# Navigation in Spinal Surgery

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## Disclosures

- Consultant-Medtronic, SI bone

## Goals of surgery

- Reproducibility
- Efficiency
- Completeness
- Safety

- Safety applies to patient, surgeon, and staff
- Ionizing radiation is a significant risk to all of us

## Hardware placement

- Significant component of spinal surgery
- Techniques
  - Anatomic
  - Fluoroscopy aided
  - Image guided
- Every surgeon should be comfortable with anatomy
- If you rely solely on technology, trouble will come when it isn't available

## Pedicle screw placement

- Anatomy
  - Free hand technique- malpositioned screws 6% of the time
    - Best of hands (Lenke, Bridwell)
    - None of these screws required revision at 10 years
  - Fast
  - Limited radiation
  - Excellent exposure for fusion

## Is MIS possible without fluoro?

## Why do we want to limit fluoro?

- Exposure to radiation
- Contamination of surgical field
- Systems are operator dependent (good tech??)
- Can de difficult with larger patients
- Ergonomics
- Lead is heavy!!!

## History of Spinal Navigation

- First described in mid 1990's
  - Screw malposition rates up to 50% in thoracic spine
    - **Usually** not symptomatic
    - Malposition rates typically similar regardless of surgical technique
  - Developed in parallel with expansion of MIS
- Goals
  - Improve accuracy
  - Save time
  - Decrease radiation

## Radiation

- Guidance offers improved dosages for OR staff and surgeon
  - 10-12X more radiation exposure to surgeon in spine cases
    - Essentially none with guidance
- More for the patient
  - 15X more radiation in CT based screw placement compared with fluoro based
  - If image guidance is used instead of pre-op CT, dose is similar
  - Less with 2 and 3 D fluoro systems

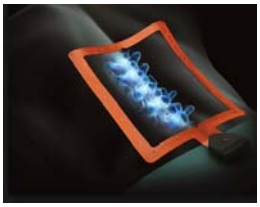
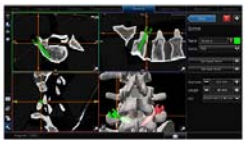
## System Types

- Initial: CT based
  - Early systems required pre-op CT scan
  - Scan was uploaded to software in OR
  - Often slow and fickle
- Newer
  - IO CT scans
  - 2D, 3D fluoroscopy
  - IO MRI
    - Used in brain tumors
  - IO Ultrasound

## Intraoperative Image Acquisition



## SpineMask

## How systems work

- Acquire images with fixed reference point(s)
  - Accuracy compromised by movement
  - Some systems allow reconfirmation with point arrays
  - Surface markers allow for non invasive reference points
    - Affixed directly to guidance system
- Images uploaded; software processes
  - Images reconstructed and deconstructed
- Instruments and implants are loaded into the system
  - Then tracked by software

## Optical Tracking

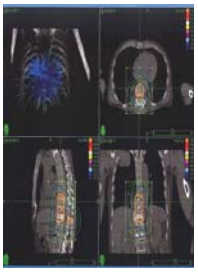
## Electromagnetic field tracking

- Fiducials used
- Can also "surface mark"
- Less sensitive to obstruction

## Accuracy of navigated screws

- Recent review of 20 studies (Shin, JNS 2012)
- 6% malposition rate in navigated screws
- 15% in "conventional" screw placement
- Neurologic complications rare
  - 3 in conventional group (3725 screws)
  - None in navigated group (4814 screws0

## Getting closer to imageless reconciliation



## Reconciliation- major limitation

- What we do to change anatomy is not accounted for
- Without new scans, software cannot update data
  - Surgeon must be aware
  - Evolution is toward overlay of pre-op and intra op films
- Possible solutions
  - Microtransmitters or fiducials
  - Active image acquisition (US??)
  - Surface onlay sheets show promise

## Considerations for use in deformity

- Pre-operative planning as standard
  - Screws
  - Interbody
  - Osteotomies
- Anatomy altering steps are not processed by computer
- Can be used in truly MIS fashion, mini open, or open

## Interbodies

- TLIF, LLIF, OLIF, corpectomy cages can all be navigated
- For placement of multiple contiguous interbodies, begin cephalad and work caudal
  - If positioning or anatomy appear to change
    - Reconcile with surface referencing
    - Respin
    - Utilize fluoro
- If osteotomies are required, perform after interbody work
  - Consider fluoro or new scan
- Always place screws first

## Case 1

- 60 year old female
- 5 feet tall, 170 pounds
- 5 year history of back and bilateral leg pain
  - Worse with walking, improved with laying and leaning back
- L LE 4/5 DF, Inversion, EHL
- No sensory deficit
- No nerve tension or long tract signs

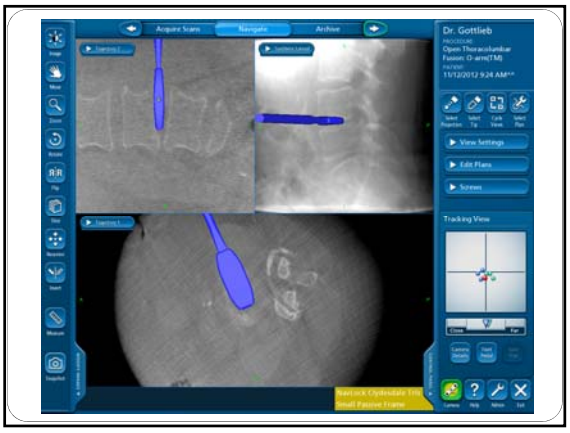
Pre-op Images

Not underpenetrated

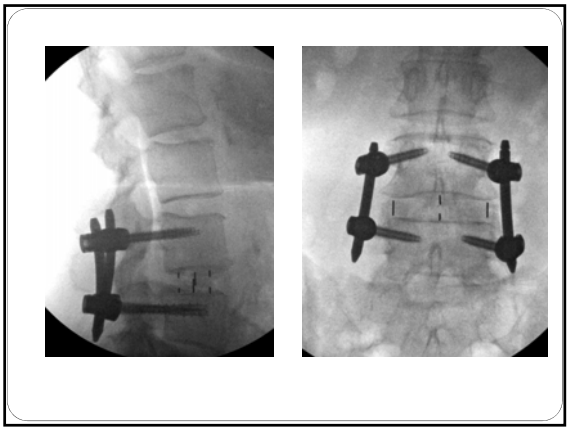
Flexion-Extension Views

## Surgical Plan

- OLIF (Oblique DLIF) L4-5
- Percutaneous pedicle screws
- O- arm guidance for interbody
  - Large patient
  - Fluoro will be difficult
- No decompression necessary
  - Slip reduces easily
  - Problem is dynamic (instability)



Acquire Scans
Navigate
Archive
Dr. Gottlieb
Open Thoracolumbar
Fusion: O-arm(TM)
View Settings
Edit Plans
Screws
Tracking View


Acquire Scans
Navigate
Archive
Dr. Gottlieb
Open Thoracolumbar
Fusion: O-arm(TM)
Select Projection
Projection: 10 x 50 (Inserter, DLIF/TLIF)



## Clinical course

- 36 hours in the hospital
- Drove home to Key West from Miami
- Full return to activities

- Image guidance improved confidence during the procedure
- Struggles with imaging mitigated