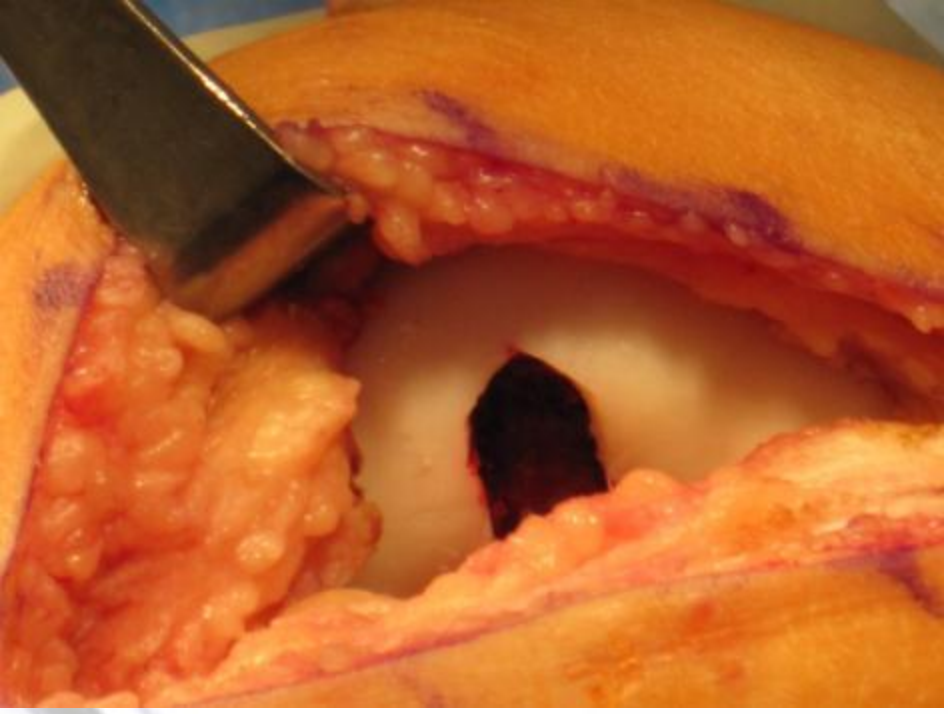
History

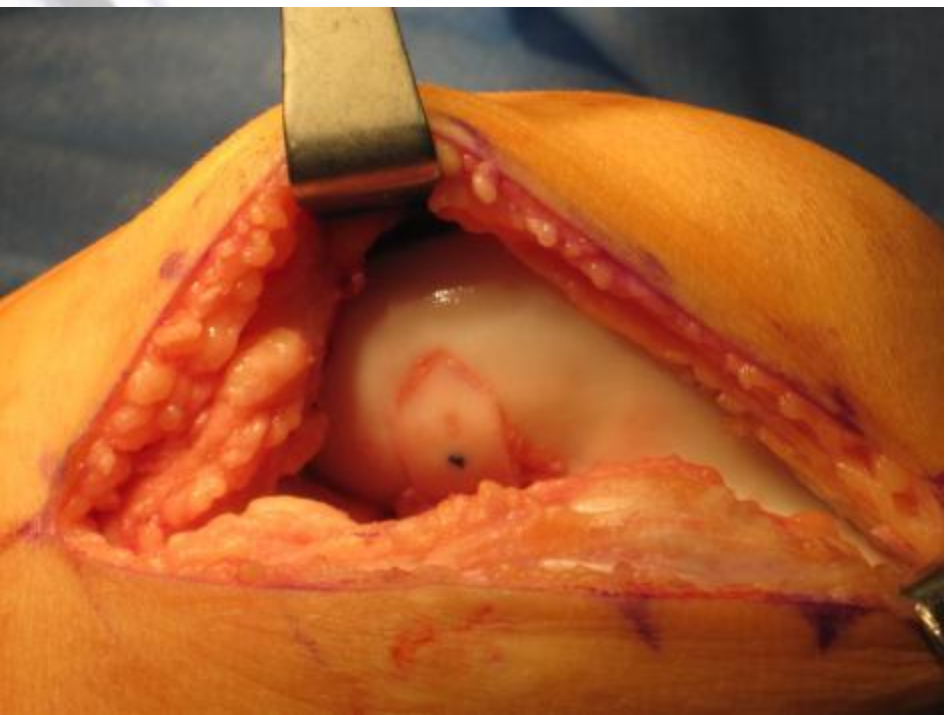
- 13 yo female w/ hx Juvenile OCD
- Cheerleader
- OCD lesion R knee ’07- improved w/ rest x 3 mos
- Developed L knee pain 10/08 and rested as she did w/ R knee
- Returned to cheerleading gradually and developed signif pain
- L knee scope at Children’s Hosp → large OCD lesion L MFC 8/24/09
- Did well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

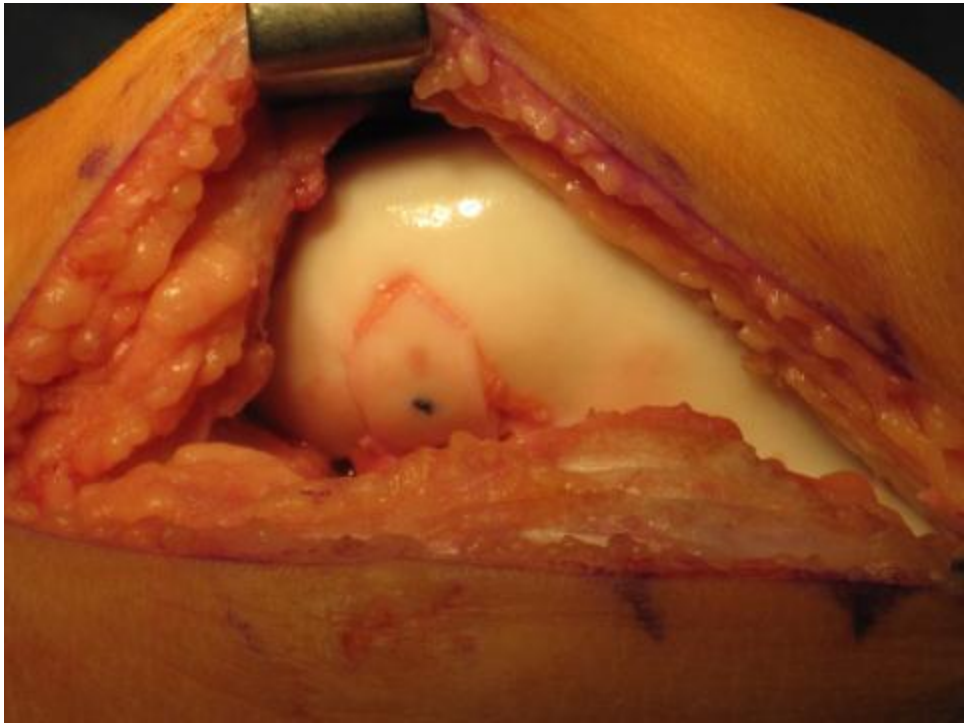
8/3/09

MRI 9/2/09

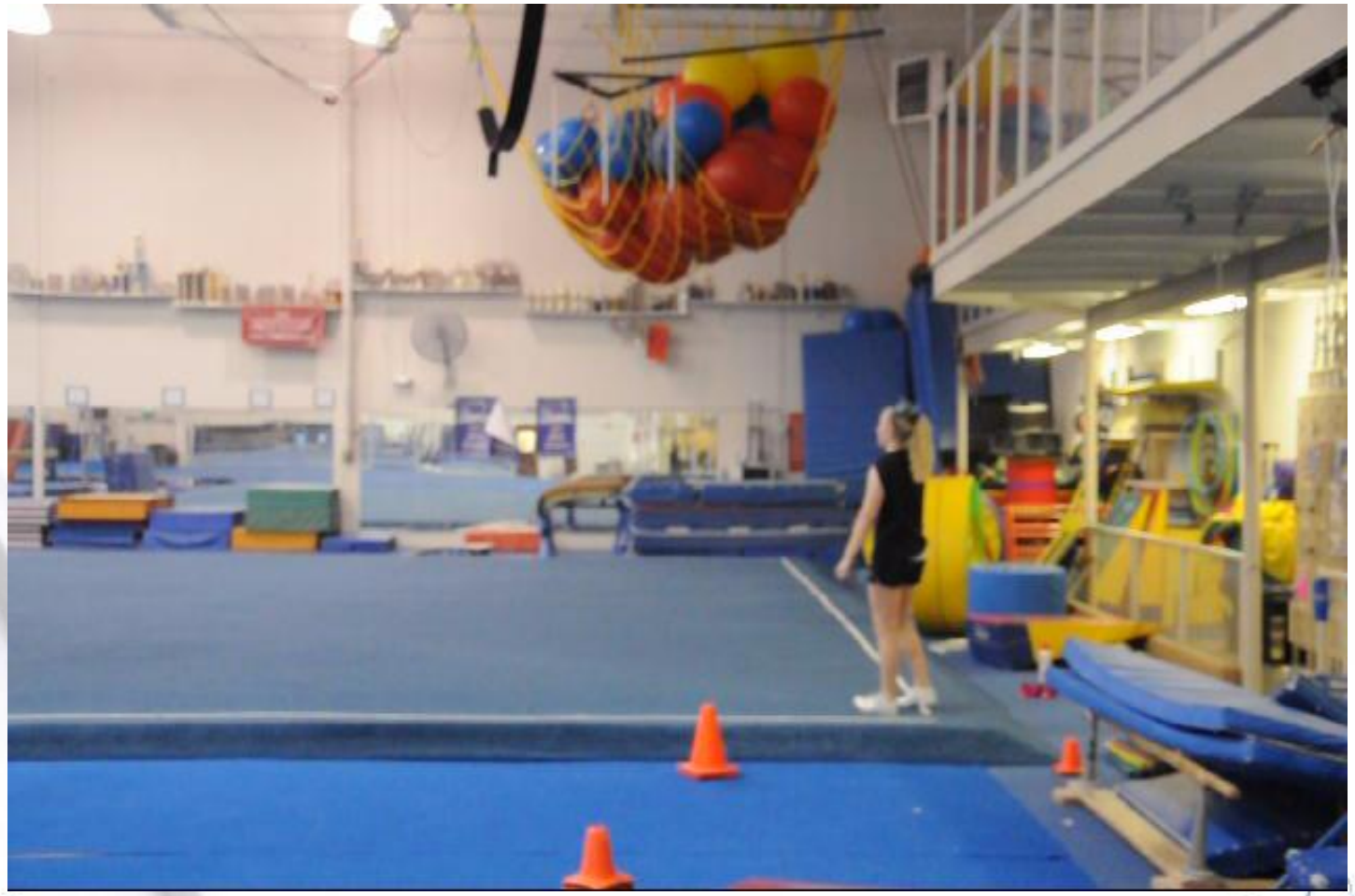




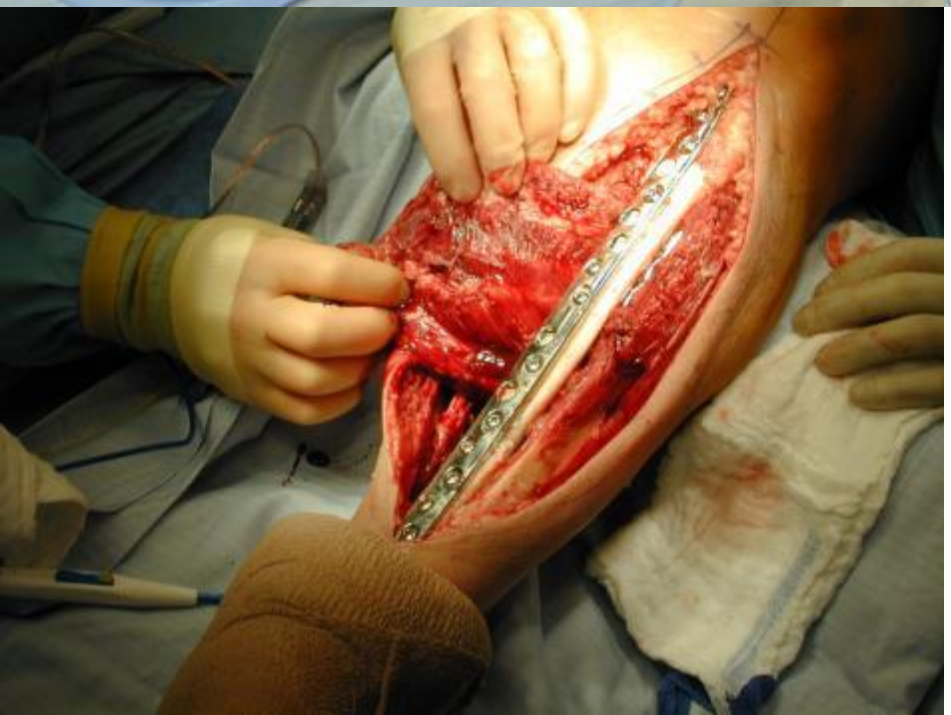




18 yo OCD Femoral condyle 6mos PO



18 yo college tennis player
osteosarcoma tibia



Back playing competitive tennis

DONOR ALLIANCE
Organ & Tissue Donation

17 you female championship basketball player low grade OGS

2013 Western Colorado DONATION SUMMIT

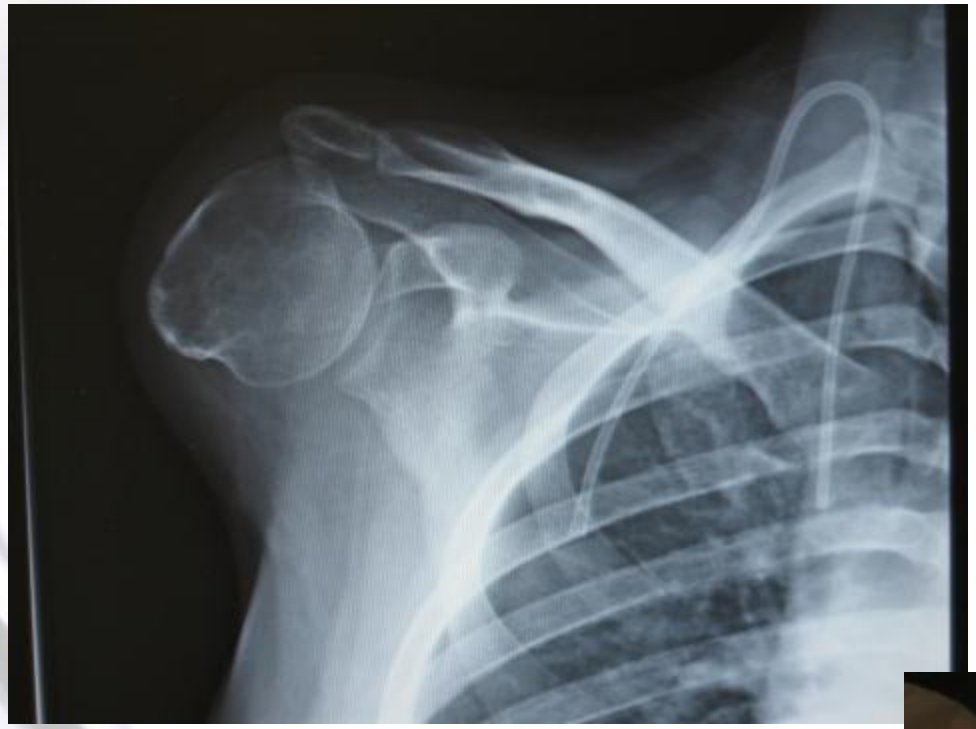
Returned to competition

Clinical Cases

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

DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado DONATION SUMMIT



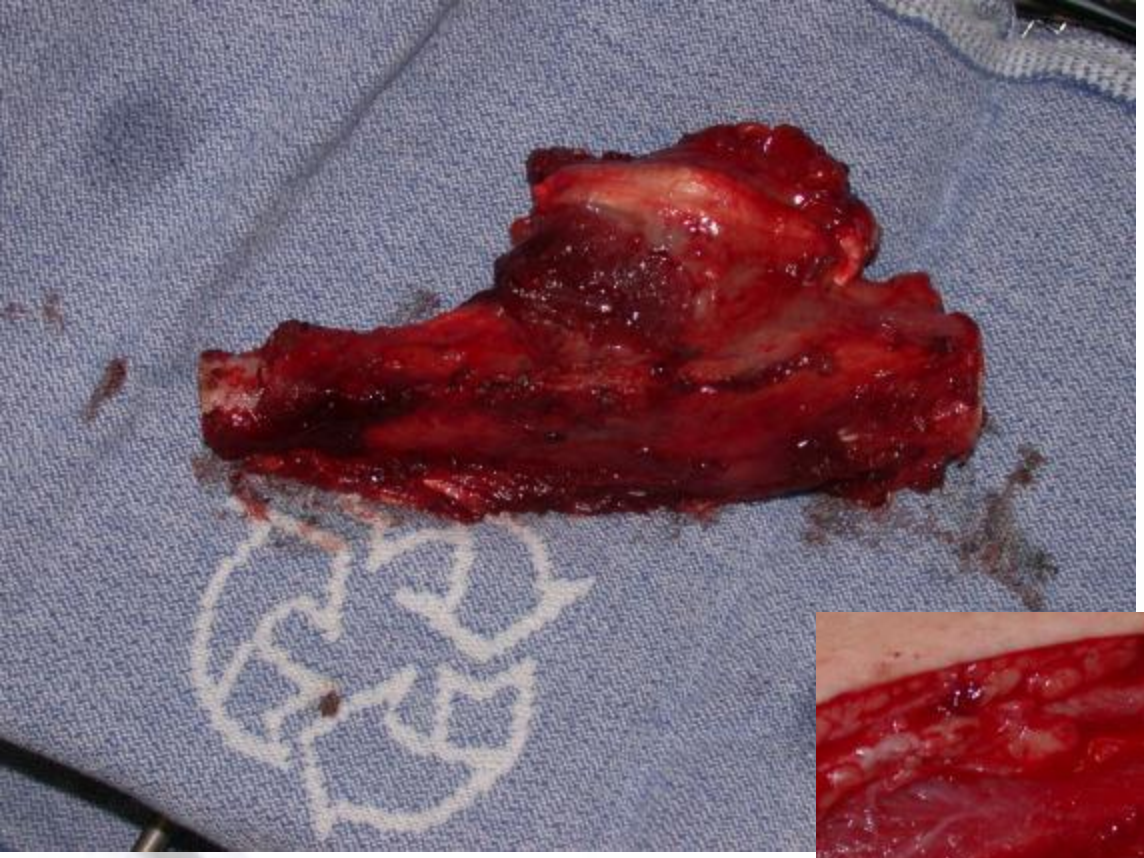
DONOR ALLIANCE
Organ & Tissue Donation

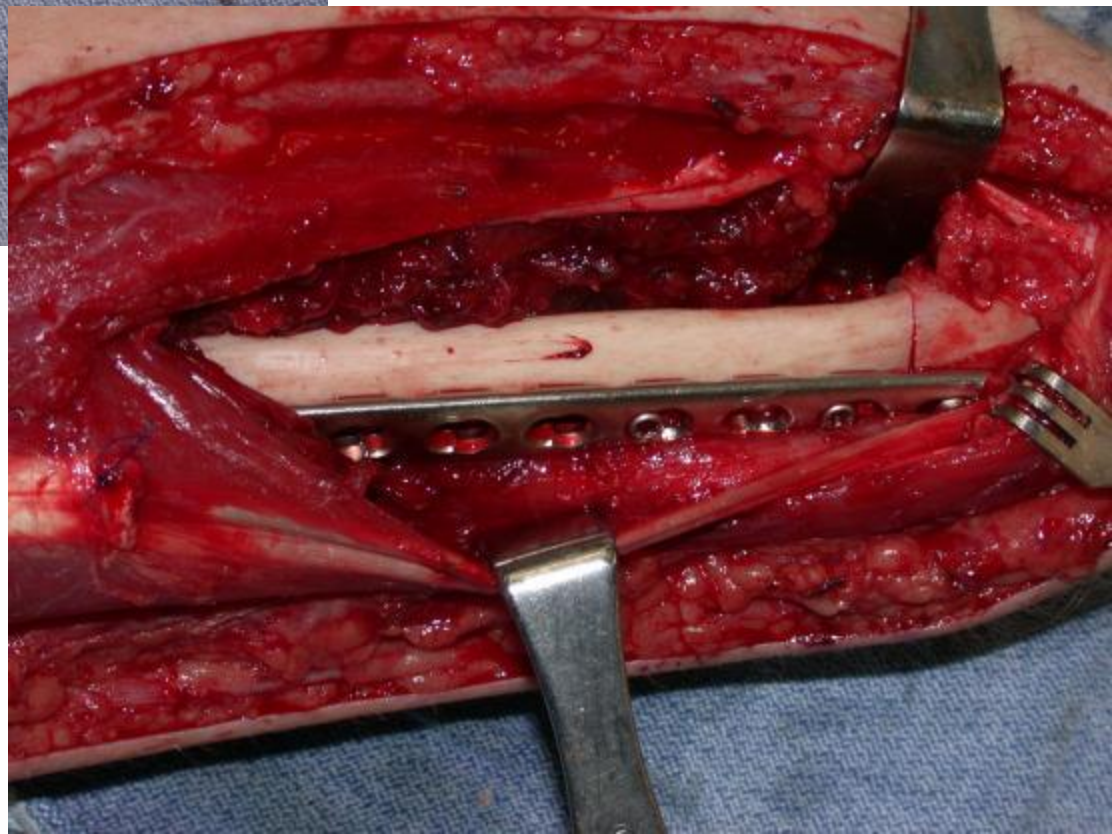
DONOR ALLIANCE
Organ & Tissue Donation

DONOR ALLIANCE
Organ & Tissue Donation

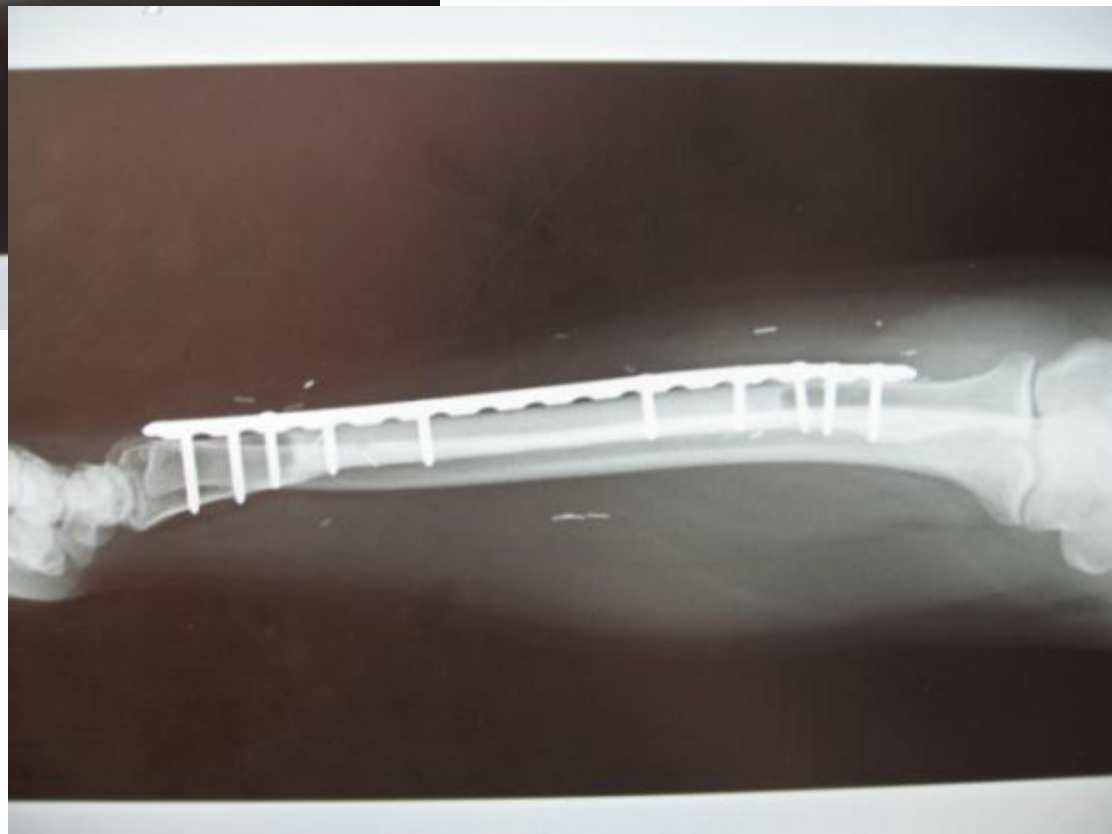
DONOR ALLIANCE
Organ & Tissue Donation

18 yo male lacrosse player ogs ulna

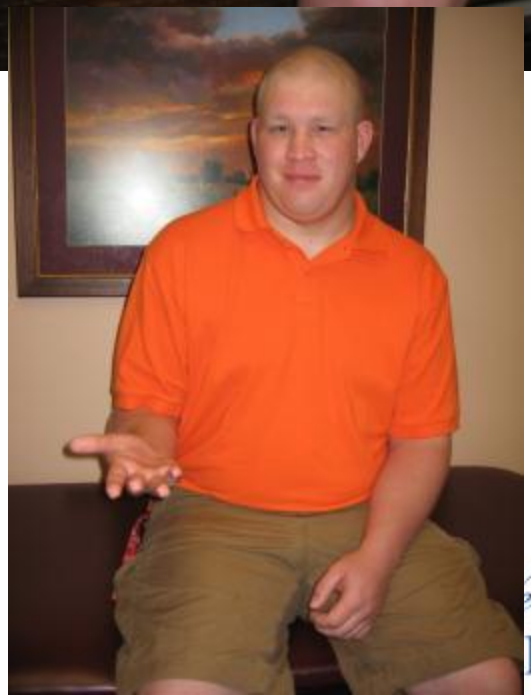




DONOR ALLIANCE
Organ & Tissue Donation



DONOR ALLIANCE
Organ & Tissue Donation



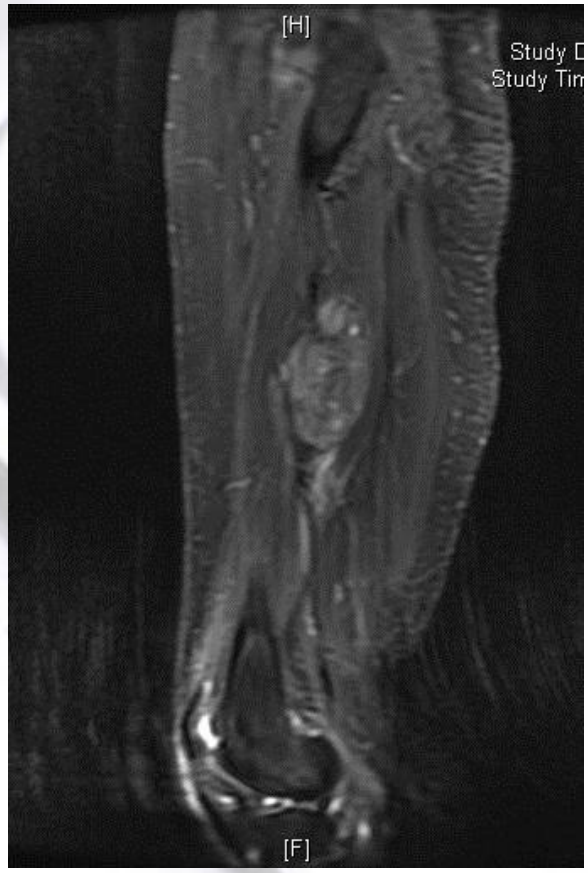
estern Colorado
ION SUMMIT

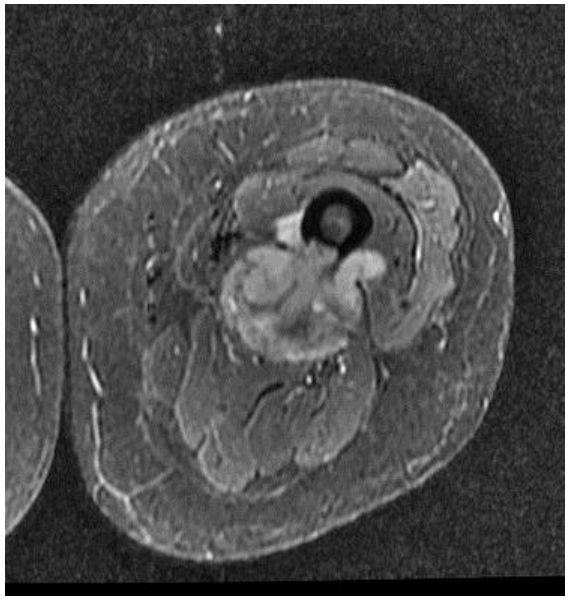
30 yo female small cell OGS femur

DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

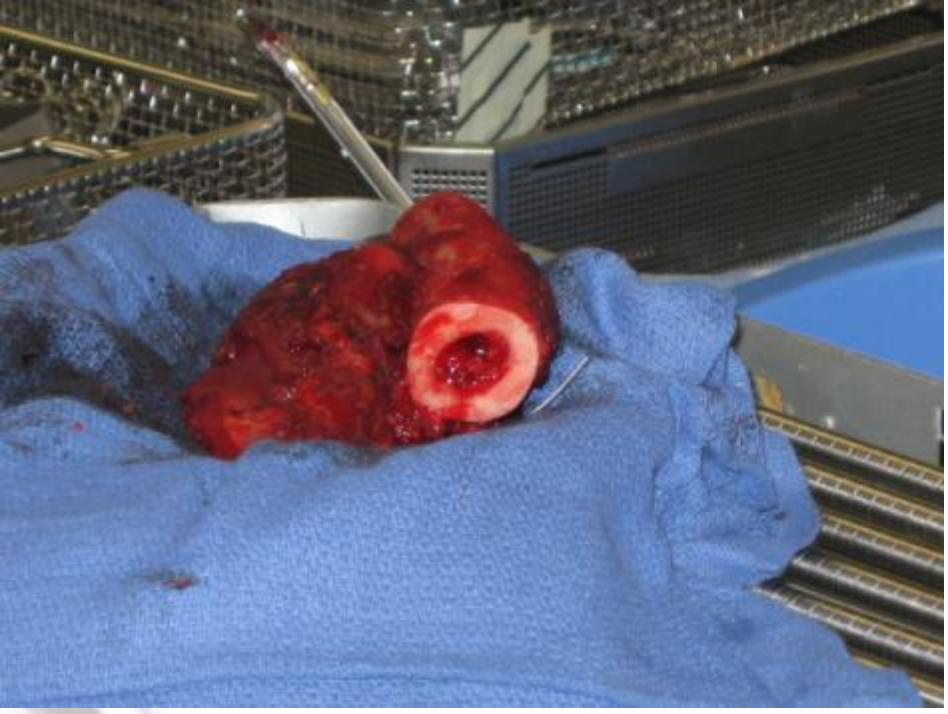
MRI 5/19/09



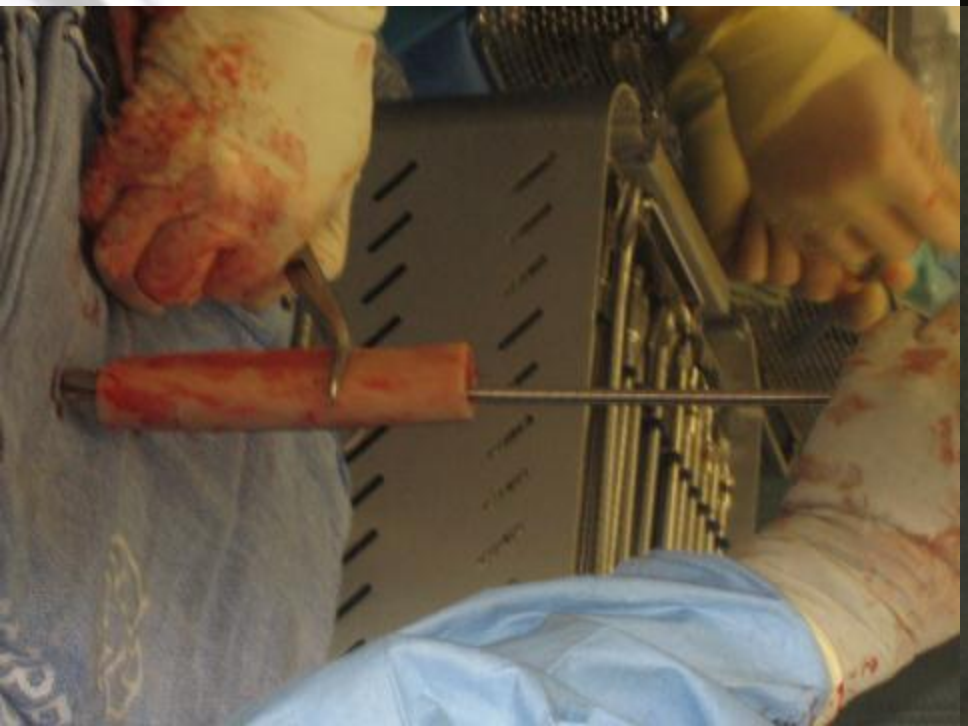


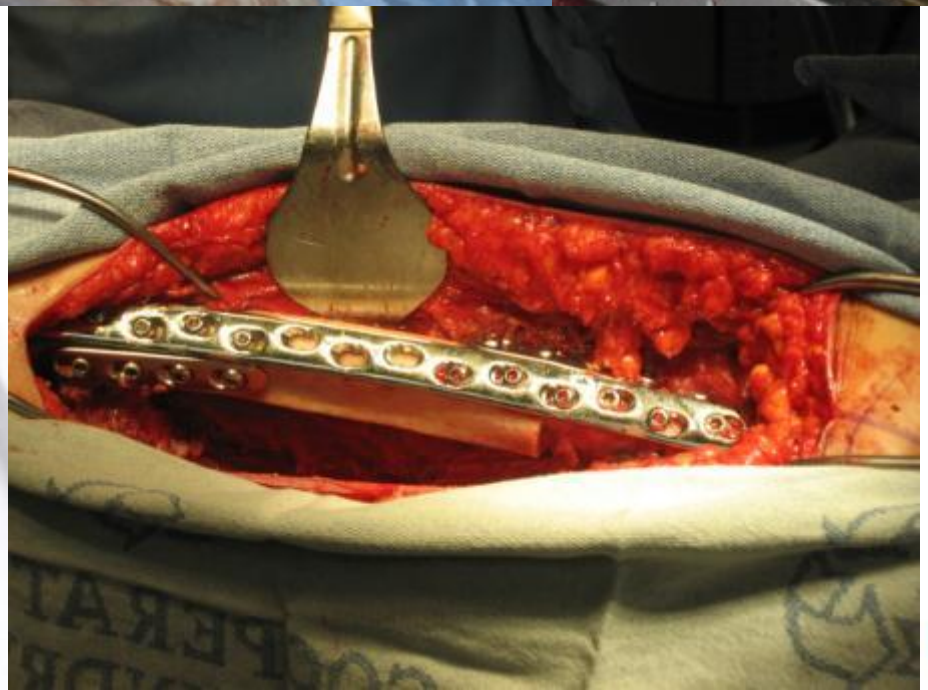
DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT




OPERATIVE
LAUNDRY

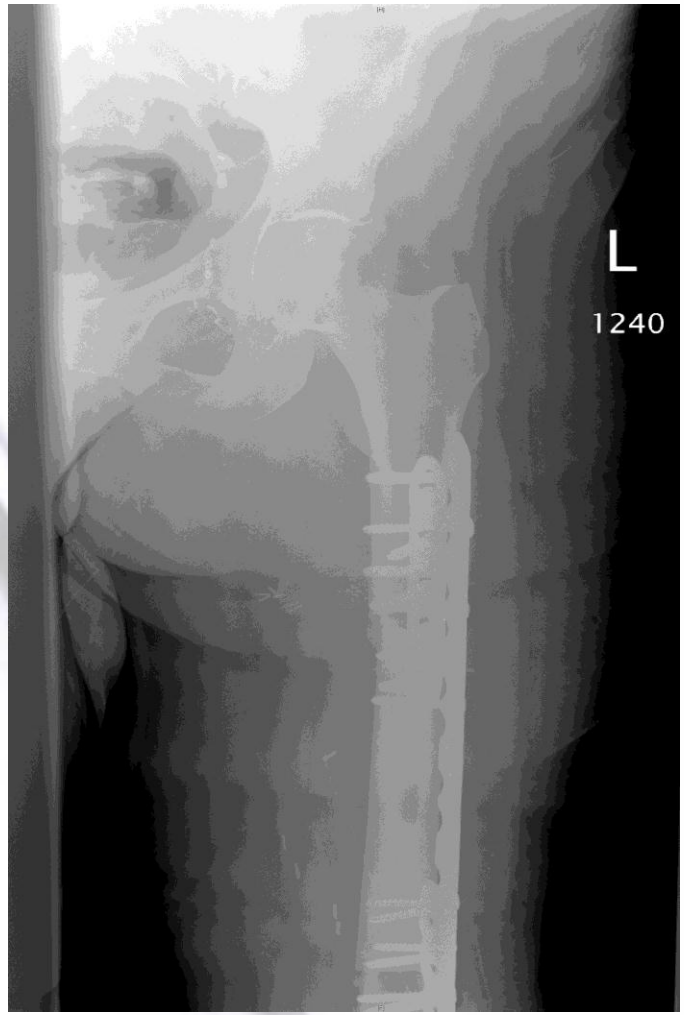


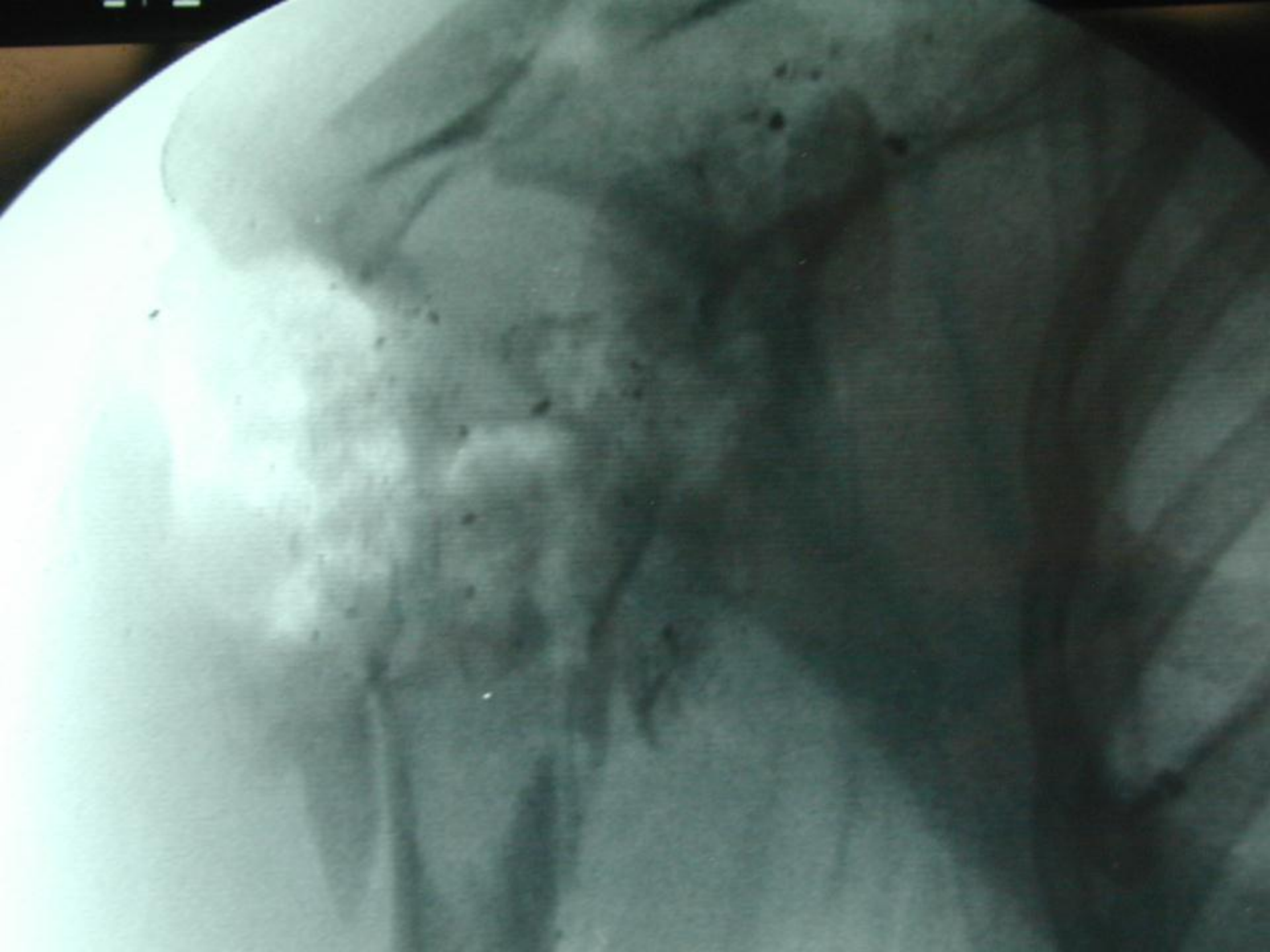


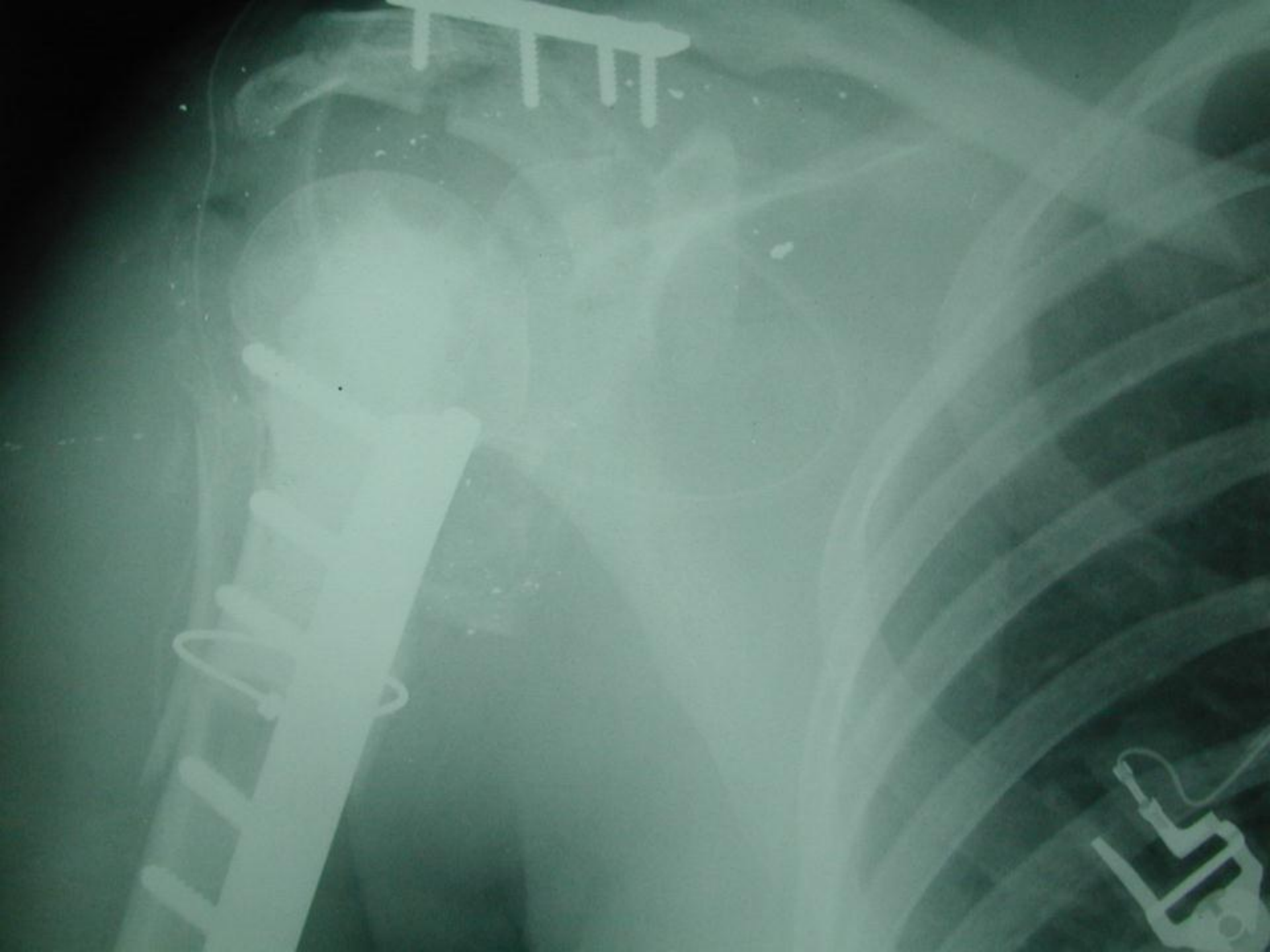
DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

Post-op 6/17/09

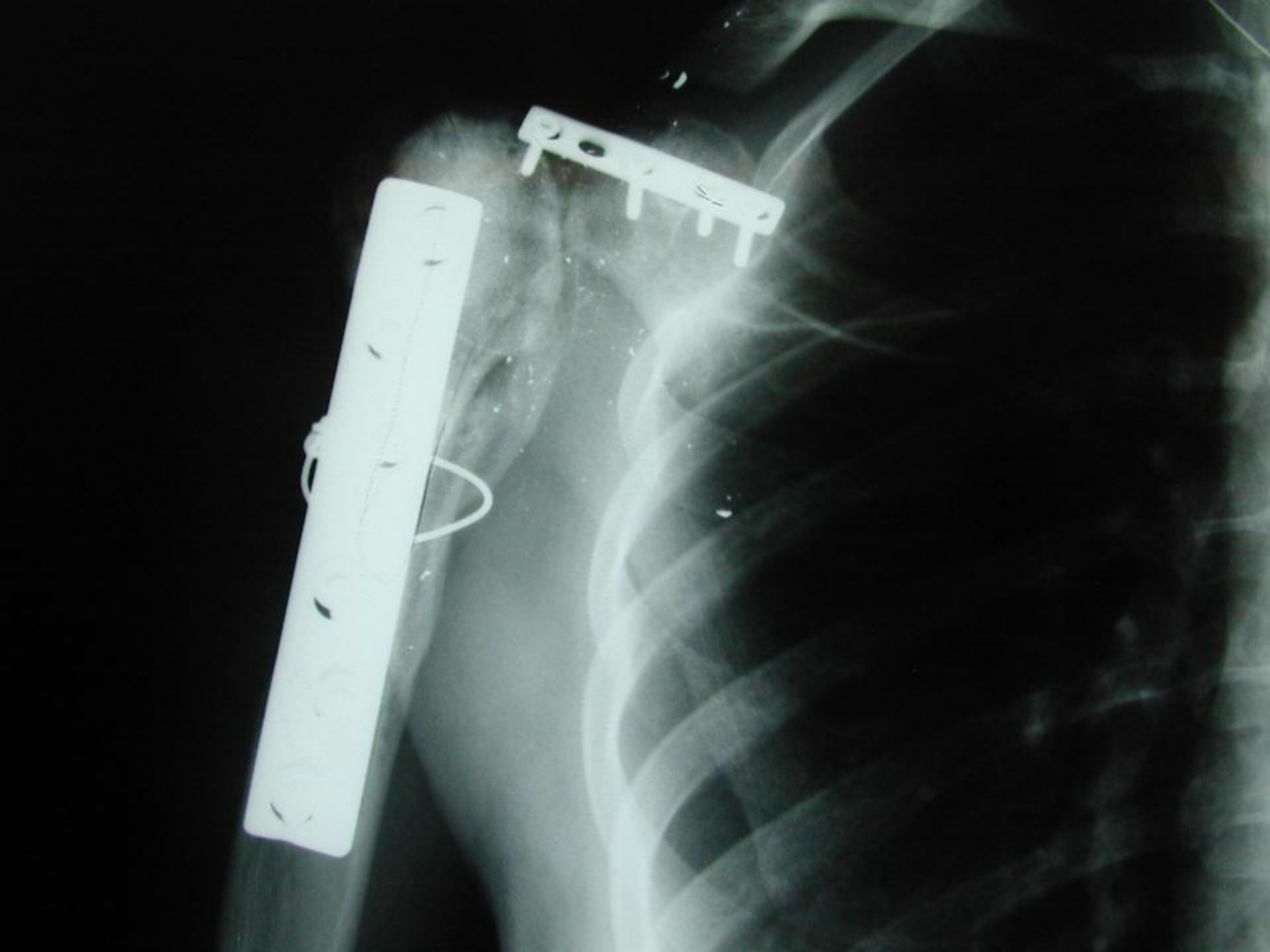






DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT



Thank you

- Questions?

drrmw@aol.com

DONOR ALLIANCE
Organ & Tissue Donation

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

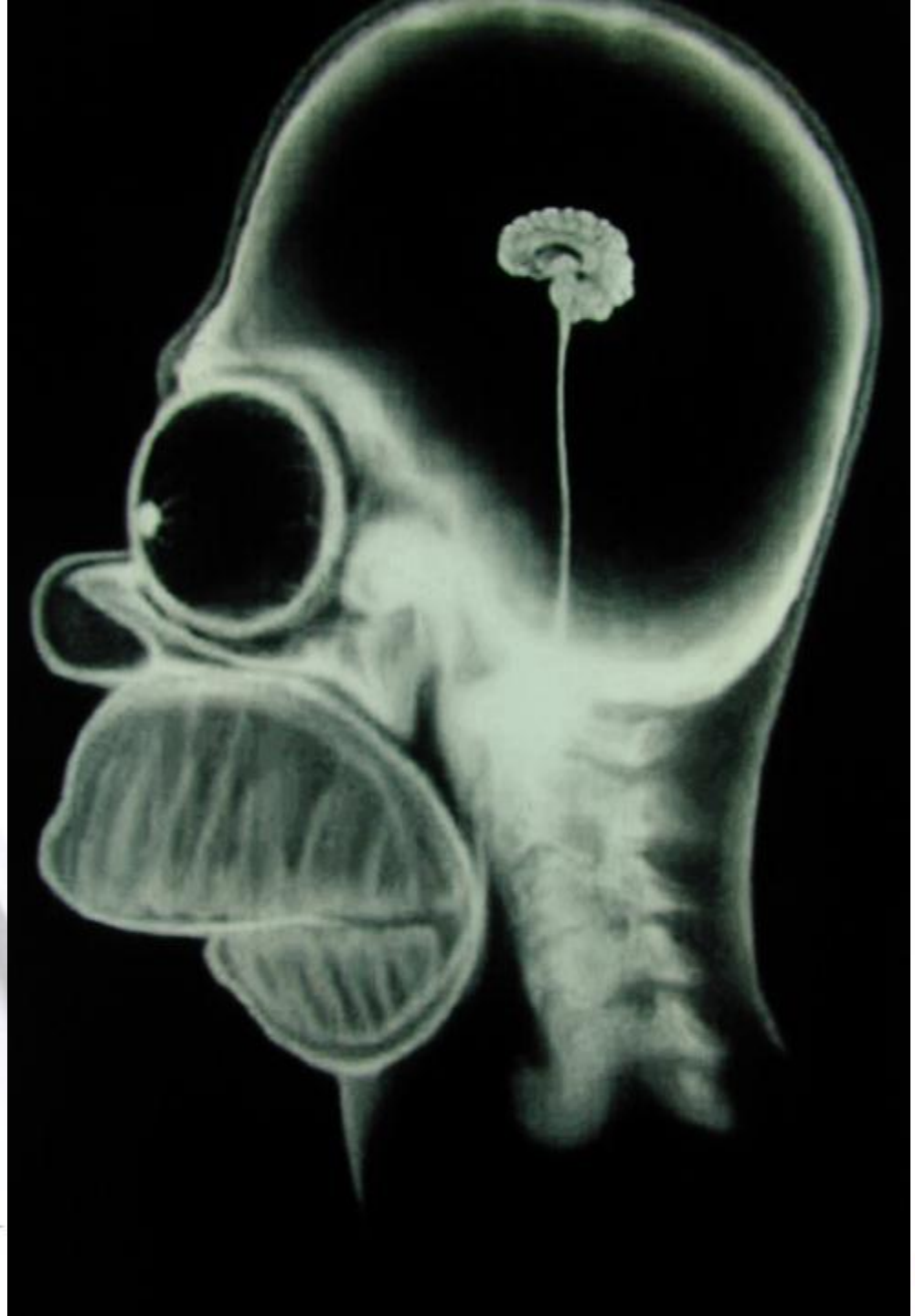
Poor soft tissue coverage
  Nutrition
  Multiple operations
  Hematoma
  Dead tissue

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



DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

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)

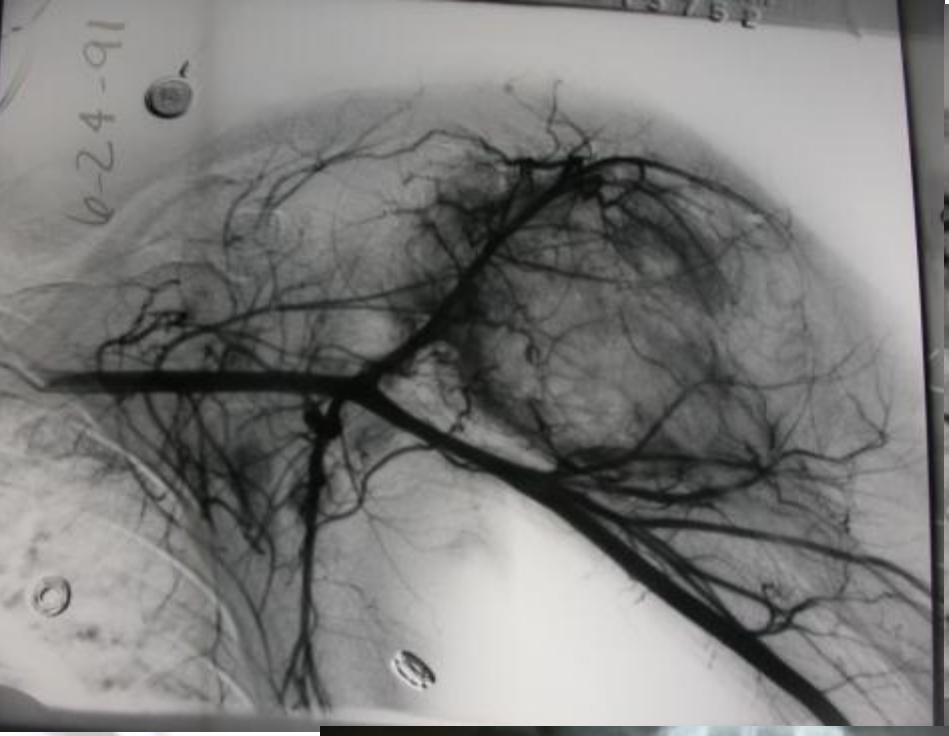
10 yo male OGS proximal humerus

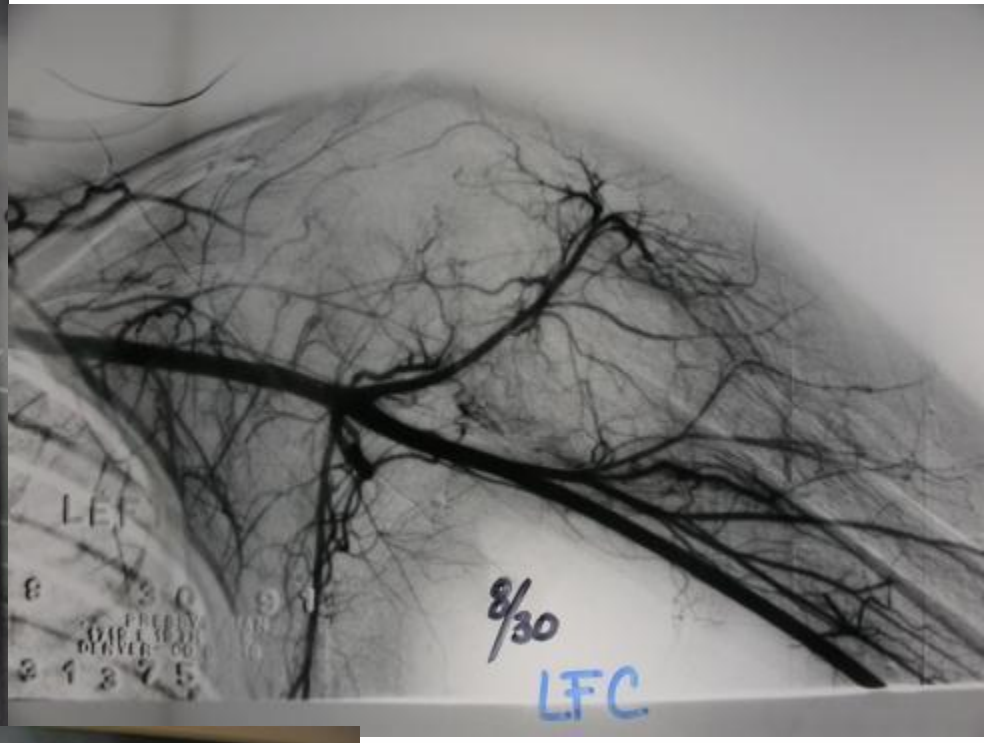




DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT





DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

- Now a professional guitar player

15 years post op

DONOR ALLIANCE
Organ & Tissue Donation

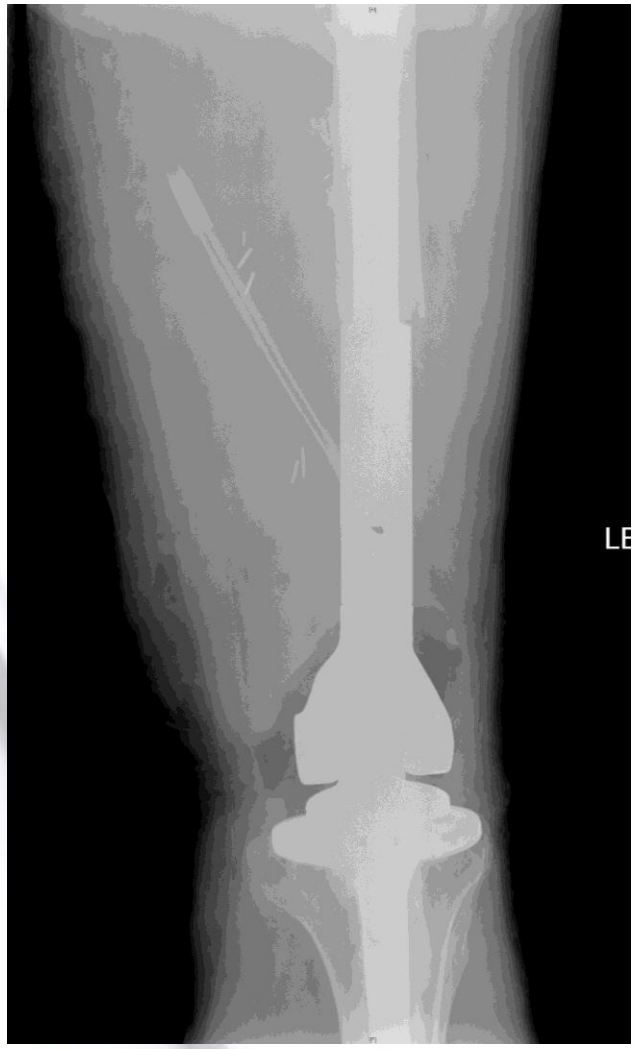
History

- 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

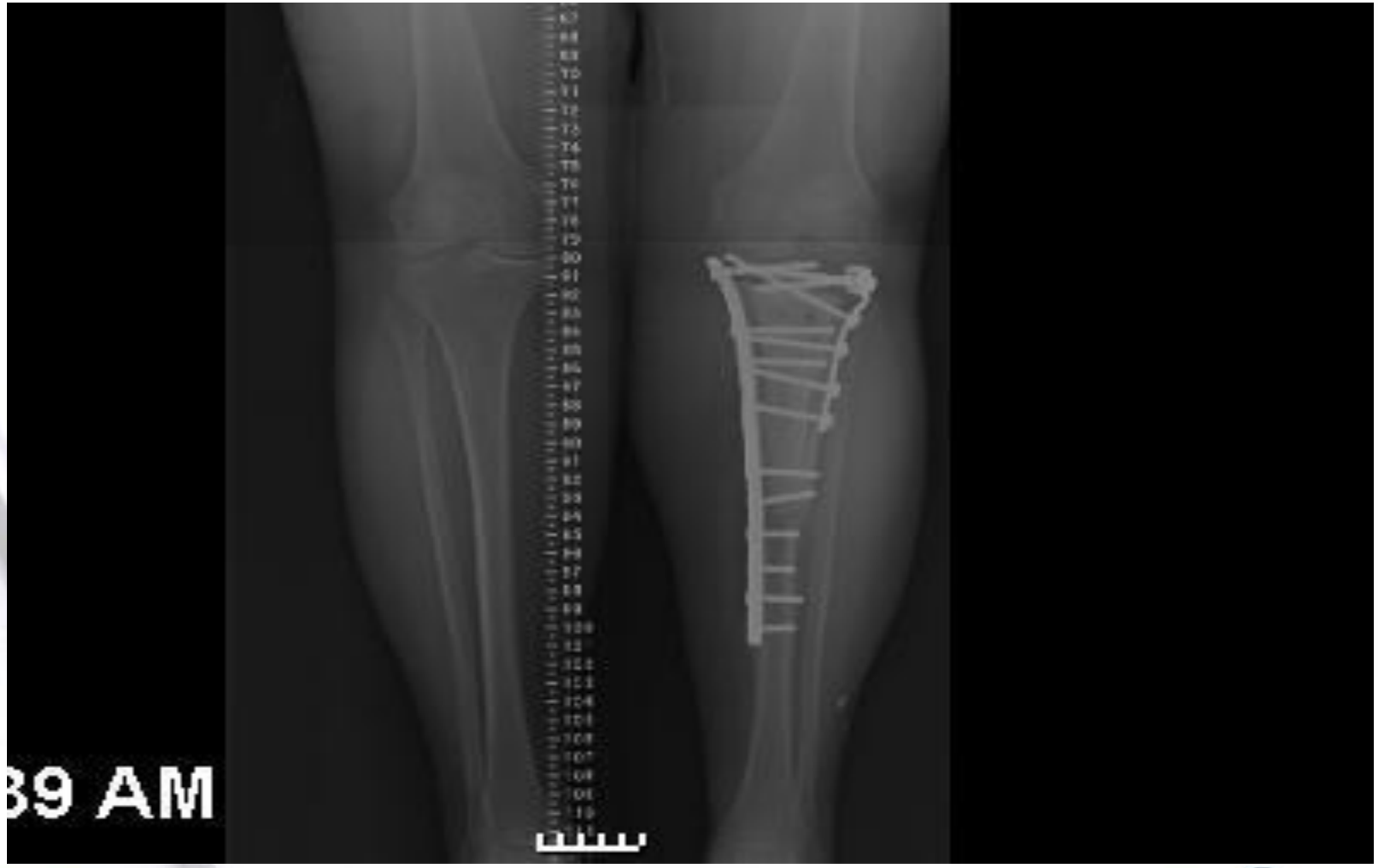
DFR 1/27/10



History 20 year follow up

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

Post-op screw removal



DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

10/25/11

DONOR ALLIANCE
Organ & Tissue Donation

20 years post op

2013 Western Colorado
DONATION SUMMIT

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

DONOR ALLIANCE
Organ & Tissue Donation

Allograft Safety: What about Infection: Viral and Bacterial

Ross M Wilkins MD MS

2013 Western Colorado DONATION SUMMIT

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 Clost. 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

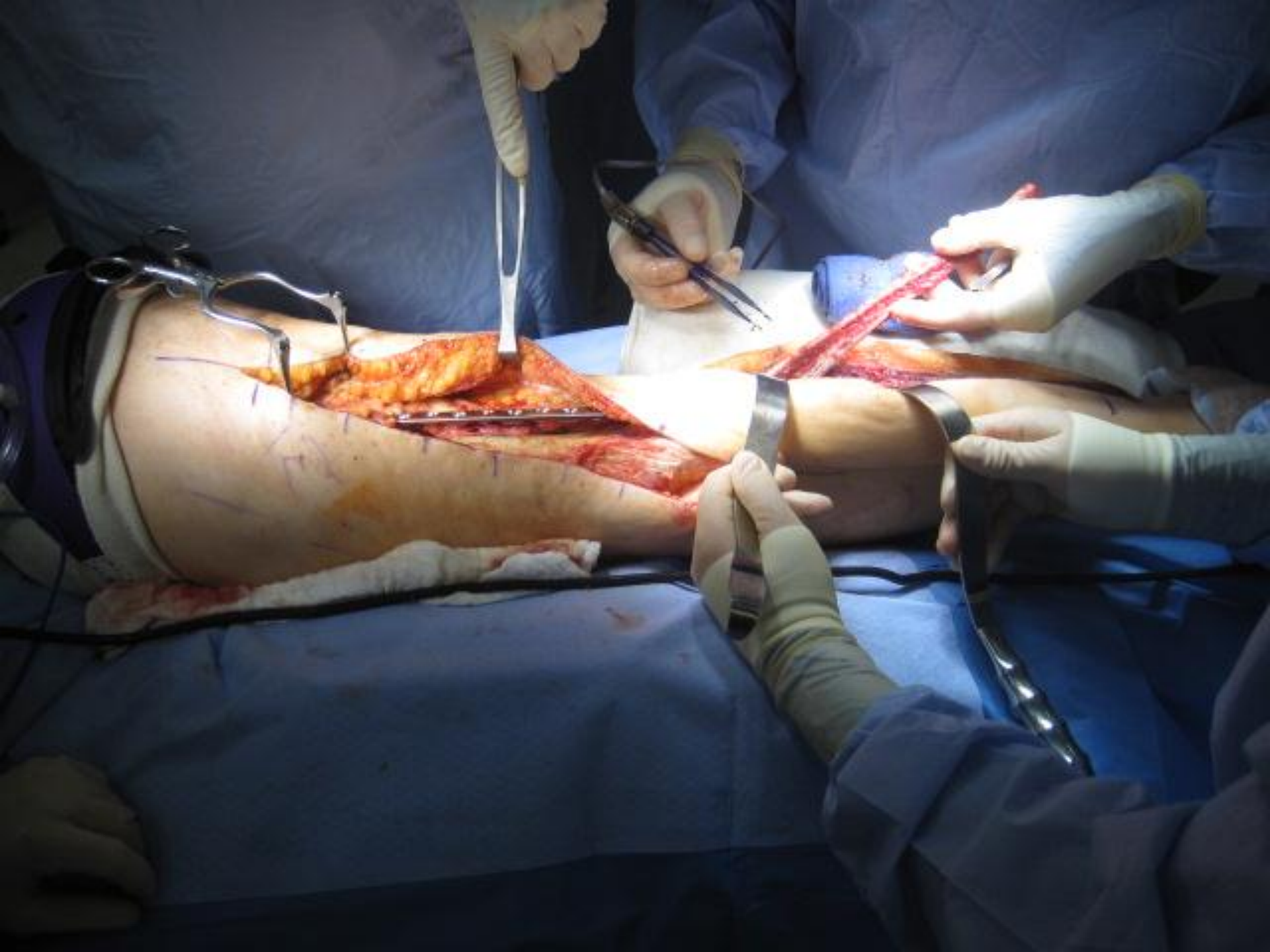

W Knee a.p. *
Se: 2/2
Im: 1/1
1968 Nov 18 F 000592026
Acc: 6007316
2011 Apr 07
Acq Tm: 15:37:24.000000
L
JH
Id:DCM / Lin:DCM / Id:ID
W:2982 L:2605


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
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
512 x 512
U75u
R F
L H
120.0 kV
0.0 mA
Tilt: 0.0
0.0 s
Lin:DCM / Lin:DCM / Id:ID
WINDOW1 W:2000 L:400
F P
DFOV: 25.0 x 25.0cm
A

Procedure

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




CROSS TABLE
2 OF 2

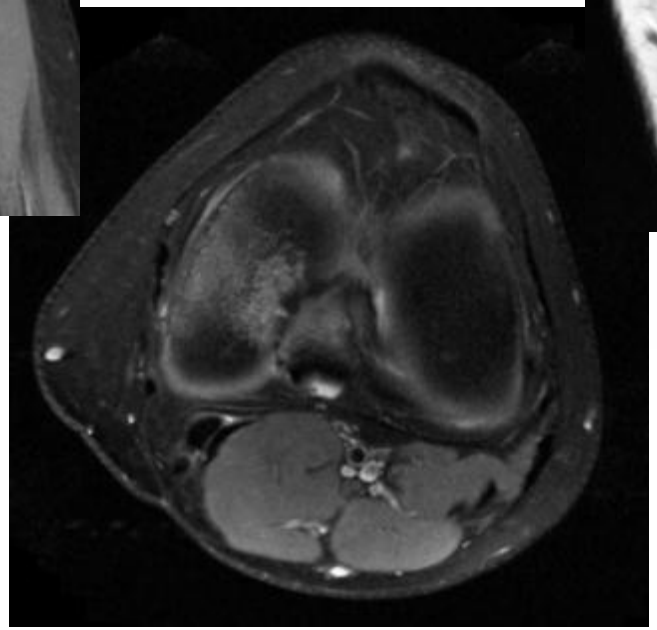
Special Case….
Special Person!!

17 yo female osteosarcoma proximal tibia

30 yo Traumatic loss distal tibia

8/3/09

MRI 7/29/09



DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

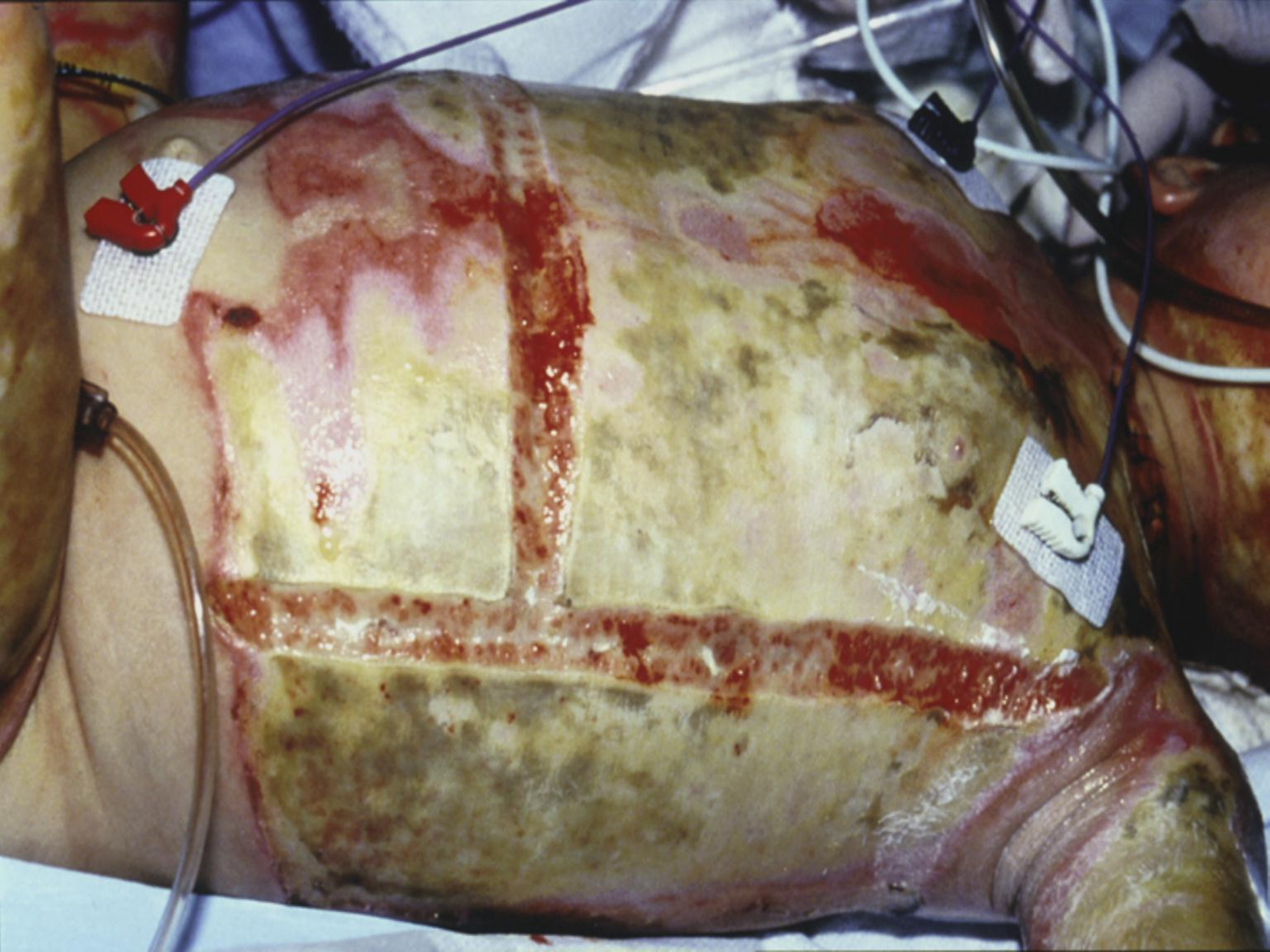
Post-op 9/30/09
Osteochondral Allograft to MFC

4/20/10

Human Allograft Skin

Traditional Indications for Use

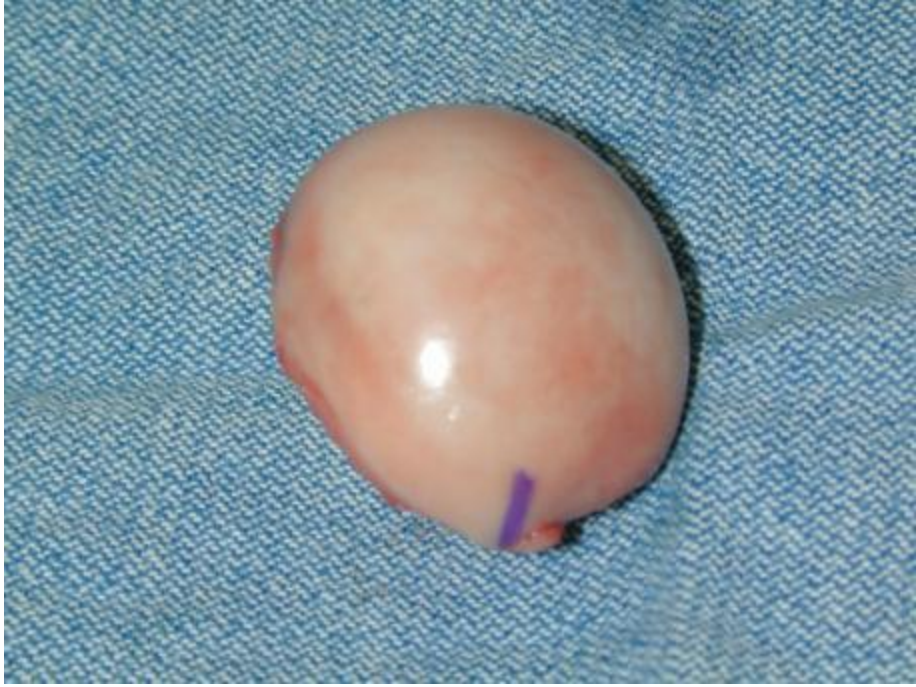
- **Excised burn wounds**
- E
- Tes
- Dern
- Necro
- Injuries

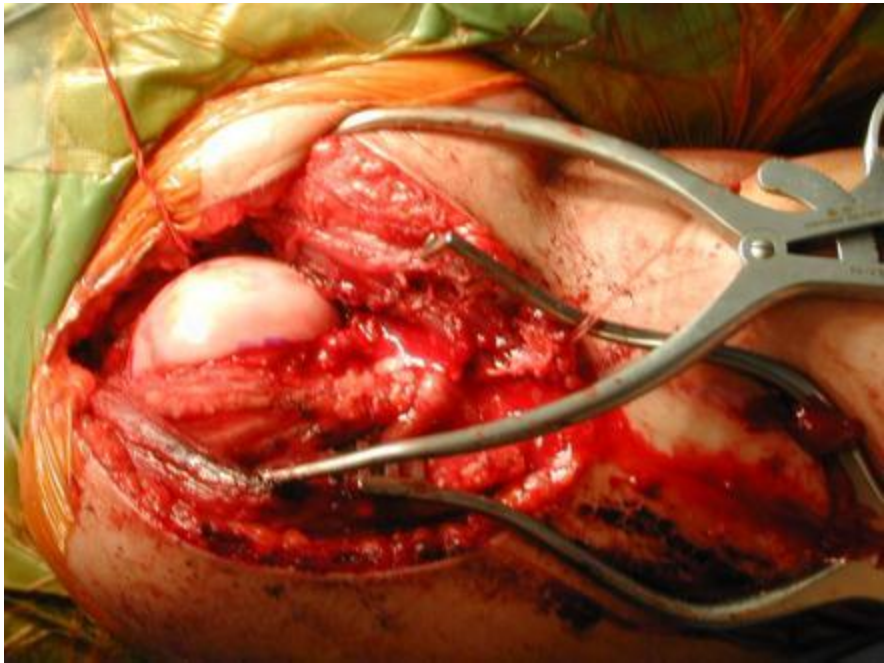


DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

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



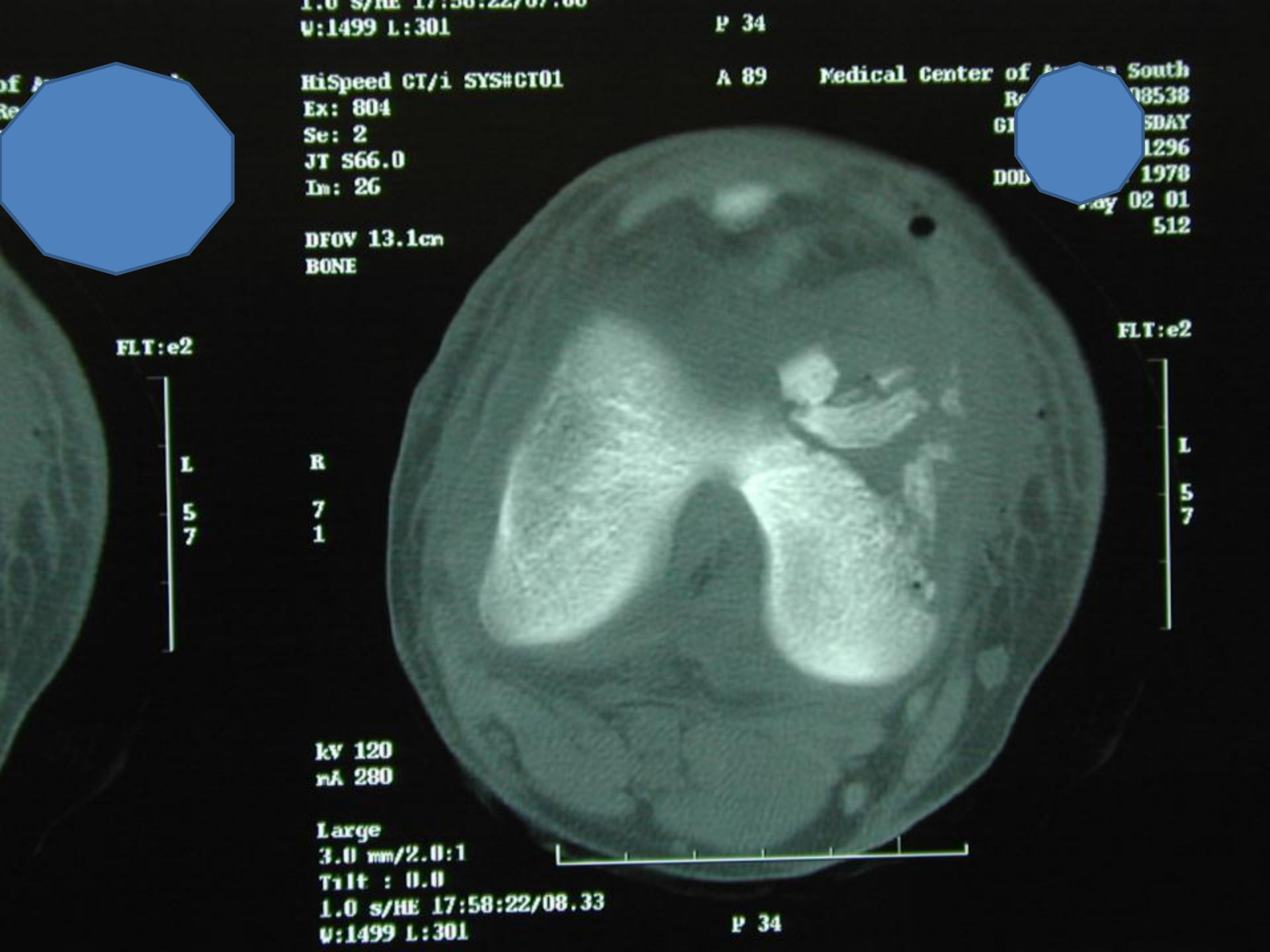


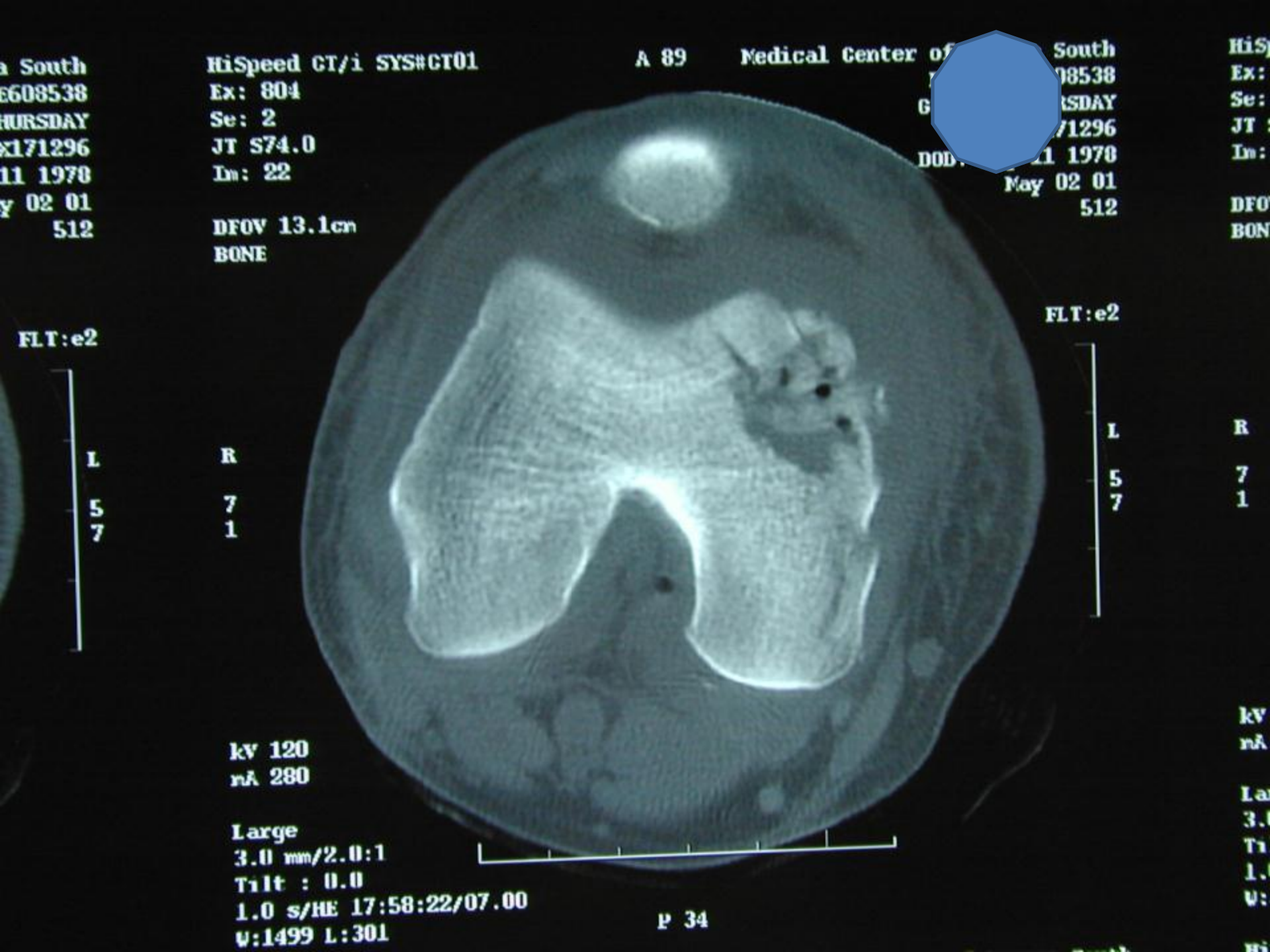
DONOR ALLIANCE
Organ & Tissue Donation

2013 Western Colorado
DONATION SUMMIT

22 yo female, shot in leg while watching television

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


W:1499 L:301
P 34
HiSpeed CT/i SYS#CT01
Ex: 804
Se: 2
JT S66.0
Im: 26
A 89
Medical Center of
South
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


HiSpeed CT/i SYS#CT01
Ex: 804
Se: 2
JT S74.0
Im: 22
DFOV 13.1cm
BONE
A 89
Medical Center of
South
May 02 01
512
FLT:e2
L
5
7
R
7
1
kV 120
mA 280
Large
3.0 mm/2.0:1
Tilt : 0.0
1.0 s/HE 17:58:22/07.00
W:1499 L:301
P 34


620
101
61