

**Integration of Robotics and Navigation with Intra-operative Imaging**

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The I-STAR Lab ([istar.jhu.edu](http://istar.jhu.edu))



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[istar.jhu.edu](http://istar.jhu.edu)

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[carnegie.jhu.edu](http://carnegie.jhu.edu)

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Medtronic (Intraoperative 3D Imaging and Registration)

**Disclosures**  
Spine Align (Consultant)  
The Phantom Laboratory (Consultant)

\* Presentation includes research systems and off-label use.



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**Intraoperative C-arms for 2D & 3D Imaging**

**Platforms**  
C-arm, U-arm, O-arm, ...

**Modern C-arms**  
Flat panel detector  
Large FOV, distortion-free  
Motorized orbit  
Cone-beam CT capable  
Low dose, high resolution

**Applications in**  
Neurosurgery, Orthopaedics,  
Vascular, Thoracic, ...

**Integration with**  
Surgical tracking,  
Robotic instruments



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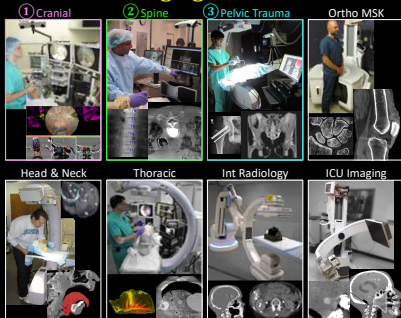
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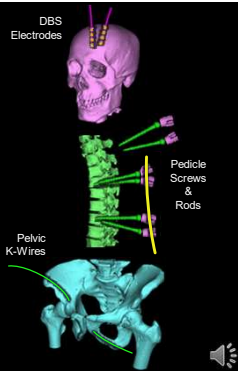
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**Presentation Outline**

**① Cranial Neurosurgery**  
Deep brain stimulation  
Imaging for soft-tissue visibility and target visualization  
Imaging and localizing implants

**② Spinal Neurosurgery**  
Deformity correction via pedicle screw placement  
Alternative imaging modalities  
Automatic registration of patient, devices, and navigation

**③ Pelvic Trauma Surgery**  
Fracture reduction and fixation  
Automating surgical planning  
Robotic assistance for imaging workflows



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**① Cranial Neurosurgery**

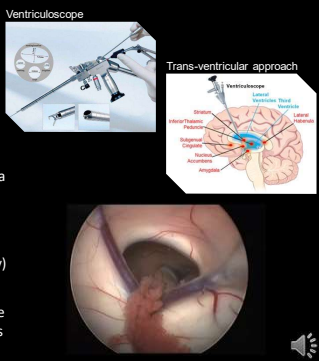
**Clinical tasks**  
Deep brain stimulation (DBS), stereotactic biopsy, sEEG electrode placement, ventriculostomy, ablation procedures

**Emerging DBS techniques**  
Novel targets: Fornix, thalamic nuclei, amygdala  
Treatment of: Alzheimer's, autism, depression

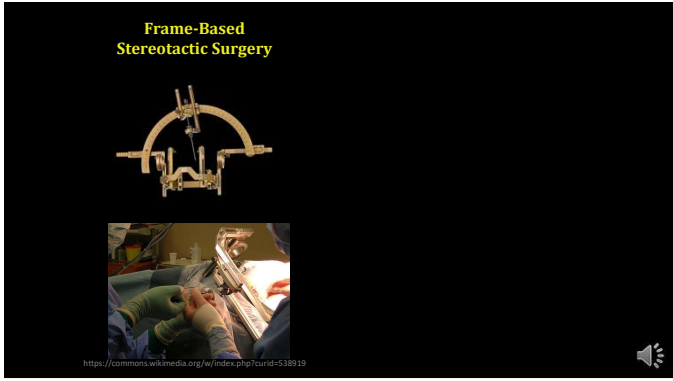
**Trans-ventricular approach**  
Confident visualization of landmarks  
Target vs. normal structures (e.g., basilar artery)

**Image guidance and robotic assistance**

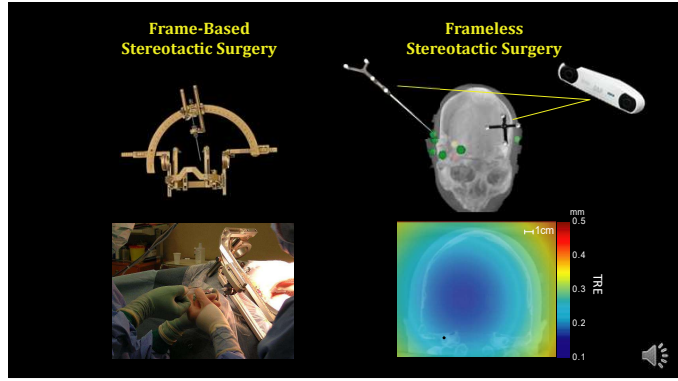
- 1) Guidance within the endoscopic video scene
- 2) Accounting for deformation from CSF egress



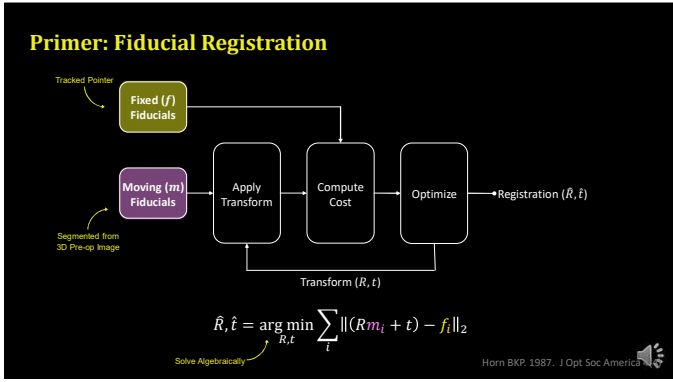
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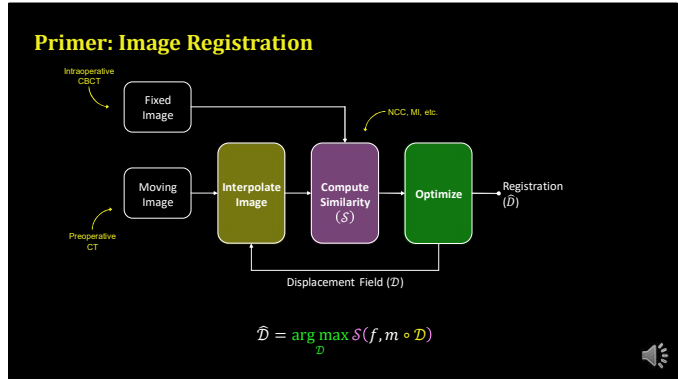
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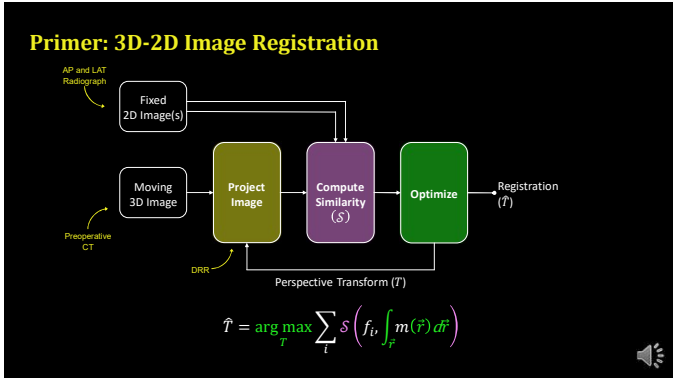
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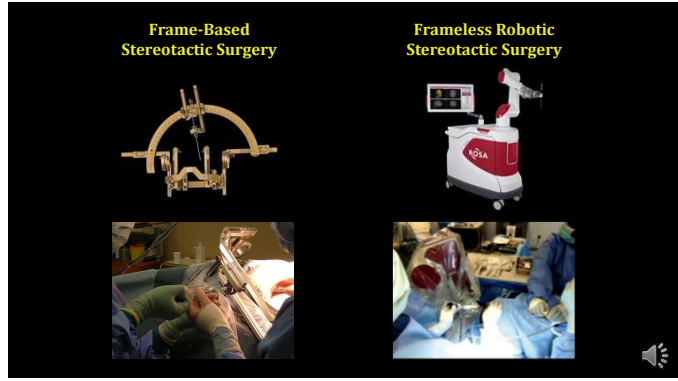
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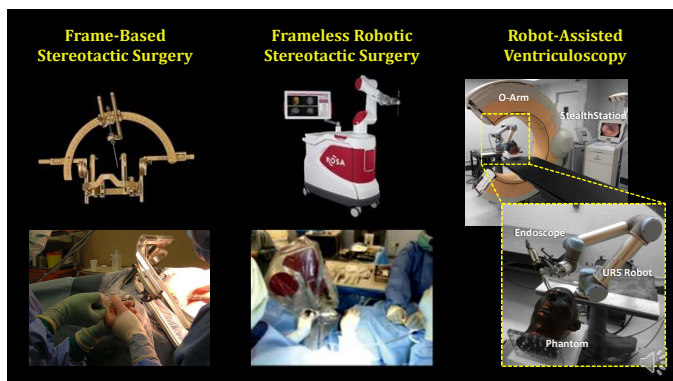
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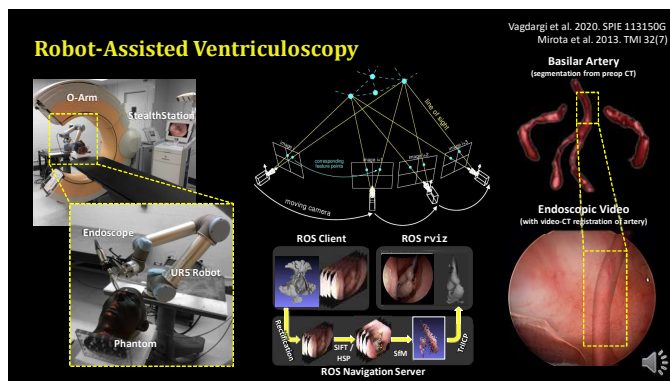
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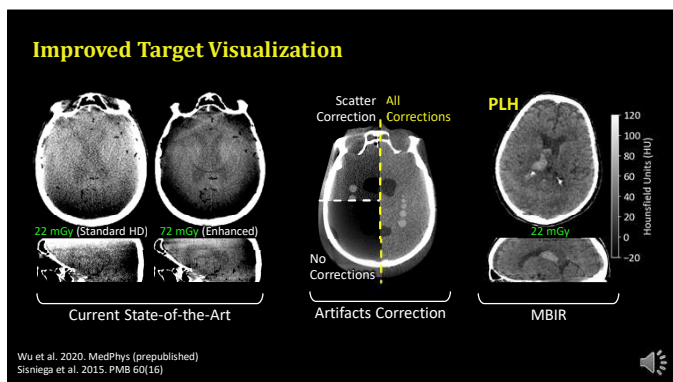
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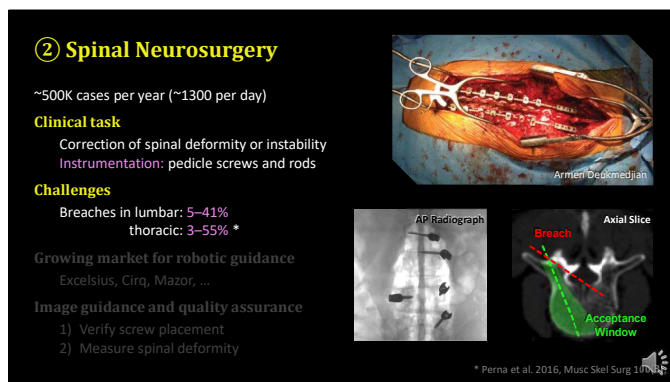
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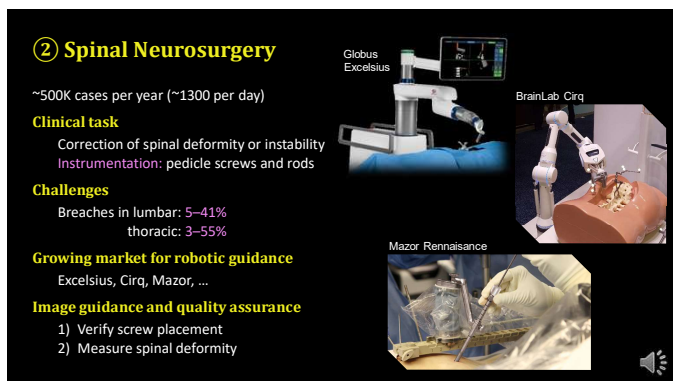
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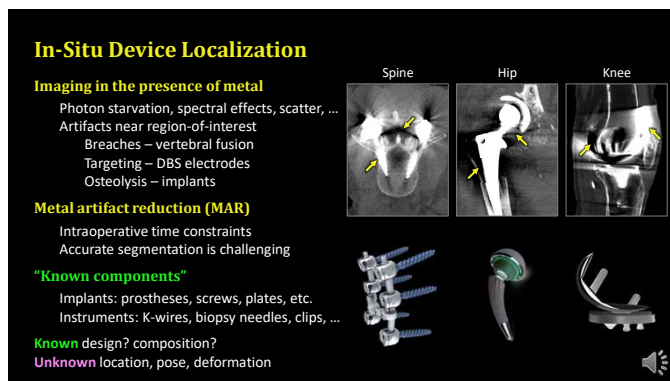
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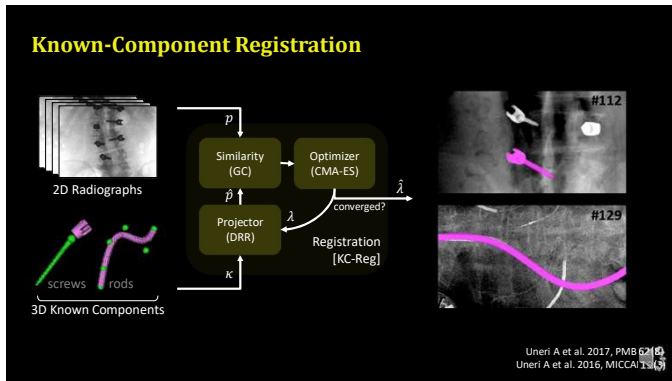
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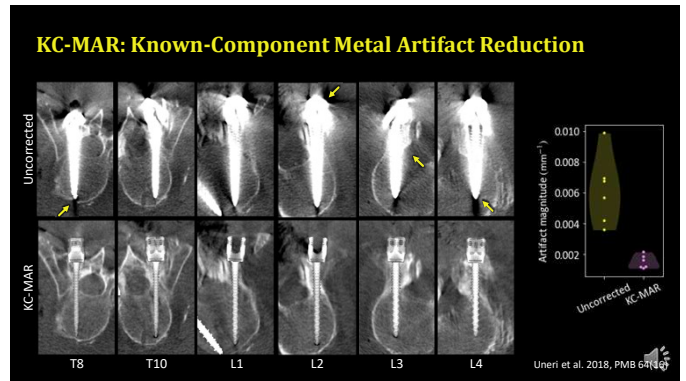
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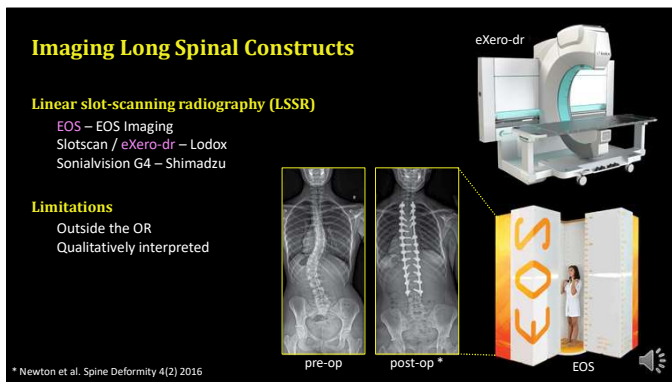
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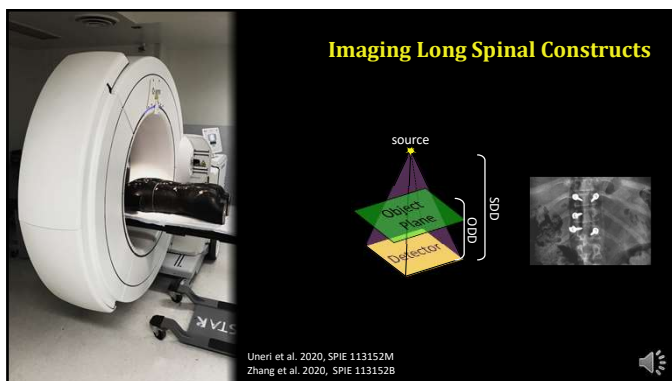
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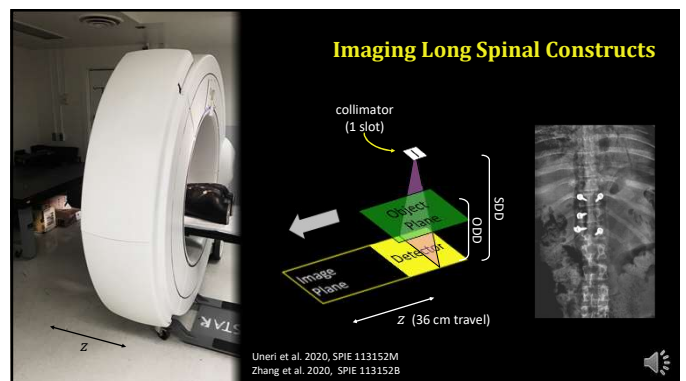
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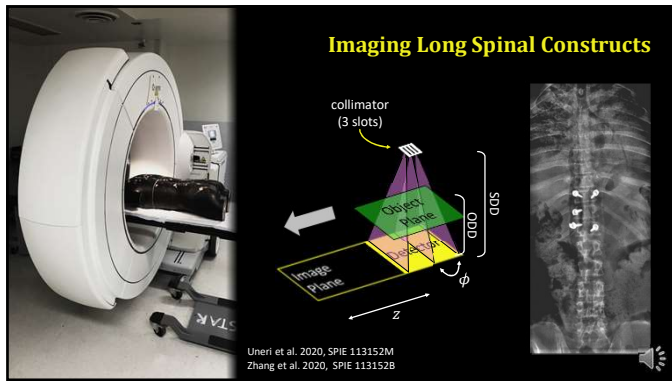
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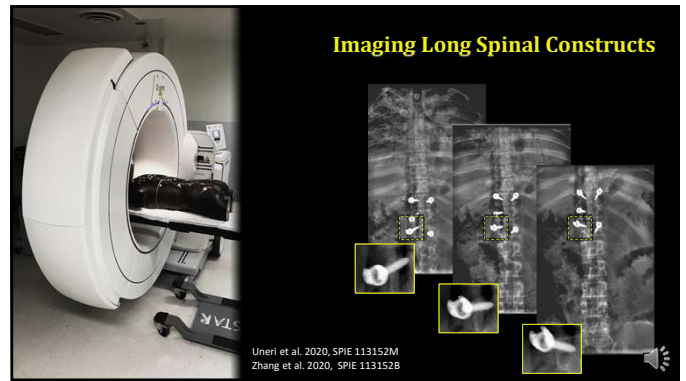
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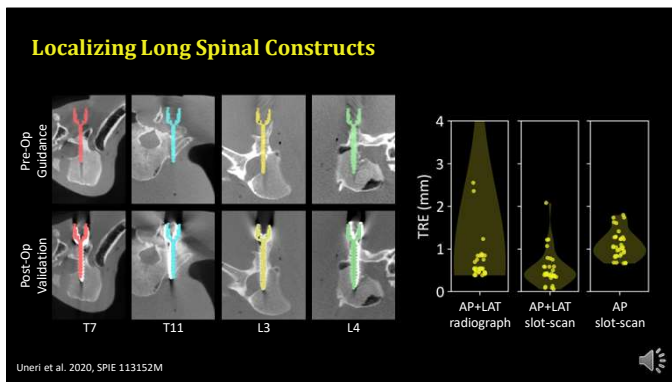
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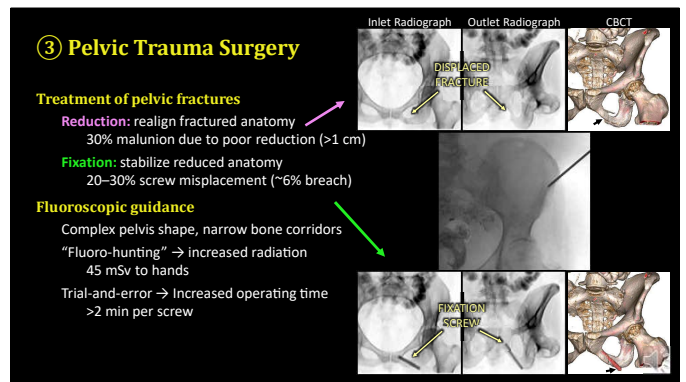
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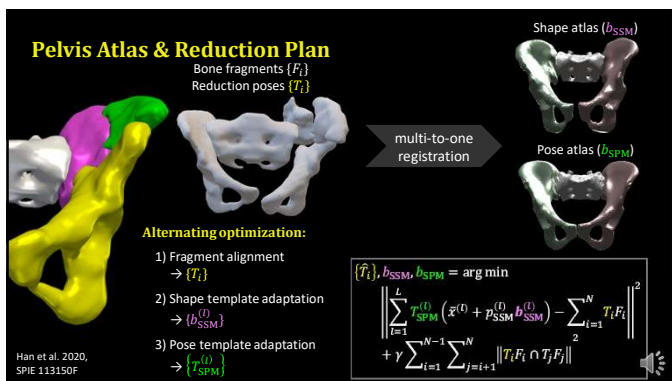
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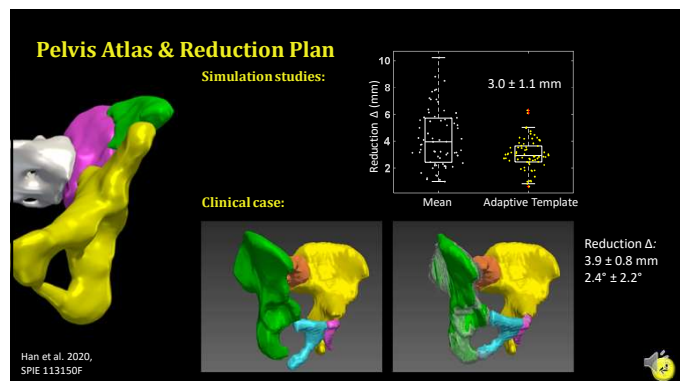
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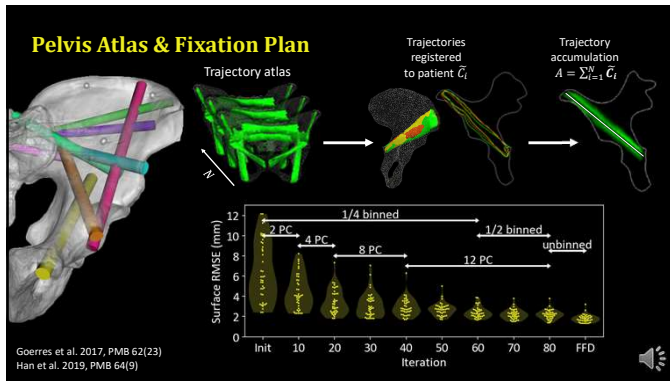
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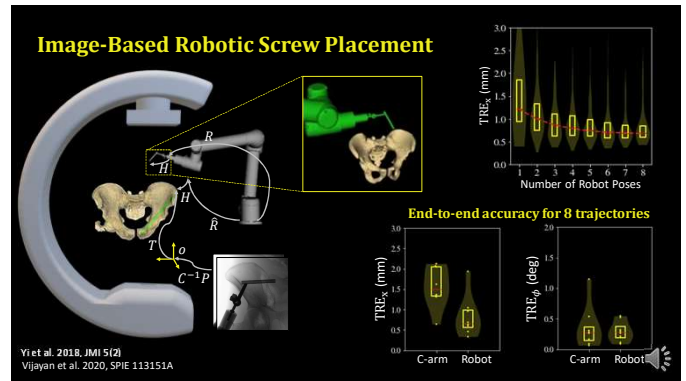
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**Conclusions**

**Intra-op imaging + prior knowledge**

- Physical device models for registration
- Learned instrument shapes for detection
- Statistical atlases for planning

**Complement standard of care**

- Use already acquired images
- Compatible with standard C-arms

**Robotic surgery for the mainstream**

- Lowering the barrier-to-entry for robotic assistance
- High-precision instrument positioning (<2 mm, <1°)
- Reduced imaging dose to staff

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**Acknowledgements**

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