



All India Institute  
of Medical Sciences

Jai Prakash Narayan  
Apex Trauma Center



# MULTI-DIMENSIONAL IMAGING USING O-ARM IN TREATMENT OF SPINAL FRACTURES



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## Multidimensional imaging in spinal fractures



- Pedicle screw insertion- easy and safe where anatomical landmarks are clear-AP/fluoroscopy enough.
- In contrast to the cranial navigation navigation of the vertebral column is complicated by the fact that the spine is a flexible structure.



# Multidimensional imaging in spinal fractures



## Indications of the O-Arm

- pathologies of difficult navigation (degenerative spine such as scoliosis)
- anatomic Landmarks difficult to identify
- Methodological limitations of fluoroscopy-(at the junction of the upper spine CT/T, or in very obese).



# Multidimensional imaging in spinal fractures



## A unique platform for intra-operative Imaging

- 2-D Fluoro with Memory

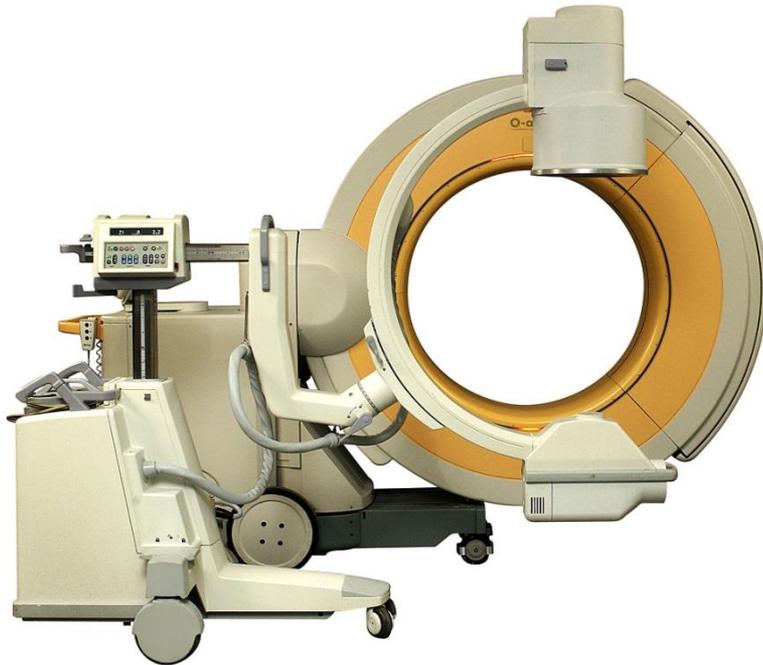
Presets

- 3-D Reconstructions
- Lateral patient access
- Robotic positioning





# Multidimensional imaging in spinal fractures

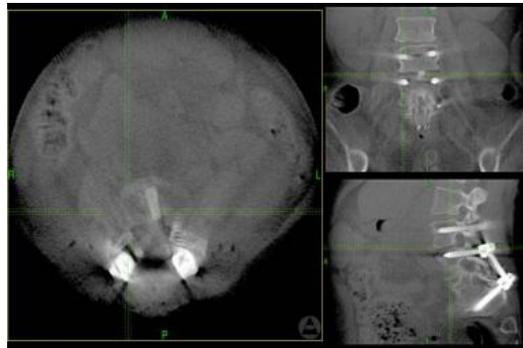




# Multidimensional imaging in spinal fractures



- Digital Display of the highest image resolution, displaying 30" diagonal flat aspect ratio 16:9 User control of imaging display functions from the viewing station or a handheld, wireless mouse, sterile



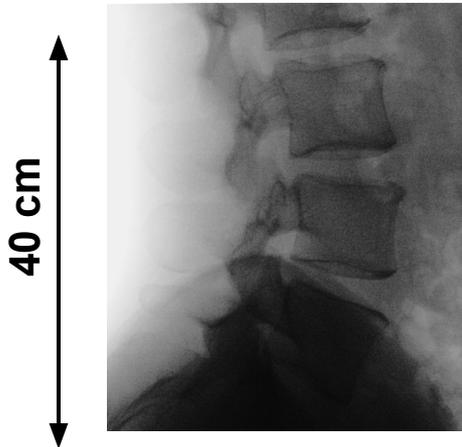


# Multidimensional imaging in spinal fractures



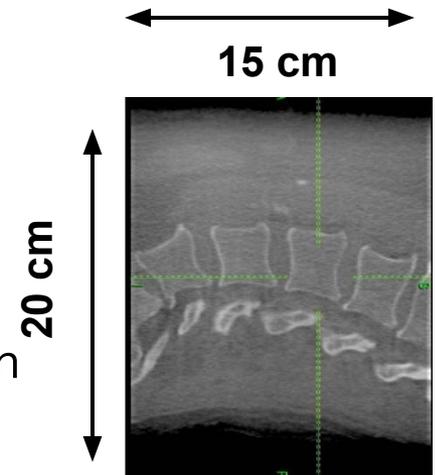
- Large field of view without distortion
- High resolution 40cm x 30cm **flat panel detector**

←→  
**30 cm**



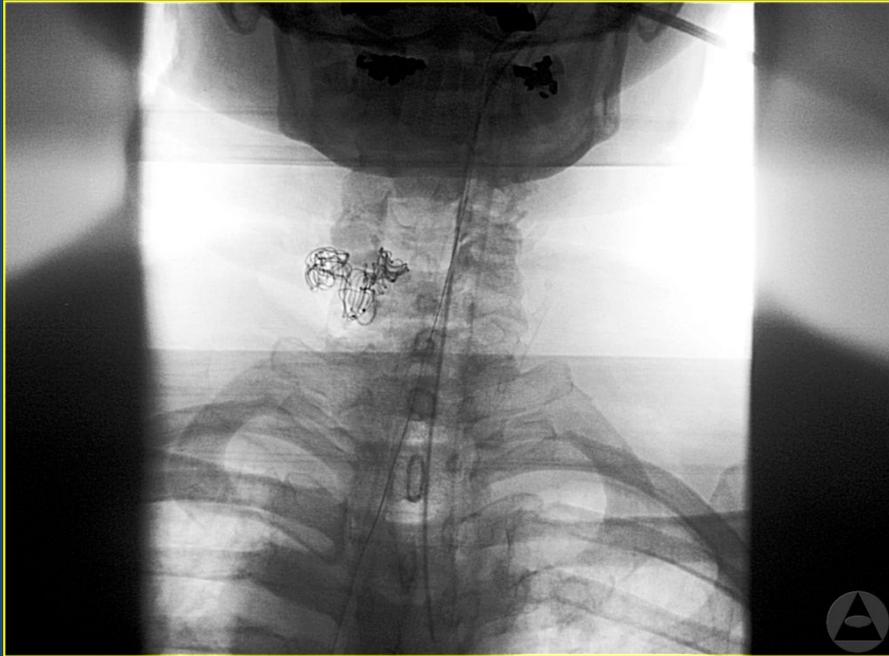
**3 times the area** of a 9" image intensifier (standard c-arm)

**6 times the 3-D volume** derived from a 9" image intensifier



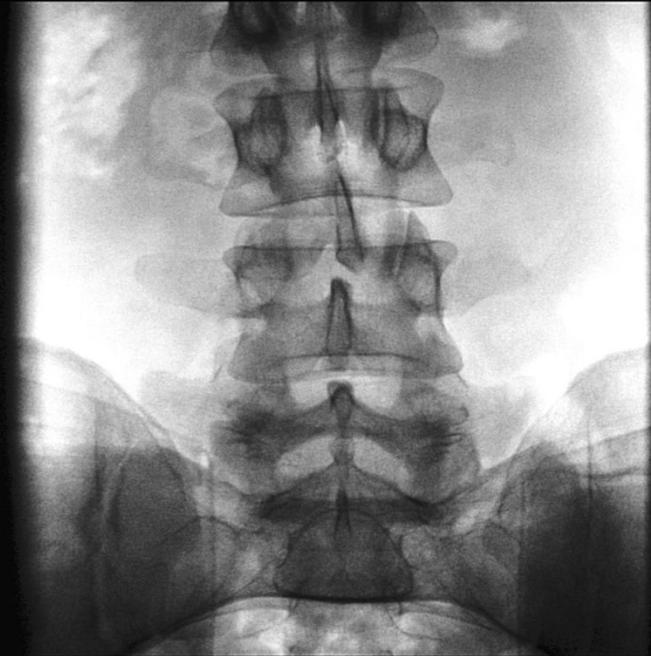
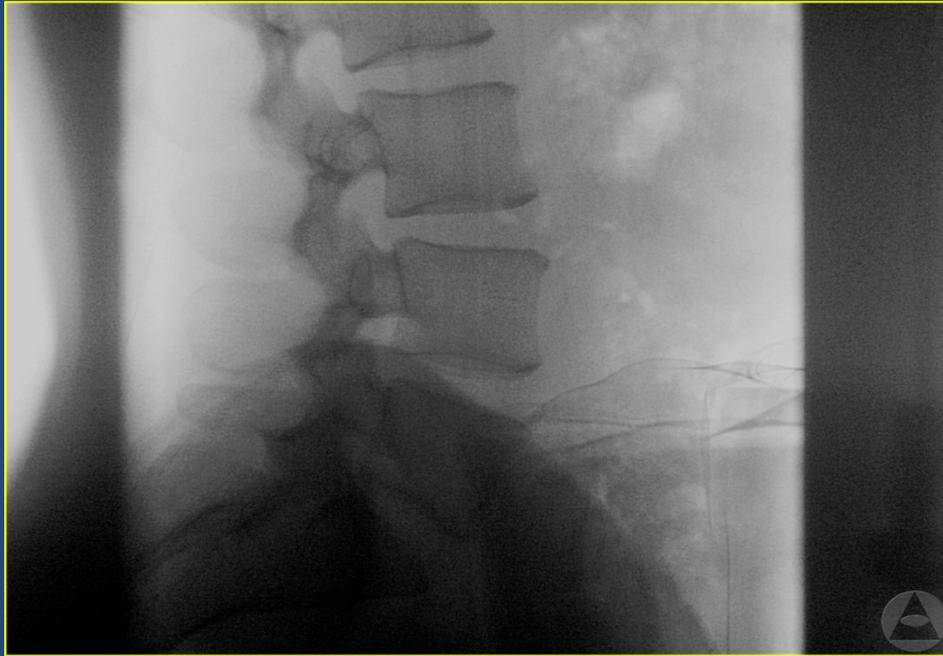


# Corpectomy Cervical 2-D.



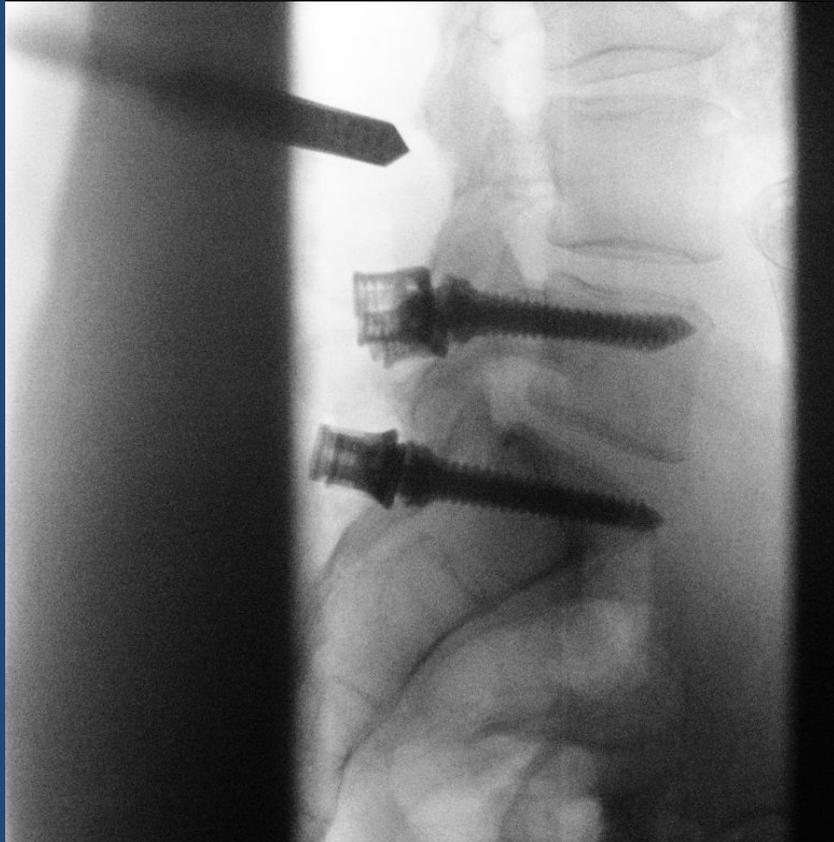


# 2-D Imaging lumbar.





# Imaging lumbar spine with sc





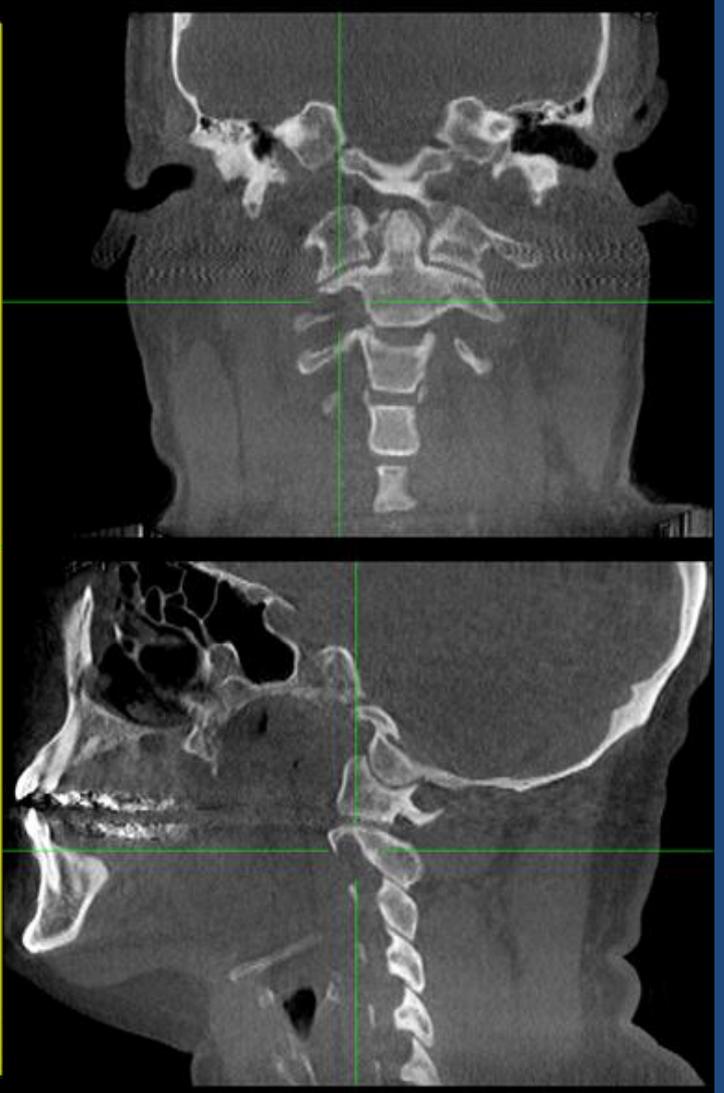
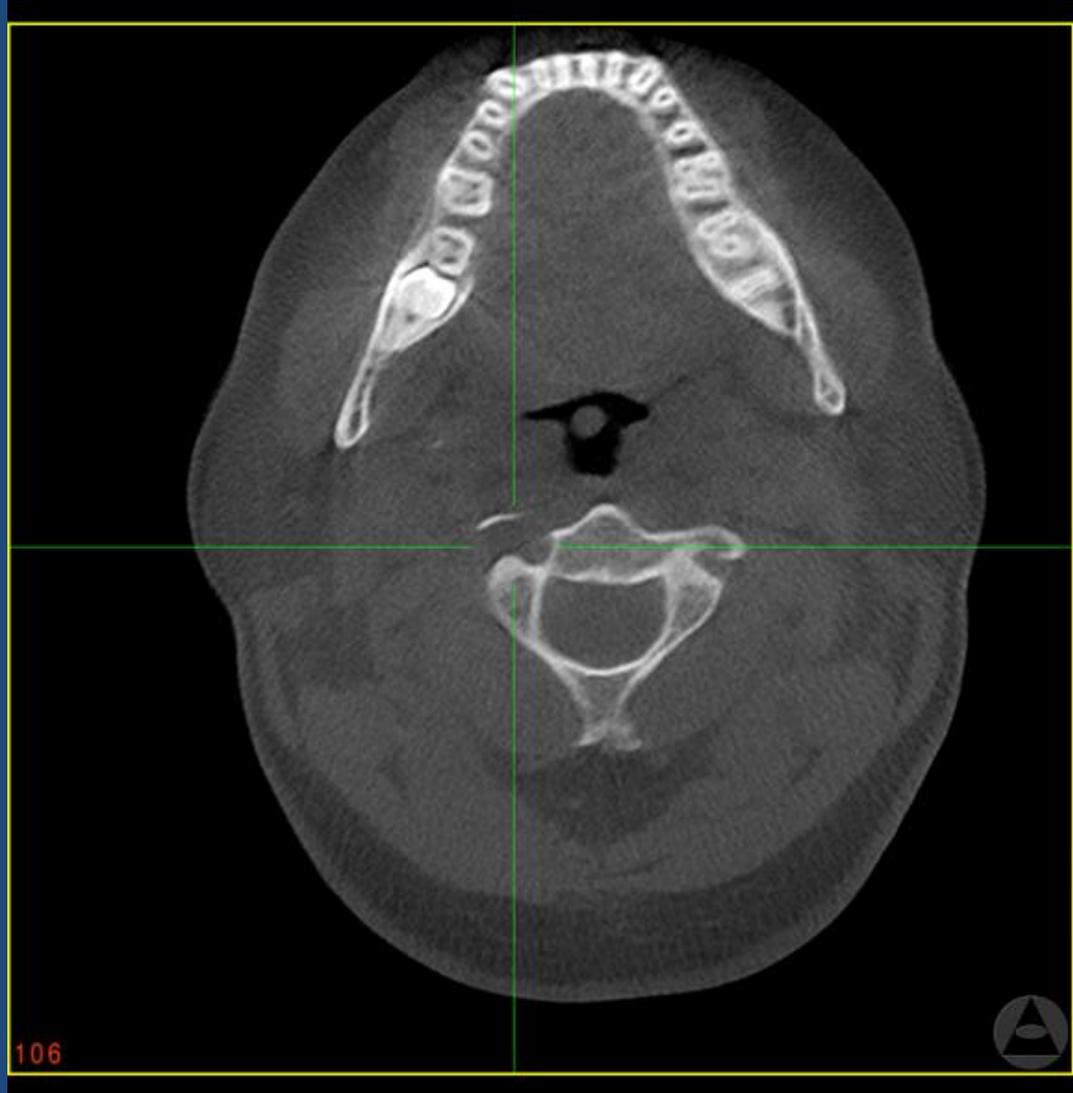
# Multidimensional imaging in spinal fractures



- Streamlined imaging for increased OR efficiency
  - Lateral Patient Access
  - No fixed room – O-arm® can be used during multiple cases
- 3-D Image created in operative position
- Obtain post-op 3-D scan before closing patient
- Fast Scan Time
  - 391 images over 360° in 13 seconds (SD)
  - 750 images over 360° in 13 seconds (HD)

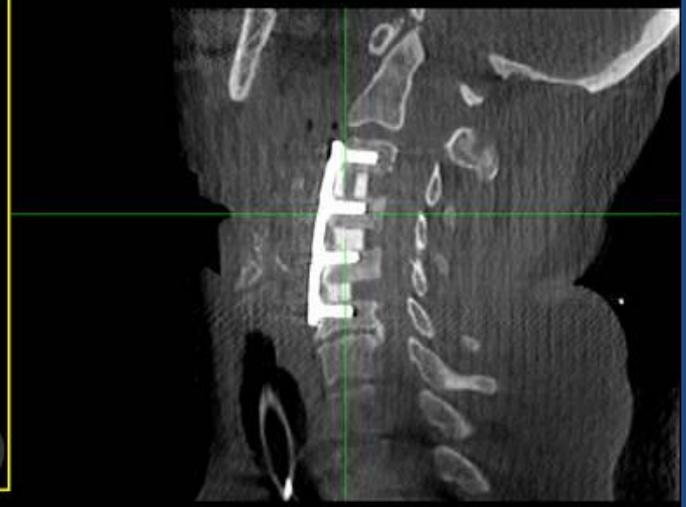
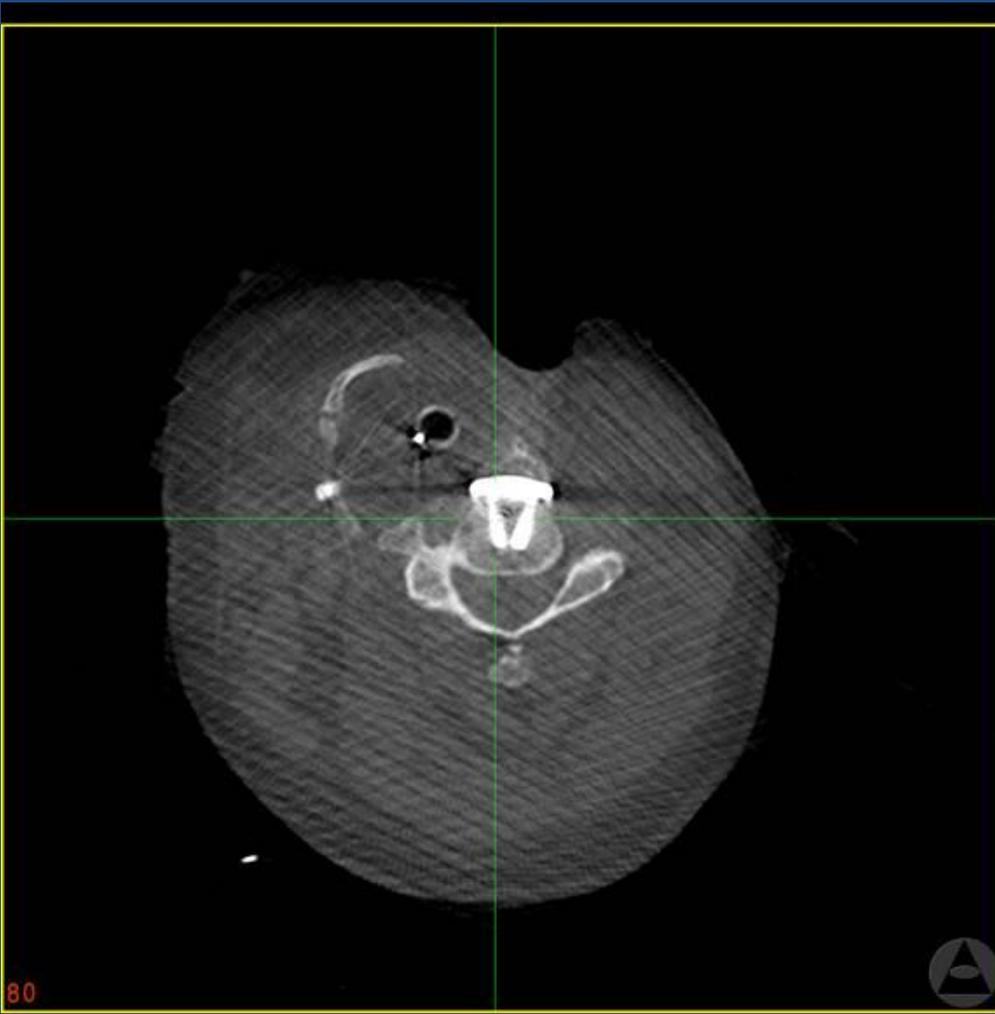


# 3-d standard cervical Imaging



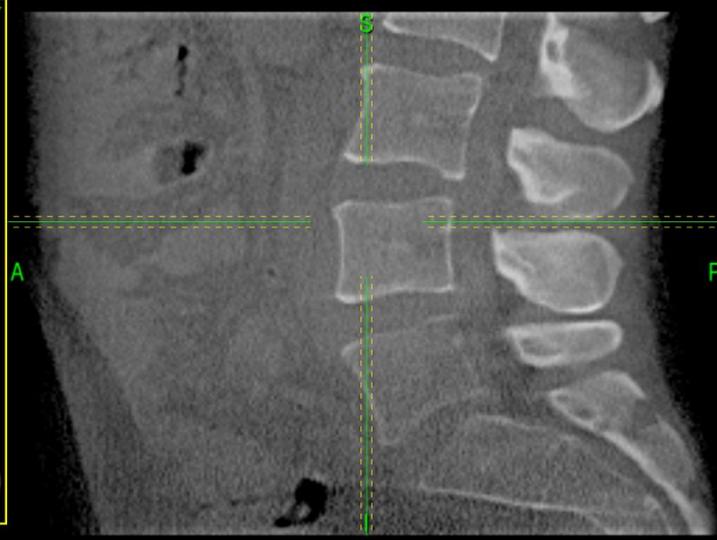
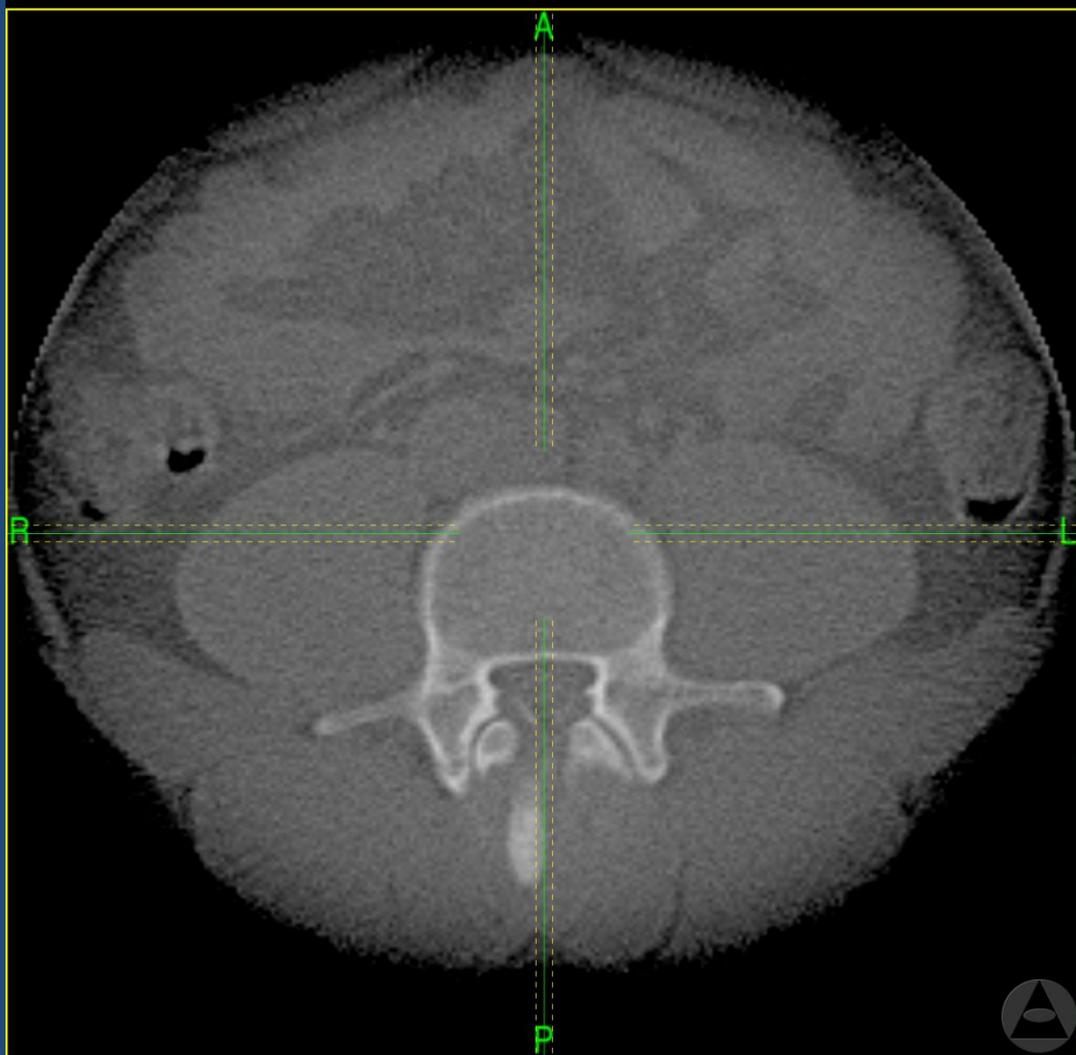


# 3-d standard cervical Fusion



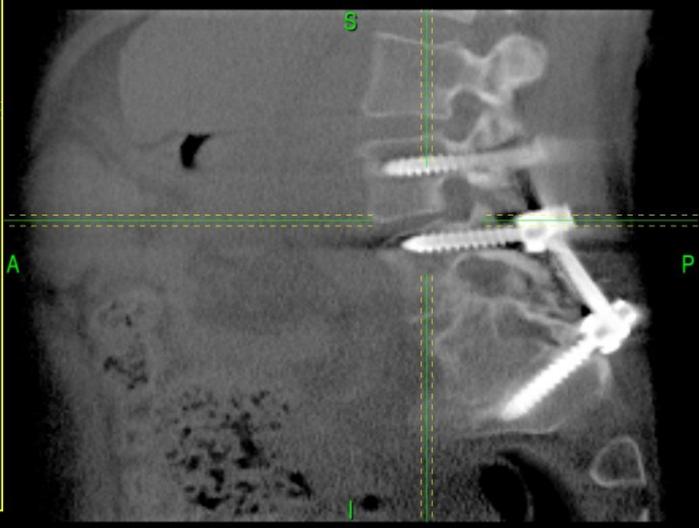
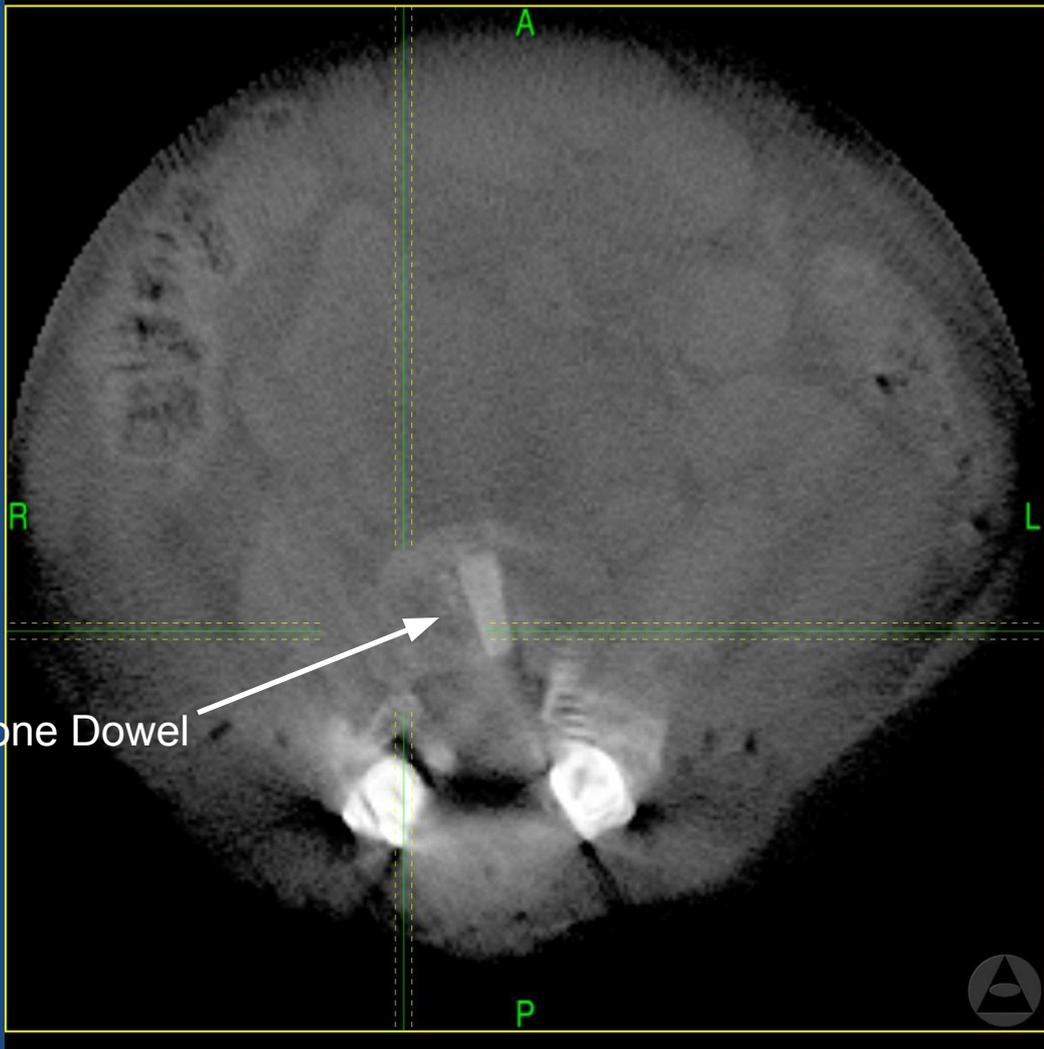


# Pattern 3-d lumbar fusion.





# Pattern 3-d lumbar fusion.



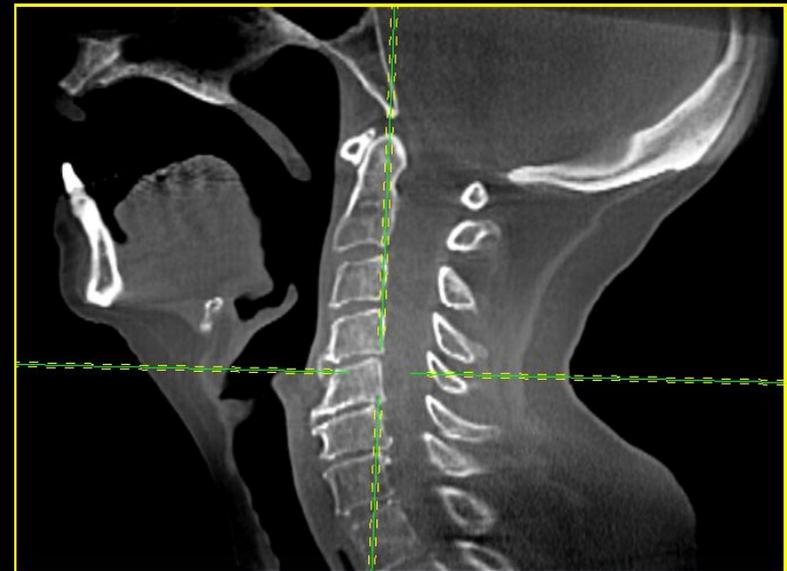
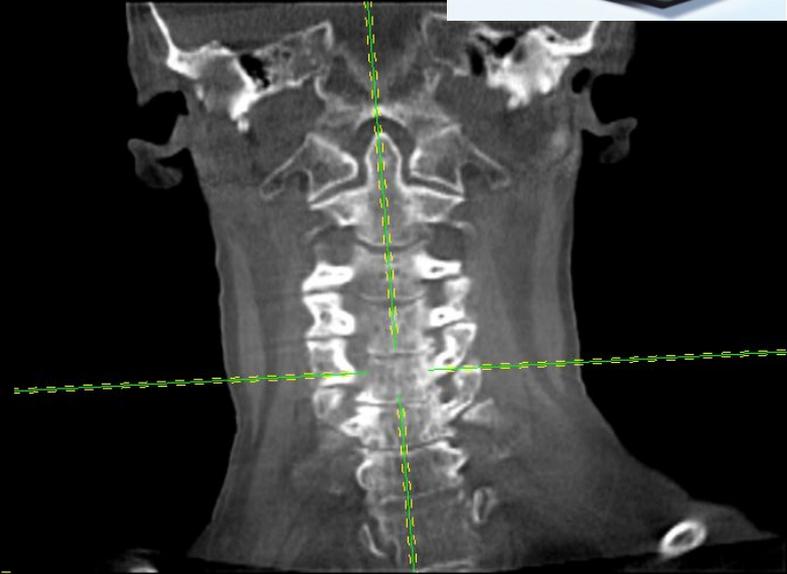
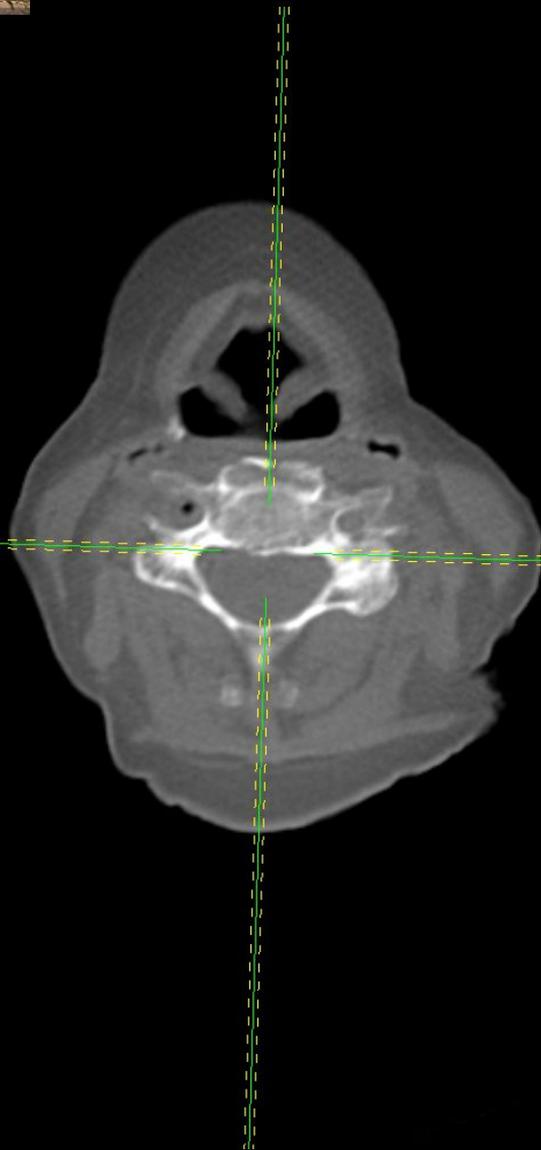


# Multidimensional imaging in spinal fractures

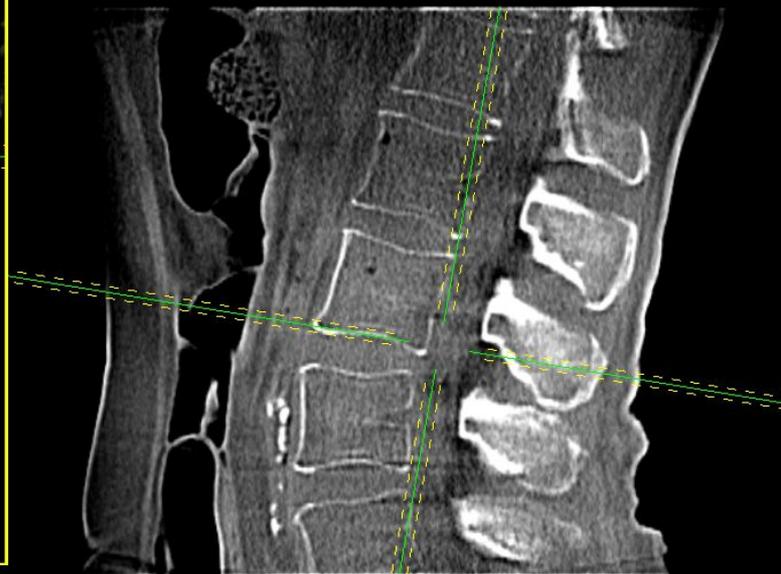
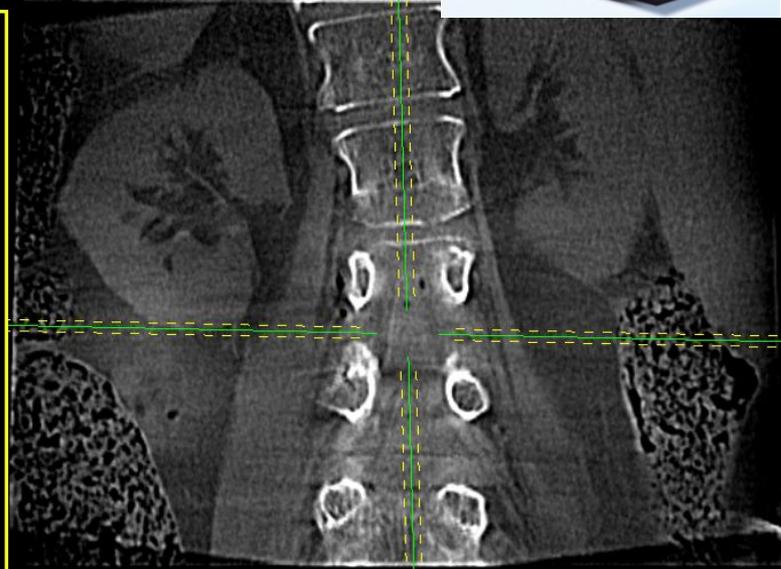
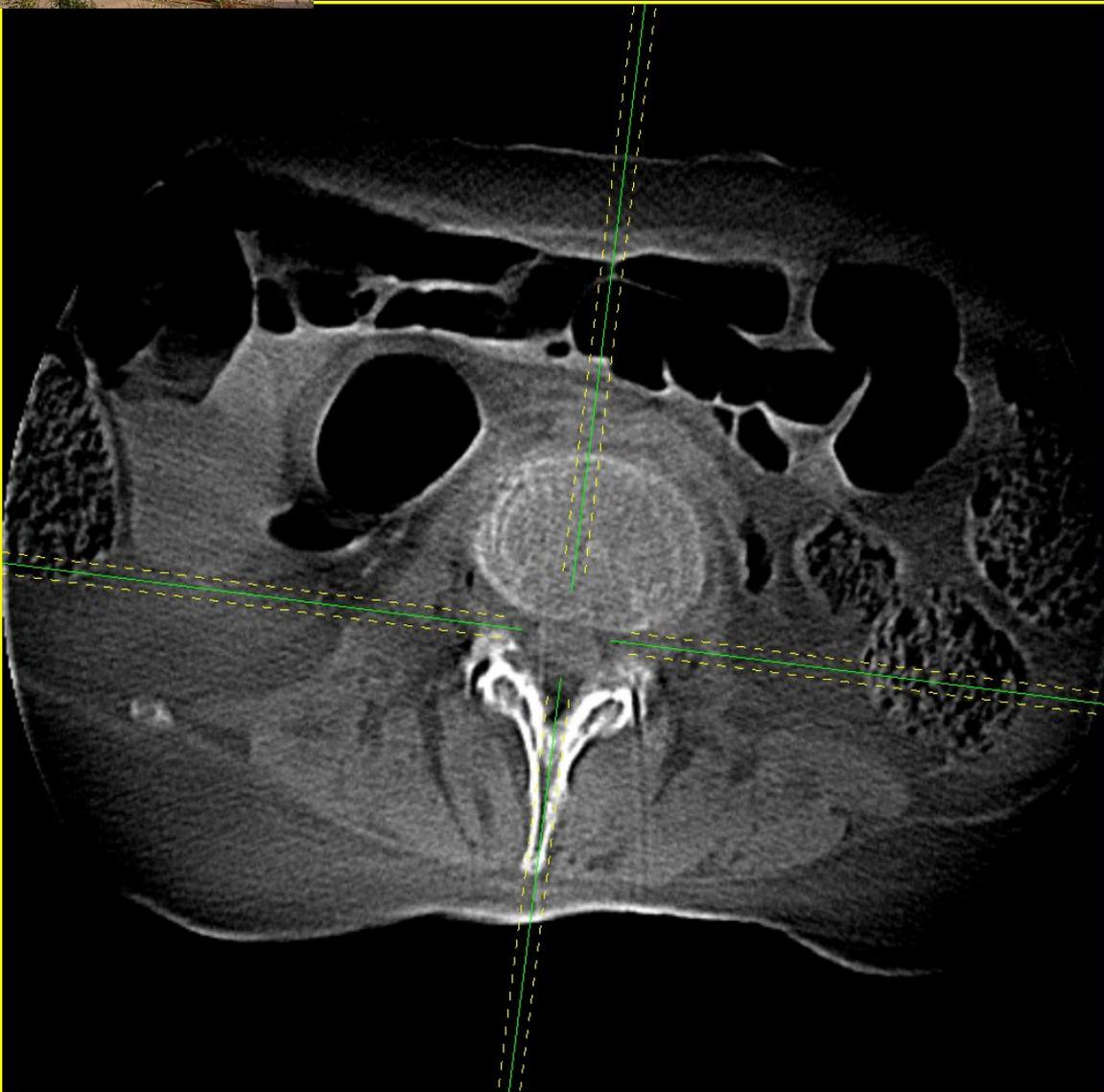


- High Definition, 3-D Imaging (HD3D)
  - 750 Images over 360° in 13 seconds
  - Higher resolution images = increased visibility
  - < 45 seconds to acquire and reconstruct data
- Oblique Slicing
  - Ability to scroll through anatomy from any angle

# HD3D Cervical Imaging



# HD3D Lumbar Imaging



# HD3D Lumbar Sacral Imaging





# Multidimensional imaging in spinal fractures



- Maximum Intensity Projection (MIP) View
  - Transparent 3D reconstruction
- Surface Rendering
  - Surface 3D reconstruction
- Collimated 3D Spin
  - Reduced radiation exposure during 3D scan acquisition



# Multidimensional imaging in spinal fractures



MIP - Cervical Thoracic Junction





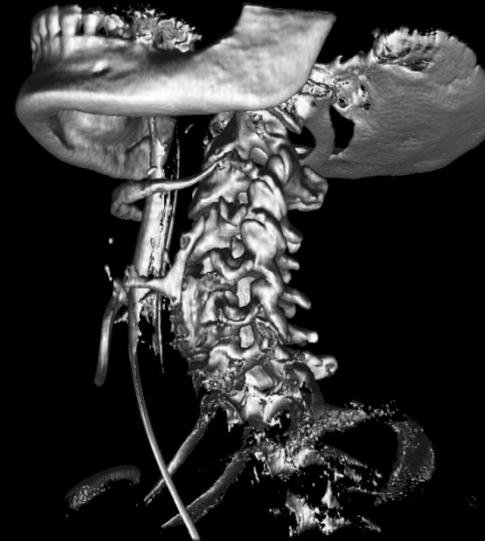
# Multidimensional imaging in spinal fractures



## MIP – Cervical Fusion

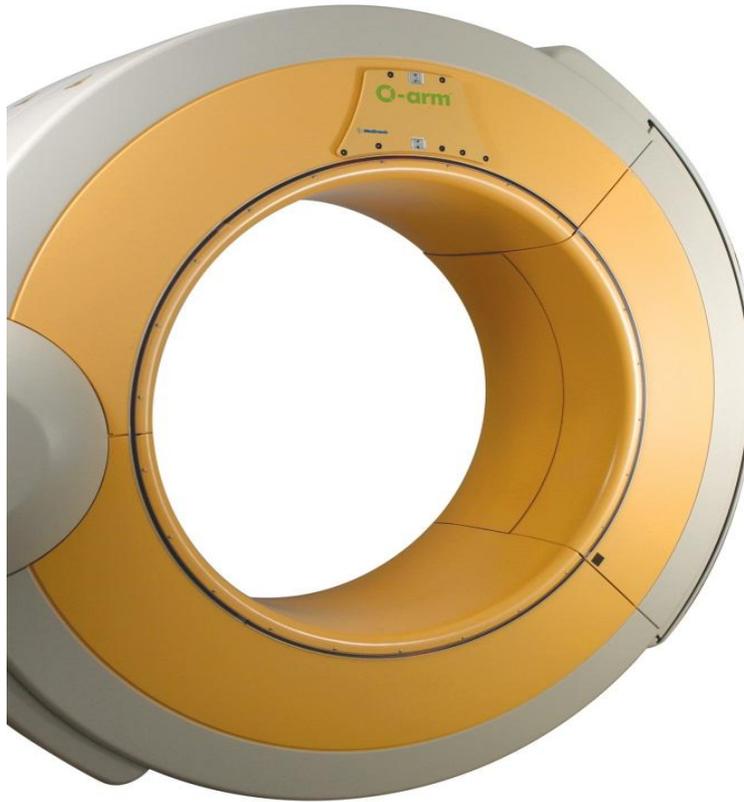


## Surface Rendering View – Cervical Fusion





# Multidimensional imaging in spinal fractures



The O-Arm<sup>®</sup>  
+  
image guided surgery



# Multidimensional imaging in spinal fractures



Welding images and imaging guidance





# Multidimensional imaging in spinal fractures



Select Surgeon



Select Procedure



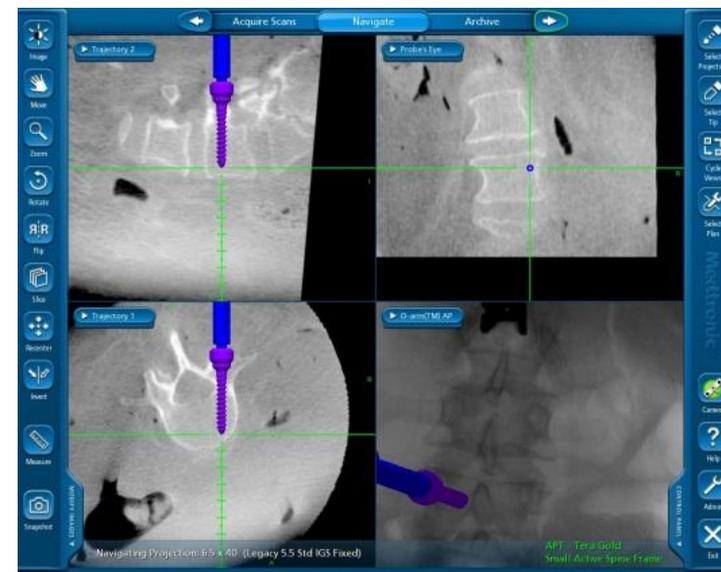
Equipment and instruments are auto-checked



Instruments per surgeon per procedure



Navigate





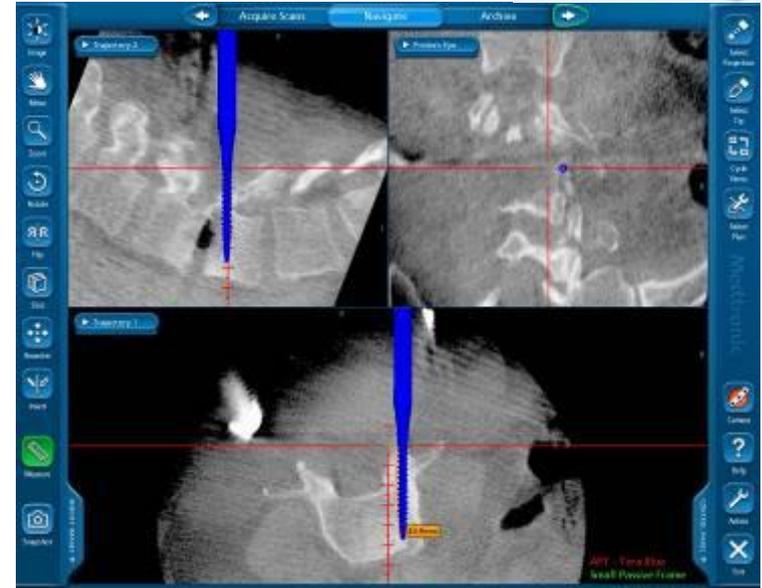
# Multidimensional imaging in spinal fractures



- The O-ARM® imaging system represents the seamless integration of intra-operative imaging with image guided surgery.
- 3-D image data set is automatically transferred to the STEALTHSTATION® TREON® and registered to the patient.



# Multidimensional imaging in spinal fractures



- Tracker permanently mounted and powered by the O-ARM® System - eliminating a manual on/off step
- System detects left vs. right by the unique geometry of the active LED spheres



# Multidimensional imaging in spinal fractures



## ***Time***

Decreased Imaging Time in OR  
Robotic Re-Positioning



## ***Image Quality***

No Correction for Distortion  
Ultra-High Resolution  
Higher X-ray Power  
Large Field of View  
Fast Scan Time  
2D and 3D  
No 'C' Flex



## ***Safety***

Fast scan time: only required  
to suspend respirations for 13  
seconds during image  
acquisition  
Moving components enclosed  
in gantry - no movement in  
free space



## ***Sterility***

No In-and-Out of Sterile Field  
Easy 1-time Draping System



## ***Dose***

Decreased Dose to Surgeon  
Robotic Re-Positioning



# Multidimensional imaging in spinal fractures



## JPNATC Data

Total Surgeries- 196

- Odontoid #-25
- Hangmann #-15
- Subaxial C-Spine #- 35
- Upper D #-57
- Lower D #-64





# Multidimensional imaging in spinal fractures



- O-arm system (Medtronic) allowed 2D and 3D imaging in OR-distortion-free digital flat-panel technology.
- 3D image acquired in 13 seconds- total of 392 single images recorded in a full 360° rotation
- The O-arm gantry positioned from lateral side over patient before being closed. The patient was placed in the isocenter of O-arm.
- Patients placed prone/ Supine.
- After sterile draping of O-arm- skin incision was made.
- The reference frame for spinal navigation was attached either to a spinous process after detachment of the spinal musculature or to the posterior superior iliac spine in percutaneous cases .
- A StealthStation Treon plus system (Medtronic) was used for navigation.

- At beginning of surgery- first 3D scan is acquired- images reconstructed automatically,
- 3D reconstructions appeared on the screen of O-arm viewing station instantly.
- Data set automatically transferred to the StealthStation, and the navigation-assisted insertion of polyaxial pedicle screws) begins without the need for any manual registration, minimizing the time for the setup of the navigation and avoiding possible errors from manual registration.
- This procedure allowed the navigation of a minimum of 4 spinal levels at the lumbar spine.

- In open cases, after detachment of the musculature, a rigid navigated awl followed by a navigable pedicle probe used to open the pedicle.
- In minimally invasive cases, a sextant system (Medtronic) used.
- A sure trak universal adapter (Medtronic) attached to the Jamshidi hollow needle to open the pedicle with help of navigation.
- The correct trajectory of the Jamshidi needle found by putting a 6-cm virtual extension on computerized image of needle.
- Once the trajectory found, needle punctured directly through pedicle into vertebral body.
- A long K-wire placed through hollow needle.
- Skin incision enlarged to allow muscle dilators to be placed over K-wire.
- A navigable hollow tab was used, followed by the hollow pedicle screw in the sextant's screw extender. After screw placement- K-wire removed.

- percutaneous screws



# Multidimensional imaging in spinal fractures



Acquire Scans    Navigate    Archive

Image  
Move  
Zoom  
Rotate  
Flip  
Slice  
Recenter  
Invert  
Measure

MODIFY IMAGES

Snapshot

Dr. Sumit Sinha  
PROCEDURE:  
Open Thoracolumbar  
Fusion: O-arm(TM)  
PATIENT:  
^Pappu^O-arm

Select Projection    Select Tip    Cycle Views    Select Plan

View Settings  
Edit Plans  
Screws

Tracking View

Close    Far

Camera Details    Foot Pedal    Sure Trak

Camera    Help    Admin    Exit

Passive Planar, Ball 1.5  
Small Passive Frame



# Multidimensional imaging in spinal fractures



Acquire Scans    Navigate    Archive

▶ Trajectory 2    ▶ Probe's Eye

▶ Trajectory 1    ▶ O-arm(TM) AP

Dr. Sumit Sinha  
PROCEDURE:  
Open Thoracolumbar  
Fusion: O-arm(TM)  
PATIENT:  
Sukhbir^singh^22 year O -/

Select Projection    Select Tip    Cycle Views    Select Plan

▶ View Settings  
▶ Edit Plans  
▶ Screws

Tracking View

Close    Far

Camera Details    Foot Pedal    Sure Trak

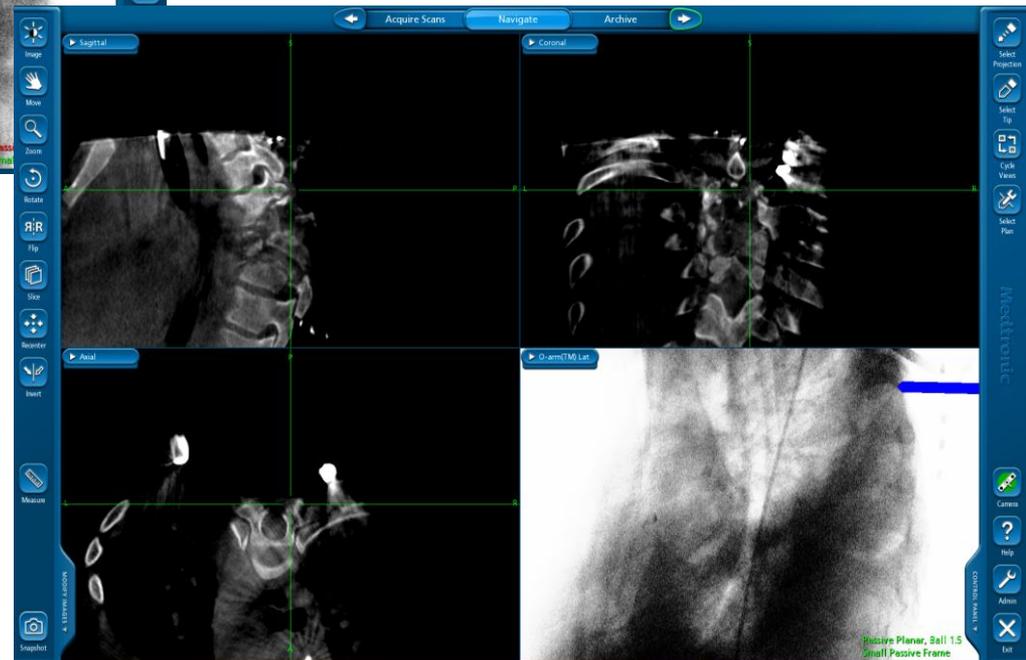
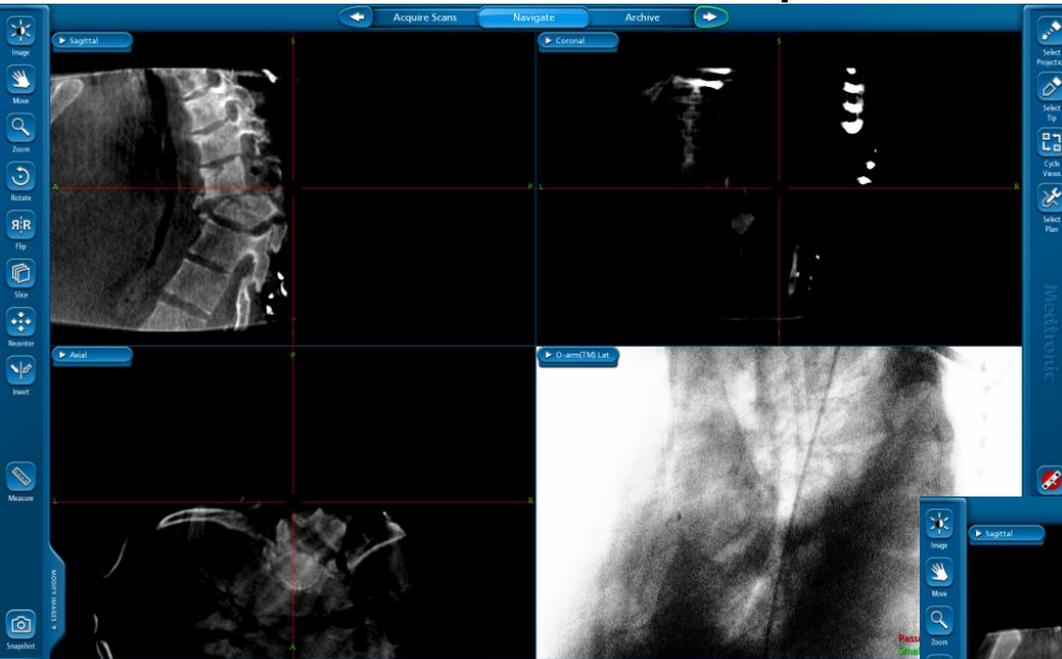
APT - Tera Purple  
Small Passive Frame

CONTROL PANEL

Camera    Help    Admin    Exit



# Multidimensional imaging in spinal fractures

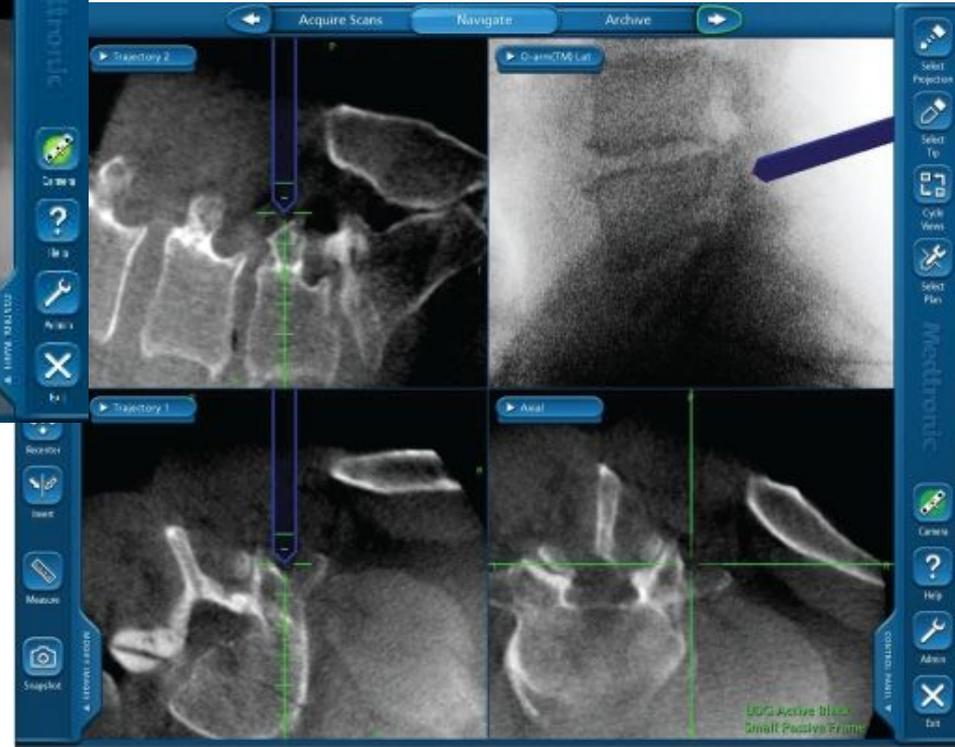




# Multidimensional imaging in spinal fractures

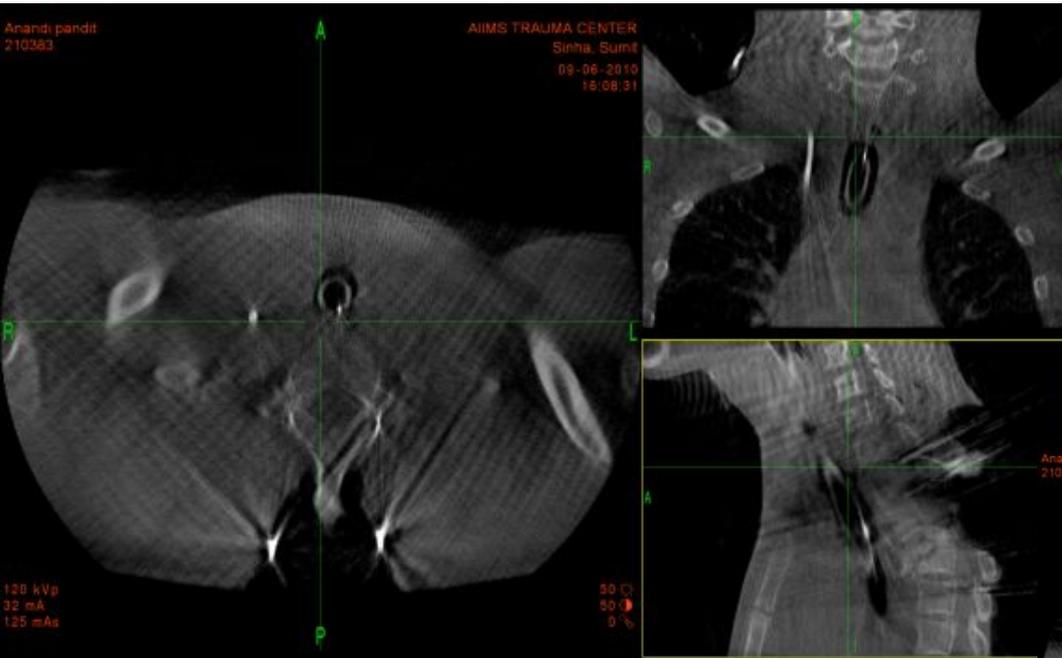


Real-time guidance  
intra-operative without  
continued exposure to  
radiation





# Multidimensional imaging in spinal fractures



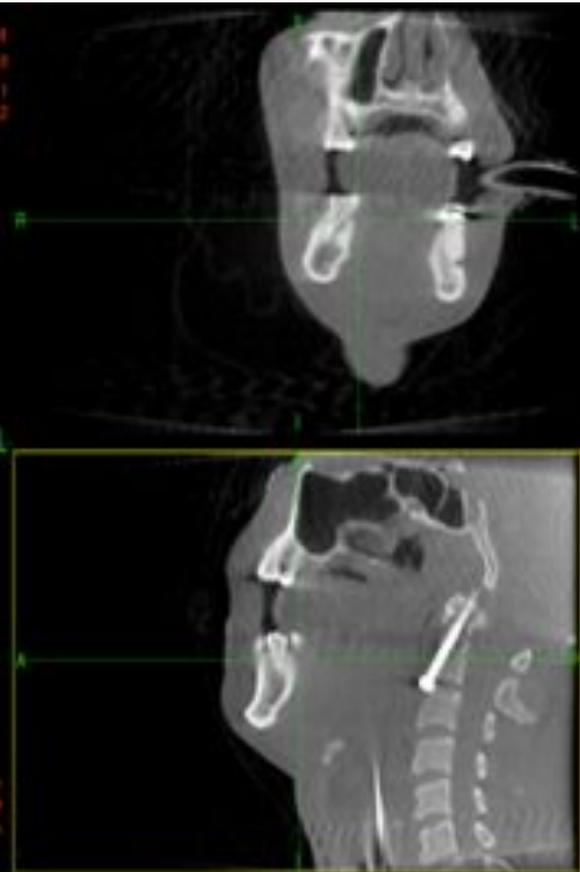
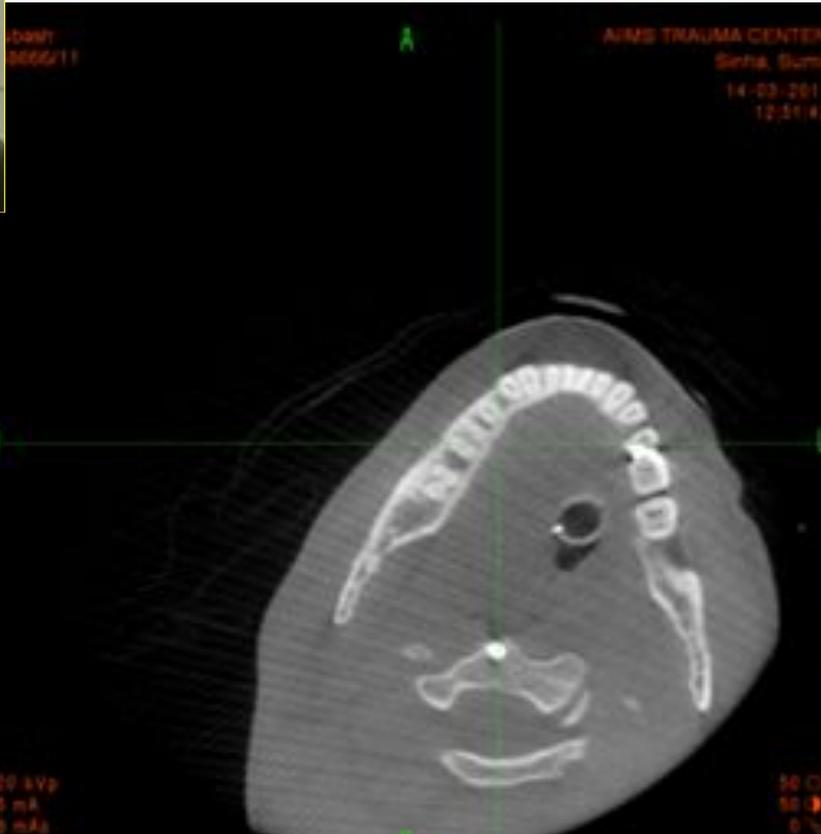
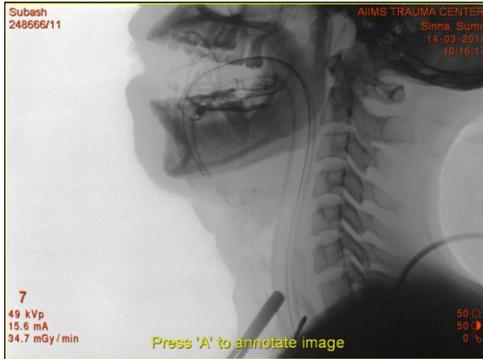


# Multidimensional imaging in spinal fractures



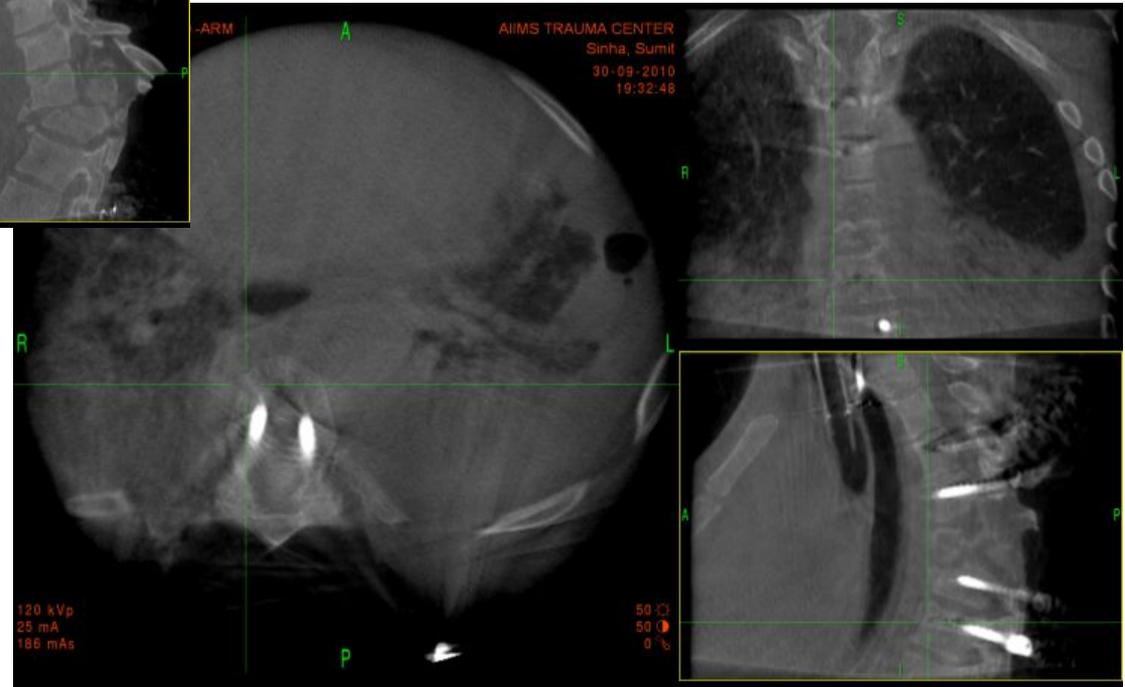
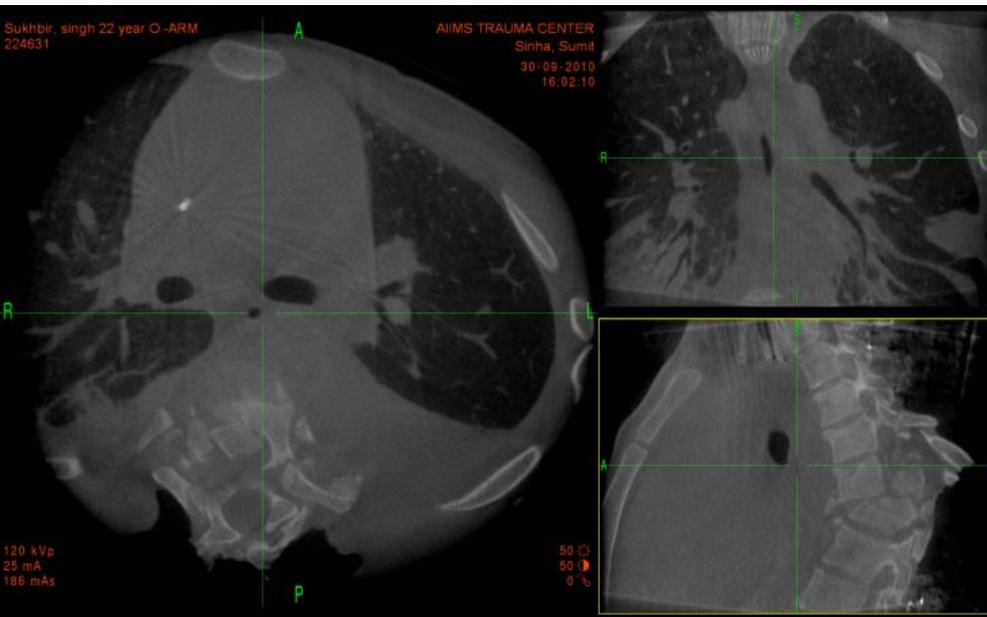


# Multidimensional imaging in spinal fractures





# Multidimensional imaging in spinal fractures

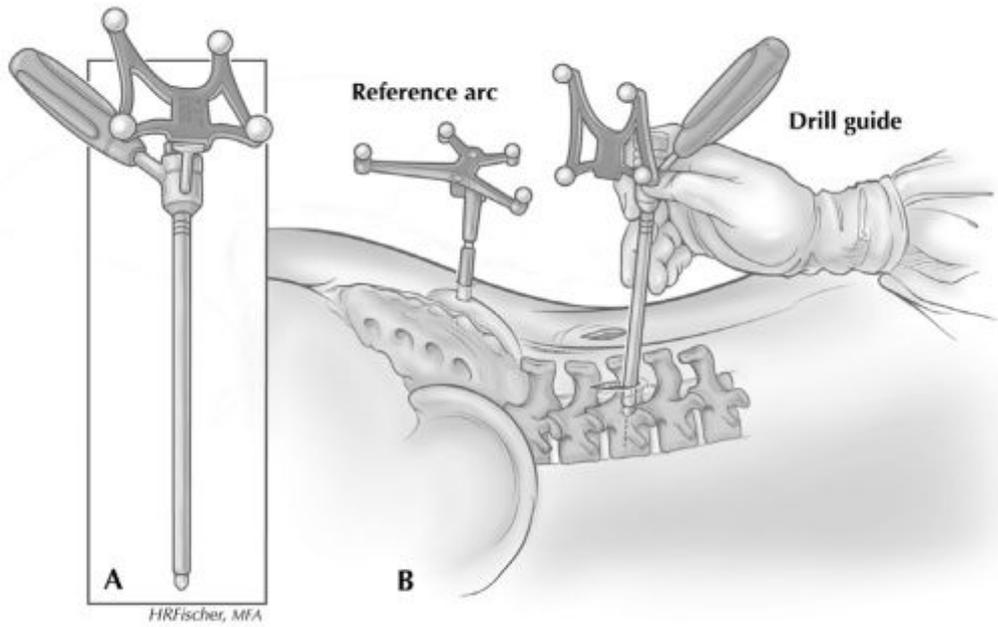




# Multidimensional imaging in spinal fractures



## Spinal fixation percutaneous



	Fluoroscopy-assisted	Preoperative CT-based CalG	Intraoperative Iso-C-based CalG	Intraoperative O-arm-based CalG
Advantages	<p>↓Time</p> <p>↓Cost</p>	<p>↑Accuracy</p> <p>↓Surgeon radiation exposure</p>	<p>↑Accuracy</p> <p>↓Surgeon radiation exposure</p> <p>↓Time (versus preoperative CT-based CalG)</p> <p>Can acquire intraoperative multi-planar images</p> <p>Can act as a fluoroscope</p>	<p>↑Accuracy*</p> <p>↓Surgeon radiation exposure</p> <p>↓Time (versus preoperative CT-based CalG)</p> <p>Can acquire intraoperative multi-planar images</p> <p>Can act as a fluoroscope</p> <p>↑Image quality (versus Iso-C-based CalG)**</p> <p>↑Field of view (more spinal segments can be imaged)**</p> <p>Robotic re-positioning to preprogrammed fluoroscopic views**</p>
Disadvantages	<p>↓Accuracy</p> <p>↑Surgeon radiation exposure</p>	<p>↑Cost</p> <p>↑Time (surgeon-derived registration)</p>	<p>↑↑Cost</p>	<p>↑↑↑Cost</p> <p>Ergonomics (O-arm is larger than a fluoroscope or Iso-C)</p>



**THANKYOU**