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

Baltimore Sun, NYTimes, 12/07
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

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

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

* Bec FIBULAR always on this test?!
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 \(\rightarrow\) PERMANENT FOOT-DROP
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
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’
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

- **ACL** restricts **ANTERIOR** tibial translation *under femur*
- **PCL** restricts **POSTERIOR** 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’;
  \textit{NOT} ‘IN FRONT OF’ or ‘ON TOP OF’
- ‘POSTERIOR, DORSAL’,
  \textit{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
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  TOO MUCH VALGUS
‘BOWED’      ‘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
  ‘BOWLEG’ 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
SYMметRIC 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
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 $\rightarrow$ BLEEDING $\rightarrow$ CLOT $\rightarrow$ CREEPING NEW MATRIX OVER ‘SCAFFOLDING’ $\rightarrow$ 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
WEIGHT-BEARING ARCHES
STAND UP FOR YOUR FEET!!

Primal Pictures 2009
23 mo. Male
Leg Lengthening: Osteodistraction

DOS 11 yr old female

7 wks out
Normal

What’s different?
Calcaneal fat pad