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
- 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

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

6 times the 3-D volume derived from a 9” image intensifier
2-D Imaging lumbar.
2-D Imaging lumbar spine with screws
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
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MIP – Cervical Fusion

Surface Rendering View – Cervical Fusion
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The O-Arm ® + 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
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

**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

**Time**
- Decreased Imaging Time in OR
- Robotic Re-Positioning

**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
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Real-time guidance intra-operative without continued exposure to radiation
Multidimensional imaging in spinal fractures
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Spinal fixation percutaneous
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<tr>
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<th>Fluoroscopy-assisted Preoperative CT-based CaIG</th>
<th>Intraoperative Iso-C-based CaIG</th>
<th>Intraoperative O-arm-based CaIG</th>
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<tr>
<td><strong>Advantages</strong></td>
<td>↓Time</td>
<td>↑Accuracy</td>
<td>↑Accuracy*</td>
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<td></td>
<td>↓Cost</td>
<td>↓Surgeon radiation exposure</td>
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<td>↓Time (versus preoperative CT-based CaIG)</td>
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<td>Can acquire intraoperative multi-planar images</td>
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<td>Can act as a fluoroscope</td>
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<td>↑Image quality (versus Iso-C-based CaIG)**</td>
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<td>↑Field of view (more spinal segments can be imaged)**</td>
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<td>Robotic re-positioning to preprogrammed fluoroscopic views**</td>
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<td><strong>Disadvantages</strong></td>
<td>↓Accuracy</td>
<td>↑Cost</td>
<td>↑↑Cost</td>
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<td>↑Surgeon radiation exposure</td>
<td>↑Time (surgeon-derived registration)</td>
<td>↑↑↑Cost</td>
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<td>Ergonomics (O-arm is larger than a fluoroscope or Iso-C)</td>
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