

Surgical Robot

“Will AI driven robot replace a surgeon?”

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Surgical Robots





Surgical Robot Functional Type

- Passive:
 - Robot / navigational tool to support a manual surgical approach
 - Surgical approach based on 2D images and/or video images
 - Decision making: Surgeon Centric
- Active:
 - Robot to support a pre-defined surgical plan
 - Surgical plan based on 2D/3D images
 - Decision making: Surgical plan centric under surgeon's supervision
- Intelligent:
 - Robot to support an AI-driven surgical plan
 - Surgical plan based on AI processed 2D/3D images and sensors
 - Decision making: AI-driven process with quality control

Surgical Robot Clinical Applications

❖ Radio-Surgery

- Unity (Elekta)
 - ✓ Semi-Active Robotics (Radio-surgery Planning)
 - ✓ MR-Linac, targeting based on 1.5T MR images
 - ✓ Improve outcome without breaking skin



❖ Soft Tissue

- Da Vinci (Intuitive Surgical)
 - ✓ Passive Robotics (Tele-presence)
 - ✓ Surgical Planning with endoscope & video imaging
 - ✓ Improve outcome



❖ Hard Tissue

- Mako (Stryker)
 - ✓ Passive / Semi-Active Robot (Surgical guidance)
 - ✓ Surgeon centric decision making based on the surgical plan
 - ✓ Improve outcome



Radio-Surgery Robot

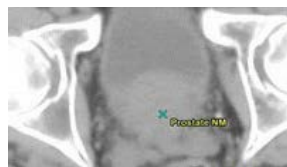
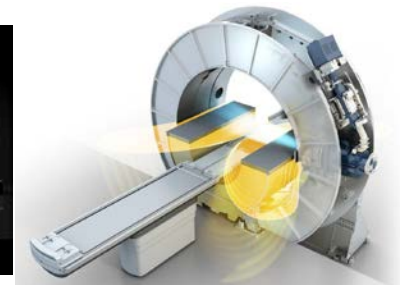
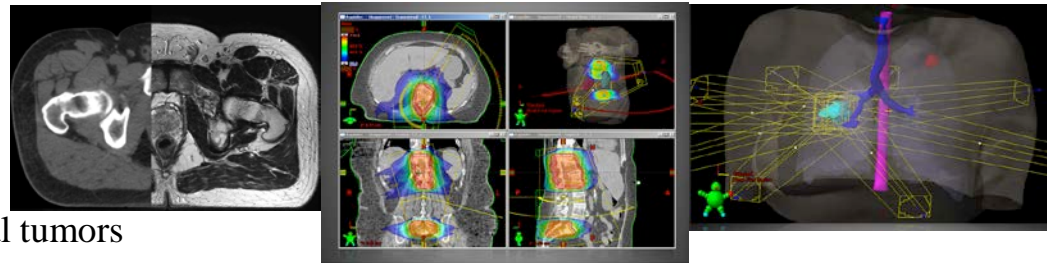
❖ Radiation Treatment Systems

- Several products from Varian, Elekta, ...
 - ✓ Treatment planning system based on CT & MRI images
 - ✓ Multiple treatments

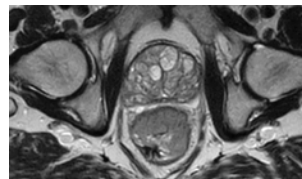


❖ Radio-Surgery

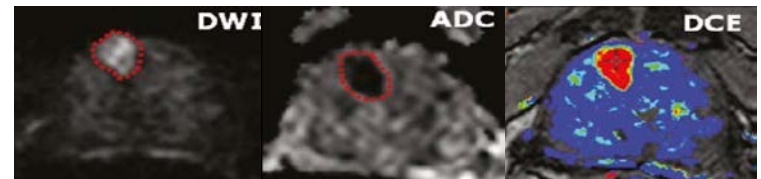
- GammaKnife (Elekta)
 - ✓ Single treatment for cranial tumors
- CyberKnife (Accuray)
 - ✓ Few treatments
- Zap-X (Zap Surgical)
 - ✓ Few treatment
 - ✓ Self-shielded
- Unity (Elekta)
 - ✓ Few treatment
 - ✓ MR-Linac, targeting based on real time MR images



CBCT



1.5T MR

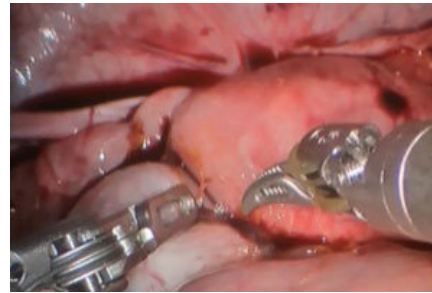


Quantitative 1.5T MR

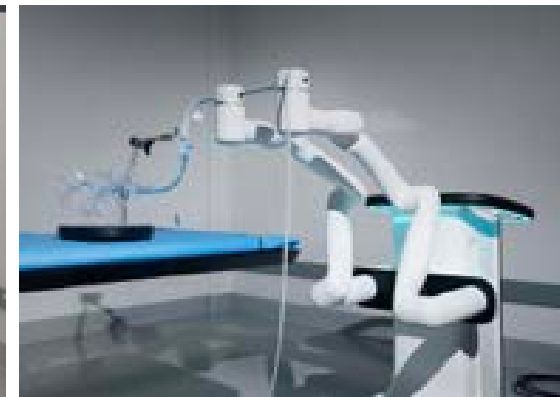
Soft Tissue Robot



Da Vinci



Monarch
"flexible robotics"



Hard Tissue Robot: Before Surgery

❖ Patient Selection

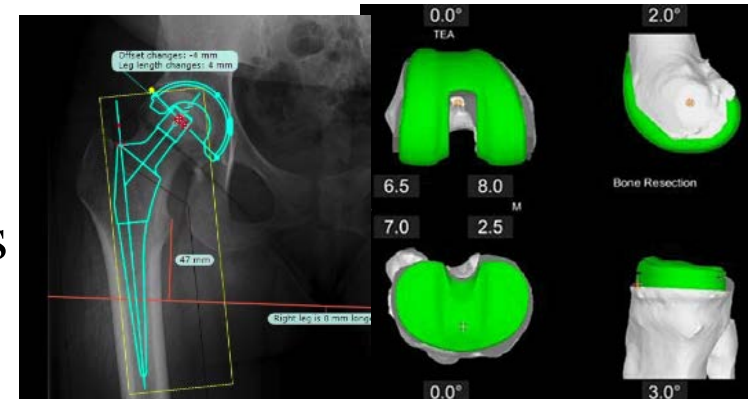
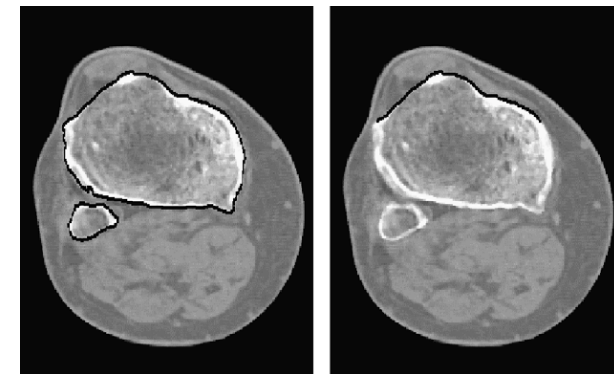
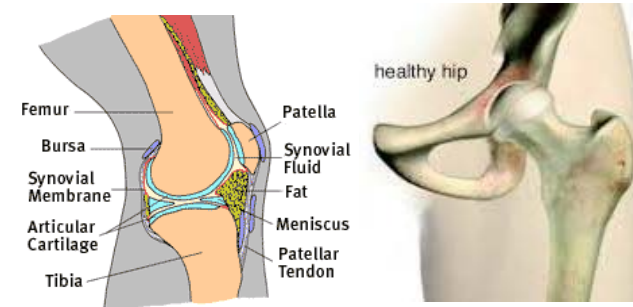
- Selecting robotic surgery candidate
- 60 – 80% of cases

❖ Imaging

- CT / X-ray / US / MRI DICOM image
- Selecting imaging quality and coverage

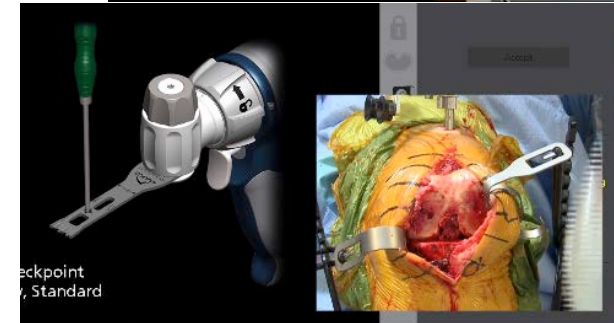
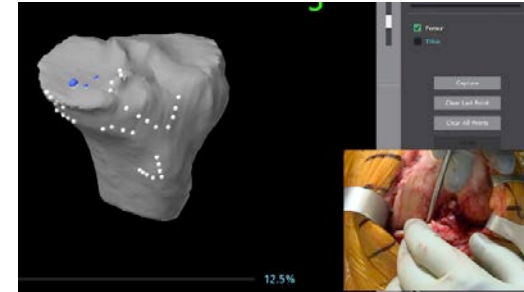
❖ Surgical Planning

- Planning quickly & reproducibly
- Placing implant accurately
- Tool path avoiding critical structures



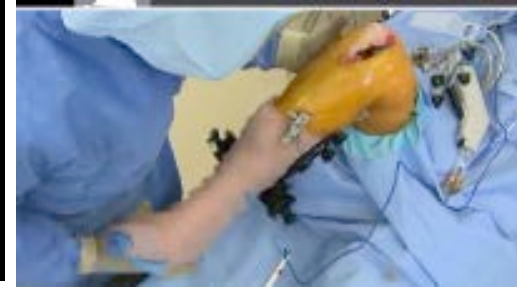
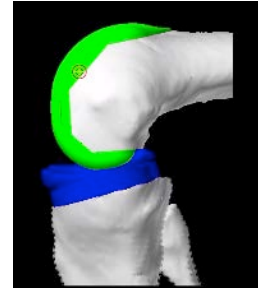
Hard Tissue Robot: During Surgery

- ❖ Registration of robot coordinate system with patient's
 - Matching surgical plan with patient anatomical structure
- ❖ Movement control (Navigation)
 - Reducing relative motion
- ❖ Protecting critical structure
 - Cut path avoiding critical structures
- ❖ Monitoring quality of incision / cutting
 - Accuracy and reproducibility



Hard Tissue Robot: Validation

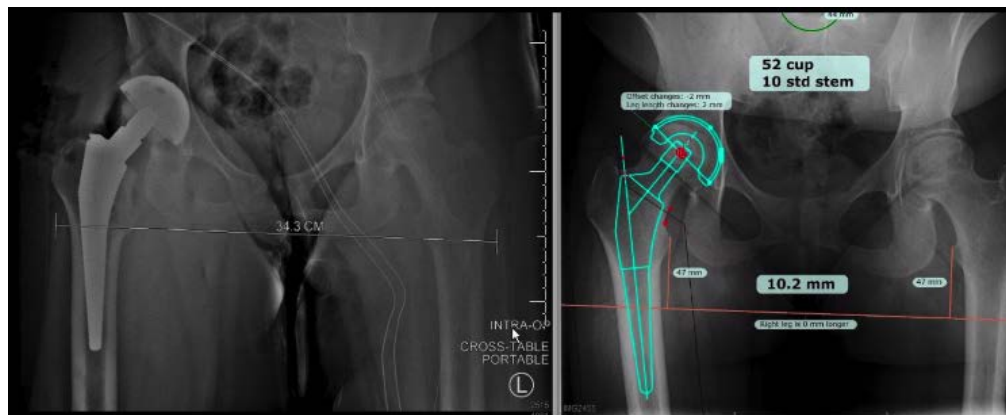
- ❖ Range of motion
 - Managing quality of life



- ❖ Implant placement and alignment
 - Placing implant accurately & reproducibly



- ❖ Infection management
 - Preventing infection



Wish List

- Real-Time Visualization / Surgical Planning:
 - DICOM image to surgical plan: 45 min to under 2 min
 - Updating surgical plan: few seconds
- Reproducibility & Precision:
 - Reproducible surgical plan
 - Dependable outcome: no surprises
- New Information:
 - Improving knowledge base with new information.
 - Real-time sensor input
- Management of Error:
 - How to identify singularity before it happens.
 - How to learn from error

Thank you.

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