

# Fragility Fractures- the problem, advances & treatment

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# What is covered

- Demographics
- Bone issues
- Mechanisms
- Basic Surgical considerations
- Avoiding failures
- Post fracture management

# Fragility Fracture

- Caused by a fall from a standing height or less
- Osteoporosis is most common cause
- 33 to 50% of women will get a fragility fracture
- 15 to 33% of men get a fragility fracture
- Likelihood increases with age

# Fragility Fractures- Risk Factors other than osteoporosis

- Women: Diabetes

Previous fractures

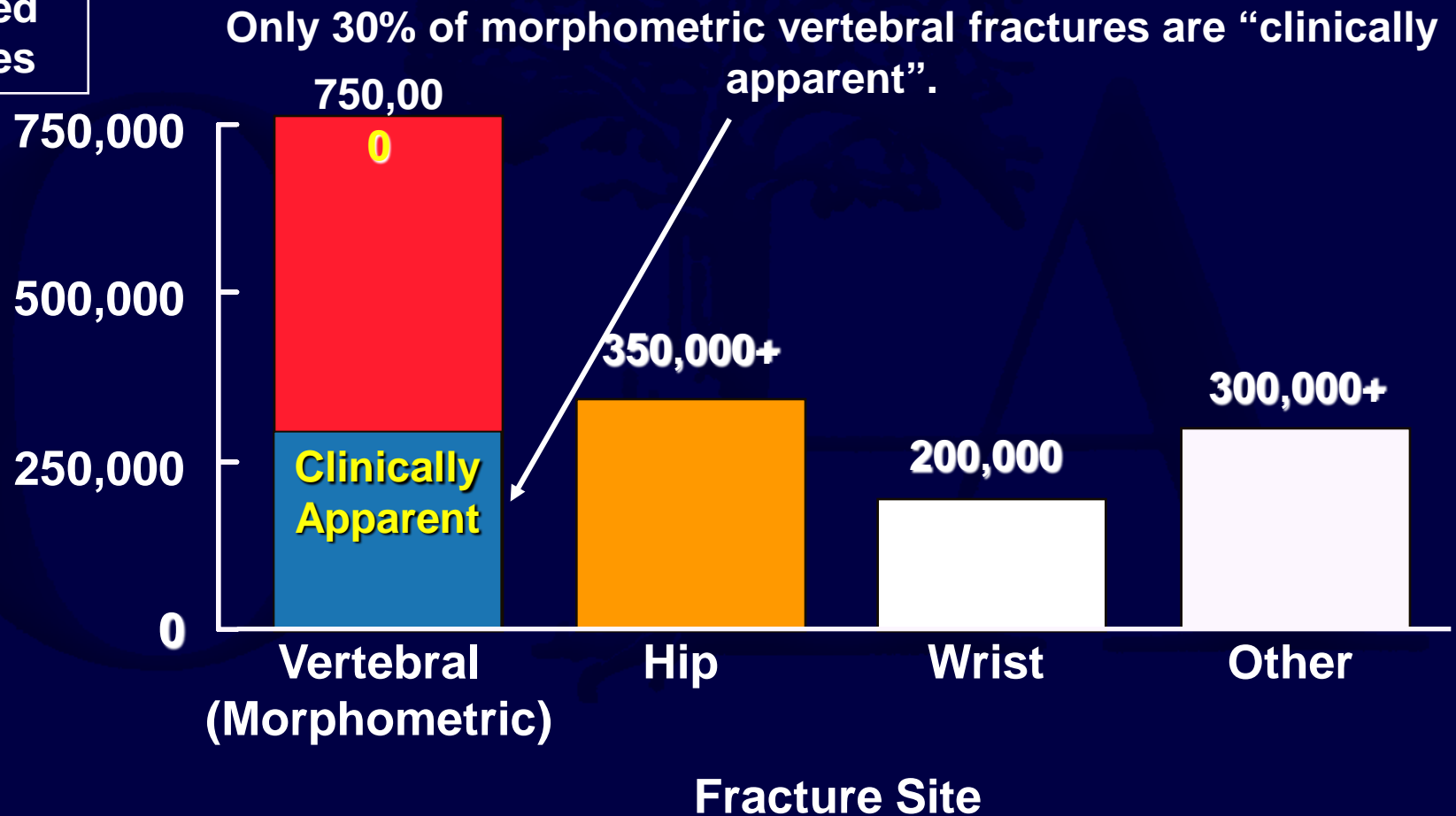
High BMI - ankle and prox  
humerus

- Men: Diabetes

Mental Health hospitalizations

# Incidence of Osteoporotic Fractures (United States)

Annual  
Incidence  
in the  
United  
States



# Demography: projection of Hip Fractures growth from 1950 to 2050

Location	1950	2050N
North America	378,000	742,000
South America	100,000	629,000
Europe	400,000	668,000
Asia	600,000	3,250,000

# What is Osteoporosis?

Skeletal disorder with

- Compromised bone strength
- Increased risk of fractures
- Deterioration of micro-architecture
- Most common bone disease
- Genetic basis (under study)
- Uncoupling of osteoblastic & osteoclastic activity

# Current Problem in US

- >5 million older women at high risk of fx
- 1/3 of these have osteoporosis diagnosis
- 1/4 of these are on appropriate treatment

Gehlbach et al; Osteoporosis International 2007 June



# Osteoporosis

Loss of critical bony inter connections,  
thinner internal support

Trabecular bone loss and thinning of  
remaining bone is seen above

Osteoporosis is loss of bone mineral density  
and critical reduction in strength of bony  
architecture

# Bones change during Life

- Modeling as a child and adolescent
- Remodeling throughout life
- Peak bone mass reached in your 20's
- Remodeling allows bones to heal
- Resorption in later years

# Bone mass changes during life

- Peak bone mass is reached at age 25
- Heredity
- Medications
- Diet, tobacco and alcohol
- Race / Weight

# Bending Stiffness / Cross section

Inner and outer  
Diameters increase



Cross section of normal bone



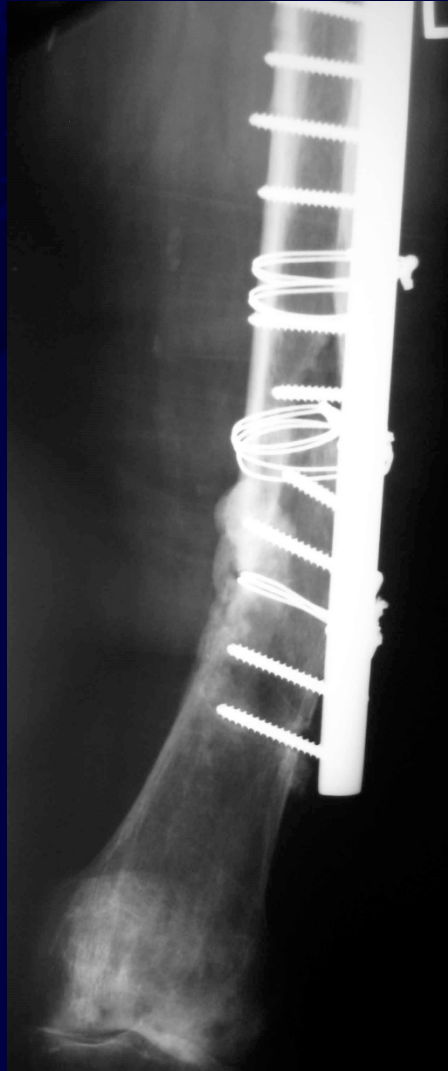
Cross section through  
Osteoporotic bone

# Issues with Osteoporotic Bone Fixation in surgery

- Poor screw purchase
- Fragile cortices
- Difficult or impossible to get rigid fixation
- Initial deformity prone to recurrence

# Conventional plate / screw failure

Screws pull out of bone sequentially



# Locked plate failure all screws fail at once

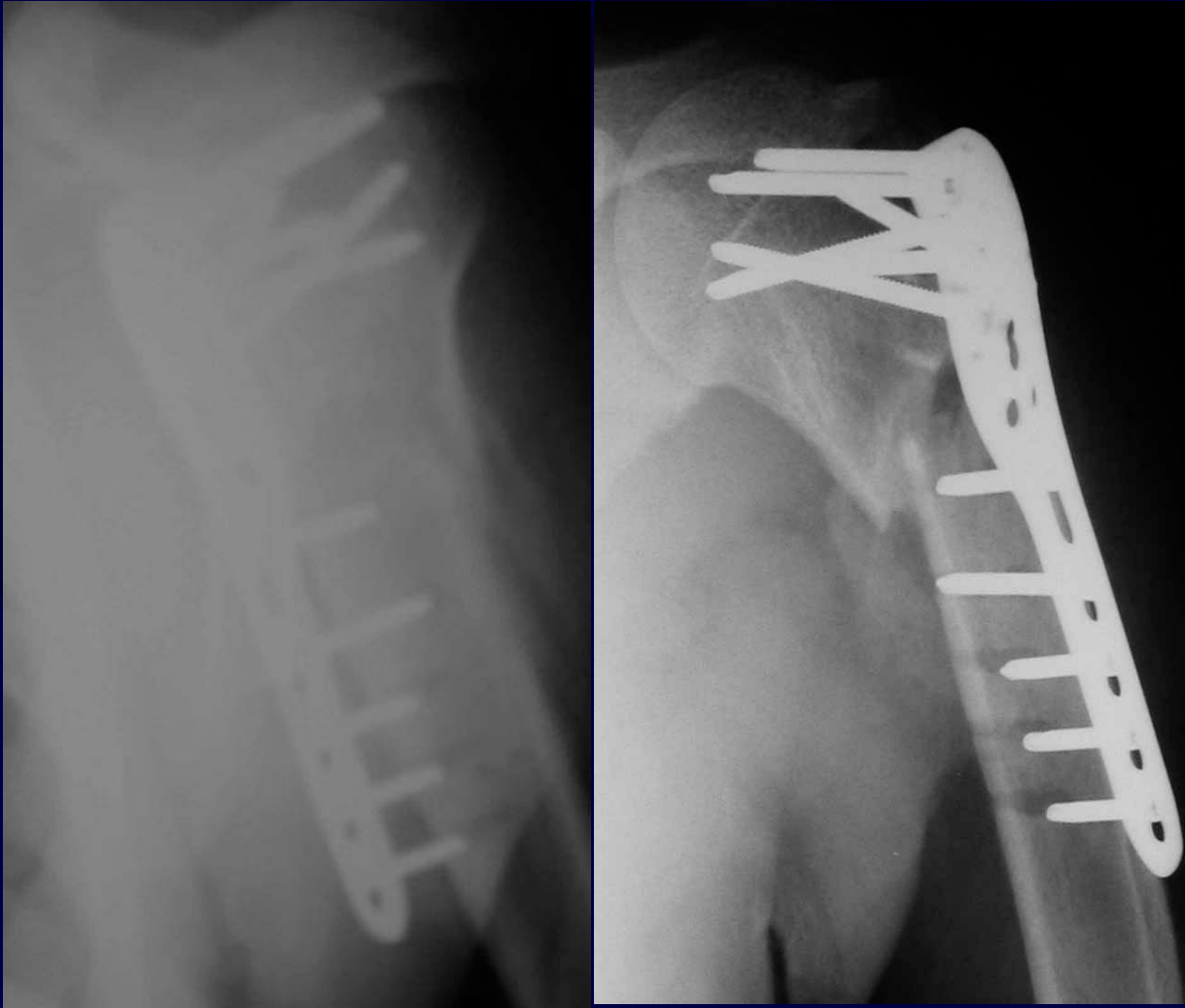
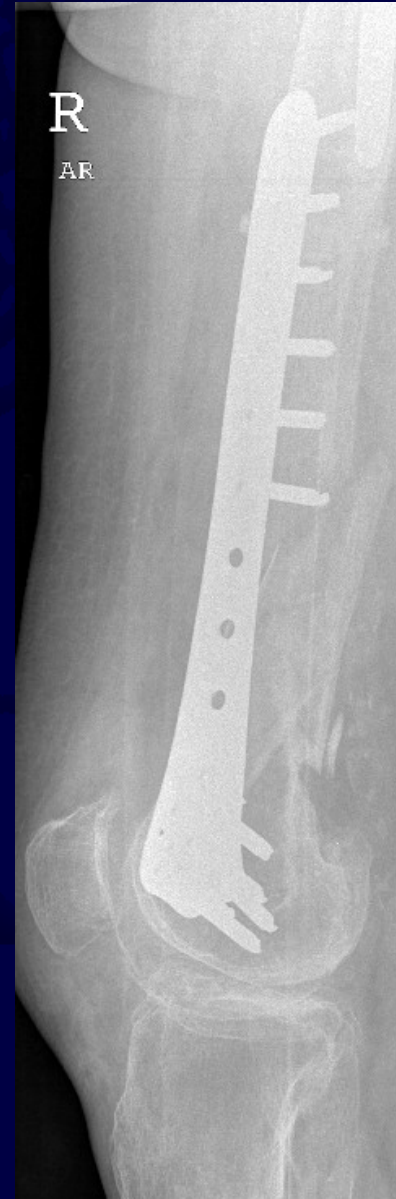


Plate-screw connection  
Is solid  
Screw-bone interface  
Fails as a unit

# Mono- vs. bicortical screw fixation







Monocortical screw fixation is not good in fragility fractures



## With thin cortices

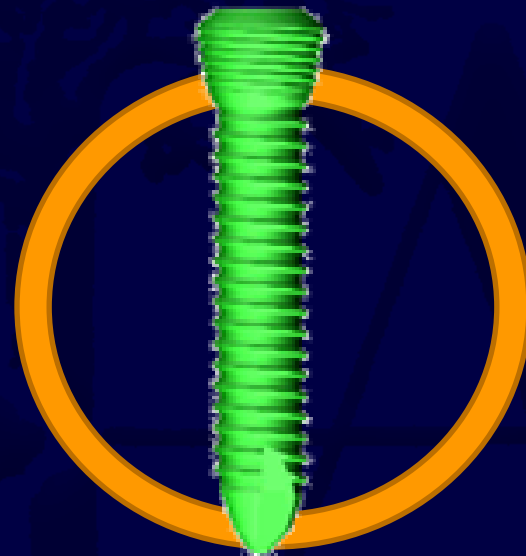
- Choose screw diameter as large as possible
- Bi-cortical fixation

# “Working length“ of bicortical screws

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3x More  
Stable

Mono locked  
Std Bicortical  
Torsional stiffness



Gautier and Sommer, *Injury* 2003, 34 (Supl) S-B63-B76.



# Bridging with Locked Implant



# Concepts of Plate Fixation in Osteoporotic Bone

- Tough to employ compression technique
- Bridge plating useful
- Neutralization plates useful
- Long plate for bone protection

Imperfect reduction--but the fracture has  
Gone on to heal



# Why is osteoporotic Bone a problem?

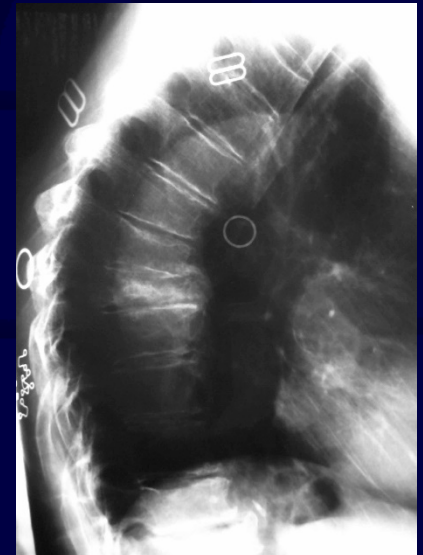
- Loss of cortical thickness
- Loss of bony trabeculae
- Loss of microarchitecture





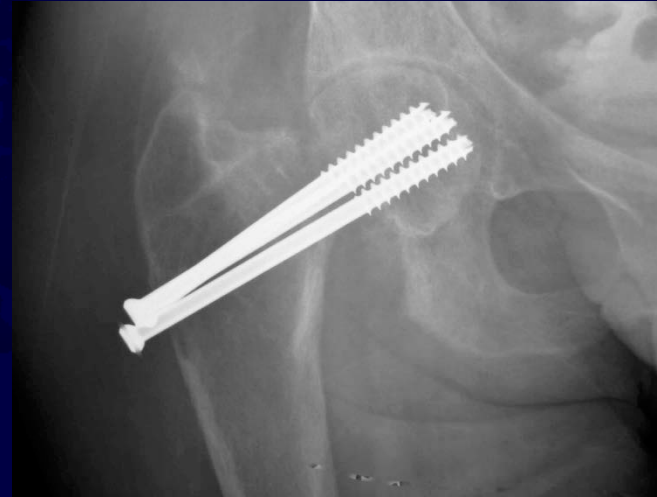
# Signs your patient has bad quality bone

- Poor dentition: Teeth are formed similar to bone
- Multiple vertebral compression fractures
- Previous hip, radius or tibial plateau fracture
- End stage renal disease
- On steroid therapy
- Anticonvulsant use



# Osteoporotic Trabecular Bone: Clinical Consequences

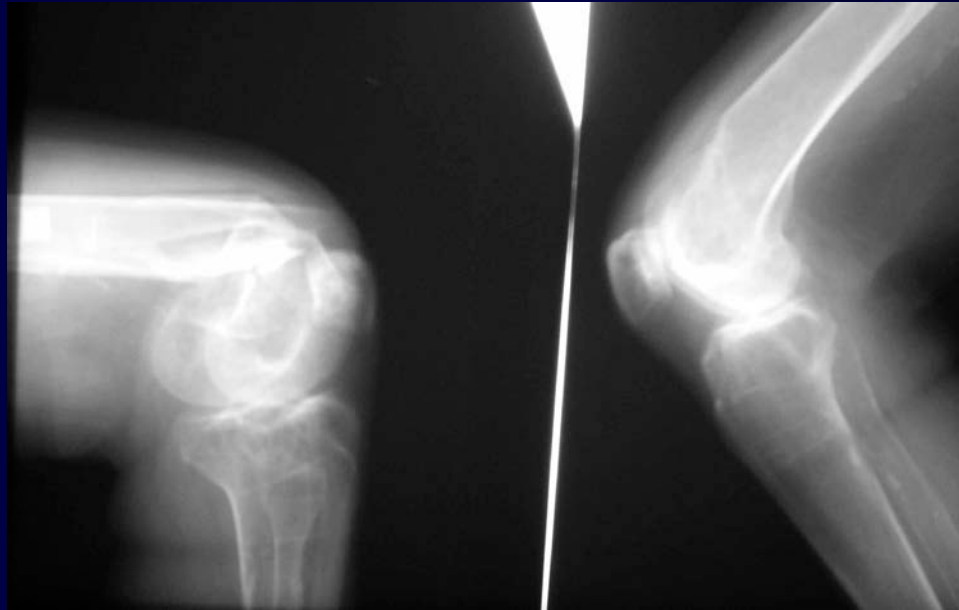
- Cut out
- Loss of screw fixation
- Spontaneous fractures





# Choice of implant

Many options, reduce the fracture first

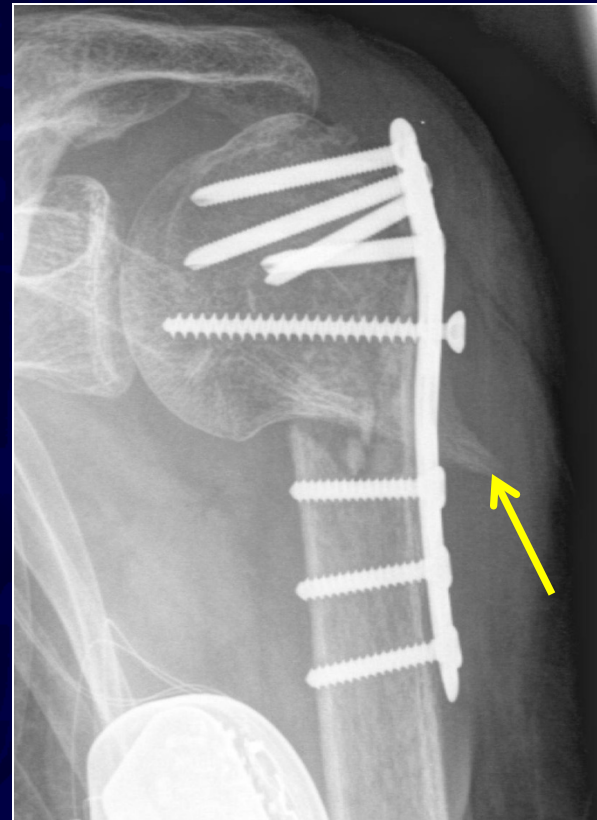
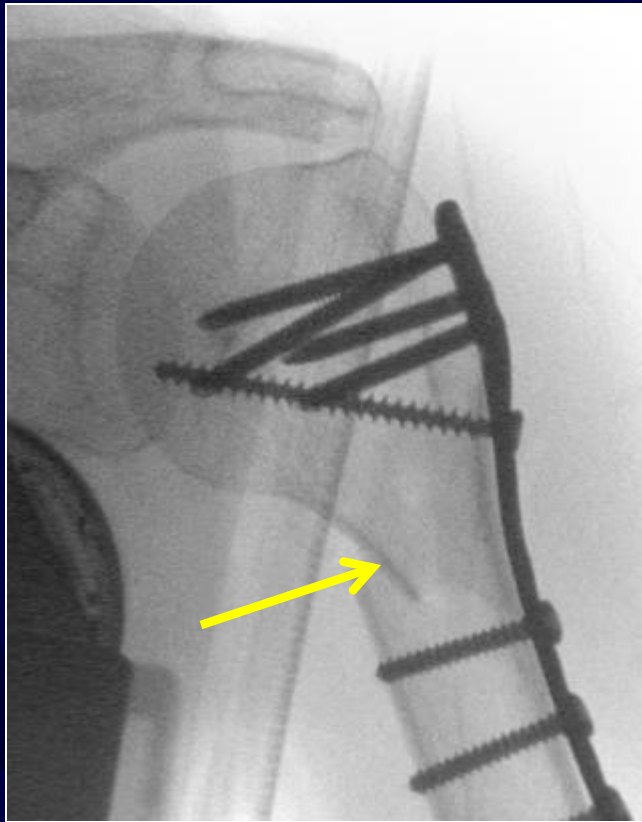


One Fixed angle with Blade plate



Multiple fixed angles, longer implant

# Varus collapse due to lack of medial buttress



# Technique: Impaction intraoperatively



# Augmentation in practice



If bone is very poor, consider  
prosthetic replacement





# Don't forget the soft tissues



Exposed implant = infection

# Incidence of Failures

- Hip: 3 to 5%
- Distal Femur: 5% ’
- Proximal humerus 30 to 40%’’
- Ankle 12% \*
- Distal Humerus 19%

\*Srinivasan and Moran; Injury, 2001; \*\* Korner, J Osteoporosis Int 2004  
“Oswley, K JBJS 2008; ‘ Smith, TO, Injury 2009

# Case Example: Female 82 years



One Day



3 weeks



6 weeks

Lag screw cuts out because the screw is not inserted deeply in the head  
A 2 hole plate is also good enough, 4 hole plate is not needed



# What areas are at risk for Fixation

- Metaphyseal > Diaphyseal Bone
- Hip
- Distal Femur
- Proximal Humerus
- Ankle
- Proximal Tibia
- Distal Radius

# Types of Failure

- Cut-out
- Cut through
- Plate pull –off
- Varus collapse
- Non-union

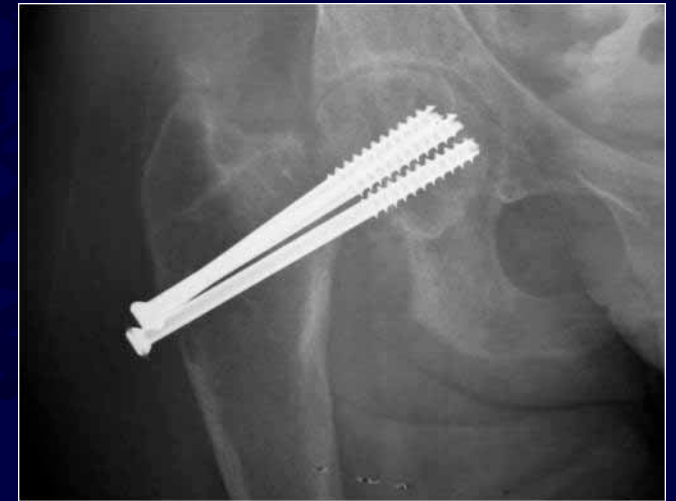


# What Factors contribute to Fixation Failure?

- Poor bone quality
- Metabolic Bone problems
- Fracture Reduction quality
- Implant choice
- Implant Placement

# Metabolic Bone Problems - secondary

- Vitamin D deficiency
  - Steroids
  - Hyperparathyroidism
  - Dialysis
- 
- All cause dramatically reduced bone quality and poor healing



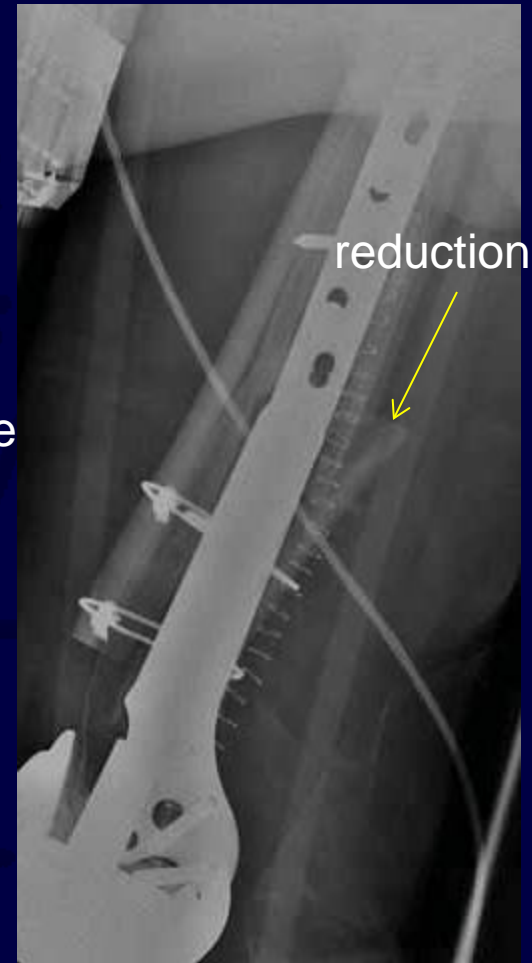
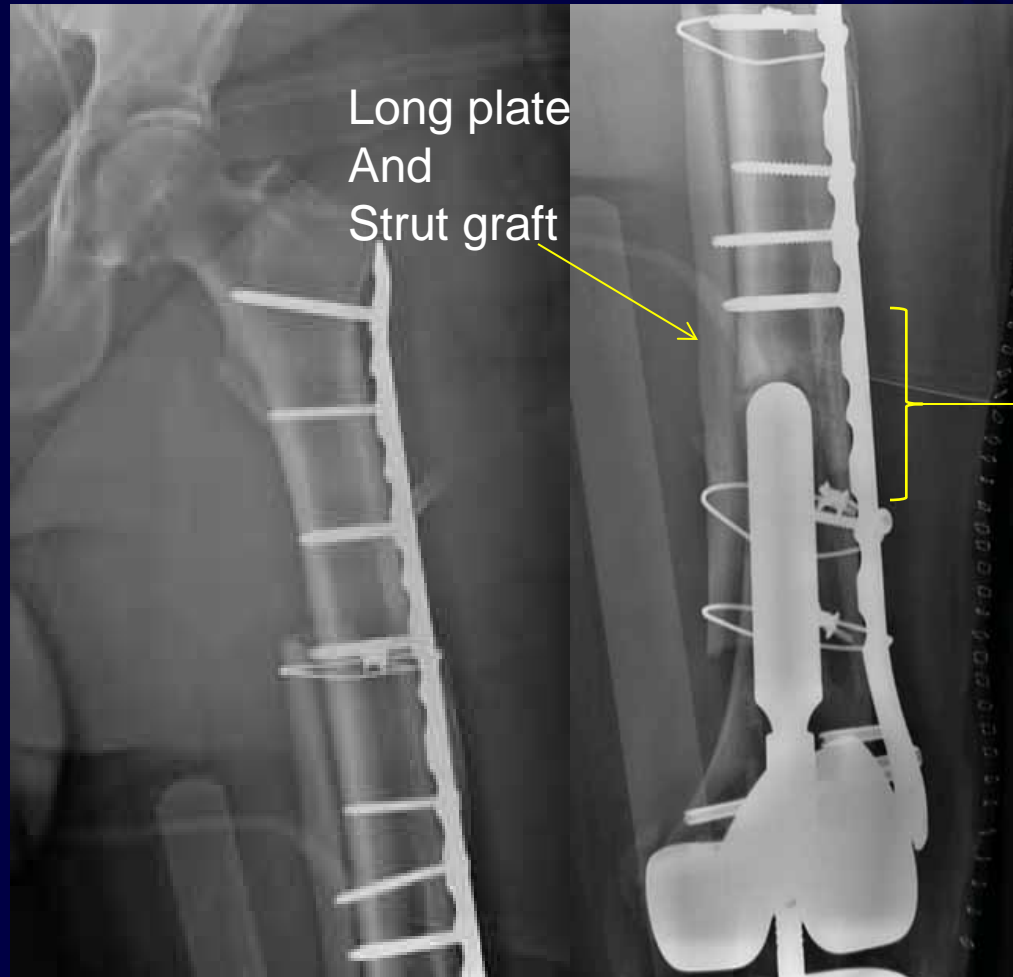
# Male 70 years, alcoholic

“AP and Lateral”

Fell while intoxicated



# Fixed with Strut Graft and Rigid



# 15 months

Knee pain and can't walk

Nonunion

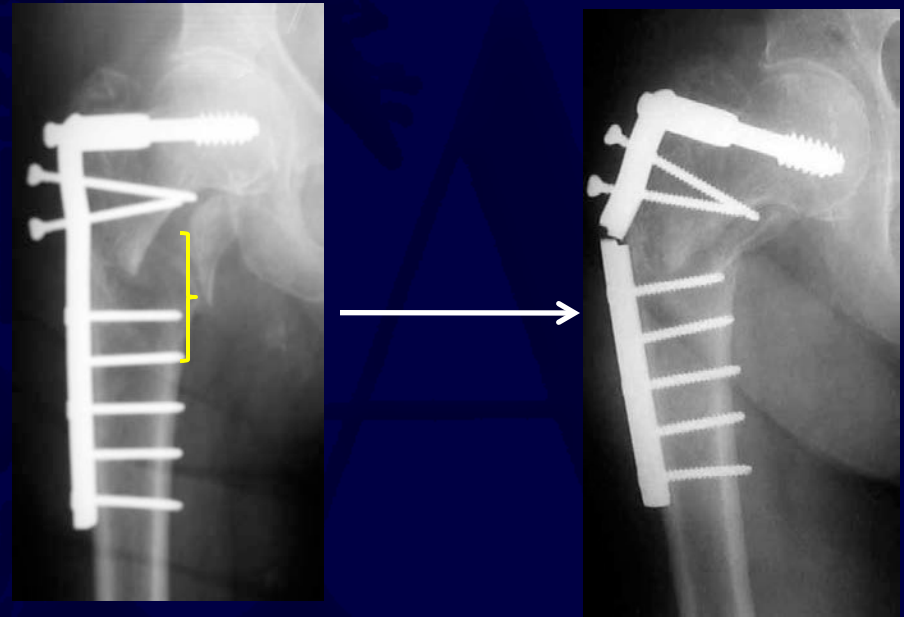
Broken plate

Causes: Disturbed biology  
No metabolic bone  
assessment



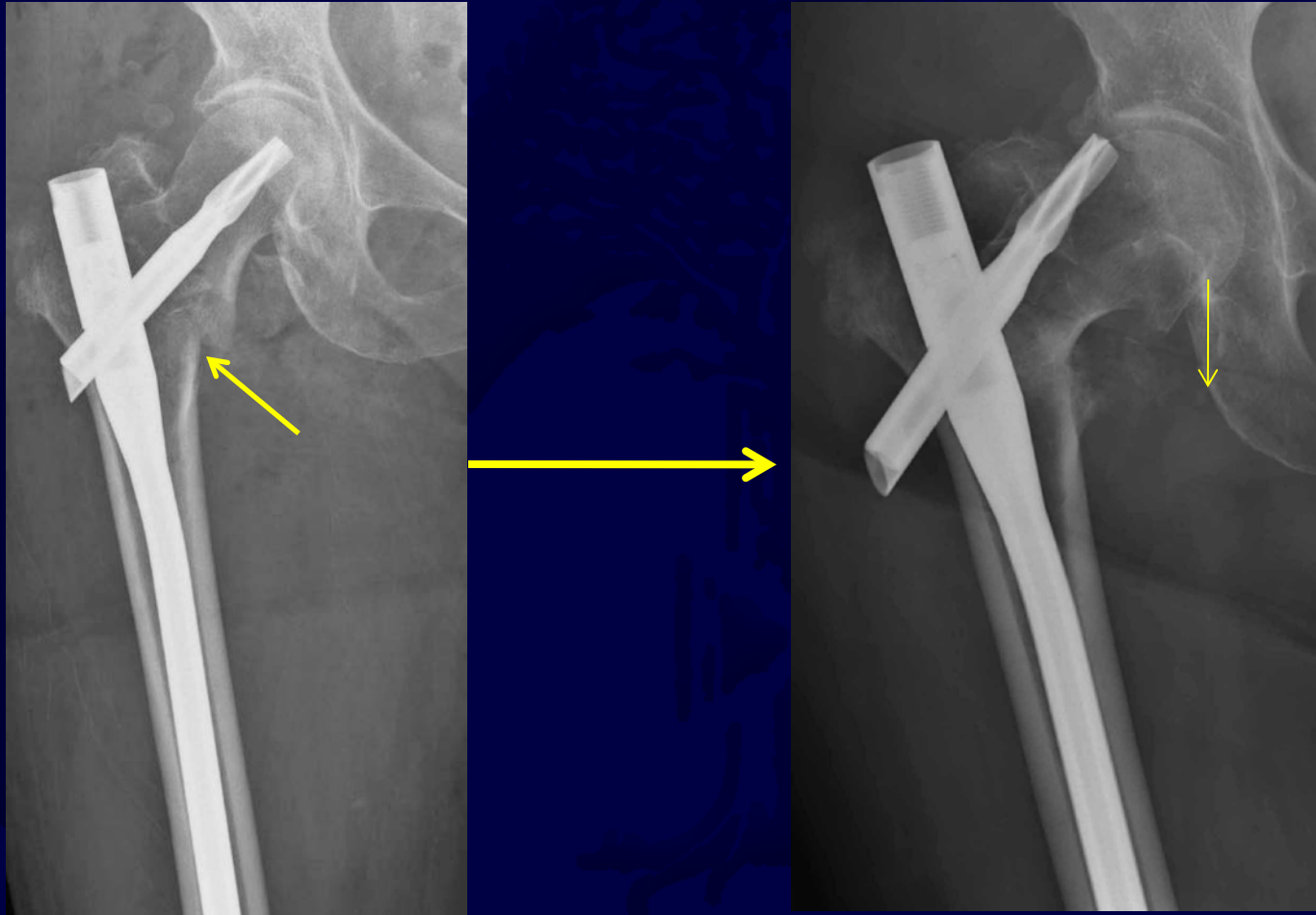
# Fracture Reduction Quality matters!

- Bony apposition important – Avoid a gap
- Stable reduction
- Correct rotation
- Angular alignment





# Example of Reduction induced failure



# Implant Choice

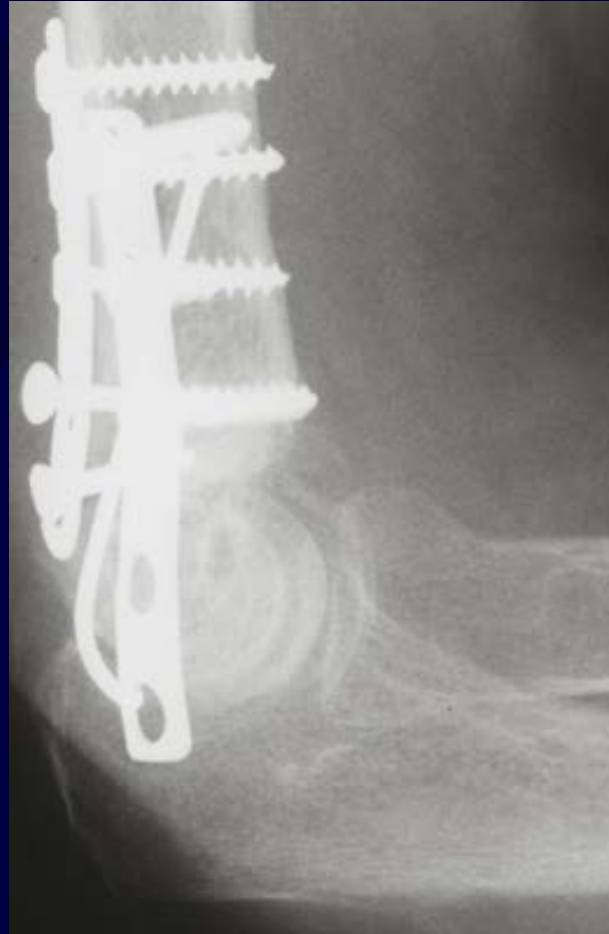
- Correct length and working length
- Correct Principle
- Correct number of screws
- Correct stiffness

# Implant choice

## A nail is better here

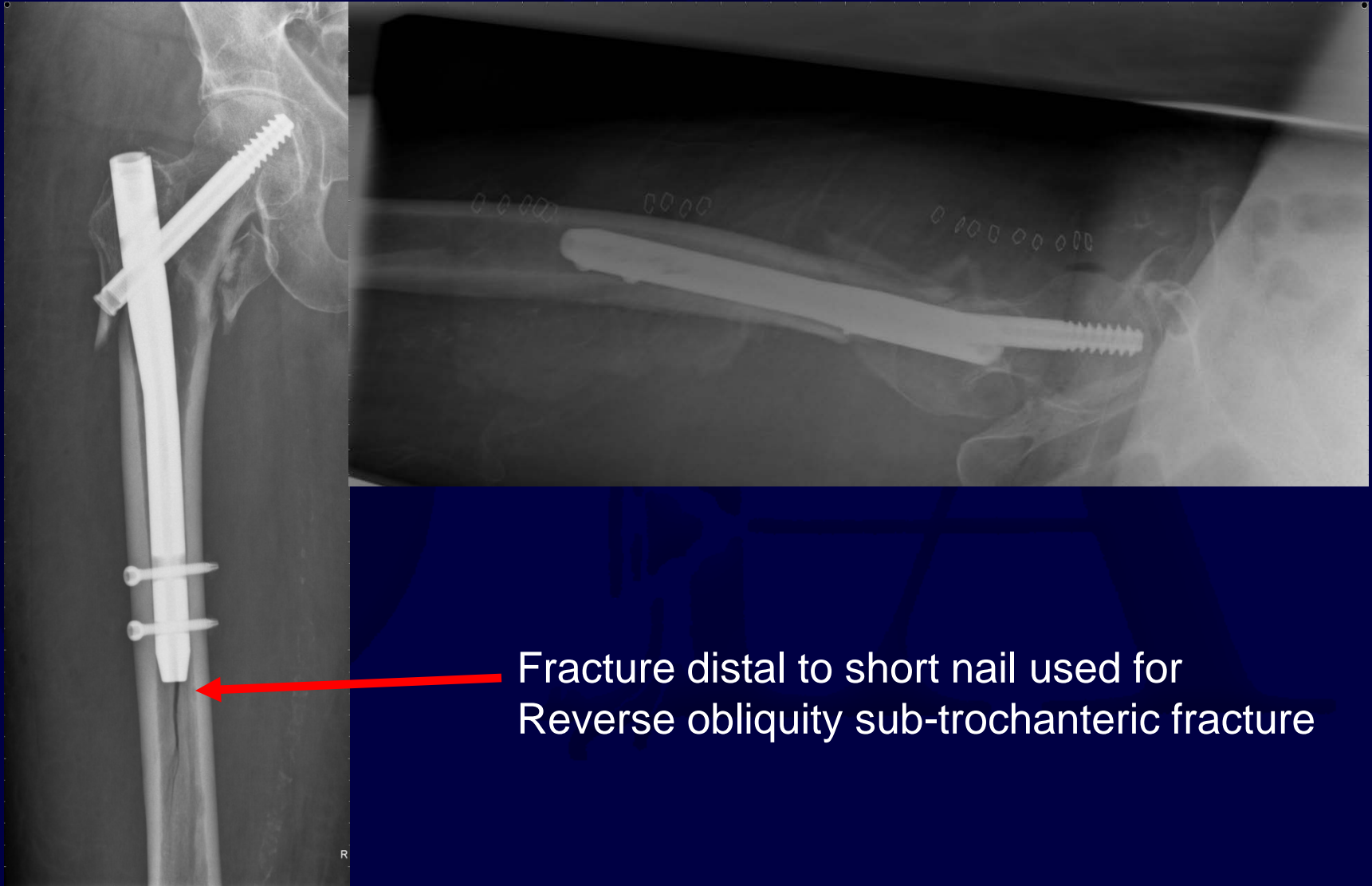


# Wrong Implant Choice



# Wrong implant

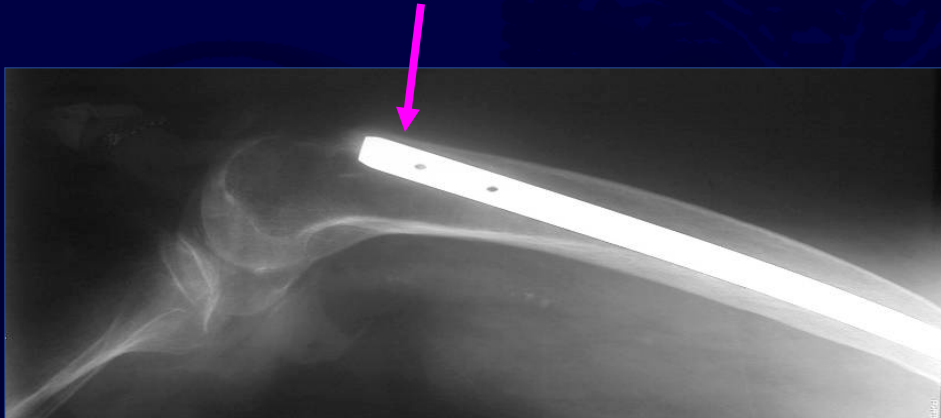
## Nail too large for canal



# Femoral Bow

## Nails that are too straight....

- Watch anterior bow\*



\* Penetration of distal femoral anterior cortex during Intramedullary nailing for subtrochanteric fractures  
Ostrum and Levy, J Orthop Trauma  
April 2006  
Haidukewych, G JBJS 2009

# Implant Placement

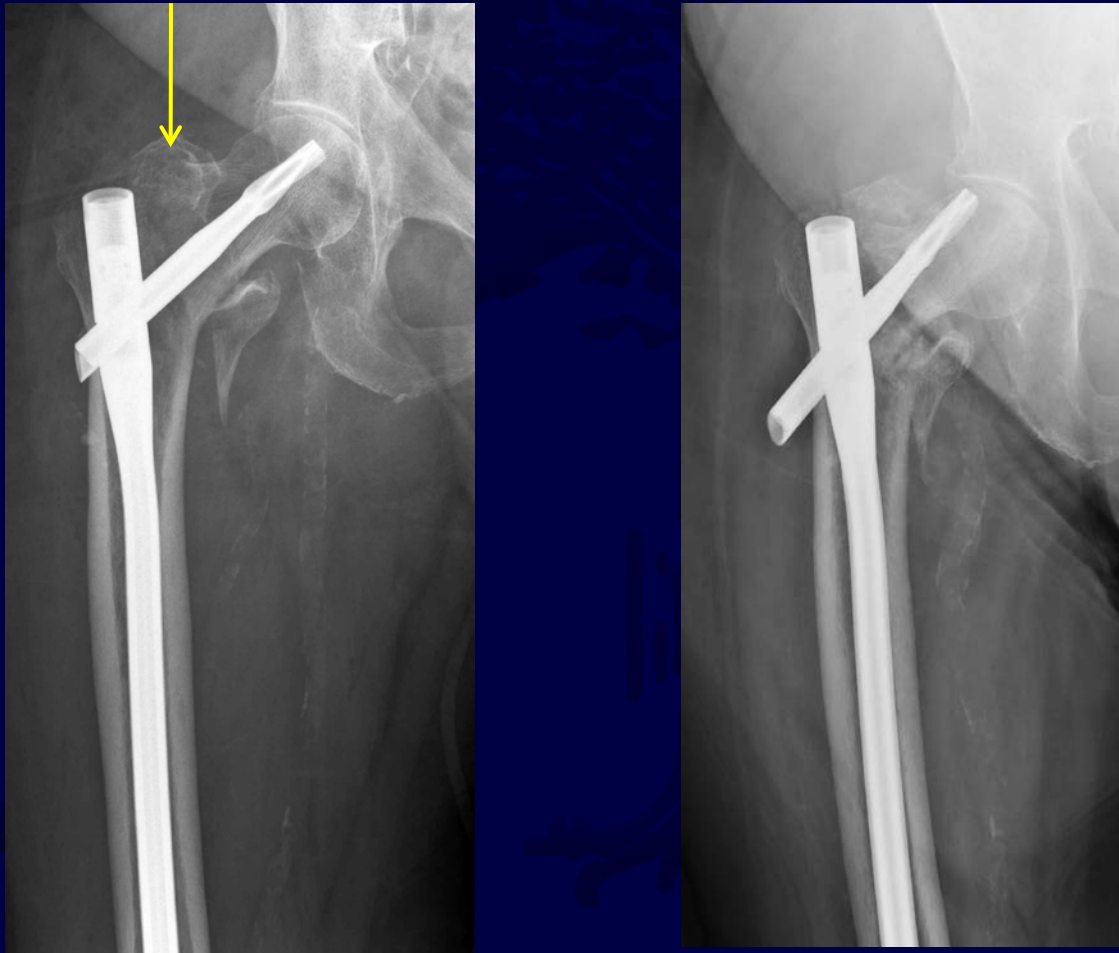
- Correct placement is often critical
- Tip – Apex distance – Hip
- Correct starting point for IM Nail
- Correct location on the bone



# Poor Tip-Apex distance



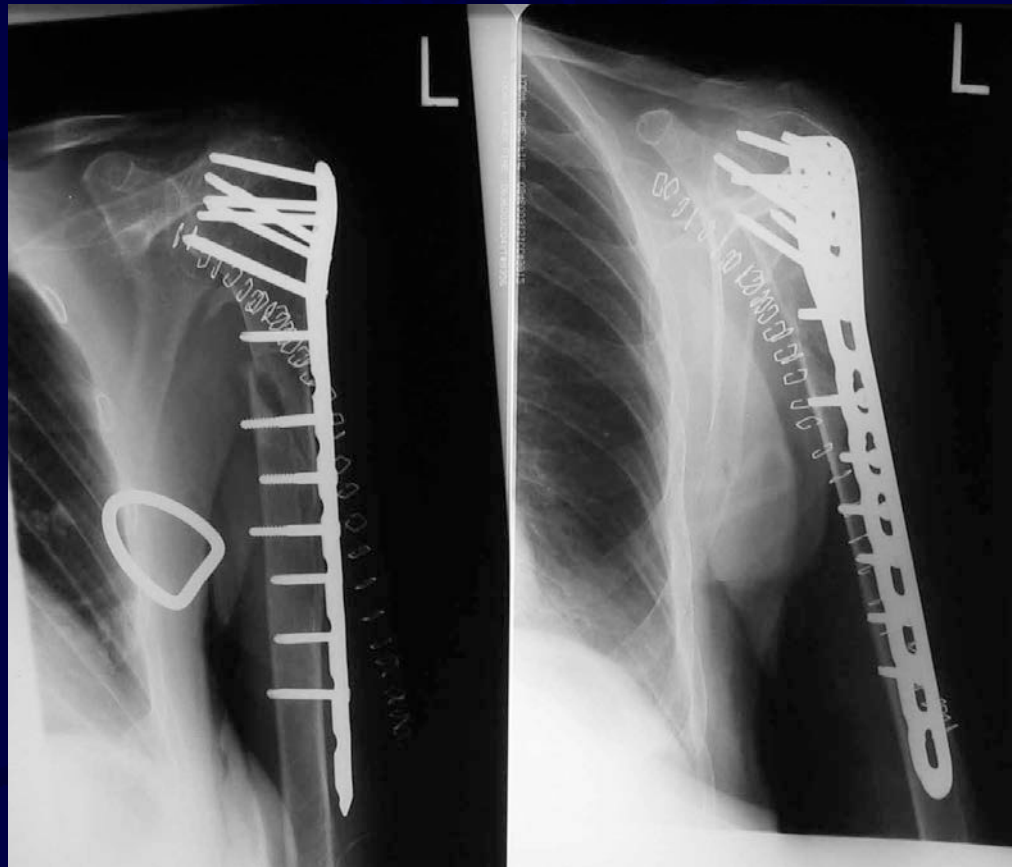
# Starting Point Error



# Plate on Wrong side of bone



# Screws too close to joint



# Follow the 4 AO Principles

1. Accurate fracture reduction
2. Stable Fixation
3. Preserve Blood Supply
4. Early mobilization of limb and patient

# How to Fix the Failures

- Revision osteosynthesis
- Prosthetic Replacement
- Change Fixation method

# Cut Through





# Nail Cut-out Revised to Prosthesis

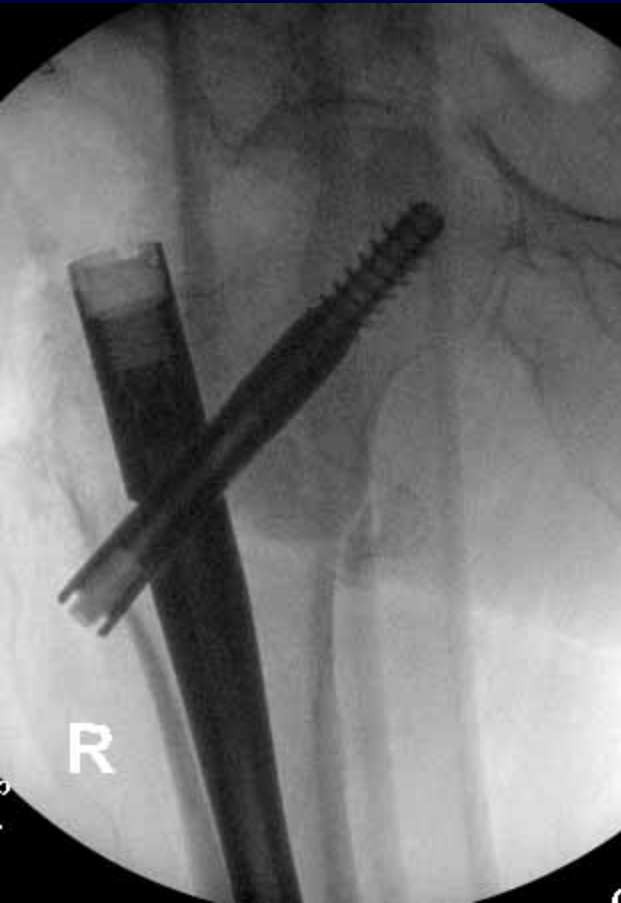


Lateral bow  
Makes straight  
Stem rubs lateral  
cortex



# Cut out revised to tumor prosthesis

## -Too much surgery



# Cut through with second fracture



Difficult Initial surgery



Minor re-injury



Revised to Prosthesis

# Failed Revision Osteosynthesis Revised to Tumor prosthesis



Third Revision osteosynthesis has failed



# Female 83 yrs -Failed Plating Revised to Nail

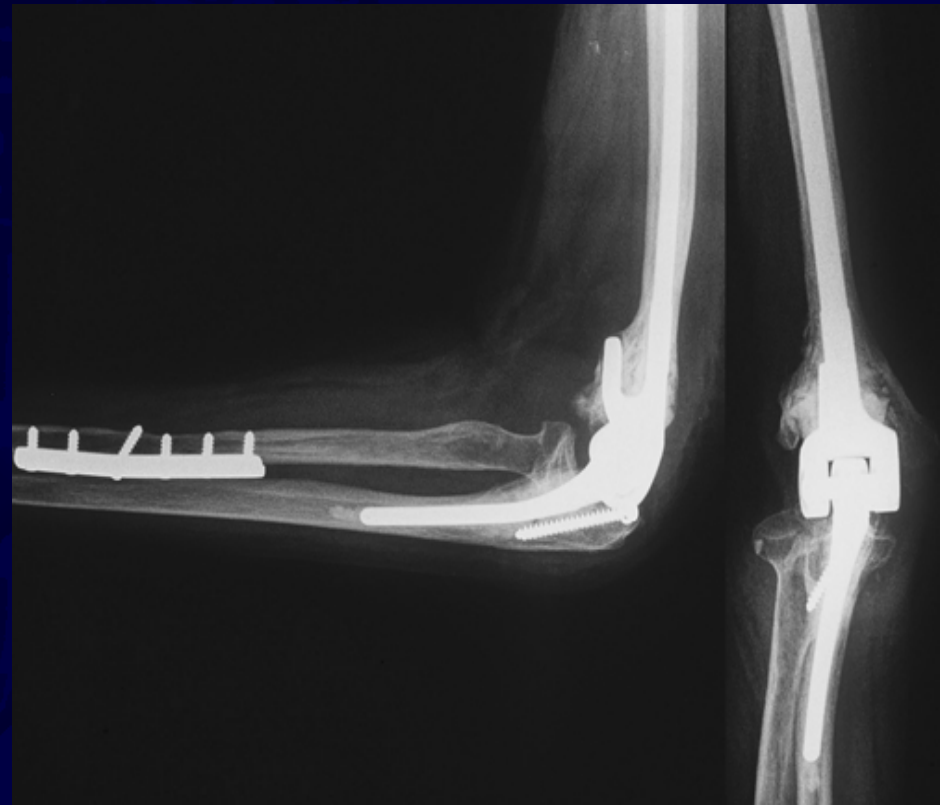
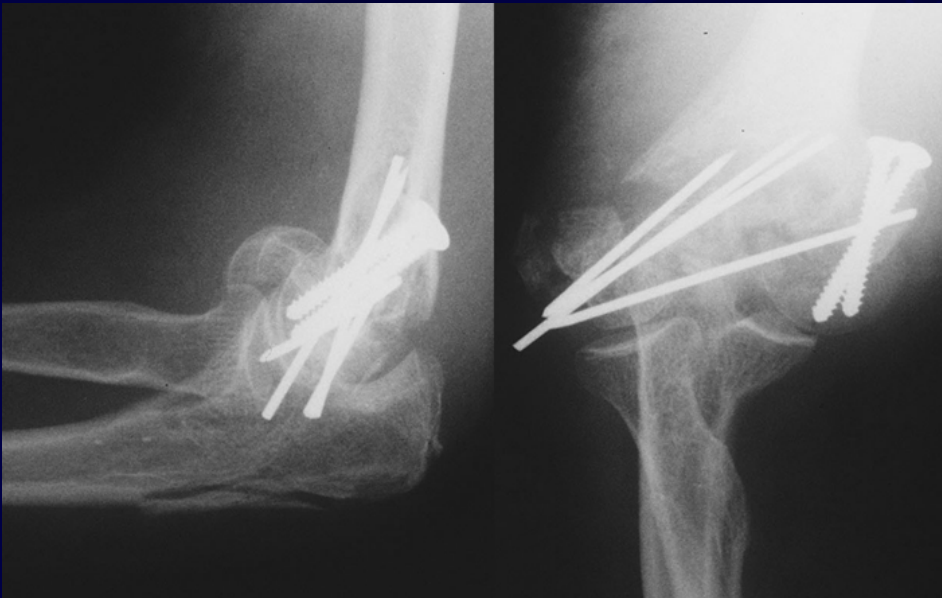


14 months post plating



7 months after revision

# Inadequate fixation Revision to prosthesis





# Plate pull-off revised to Nail

Male 65 years alcoholic





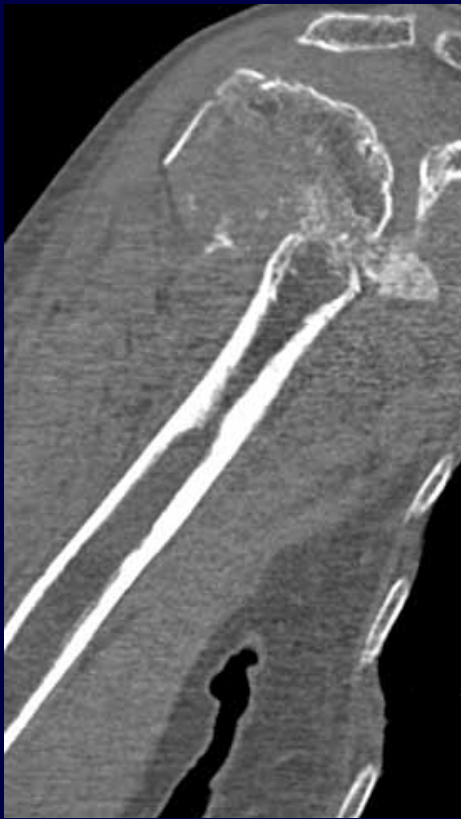
# Screw Penetration

## Revised to prosthesis



# Early Screw Penetration

## Revised by shortening screws



Preoperative

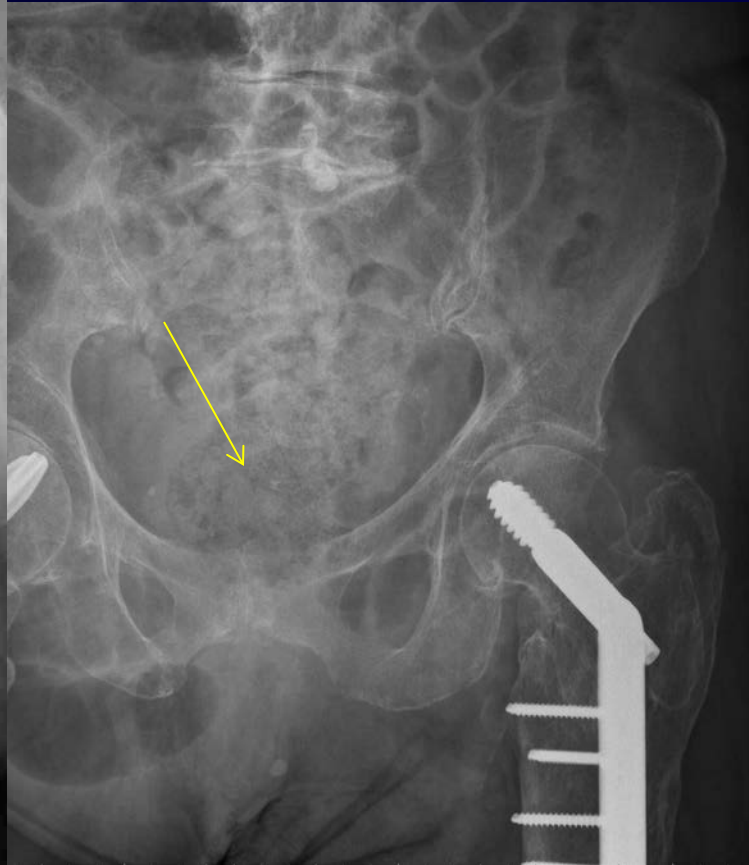


2 weeks, screw in joint



6 months

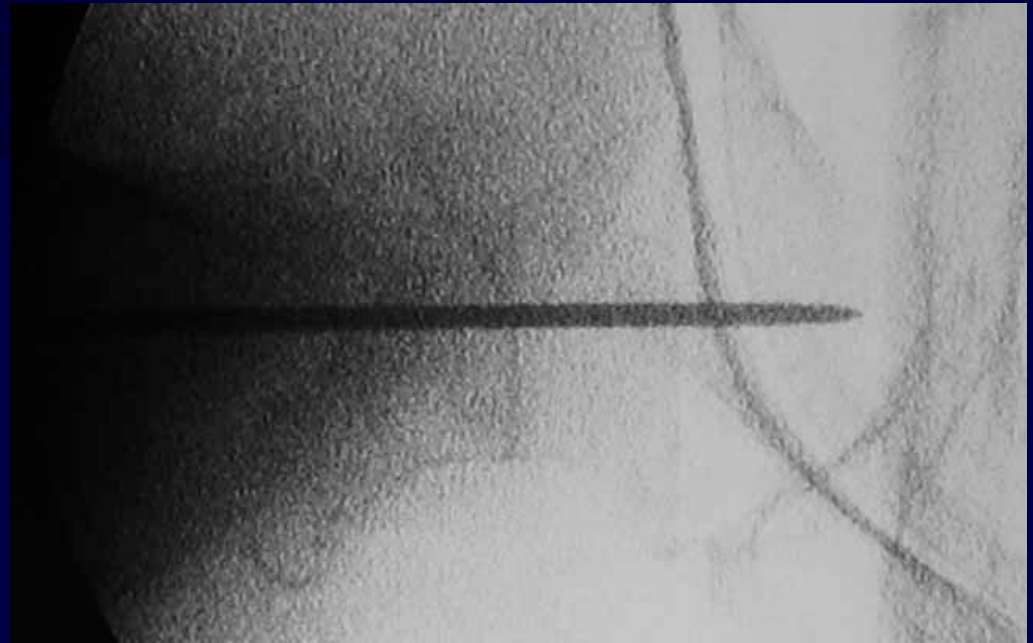
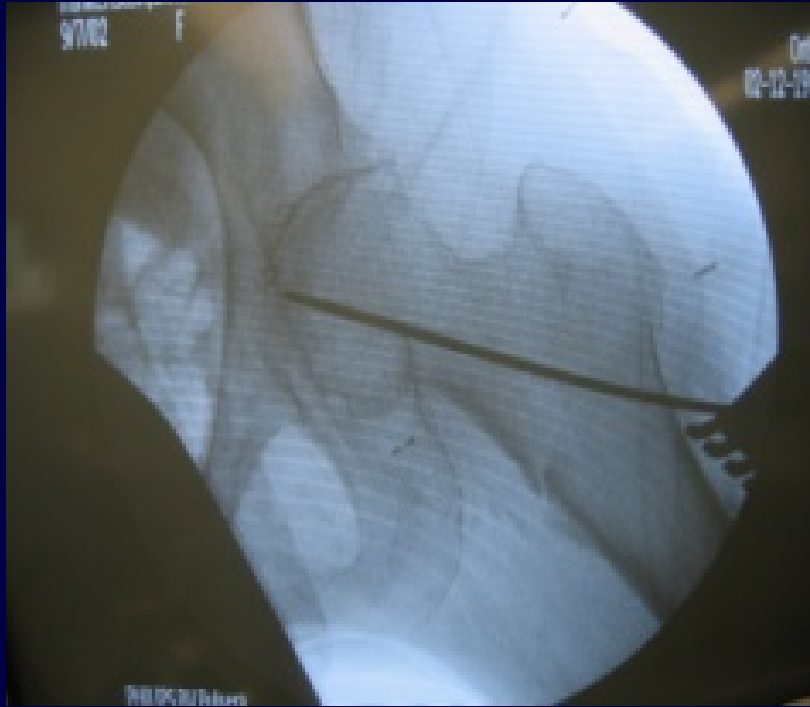
# Failed DCS revised to augmented hip screw



Calcium phosphate cement augmentation

# Avoid Failures

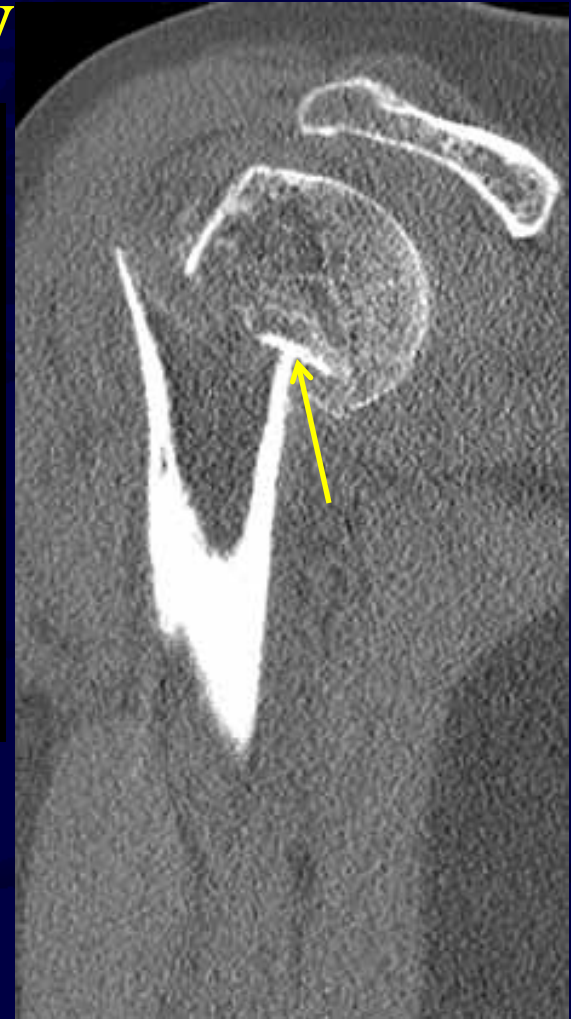
## correct Guide wire placement



# Assess the fracture for stability

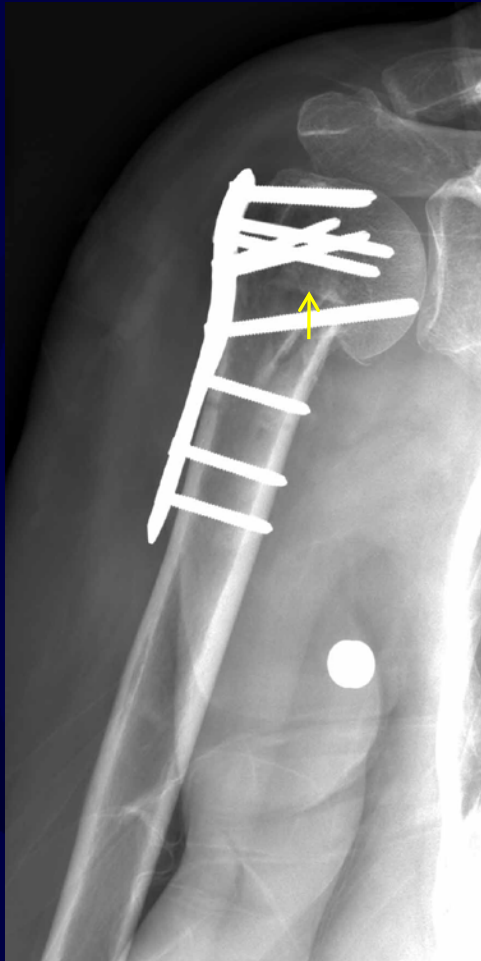


Fractured calcar  
Varus position

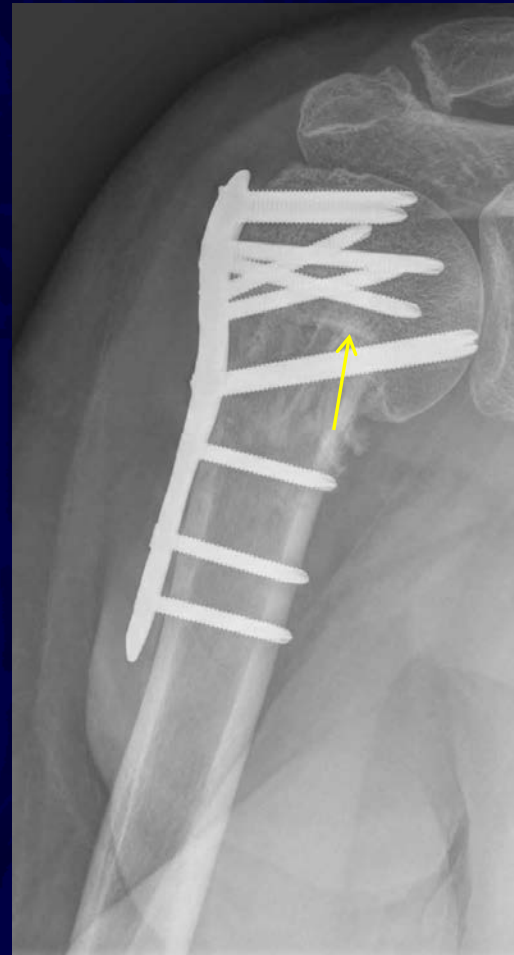




# Impact the Fracture for stability



3 months



9 months

# Avoid Stress Concentration between implants





# Failed Fixation, 4 surgeries

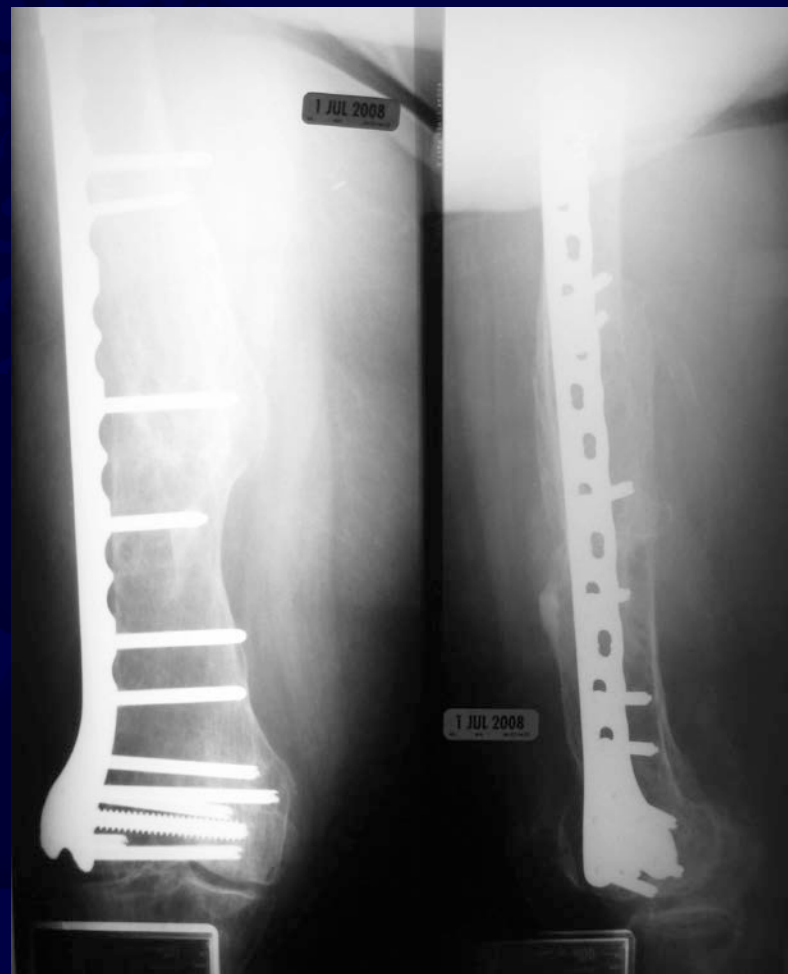
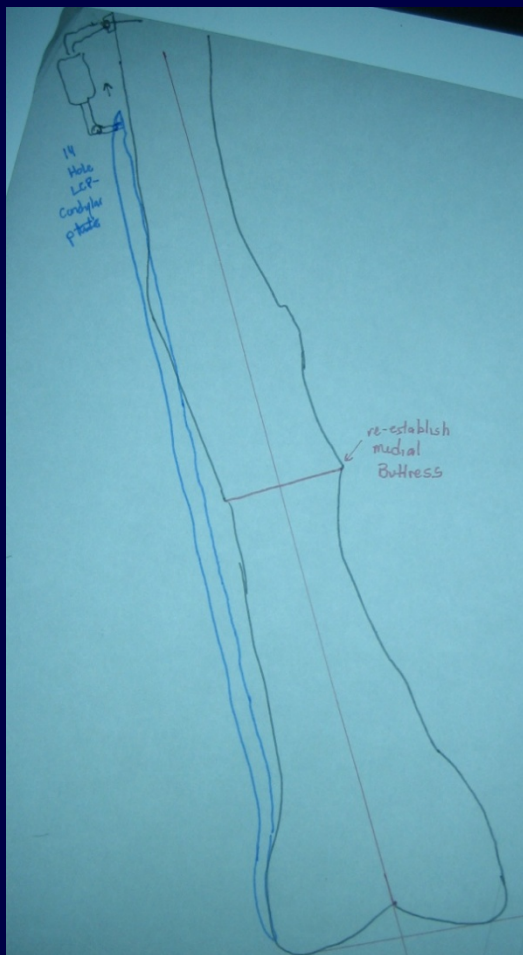
Broken plate  
Installed 5 months  
earlier

Varus deformity

Low Vitamin D level



# Correct the deformity..... and metabolic problem



Preop Planning

# Don't leave a void if possible

## Female, 73 years with osteoporosis



# Summary

- Plan your cases
- Assess the bone quality
- Proper implant choice and placement
- Reduce the fracture
- Impact the fracture if needed
- Respect the bone biology
- Bridging construct for comminution

# Basic Post Fracture Osteoporosis Workup : Metabolic

- 25-OH Vitamin D level
- Intact PTH Level
- Calcium
- Phosphate
- TSH
- Albumin level

# Causes of Osteoporosis

- Primary
- Secondary
- Nutrition
- Lifestyle (Exercise, smoking, alcohol)
- Hormonal problems
- Age
- Medications (steroids, seizure meds)

# Keeping the bone healthy

- Genetic factors – unclear transmission
- Moderate Physical activity
- Calcium
- Vitamin D
- Hormones Parathyroid hormone  
Calcitonin  
Estrogen  
Testosterone



# Remember Metabolic Health

- Serum Albumin  $< 3$  = higher mortality\*\*
- Vitamin D levels – often low \*
- Parathyroid Hormone level
- Calcium level
- **Avoid malnutrition and Osteomalacia in your elderly patients!**

•Guisti, Barone, Razzano, Pizzonia, Oliveri, Palummmmeri, Pioli; J Endocrinol Invest  
•Oct 2006, \*\*Aging Clin Exp Res Oct 2006; Bukata et al, CORR 2011



# Diagnosis of Osteoporosis

- DEXA Scan is best at present
- T score
  - Compares density relative to peak bone mass (Normal healthy 25 year old)
  - Matched to sex and race
- Z score
  - Compares density to peers



## Osteoporosis: a 2-Stage Disease

- **With**
- **Without Fracture**

# Hip Fracture

Lifetime incidence in women 1:6



# Diagnosis of Osteoporosis Using Central DXA

## WHO-Definition

	T-score
<b>Normal</b>	$> -1$
<b>Osteopenia</b>	$< -1$ and $> -2.5$
<b>Osteoporosis</b>	$\leq -2.5$
<b>Severe Osteoporosis</b>	$\leq -2.5$ with Fracture

**Mainly for Spine and Hip in Women**

# Who Should be Tested ?

- All women aged 65 and older regardless of risk factors\*
- Younger postmenopausal women with one or more risk factors (other than being white, postmenopausal and female).
- Postmenopausal women who present with fractures (to confirm the diagnosis and determine disease severity).
- Many women with osteopenia will fracture\*

\*Pasco et al.; Osteoporosis International, 2006

# What Medicare covers

## DEXA every 2 years

- Estrogen deficient women at clinical risk for osteoporosis
- Individuals with vertebral abnormalities
- Individuals receiving, or planning to receive, long-term glucocorticoid (steroid) therapy
- Individuals with primary hyperparathyroidism
- Individuals being monitored to assess the response or efficacy of an approved osteoporosis drug therapy.



# Workup for the Fragility Fracture patient

- Labs: Basic
  - Intact PTH
  - 25 vit D level
  - serum calcium

## Advanced

- serum alkaline phosphatase
- 24 hour urinary calcium
- urine N-telopeptide
- TSH





# What about Men?

- Higher peak bone mass
- Fragility fracture
- Steroid use
- Forearm fracture
- Vertebral fracture

# Osteoporosis is Treatable

- Nutrition
- Exercise
- Lifestyle changes
- Medications
- Fall prevention
- No treatment completely abolishes fracture risk

# Nutrition

- Calcium requirements
- Young 1000mg / day in 2 doses
- Older 1500mg /d in 3 doses
- Calcium gluconate
- Calcium Citrate
- Calcium Carbonate
- Whichever is tolerated

# Body weight

- Very low weight is a risk factor BMI < 18
- Normal weight best
- Obesity predisposes to falls

# Vitamin D3

- Deficiency is common with age
- Lack of sunlight
- Deficiency = Osteomalacia
- Very common in Nursing homes
- May cause fracture not to heal

# Vitamin D3

- Vitamin D3 -not D2- is best
- Dose -Young 400units / d
- Older 800 units / day - maintenance
- If deficient, D2 50,000 units/ wk
- 25 OH Vit D level to diagnose deficiency
- Sunlight helps - Essential for bone health!!!!!!

# Exercise

- Weight bearing exercise best
- Low impact exercise can help prevent falls
- Weight training
- Tai Chi
- Exercise helps other body systems too
- Patients have control over this!
- Helps to start young



# Fall Prevention

- Medications can cause falls
- Poor lighting
- Throw rugs
- Fall proofing the home
- Exercise, balance and strength training
- Correct the vision
- Pets

# Lifestyle

- Alcohol in moderation only
- Alcohol can cause osteoporosis
- Alcohol can cause falls
- Cigarette smoking causes osteoporosis
- Slows bone healing
- Smoking cessation is the best plan

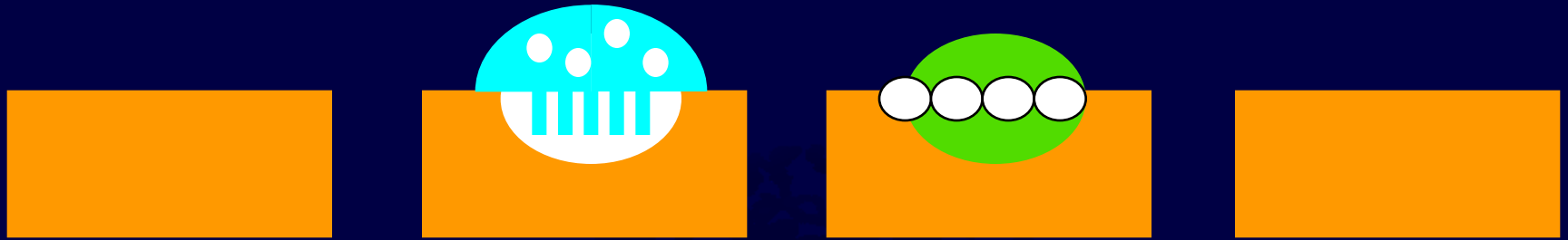
# Medications

- Many medications harm the bones
- Steroids (Prednisone)
- Seizure drugs
- Elevated Thyroid hormone
- Cancer drugs (Lupron)
- Avoid these if possible
- DEXA scans necessary with these

# Osteoporosis Medications

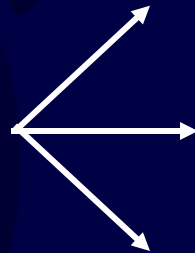
- Antiresorptive drugs
- Anabolic therapies





**Inhibitors of  
bone resorption**

**Osteoporosis  
Treatments**



**Stimulators of  
bone formation  
Anabolic**

**Stimulators of bone  
formation  
Inhibitor of bone  
resorption**

# Anti-resorptive Therapies

## Bisphosphonates

- Non hormone compounds
- Bind to Hydroxyapatite crystals
- Inhibit Osteoclastic activity
- Cause Osteoclasts to die prematurely
- Half life 6 to 10 years in bone
- Can be taken by mouth or IV

# Oral Bisphosphonates

- Alendronate (Fosamax)
- Risedronate (Actonel)
- Ibandronate (Boniva)
- IV bisphosphonates are used when oral medications are not tolerated
- Work for men and women
- Best treatment for steroid osteoporosis



# Bisphosphonates - problems

- Reflux
- Must be upright for one hour
- Mostly GI symptoms
- Rare: osteonecrosis of mandible
- Long term effects not known
- Need to take Ca, Vit D\*
- Compliance a problem\*

\*Adami et al.; J Bone Mineral Research, 2006 Oct

# Anti-Resorptive: SERM's

- Raloxifene and Tamoxifen
- Bind to Estrogen Receptor
- Have a good effect on Bone density
- For women only
- Should be used with Calcium, Vit D
- Reduces risk of breast cancer
- Increases risk of DVT

# Calcitonin

- Hormone that regulates calcium, bone
- Synthetic Salmon calcitonin
- Decreases bone resorption
- Reduces pain from Vertebral fractures
- Nasal spray or injection

# Teriparatide (Forteo)

- Synthetic hormone like human Parathyroid hormone 1-34
- Builds bone mass
- Improves bone quality
- Increases the life span of osteoblasts
- Injection for 2 to 3 years
- May increase periosteal thickness, activity

# Teriparatide (Forteo)

- FDA approved for women with:
- High fracture risk
- Multiple fractures
- Failure of other therapies
- For men with:
- Hypogonadal osteoporosis
- High fracture risk men

# Teriparatide Contraindications

## PDR Black Box

- Previous Radiation therapy
- Paget's disease
- Young patients open physes
- Very Expensive \$\$\$\$

# Treatment following Fragility Fractures

- Published low rates 15 -20%
- Should be much higher - 50% plus\*
- Communication between hospital, MD's and patients essential\*\*
- CMS planning to penalize us for this

\*Gidwani et al, Ann RCS Engl, 2007

\*\* Meadows et al; Osteoporosis Int ,2007 Feb

# The Orthopaedist's Responsibility

## CMS guidelines

- Diagnose the Fragility Fracture as such
- Obtain Lab tests
- DEXA scan
- Institute Therapy

or

Refer for treatment to PCP or Metabolic Bone  
Clinic