

LOVING THE LOWER EXTREMITY

(EVEN IF YOU ARE FROM HOPKINS SOM)

‘THE HAND IS JUST A WEAK FOOT’

DONNA MAGID, MD, MEd

**DIRECTOR, JHU SOM HORIZONTAL
STRAND, DIAGNOSTIC IMAGING**

OBJECTIVES: LE

(LOWER EXTREMITY)

ANATOMY: DETAILS, TISSUES, FACTFACTFACTS

RADIOLOGY: WHY IT MATTERS CLINICALLY

BIG-PICTURE INTEGRATION OF FACTS

STEP ONE TEST

UPRIGHT STANCE AND LEG AXIS

NORMAL GROWTH AND WEIGHT-BEARING

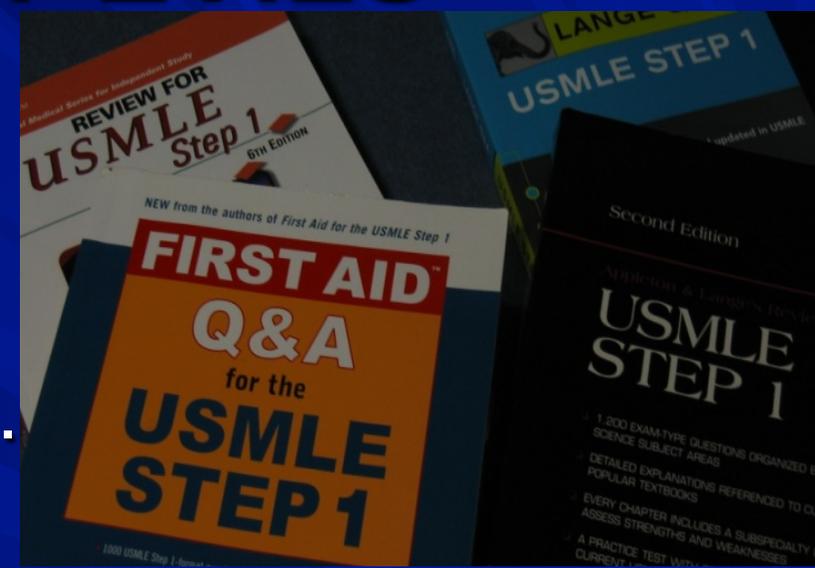
CONSEQUENCES OF LLD (LEG LENGTH DISCREPANCY)

TREATMENT OF LLD

OSTEODISTRACTION

NECESSARY EVILS

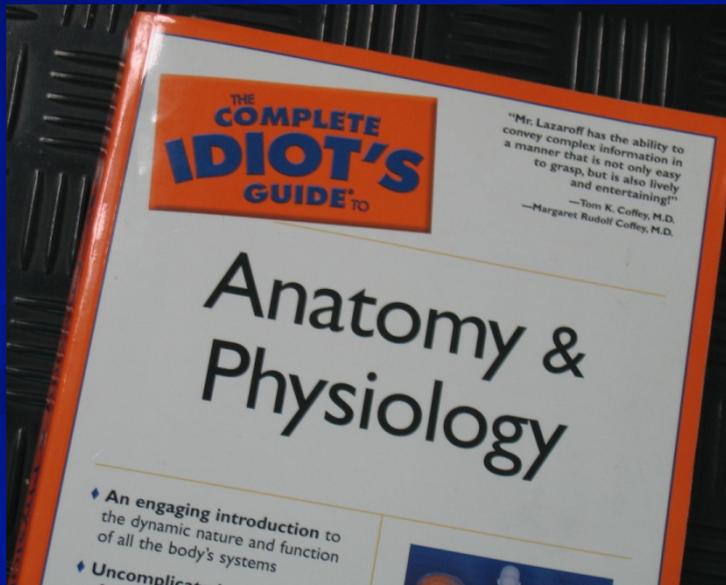
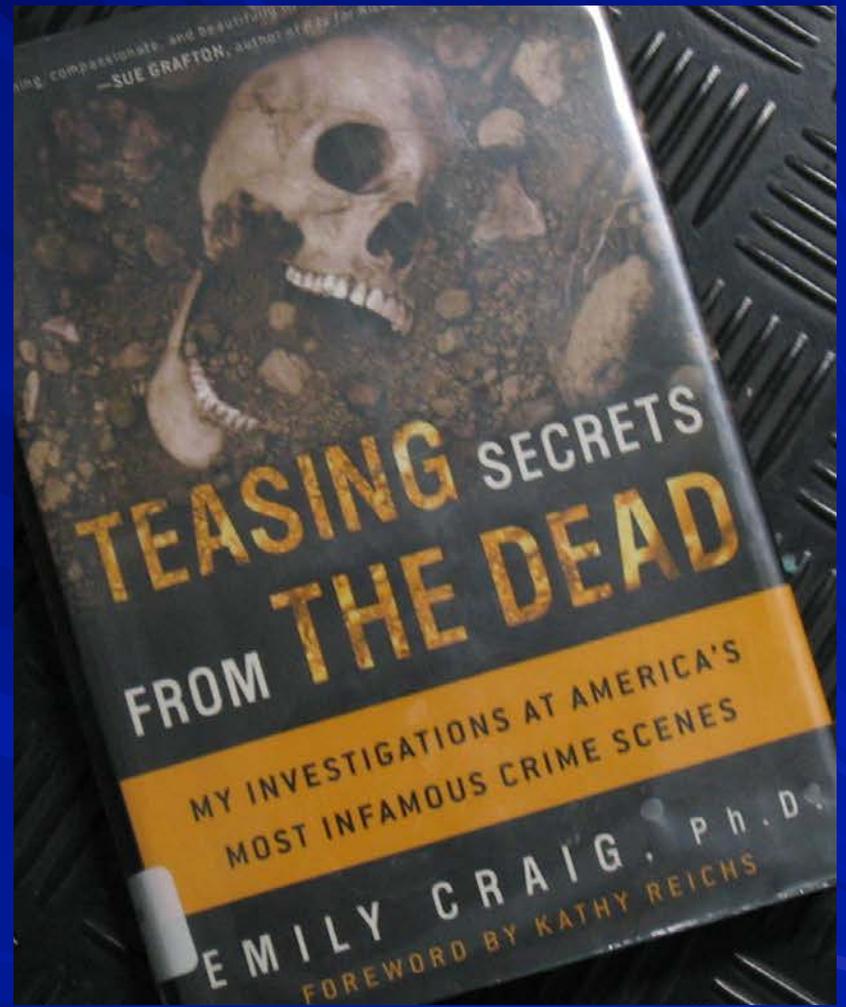
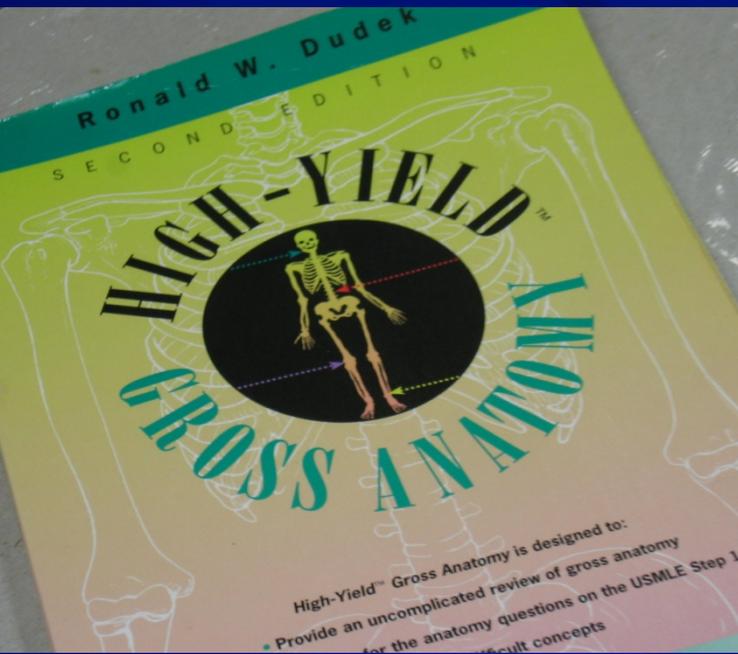
STEP ONE INCREASINGLY
USED AS 'FILTER' FOR
RESIDENCIES; KEEP
POTENTIAL DOORS OPEN.



DON'T REINVENT THE WHEEL!

USE PEER ADVISORY AND
SURVIVOR ADVICE

MAKE MUST-KNOW LISTS
AND THEN...KNOW THEM.



THE 'STUPID SHOES' APPROACH



COMPARATIVE ANATOMY APPROACH

4-LEGGED ANIMALS' SPINE
PELVIS AND LE

EVOLUTION OF UE's
OPPOSABLE THUMB

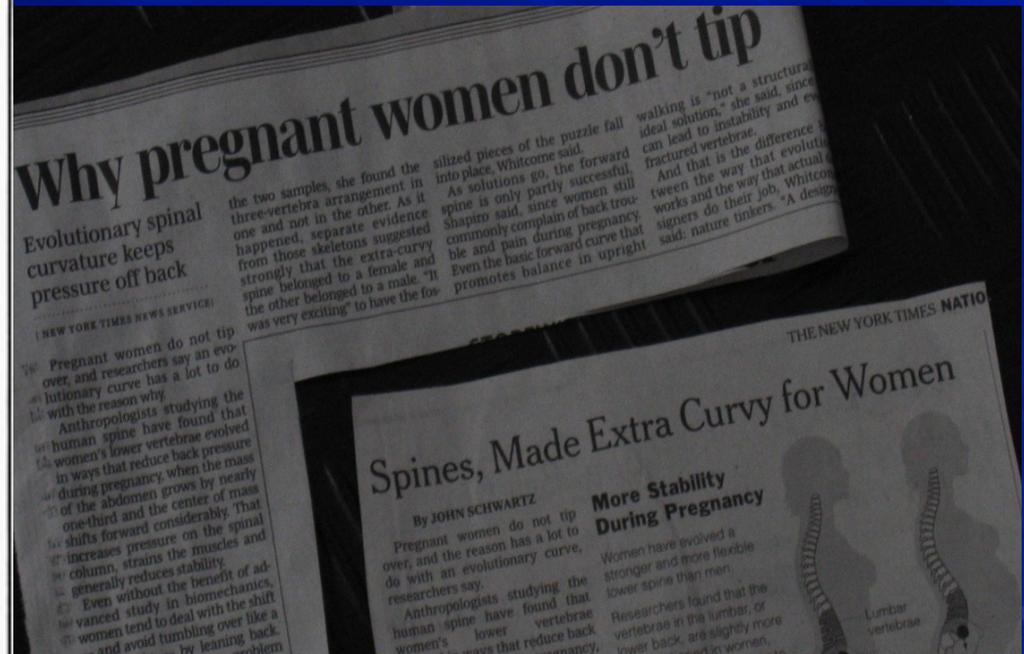
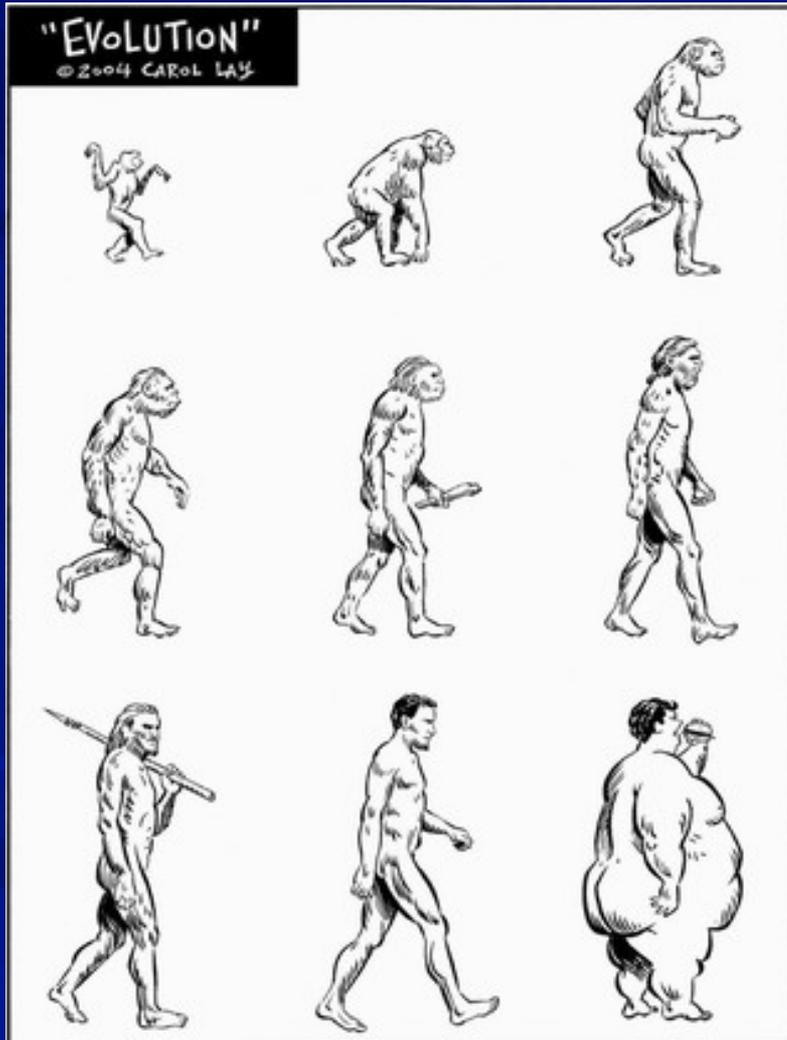
CONVERSION TO LE's
PLANTIGRADE FOOT
MUSCLES OF GAIT,
BALANCE



UPRIGHT POSTURE: NEW STRESS



American Dime Museum



SPINAL CURVES: LUMBAR LORDOSIS UNIQUE TO UPRIGHT POSTURE (ARCH)

CENTER OF GRAVITY: ' PLUMB LINE'
SHIFTS FORWARD IN PREGNANCY
HEAD CENTERS OVER SACRUM
SHIFTS UPHILL/DOWNHILL

KNEE → FULCRUM, PATELLA → LEVER

BI-ARCHED FOOT FOR STABILITY
AT REST AND IN MOTION
LOSS OF TOES' AGILITY



LE: THINGS 'THEY' SAY YOU NEED TO KNOW FOR STEP ONE

PELVIS: ISCHIAL SPINE LOCATION

AVASCULAR NECROSIS (OSTEONECROSIS)

PERTHES DISEASE (IDIOPATHIC AVN 4-8 yo CHILD)

erroneously called 'LEGG-CALVE-PERTHES'

KNEE: 'UNHAPPY TRIAD' (LIGAMENTS, CARTILAGES)

OSTEOARTHRITIS VS RHEUMATOID ARTHRITIS

RUDIMENTARY EXAM (DRAWER SIGN ETC)

FUNCTION, ORIGIN, INSERTIONS, PATELLA AND LIGA.

GOUT VS PSEUDOGOUT

WHAT TO LOOK FOR IN **JOINT FLUID** (SIGNS OF INFECTION, CRYSTALS, MICROBES..)

LEG: BONES

FEMORAL VESSELS → MAJOR BRANCHES THROUGH FOOT

SCIATIC NERVE → MAJOR BRANCHES THROUGH FOOT

PERONEAL NERVE → FOOT DROP

SAPHENOUS VEIN- USE IN GRAFT HARVEST/BYPASS

DVT: CLINICAL HX OFTEN INCLUDES 'IMMOBILITY'

BONES OF THE FOOT (AND HAND)- CALCANEUS, TALUS, LISFRANC JOINT

(PS—I'M *NOT* COVERING THESE SPECIFICALLY TODAY!!!)

OK, MAYBE JUST A COUPLE...

“PT. CAN’T DORSIFLEX OR EVERT FOOT”

1st: WHAT IS DORSIFLEXION? EVERSION?

2nd: WHICH COMPARTMENTS’ MUSCLES NEEDED?

“NERVE MOST LIKELY DAMAGED:

- A) COMMON FIBULAR (PERONEAL)**
- B) SUPERFICIAL PERONEAL**
- C) DEEP FIBULAR (PERONEAL)**
- D) TIBIAL**
- E) OBTURATOR**

**A) COMMON FIBULAR (PERONEAL)--
WHY??????***

**DORSIFLEX: ANTERIOR COMPARTMENT,
DEEP PERONEAL NV.**

**EVERSION FOOT: LATERAL COMPARTMENT
SUPERFICIAL PERONEAL NERVE**

**COMMON FIBULAR ONLY CHOICE THAT
INCLUDES BOTH**

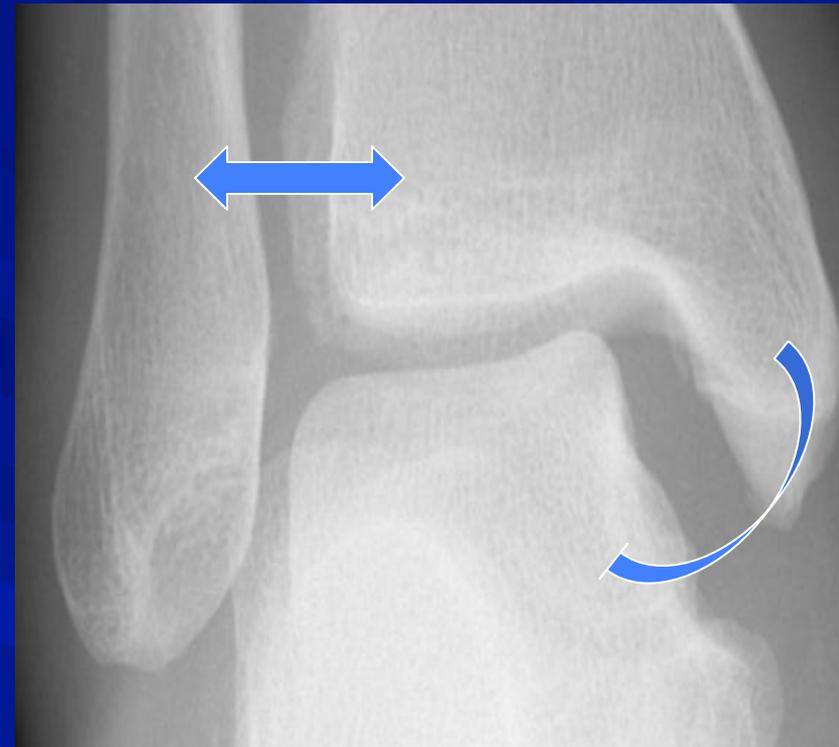
APPLETON AND LANGE'S REVIEW FOR
THE USMLE STEP 1, 2nd EDITION

**(TIBIAL NV: POSTERIOR LEG
PLANTAR FLEX, INVERT FOOT ...)**

*** Bec FIBULAR always on this test?!**

CLINICAL RELEVANCE: STEPWISE LOGIC BASED ON ANATOMY

- A) LIGAMENTOUS COMPROMISE MEDIAL ANKLE
- B) ANATOMIST-CLINICIAN REMEMBERS TOUGH INTRAOSSEOUS TIB-FIB MEMBRANE RUNS TO KNEE ('RING')
- C) THEREFORE EXAMINES KNEE AND....



DISCOVERS FORCE
TRAVELED UP
MEMBRANE, EXITED
THROUGH FIBULA
(FRACTURE)

SHORT- vs LONG-LEG
CAST: INEVITABLE
SWELLING –FAILURE
TO UNDERSTAND →
PERMANENT FOOT-
DROP



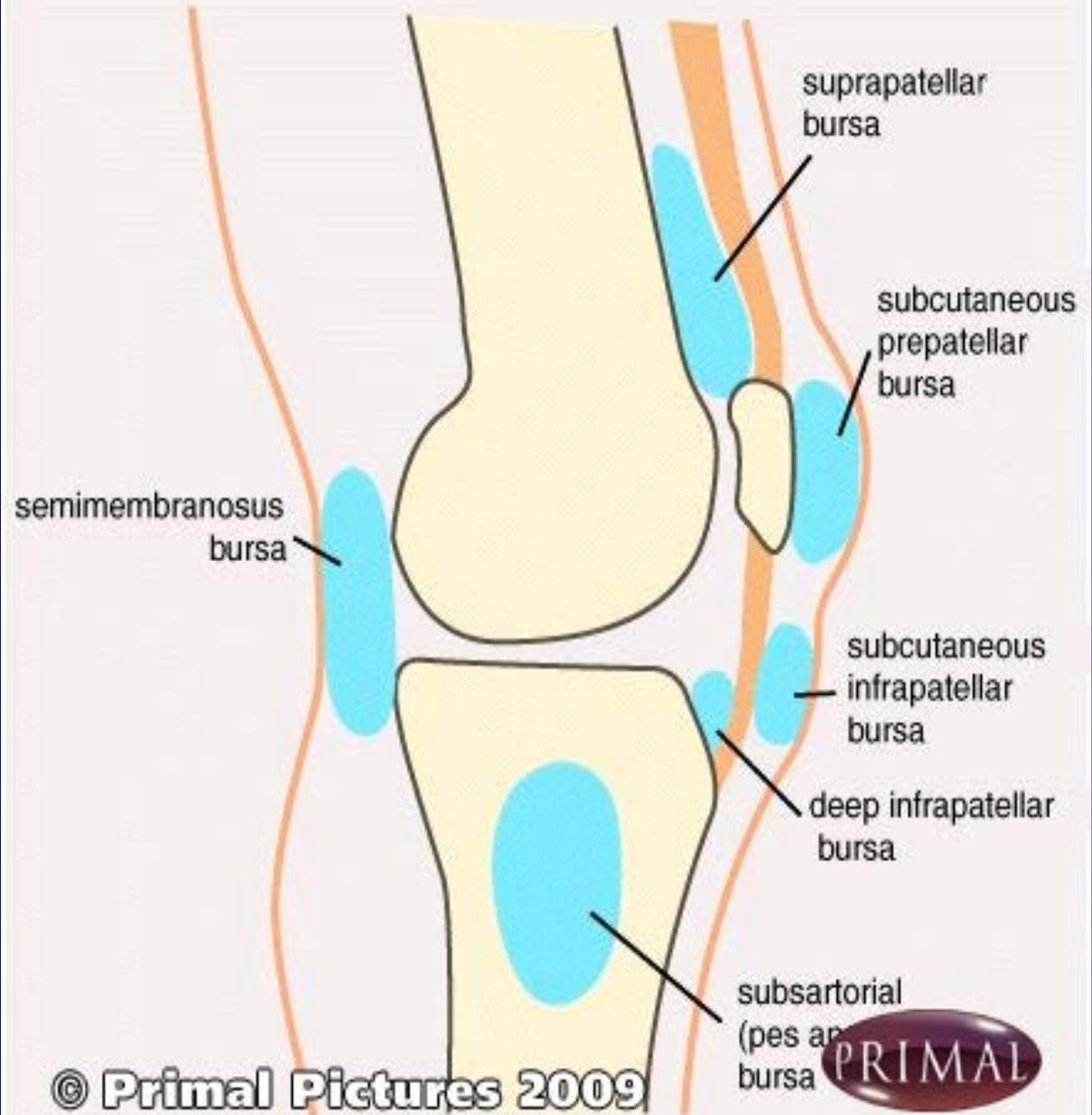
KNEE:

**ANATOMY →
PATHOLOGY**



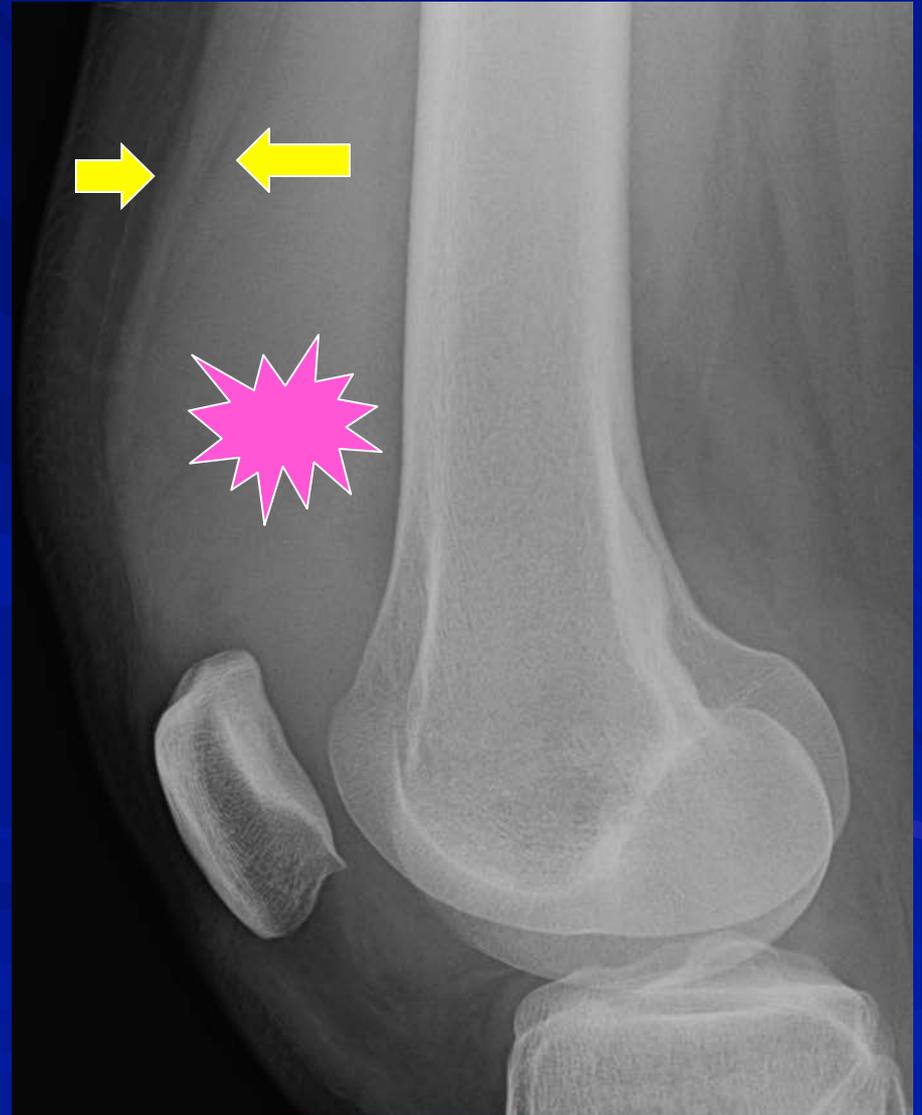
BURSAE:
SACS OF
SYNOVIAL TX
AND FLUID

CUSHION
THROUGH
R.O.M.



'WORRY/DON'T WORRY'

LOOK FOR CLUES



FLUID-FLUID LEVEL: 'WORRY'



NO BONY INTERLOCK STABILITY FROM LIGAMENTS

X-Table



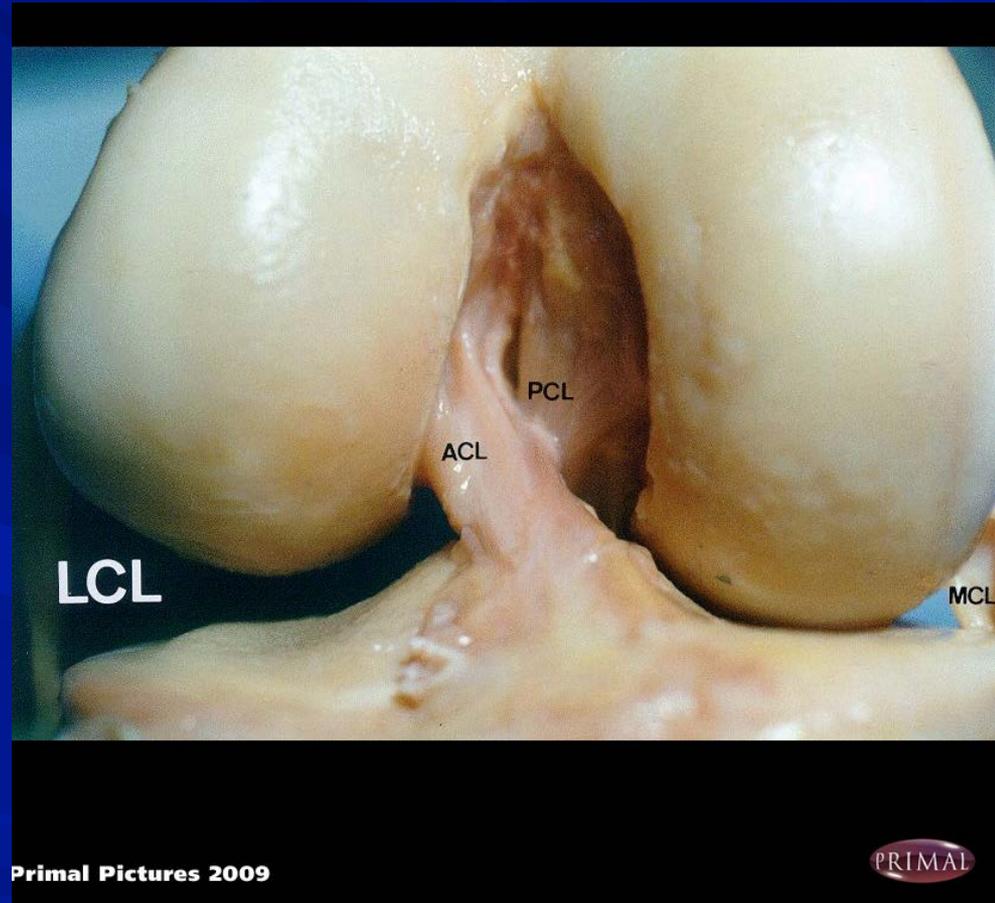
ALPHABET SOUP: ACL, PCL, MCL, LCL

CRUCIATE LIGAMENTS

FORM CENTRAL 'X'

RESTRAIN TIBIA FROM
EXCESSIVE ANTERIOR-
POSTERIOR EXCURSION
UNDER FEMUR

DESCRIBE 'DISTAL
relative to PROXIMAL'
(STEP EXAMS DON'T)



**'THE CHIEF LIGAMENT PREVENTING
FORWARD MOTION OF THE FEMUR
ON THE TIBIA IS:**

- A) TIBIAL COLLATERAL LIGAMENT
- B) FIBULAR COLLATERAL LIGAMENT
- C) OBLIQUE POPLITEAL LIGAMENT
- D) ANTERIOR CRUCIATE LIGAMENT
- E) POSTERIOR CRUCIATE LIGAMENT'

“E) POSTERIOR CRUCIATE LIGAMENT”

WHY???

POSTERIOR CRUCIATE LIGAMENT PREVENTS ‘*FORWARD MOTION OF FEMUR*’...poor medical usage; meant

POSTERIOR MOTION TIBIA UNDER FEMUR

ANTERIOR C.L.PREVENTS ‘*BACKWARDS*’ SLIDING OF *TIBIA UNDER FEMUR*’... poor usage again

PROPER = ‘**ANTERIOR MOTION TIBIA UNDER FEMUR**

ABNORMAL AP (ANTEROPOSTERIOR) MOTION OF TIBIA UNDER FEMUR WHEN KNEE IS FLEXED = ‘**DRAWER SIGN**’

APPLETON AND LANGE’S REVIEW FOR THE USMLE, 2nd EDITION

* **BECAUSE EITHER THE ACL OR PCL ARE ALWAYS ON THESE BLASTED TESTS!!!**

D.MAGID PERSONAL COMMUNICATION

ACL, PCL mnemonic

- **A**CL restricts **A**NTERIOR tibial translation
under femur
- **P**CL restricts **P**OSTERIOR translation
tibia under femur
- ONLY WORKS if you remember to describe **DISTAL** relative to **PROXIMAL**...
and **READ CAREFULLY!!!**

MEDICAL LINGUISTIC PRECISION: NOT OPTIONAL!!

- ERADICATE IMPRECISION, ERRORS
- REFERENCE = ANATOMIC POSITION
- ‘ANTERIOR, VOLAR, VENTRAL’;
NOT ‘IN FRONT OF’ or ‘ON TOP OF’
- ‘POSTERIOR, DORSAL’,
NOT ‘BEHIND’, “UNDER”
- MEANLESS/**DANGEROUS**:
‘RIGHT NEXT TO’; “ABOVE”;
‘NEAR..’ ‘BESIDE..’ ‘THERE...’ ‘ON TOP..’

IMAGINE YOU ARE CLIPPING
MAJOR VESSELS:

NO DO-OVERS,
NO 'OOPS!',
NO 2ND TRY.

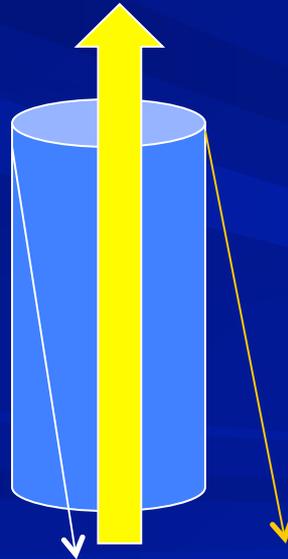
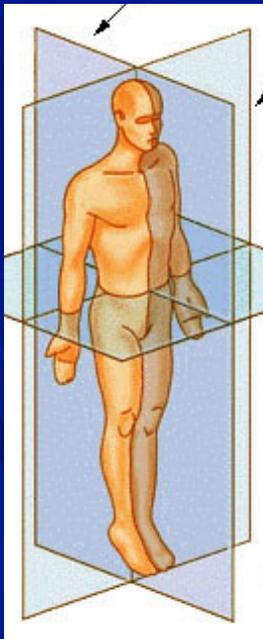
IMPRECISION KILLS

AXIS, VARUS, VALGUS

VARUS: DISTAL PART TOWARDS MIDLINE

VALGUS: DISTAL PART GOES LATERAL

AXIS: LONGITUDINAL MIDLINE, CENTER



LE: Functional Axes

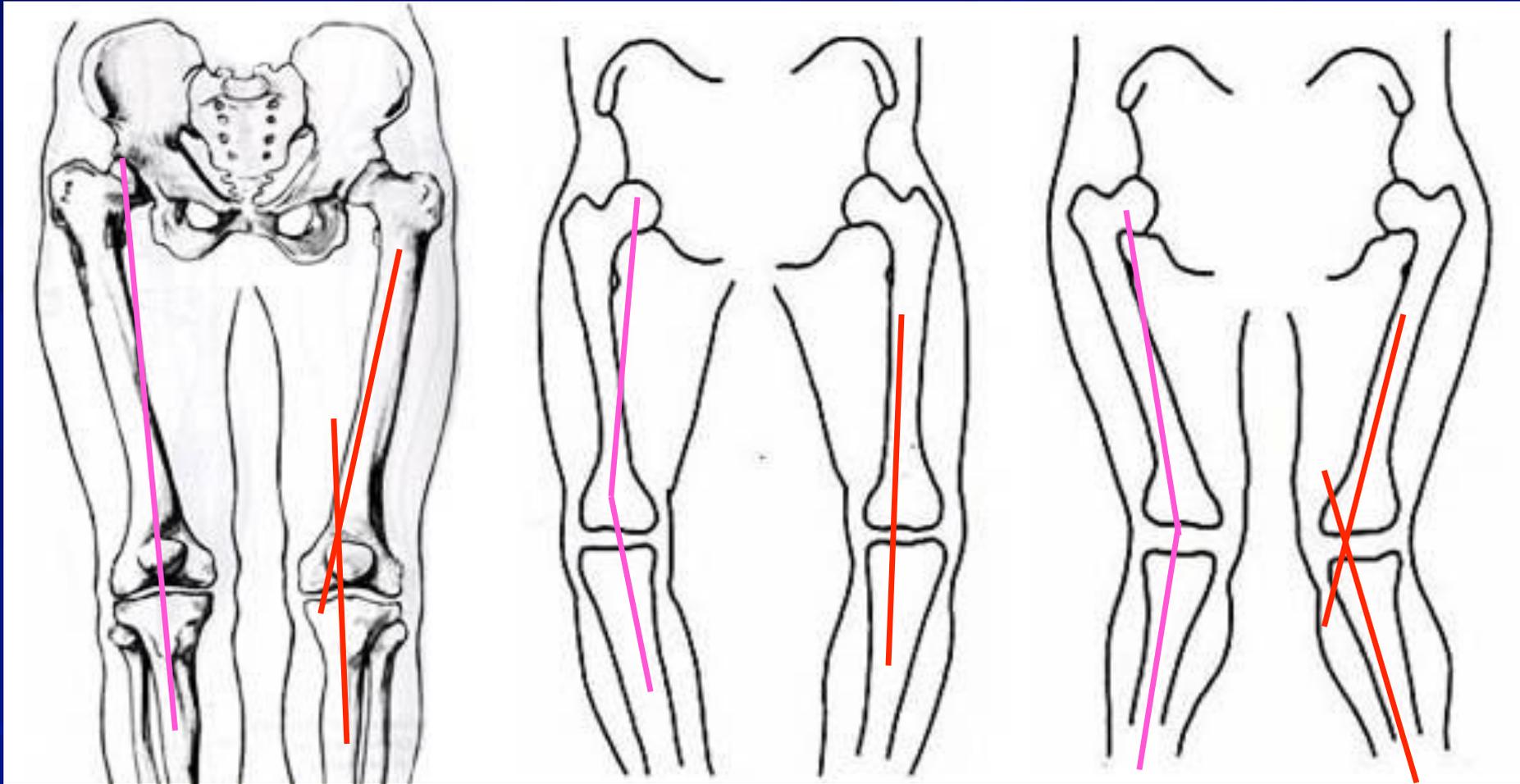
MECHANICAL AXIS : CONNECT THE CENTER OF FEMORAL HEAD, FEMORAL CONDYLES, MID TIBIAL PLAFOND.

NORMAL = ZERO DEGREES

ANATOMIC AXIS: SHAFT-SHAFT MIDLINES, FEMUR/TIBIA.

NORMAL = 6-8 DEGREES VALGUS

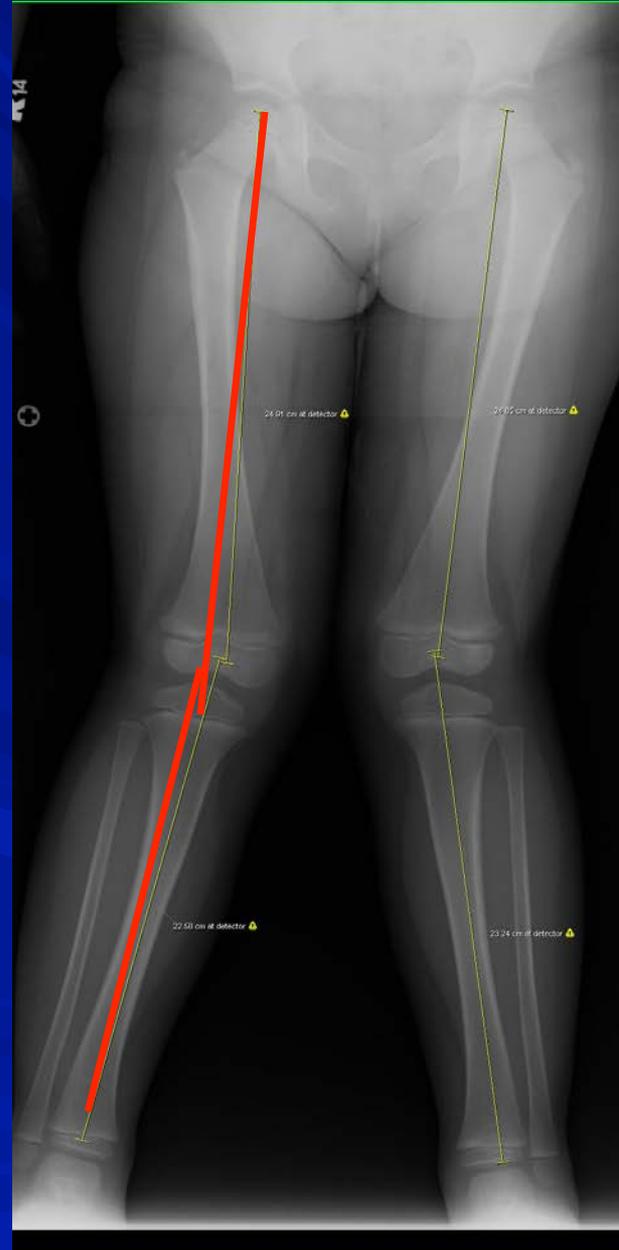
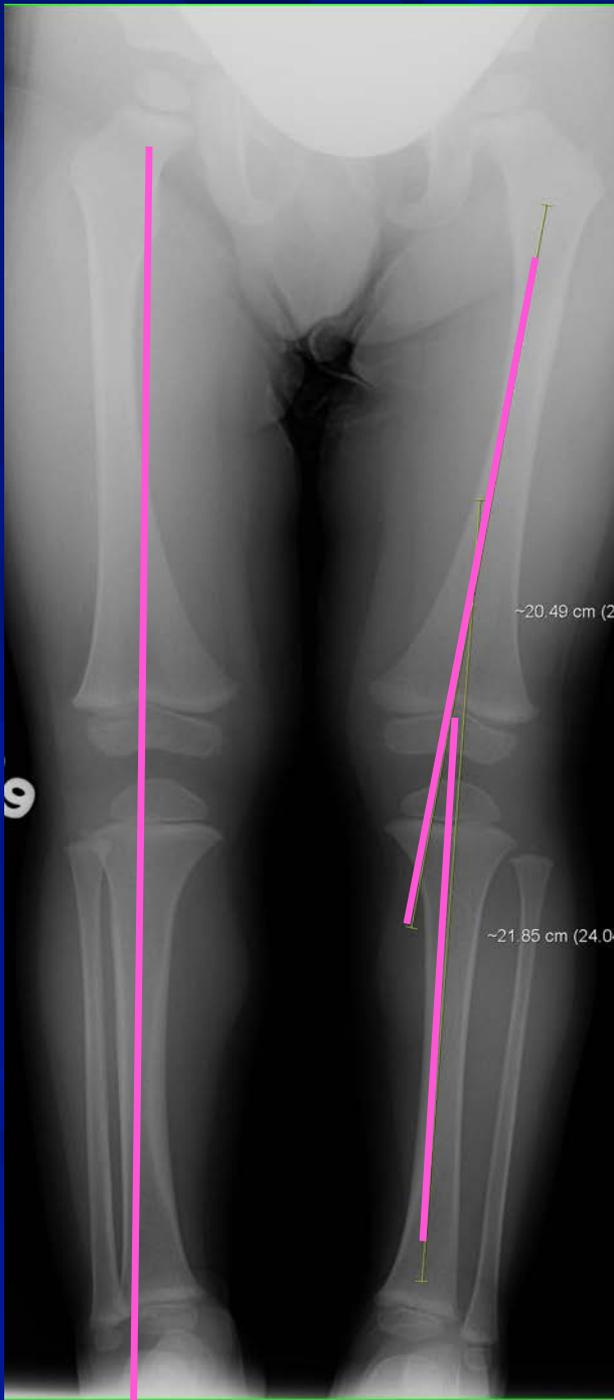
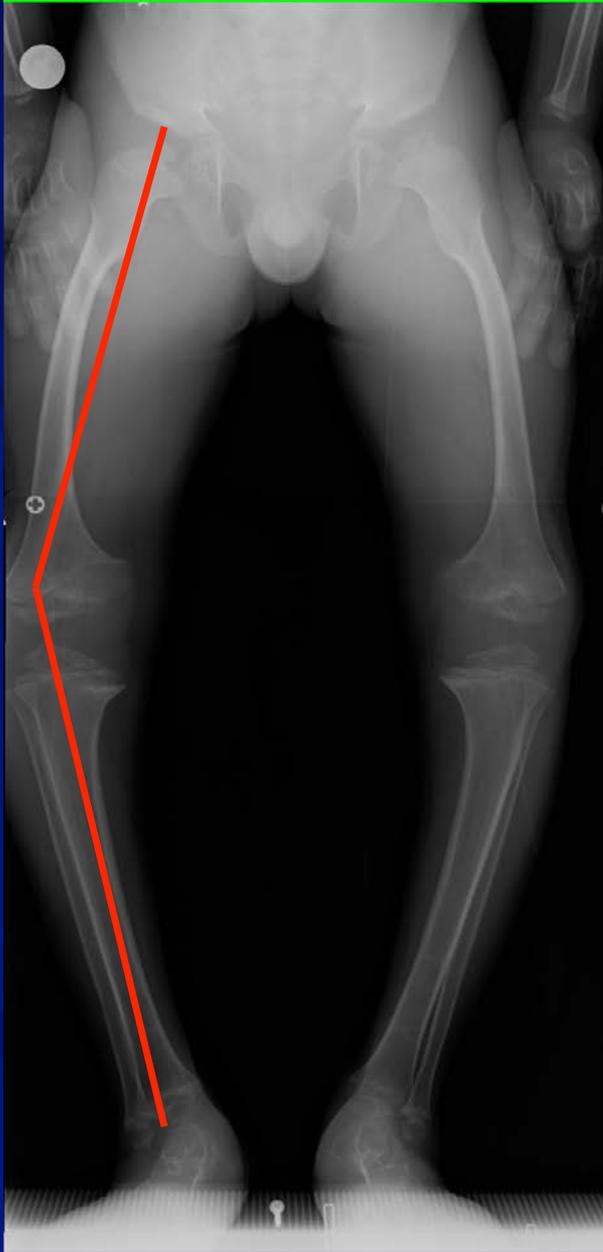
AXIS: LEGS ARE NOT STRAIGHT!



NORMAL VALGUS

**LOST VALGUS
'BOWED'**

**TOO MUCH VALGUS
'KNOCK-KNEE'D'**



NORMAL DEVELOPMENT

NEONATE CURLED, FLEXED

'CRUISER' (~10-12 mo) BOW-LEGGED

WEIGHT-BEARING, GROWTH, GRAVITY,
GRADUALLY REDUCE VARUS AXIS (BOW)

NON-AMBULATORY CHILD LAGS

BY ~2yo, LOSING/LOST THE VARUS

'BOWLEGS' BECOME 'STRAIGHT'

PARENTS KNOW THIS INTUITIVELY

BY ~4, APPROACHING ADULT VALGUS

TRULY 'NORMAL' LEGS = slight 'KNOCK-KNEE'D'

GENU VARUM: BOWING

IN NEONATE, NEW 'CRUISER,'
'**NORMAL**' RELATIVE TO AGE AND
STAGE



ADORABLE →

GROSSLY ABNORMAL if 11 yr →

ABNORMAL WEIGHT-BEARING:

GAIT, BIOMECHANICAL, PHYSIOLOGIC,
ORTHOPAEDIC AND PSYCHOSOCIAL
CONSEQUENCES

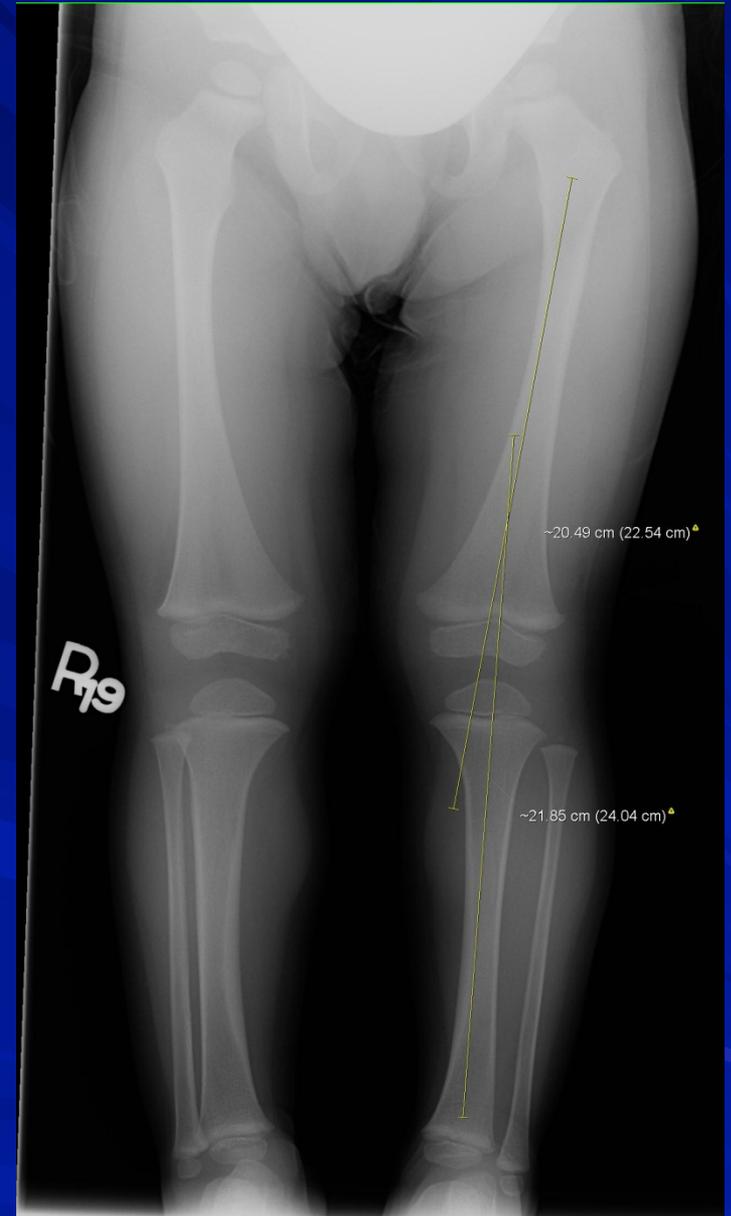


2 YR 7 MO FEMALE
MOVING INTO NL VALGUS

SLIGHT ASYMMETRY IN SHAFT-
SHAFT (**ANATOMIC**) AXES 'WNL'
BUT WILL BE FOLLOWED

'WNL' = **'W/IN NORMAL LIMITS'**
ACKNOWLEDGES WIDE
SPECTRUM OF NORMAL
VARIATION

OCCASIONALLY MEANS
'WE NEVER LOOKED'

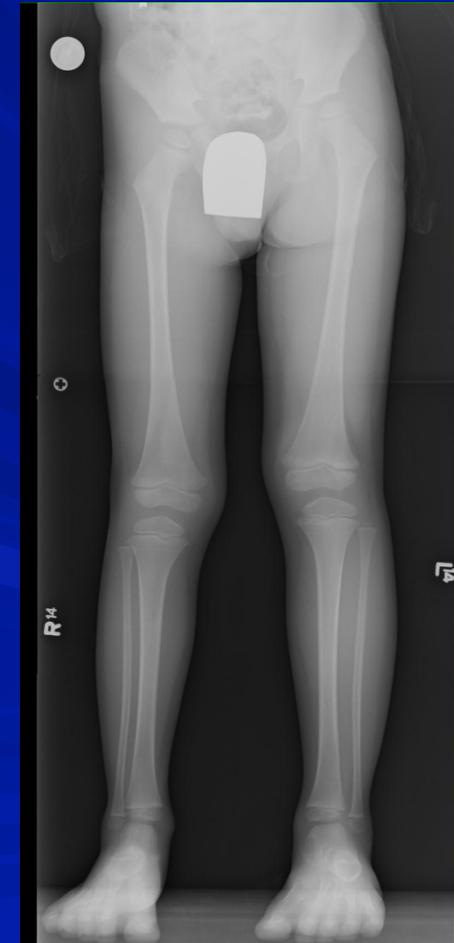
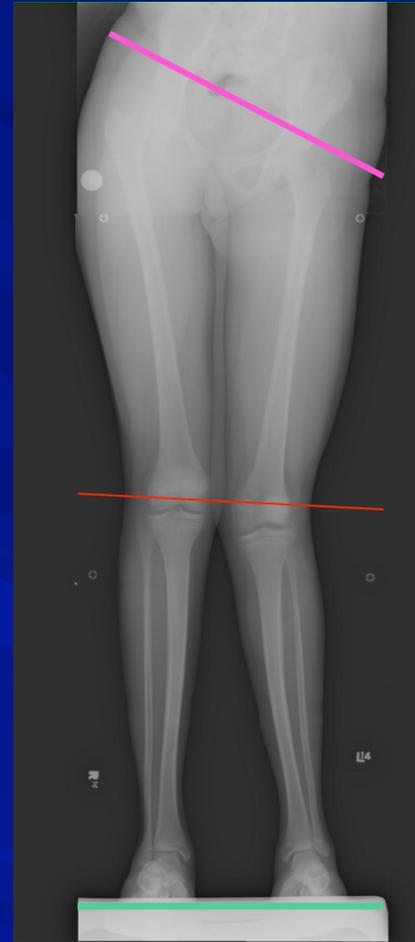


LLD and PELVIC OBLIQUITY

LLD FORCES PELVIS,
SPINE, GAIT, TO
ACCOMMODATE

CRANIUM 'WANTS' TO
BE IN **PLUMB LINE**
OVER SACRUM
(GRAVITY)

(TRY WALKING IN ONE HIGH
HEEL FOR 10 MINUTES)



LEG LENGTH DISCREPANCY

NO ONE IS PERFECTLY SYMMETRIC

ADULTS TOLERATE 2.5 cm (~1") LLD

STANCE, GAIT, SPINAL, PELVIC ACCOMODATION

WATCH PEOPLE WALK!

>2.5 cm ADULT: SIGNS AND SYMPTOMS

SIGN DETECTED BY OBSERVER, **SYMPTOM** BY PATIENT

CHILDREN: SIGNIFICANCE ↔ AGE

PREDICTS SEVERE CONSEQUENCE IN TODDLER

MINOR IN PERIADOLESCENT

MINIMAL IF CLOSE TO SKELETAL MATURITY

GROWTH DISRUPTION:

Curvature if partial physis
Shortened limb if total physis



LEG LENGTH DISCREPANCY (LLD)

DIFFERENTIAL DIAGNOSIS (DDx):

CONGENITAL/DEVELOPMENTAL

NEUROVASCULAR POLIO, STROKE, VASC.MALFORMAT'N

CHILDHOOD INFECTION BONE, JOINT

PHYSEAL (GROWTH PLATE) TRAUMA

TOTAL OR PARTIAL LOCAL GROWTH ARREST

SYMMETRIC SHORTENING OR 'BONSAI TREE' EFFECT

PLANNING LLD TREATMENT: BIOLOGICAL CONSIDERATIONS

HOW MUCH GROWTH IS LEFT?

BONE AGE vs CHRONOLOGIC AGE

PARENTAL HEIGHT FORMULA BY GENDER

PREDICTIVE PEDIATRIC CHARTS

WHERE IN EACH BONE GROWTH OCCURS

KNEE CONTRIBUTES ~70% LONGITUDINAL GROWTH

DISTAL FEMUR OR PROX TIBIA THEREFORE 'WORST'

VASCULAR SUPPLY AND HEALING VARIABLES

LLD: Pt. Considerations

LONG-TERM FUNCTIONAL EXPECTATIONS

Basic ambulation or high performance?

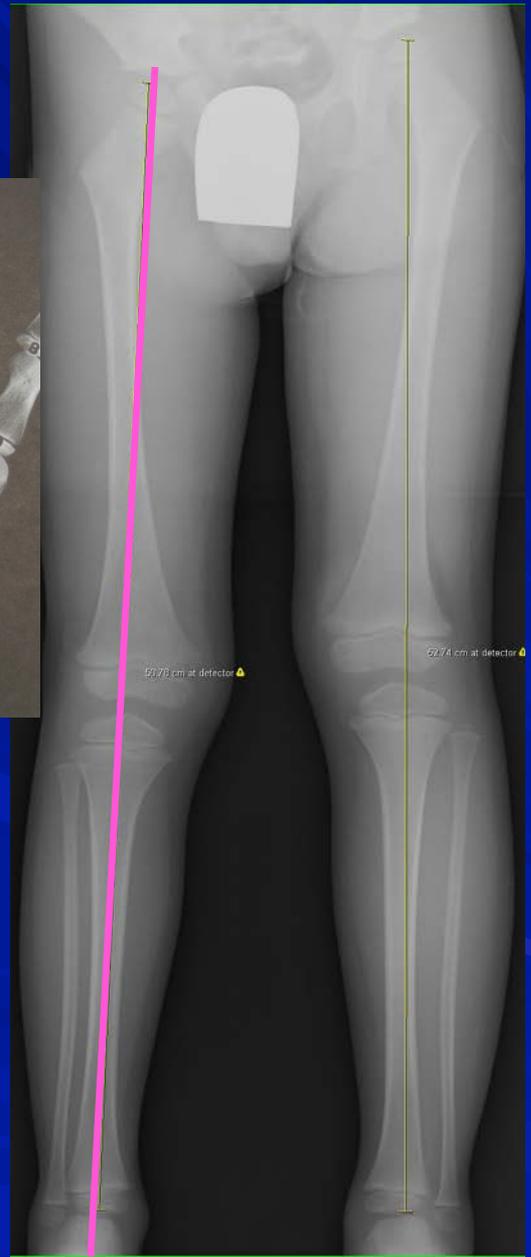
ASSOCIATED OR COEXISTING FACTORS

Co-morbidity: HIV, CP, malabsorption, social

One year of dependency: school, life, medical

COSMETIC CONSIDERATIONS

LEG-LENGTH DISCREPANCY



OSTEODYSTRACTION: LENGTHENING PROCEDURE CHOOSE BEST TARGET

AFFECTED PART OF BONE MAY NOT BE

GOOD CANDIDATE: SCAR, INFECTION,
FIBROUS TISSUE (FD, NF), COMPROMISED OR
NATURALLY POOR BLOOD SUPPLY AND HEALING
POTENTIAL

TOTAL LEG LENGTH NEEDS SYMMETRY

INDIVIDUAL BONES LESS CRITICAL

VASCULARITY IS HEALING DESTINY

DISTAL THIRD TIBIA

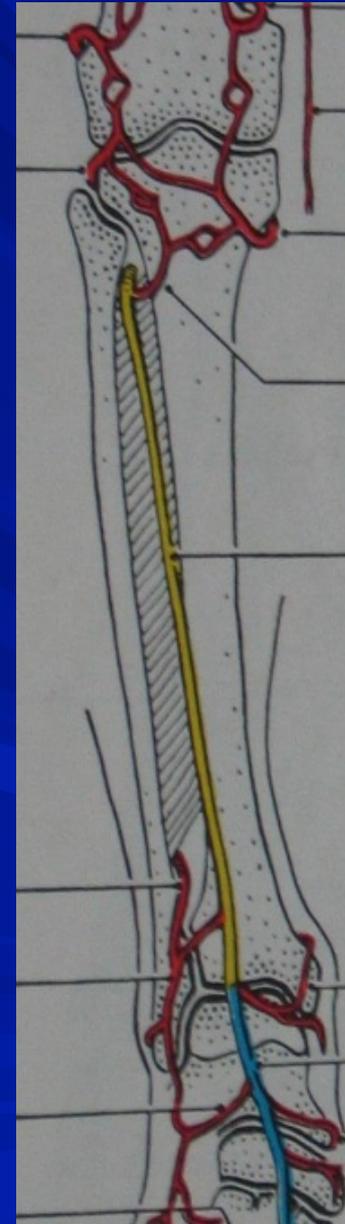
'WATERSHED' SUPPLY
BETWEEN ANKLE, CALF

MUSCLE: TRANSPORTS,
PROTECTS, OSSEOUS
BLOOD SUPPLY

MUSCLE MARKEDLY
DIMINISHED DISTAL 1/3

**HIGH RATE FX,SURGERY
COMPLICATIONS**

From GRANT'S ANATOMY



DISTRACTION OSTEOGENESIS

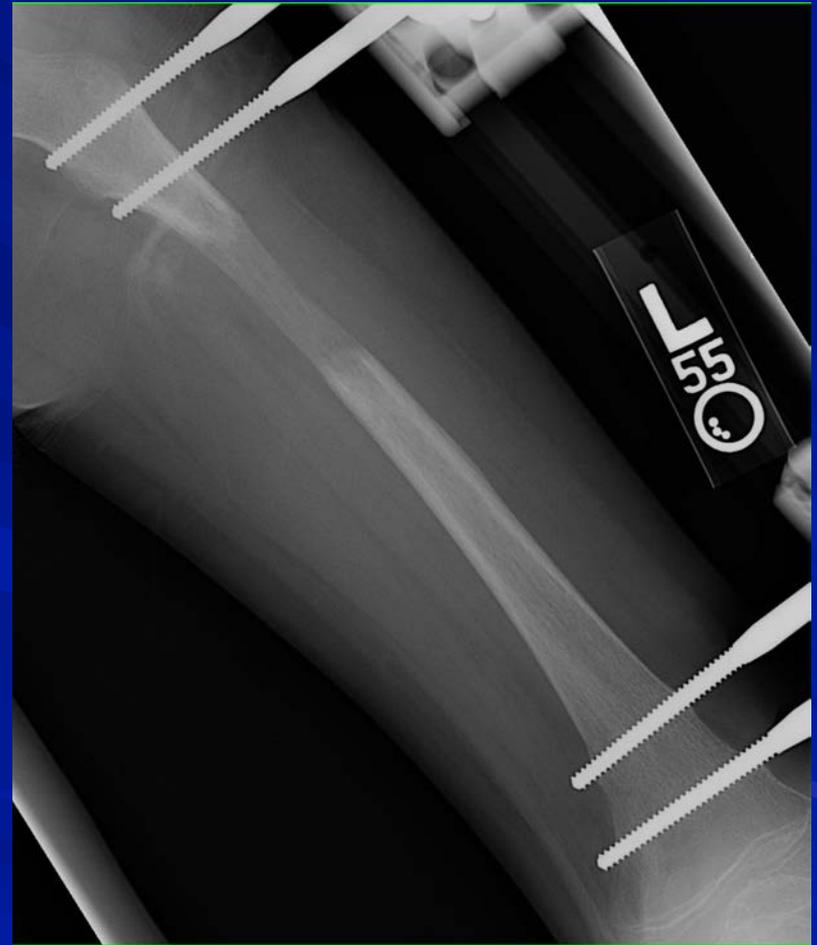
BONE CAN REPAIR AND REMODEL

FRACTURE → BLEEDING → CLOT → CREEPING
NEW MATRIX OVER 'SCAFFOLDING' →
MINERALIZATION

DISTRACTION OF IATROGENIC 'FRACTURE'
CONSTANT, .25 MM 4x DAY, TO = RATE OF
OSTEOBLASTIC CREEP

WOLFF'S LAW DIRECTS (PHYSICAL THERAPY,
GRADUAL WT-BEARING

DISTRACTION OSTEOGENESIS: 'LEG LENGTHENING' HARNESSING NL. TO CORRECT ABNL.



LEG-LENGTHENING

MAY TAKE UP TO ONE YR:

NEED COMPLIANT *HEALTHY* CHILD

10-13 yo, MOTIVATED, NONDEFIANT

HEALTHY ADULT POSSIBLE, SLOWER

FAMILIAL/CARETAKER SUPPORT

PIN TRACK CARE, SELF-CARE, NUTRITION, MED VISITS

APPROPRIATE STABLE LIVING SITUATION

SCHOLASTIC ISSUES

PROCESS ILLUSTRATED AT:

LIMBLENGTHENING.COM/MMEDIA.html

Elan D. Bomsztyk MS IV, Cornell

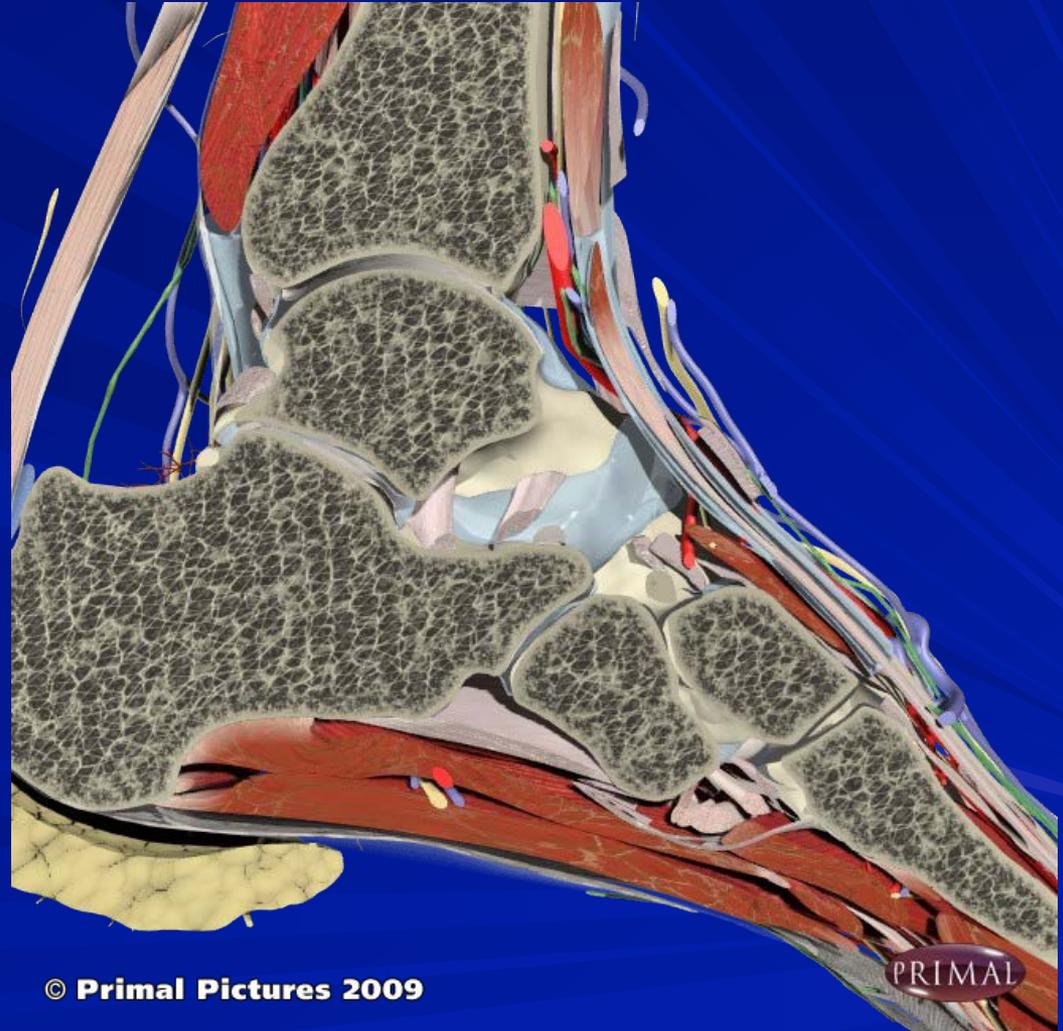


Primal Pictures/DStoller

WEIGHT-BEARING ARCHES



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PRIMAL

STAND UP FOR YOUR FEET!!



Primal Pictures 2009



3D

140



Volume Rendering No cut

DFOV 52.0cm
STND

R
2
6
7

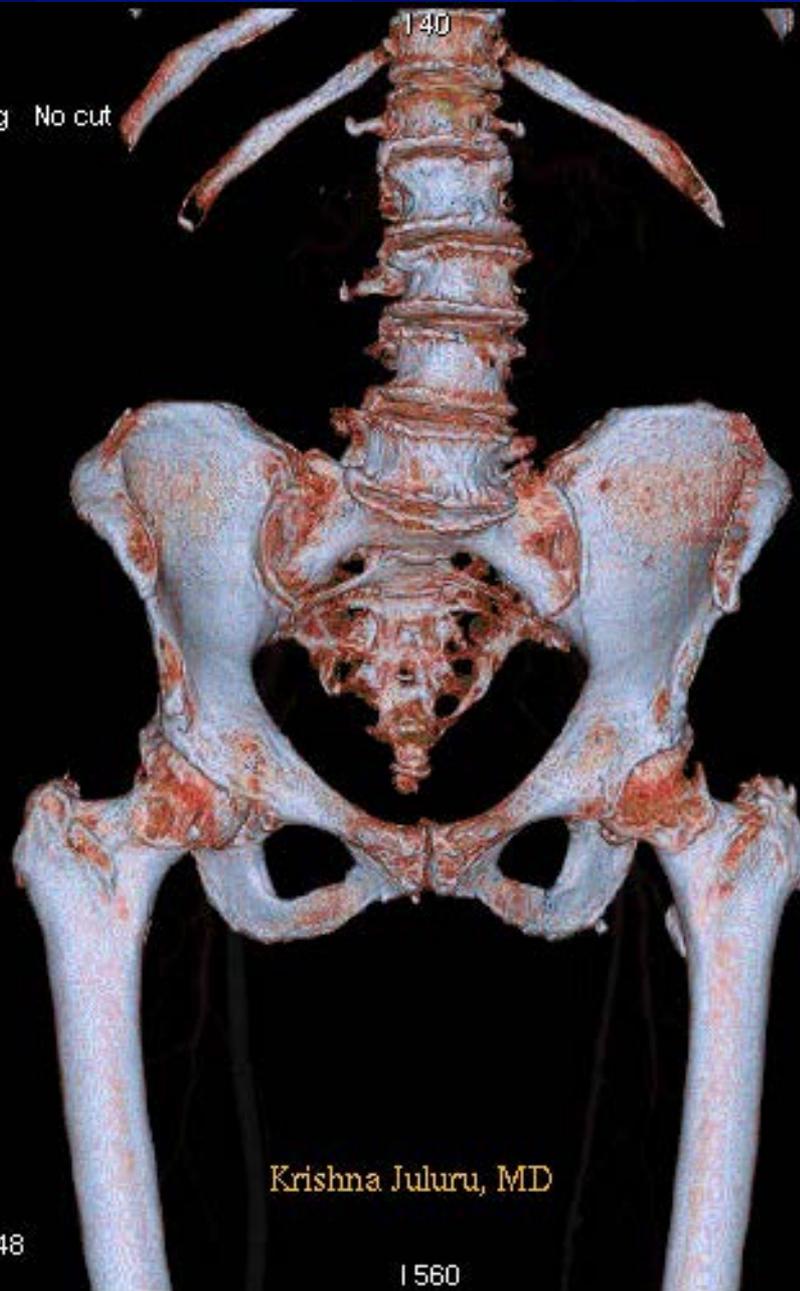
L
2
5
3

No VOI

Krishna Juluru, MD

W = 4095 L = 2048

1560



9 yr.old



18 mo. old



23 mo. Male



Leg Lengthening: Osteodistraction

DOS 11 yr old female



7 wks out



Normal adult



What's different?



Normal



What's different?



Calcaneal fat pad

