HANDHELD NAVIGATION

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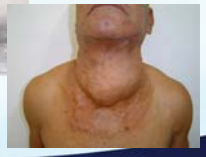
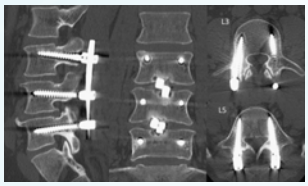
DISCLOSURES

- Orthofix—Royalties
- Republic Spine —IP
- K2M — Advisory Board
- Titan — Speaking

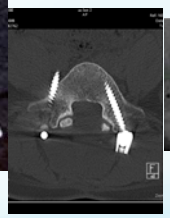
RADIATION —BAD

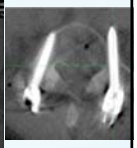


PSEUDARTHROSIS —BAD



MISPLACED PEDICLE SCREWS —BAD





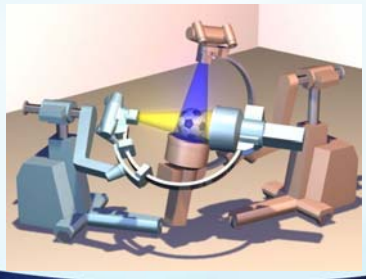
MEDICAL COSTS —BAD

(INDUCING HEART ATTACK IN HOSPITAL ADMINISTRATION —?)

MIS SPINE SURGERY —GOOD

- Shorter LOS
- Less Blood Loss
- Less Pain Medication
- Better Fusion Rates?
  - Challenges to MIS spine Surgery include:
    - radiation, technique, expense of technology

BIPLANER FLUOROSCOPY



AP ONLY IMAGING — APPROPRIATE FOR MIS?

- common in open procedures
- combines tactile feedback with AP imaging
- Requires pedicle finders, pedicle probe, visualization of landmarks (challenges in MIS)
  - 10-40% screw misplacement rate (all techniques)

Gelalis ID, Paschos NK, Pakos EE, Politis AN, Arnaoutoglou CM, Karageorgos AC, et al. Accuracy of pedicle screw placement: a systematic review of prospective in vivo studies comparing free hand, fluoroscopy guidance and navigation techniques. Eur Spine J 2011;21:247-55. 5

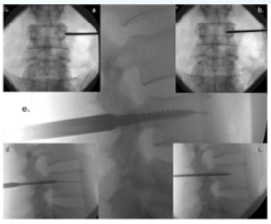
- 5% cortical violation AP only Lumbar pedicle screw placement: Using only AP plane imaging Sethi A, Lee A, Vaidya R - Indian J Orthop 2012;46: 434-8.4

COMPROMISE?

- Reliable?
- Reproducable?
- Familiar technique?
- Inexpensive?
- Efficient?

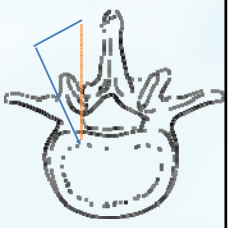
GOAL

- Mitigate challenges of MIS without introducing inefficiencies and cost
- Provide 3 dimensional visual feedback from a 2 dimensional AP image



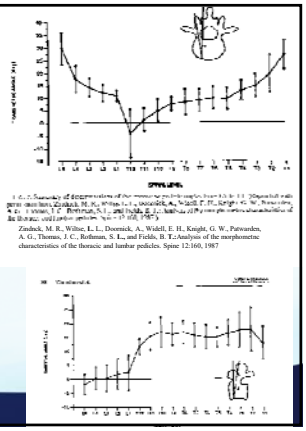
GOAL

- Determine angle of Instrument in relation to pedicle anatomy off of a 2D picture
- Predict position of instrument at different depths off of a 2D picture



PEDICLE MORPHOLOGY

- Decreasing Avg transverse pedicle angle from s1 to t12
- L5 avg 30 degrees
- L3 avg 15 degrees
- Increasing sagittal angle from s1 to t12 (-3 to 3 degrees)
- Avg length of pedicle 20mm



Zindrick, M. R., Wiltse, L. L., Doornick, A., Widell, E. H., Knight, G. W., Patwardeen, A. G., Thomas, J. C., Rothman, S. L., and Fields, B. T.:Analysis of the morphometric characteristics of the thoracic and lumbar pedicles. Spine 12:160, 1987

Angles for "Free-Hand" Pedicle Screw Instrumentation

Cranial-Caudal (Sagittal Angle)		Medial-Lateral (Transverse Angle)
-14°	T1	22°
-13°	T2	18°
-12°	T3	15°
-11°	T4	14°
-11°	T5	13°
-10°	T6	11°
- 8°	T7	10°
-6°	T8	9°
-4°	T9	8°
-1°	T10	8°
1°	T11	11°
4°	T12	14°
9°	L1	14°
9°	L2	16°
11°	L3	17°
13°	L4	19°
14°	L5	22°
20°	S1	35°

THE SPINE INSTITUTE at CHATHAM ORTHOPAEDIC ASSOCIATES

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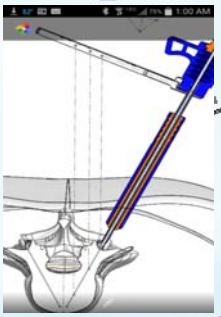
PREMISE

- Utilize pre-operative planning to determine pedicular anatomy
- Provide real time visualization of anatomy with minimal exposure (AP only fluoro)
- Develop aiming jig capable of extrapolating instrument (jam-sheedy needle) transverse angle trajectory and depth off of AP X-ray
- Possible?



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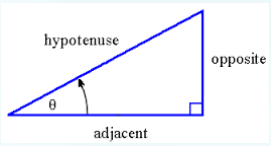
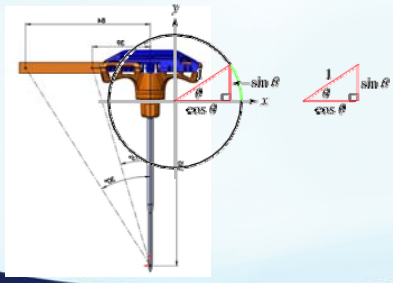
TRIGONOMETRY!

- Right triangle has two acute angles (sum =90 degrees)
- The hypotenuse is the side opposite the right angle of a right triangle
- The ratio of a side of the triangle to the hypotenuse is constant for any given angle (regardless of size of triangle)

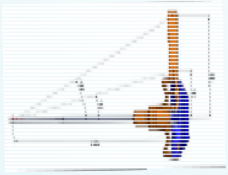


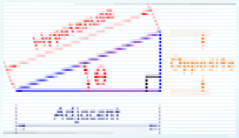
COSINE



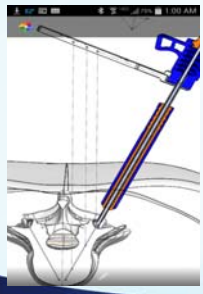
COSINE

cosine=Adjacent/hypotenuse



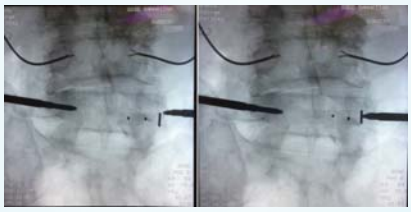


EXPLANATION



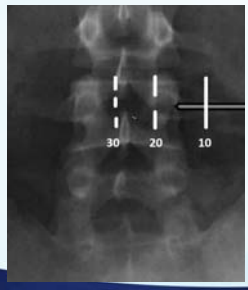
- Based on this trigonometric ratio, an AP x-ray can show the transverse sagittal trajectory of the jam-sheedy needle
- Using the ratio, a marker is added showing the projected tip of the needle when advanced 20 mm (avg length of pedicle)
- This is possible by forming a right angle with the jam-sheedy acting as the adjacent leg, the aiming jig as the opposite leg, and the hypotenuse 90 degrees to the spine

COSINE— DEPTH TARGETING



1st Dot indicates tip of needle when advanced 20mm— extra safeguard to prevent breach

COSINE —ANGLE TARGETING



Align tip of needle with vertical marker to achieve specific trajectory (transverse angle). Here the angle is approximately 15 degrees

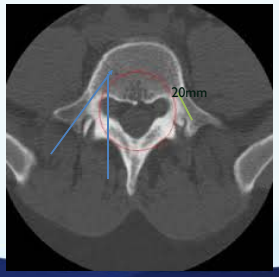
COSINE— DEPTH AND ANGLE TARGETING

Notice that the steeper the angle, the more space between angular marker and depth marker

ADVANTAGES

- Cheap
- Simple
- Instant registration off of real time imaging (no stored data, no markers)
- Utilizes familiar technique, surgeons, skill, perception, and eyes

KEY TO SUCCESS



pre op planning

THANK YOU