Intraoperative simulator for navigated surgeries of the scoliotic spine: first results

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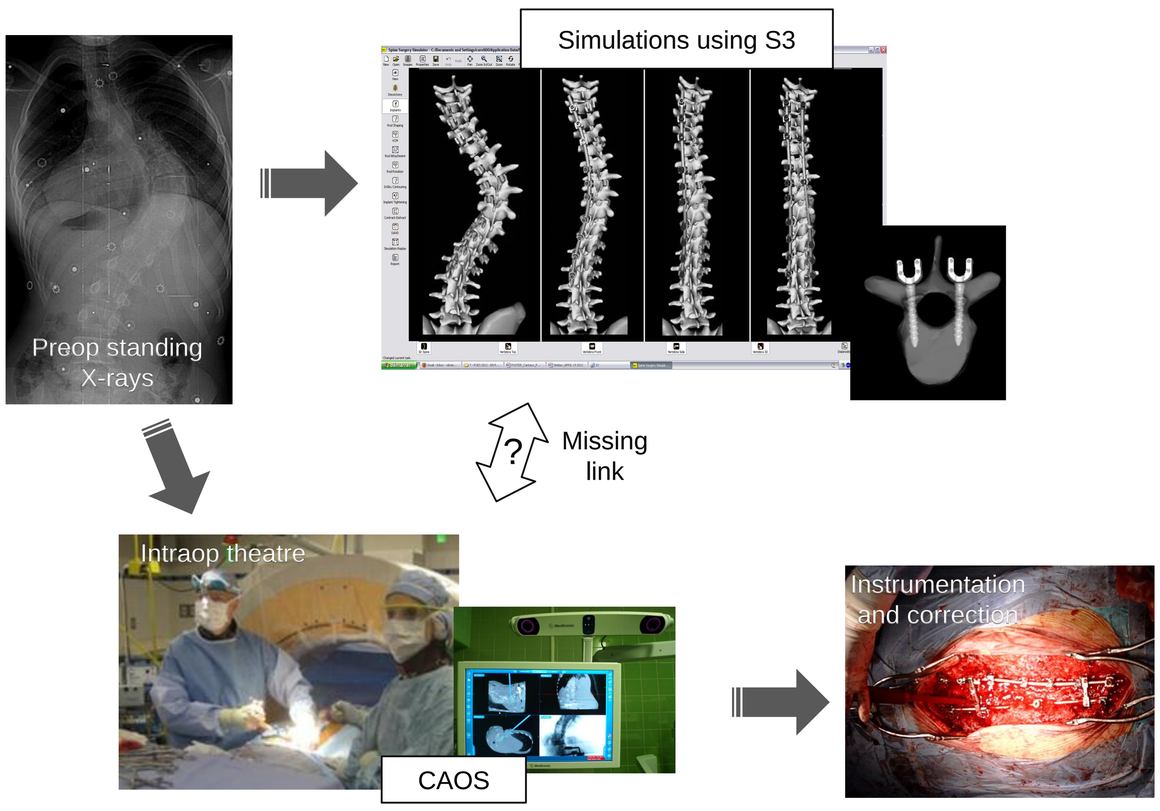
Introduction

- Scoliotic spine instrumentation = complex surgery requiring many decisions pre- and intraoperatively[1,2]
- Preop computational simulator (S3) → allows planning screw pattern design and simulating instrumentation correction[3]
- Commercially available intraop imaging/navigation systems (CAOS) → allow guiding pedicle screws insertion[4]



Objective

To develop a new computational simulator for navigated surgeries of the scoliotic spine.

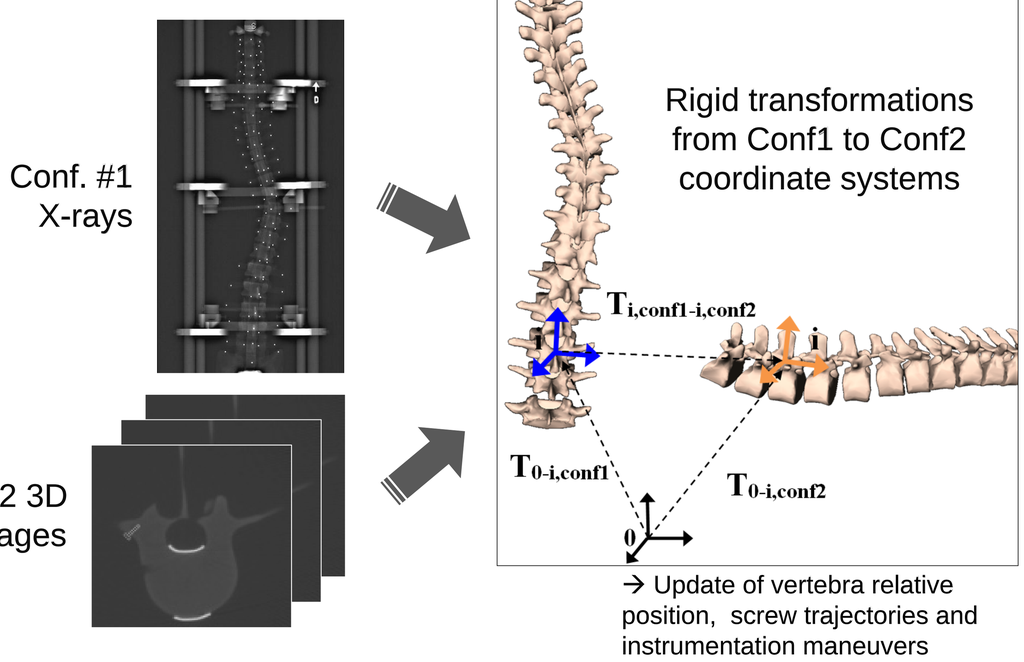
Prototype development and testing

- Synthetic model of a scoliotic spine
- Configuration #1
  - Preop standing posture
  - Biplanar radiographs
  - S3 simulation/planning
    1. Desired pedicle screw trajectories
    2. Correction maneuvers
    3. Resulting clinical indices (Cobb angles…)
- Configuration #2
  - Intraop prone positioning
  - Intraop 2D/3D fluoroscopic images

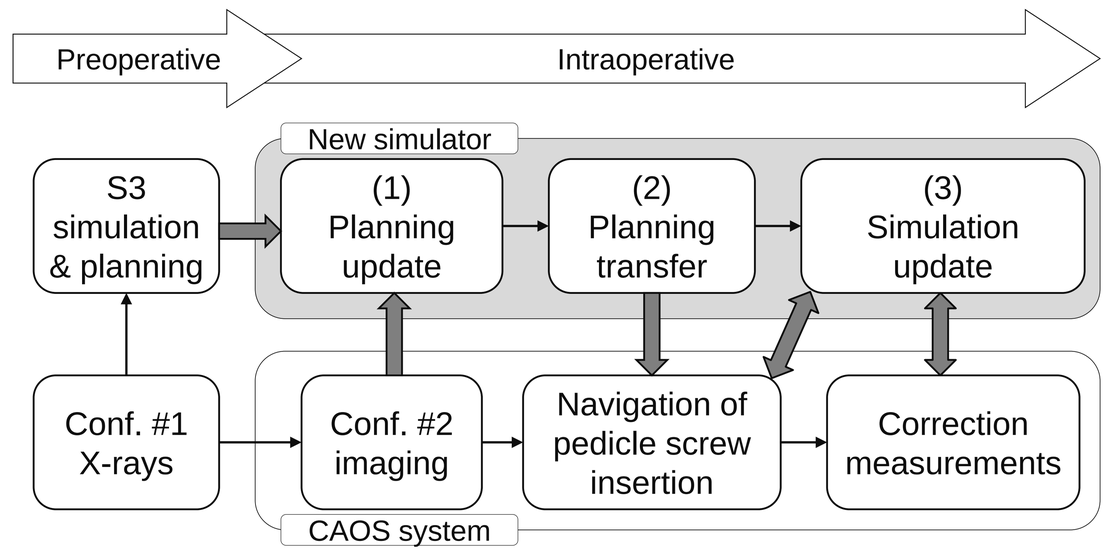
Conf. #1

Conf. #2

(1) Planning update

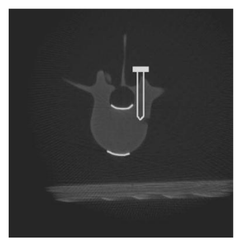


Workflow diagram

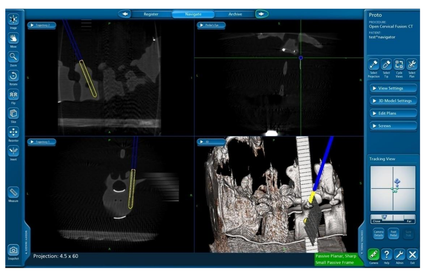


(2) Planning transfer

Conf. #2 fluoro images with updated screw trajectories



Optical navigation



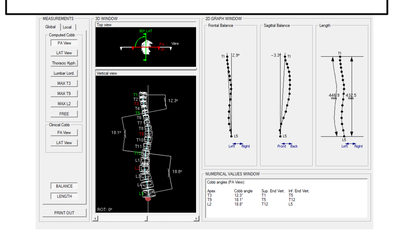
First results

(1) Planning update accuracy ~ 0.5 mm
(2) Planning transfer accuracy ~ 1 voxel
(3) Simulation update:

	Cobb angle	
	Pre-instrumentation	**Simulated instrumentation**
Conf. #1	34°	12°
Conf. #2	24°	12°

(3) Simulation update

Conf. #2 clinical indices and correction maneuvers



Preliminary conclusions and perspectives

- First results using a physical model:
  - Intraop data from CAOS systems can be used to update preop simulations/planning, account for changes occurring in the OR, and test other instrumentation strategies
    - These results have to be validated during real surgeries
  - The new intraop simulator may contribute to obtain real-time feedback during CAOS surgeries and optimize correction

References

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4. AN. Larson, ER. Santos, DW. Jr Polly, et al. Pediatric Pedicle Screw Placement Using Intraoperative CT and 3D Image-Guided Navigation. Spine. 2012;37(3):E188-94.

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