

**Navigated Deformity Surgery**

Jonathan Gottlieb, MD  
Miami Back and Neck Specialists  
Key West NeuroSpine and Pain

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**Disclosures**

- Consultant-Medtronic, SI bone, Mighty Oak

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**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

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### 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

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### Can we do without fluoro?



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### Why should we?

- Surgeon and staff exposure to radiation
- Contamination
- Operator dependent
- Patient anatomy not always favorable
- Working around machines
- Lead is heavy!!!
  
- Can we improve precision?
- Cost effectiveness?

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## 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

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## 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
  - Robotic (requires pre op scan)
    - Mazor claims 1.5mm accuracy <98% of cases

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## Contemporary Systems



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### How systems work

- Acquire images with fixed reference point
  - If this point is moved, guidance becomes inaccurate
  - Some systems allow reconfirmation with point arrays
- Images uploaded; software processes
  - Images reconstructed and deconstructed
- Instruments and implants are loaded into the system
  - Then tracked by software

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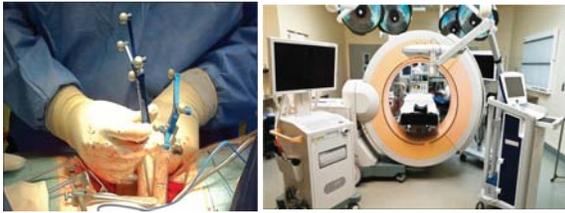
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### Radiofrequency Tracking



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### Electromagnetic field tracking



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

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### 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 screws)

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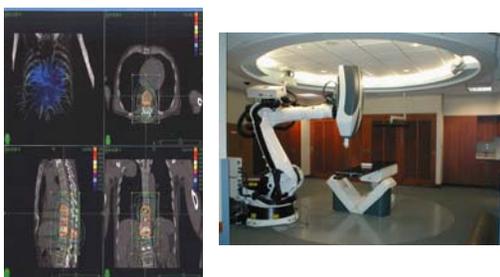
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### We cannot reconcile yet



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### Reconciliation- major limitation

- What we do to change anatomy is not accounted for
- Without new scans, computer is blissfully unaware
  - Surgeon need to not be
- Possible solutions
  - Microtransmitters in implants
  - Active image acquisition
    - Non ionizing

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### Radiation

- Better 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
- We are exposed to way too much fluoro

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### 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

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### Order of procedures

- Whether MIS or open, screw placement should generally be first
  - Rods are not placed at that time
- If no interbody work is planned, proceed with osteotomies
  - Pre op plan and localizing device (such as planar probe) can be used to mark osteotomy sites and also determine depth/completeness

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### 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

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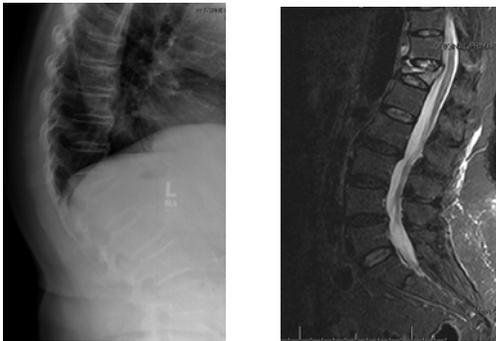
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### Case: 77 y/o female August 2013



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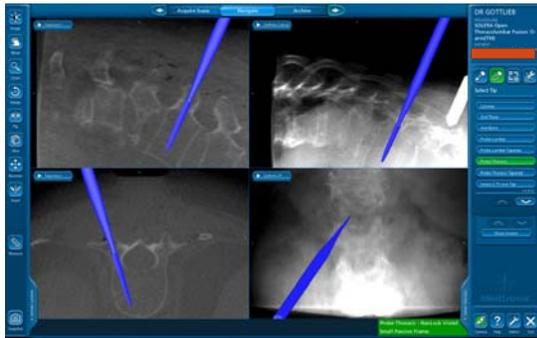
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### Screw Placement



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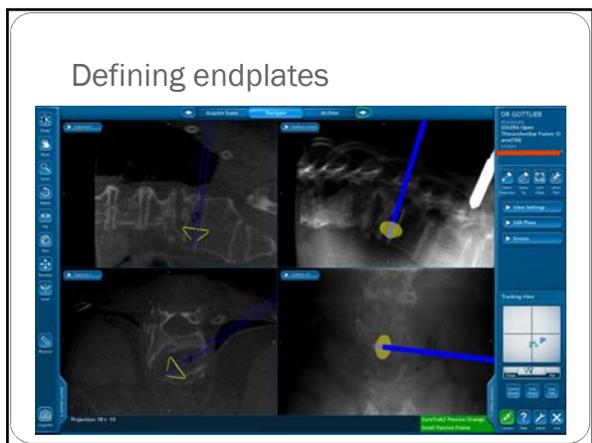
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### Defining endplates



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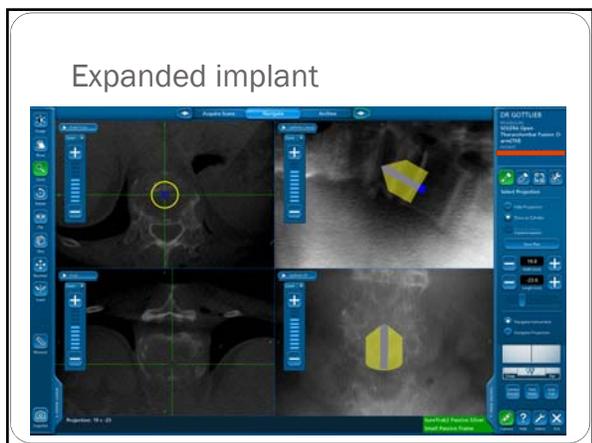
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### Expanded implant



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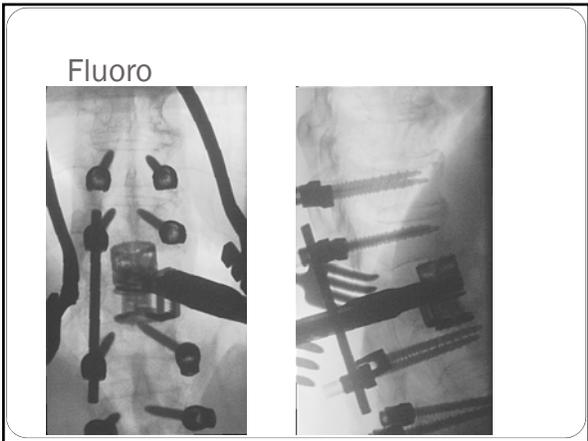
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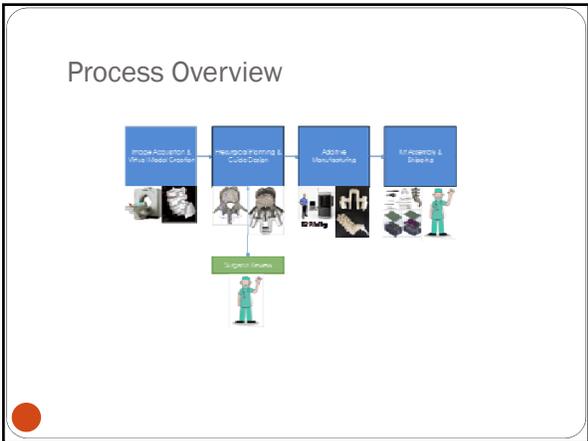
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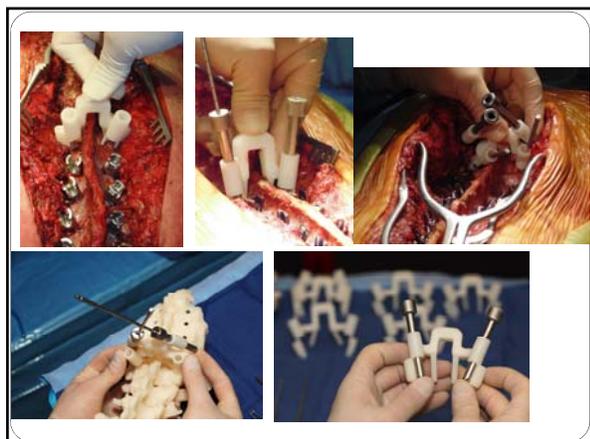
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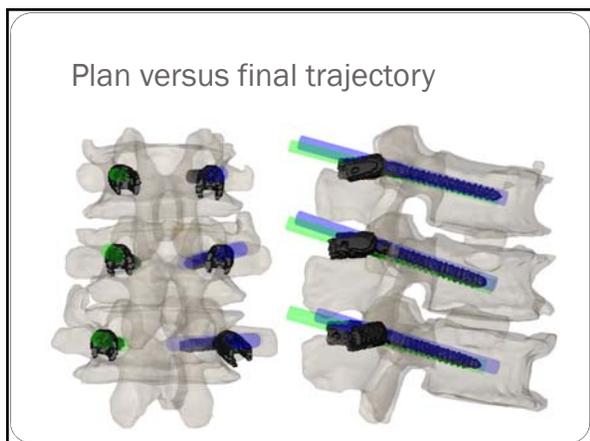
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**Conclusion/Predictions**

- The role of navigation will continue to grow in all aspects of spinal surgery, including deformity
- Generation times between advancements are shortening and will continue to do so
- Precision will increase as active image reconciliation develops
- Radiation doses will decrease

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