9th Biannual Scientific Meeting IRSSD International Research Society of Spinal Deformities,
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TOWARD THE NEXT GENERATION OF SIMULATOR FOR INTRAOPERATIVE NAVIGATION OF SCOLIOTIC SPINE SURGERIES

- First prototyping results -

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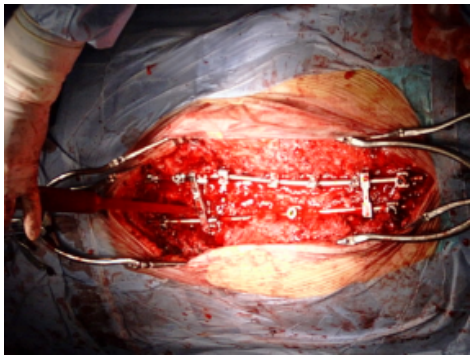
POLYTECHNIQUE MONTRÉAL
LE GÉNIE EN PREMIÈRE CLASSE

SCOLIOTIC SPINE SURGERY

Preop standing X-rays

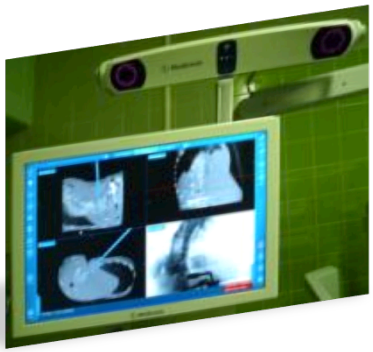
Many pre- and intraop "STRATEGY" decisions[1,2]

Instrumentation and correction



Allow intraop guidance of pedicle screw insertion[3]

Intraop imaging and navigation systems



But it is not yet possible to intraoperatively predict the correction resulting from a specific strategy

[1]Majdouline, *J Pediatr Orthop*, 2007
[2]Robitaille, *Eur Spine J*, 2007
[3]Larson, *Spine*, 2012

OBJECTIVE

TO DEVELOP A NEW INTRAOPERATIVE SIMULATOR FOR NAVIGATED SURGERIES OF THE SCOLIOTIC SPINE

NEW INTRAOP SIMULATOR

1. QUANTIFICATION OF 3D DEFORMITIES

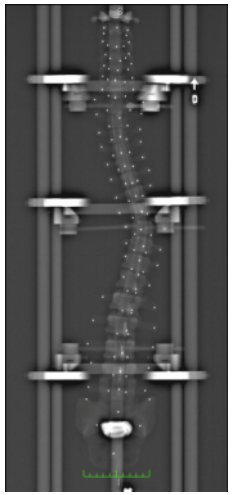
2. SIMULATION OF CORRECTION RESULTS

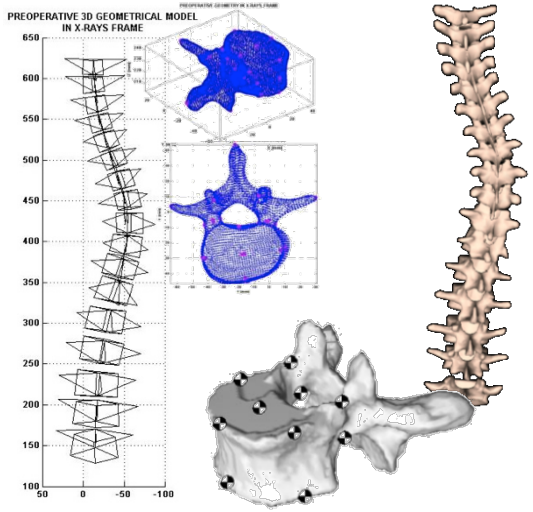
Intraop data transfer

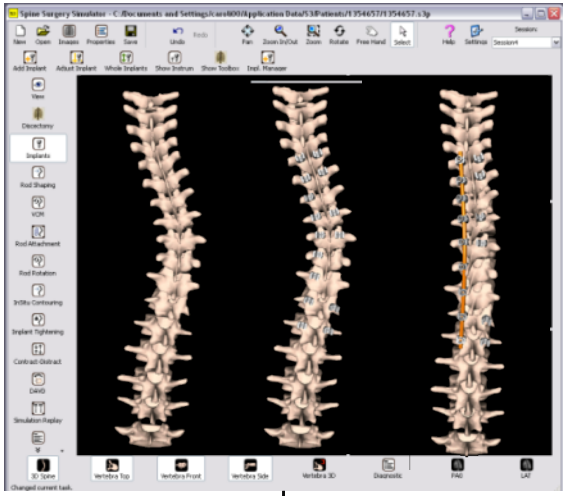
INTRAOP IMAGING AND NAVIGATION

PREOPERATIVE PLANNING[3]

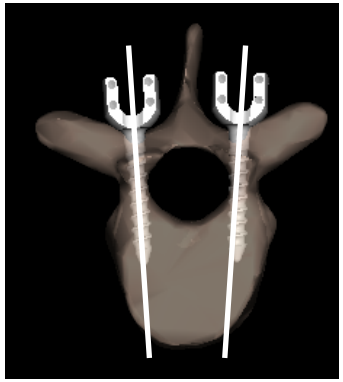
PREOP STANDING → BIPLANAR X-RAYS → 3D RECONSTRUCTION AND GEOMETRIC MODEL → SIMULATIONS USING S3







(1) SCREW TRAJECTORIES



(2) INSTRUMENTATION STRATEGY

1. Attachment of the 1st rod
2. Rod derotation
3. Vertebral derotation maneuvers
4. Attachment of the 2nd rod
5. Distraction/Compression
6. Screw tightening
7. …

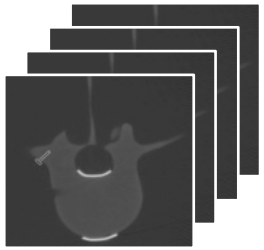
(3) COMPUTATION OF CLINICAL INDICES

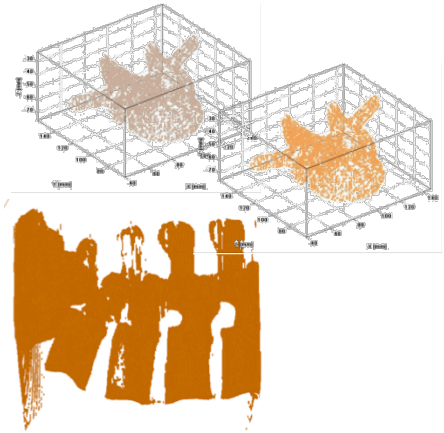
Cobb angle	
Pre-instrumentation	**Simulated instrumentation**
34°	12°

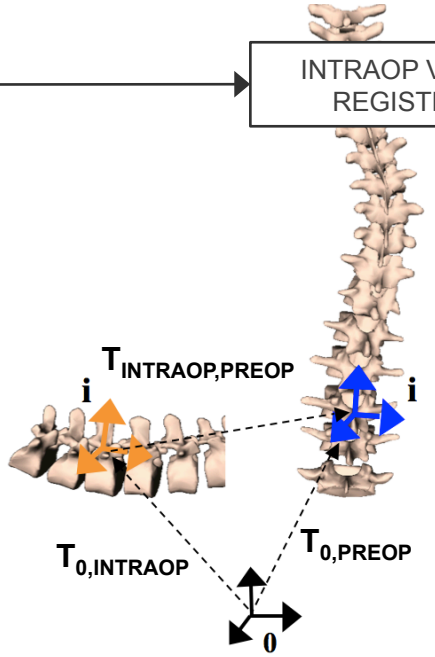
[3] Aubin et al., *Spine*, 2008

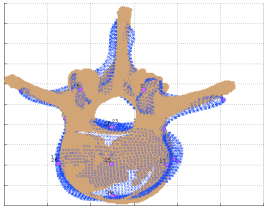
1 - INTRAOPERATIVE UPDATE

INTRAOP DECUBITUS → 2D/3D FLUORO → 3D RECONSTRUCTION AND GEOMETRIC MODEL → INTRAOP VS PREOP REGISTRATION





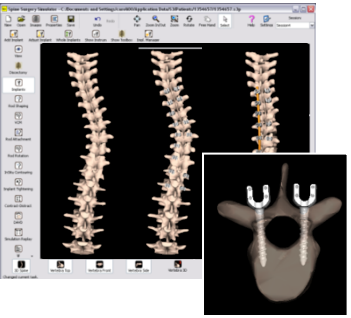


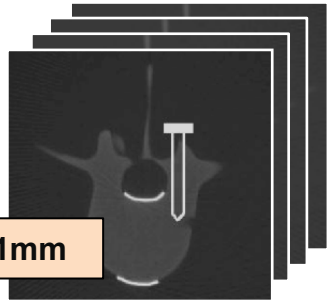


(1) UPDATE OF SCREW TRAJECTORIES

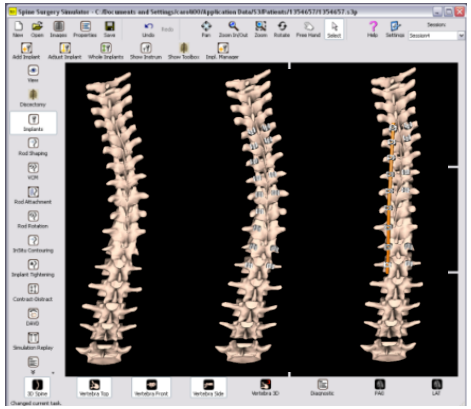
(2) UPDATE OF INSTRU-MENTATION STRATEGY

(3) UPDATE OF CLINICAL INDICES





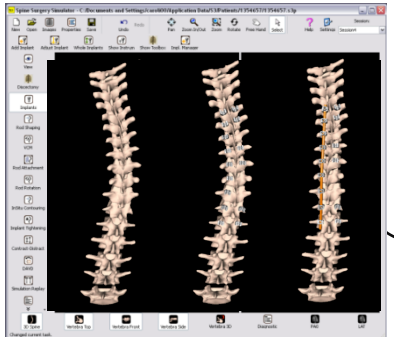
update accuracy ~ 1mm

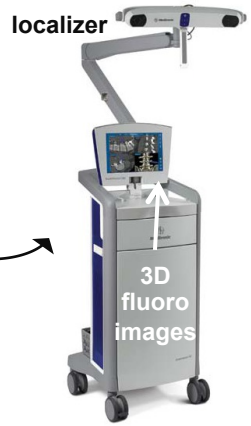


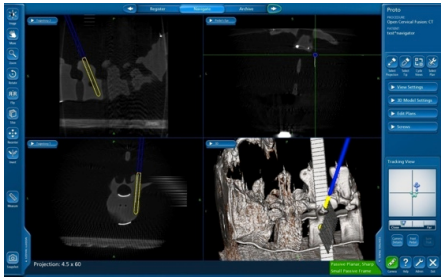
	Cobb angle	
	Pre-instrumentation	**Simulated instrumentation**
Preop geometry	34°	12°
Intraop geometry	**24°**	**12°**

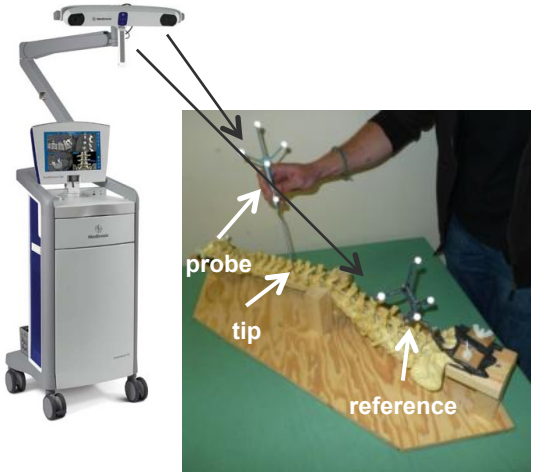
2 - INTRAOPERATIVE SIMULATION

INITIAL STRATEGY → SCREW INSERTION NAVIGATION & ROTATION MANEUVERS → MEASUREMENT OF SCREW & VERTEBRA POSITIONS

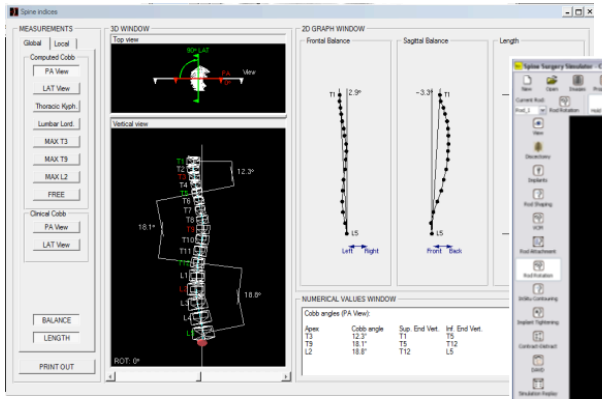


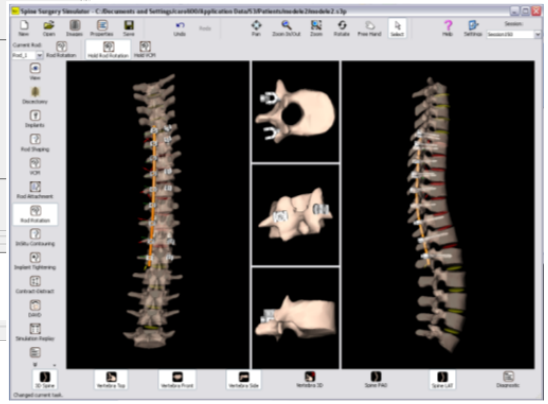


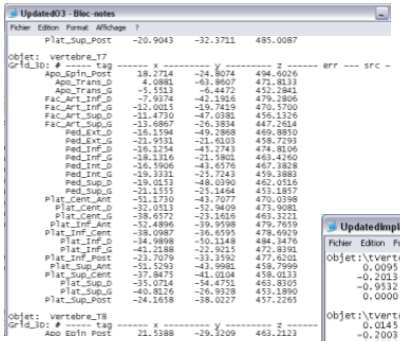


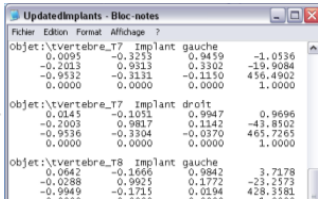


DATA TRANSPOSITION IN SIMULATOR COORD. SYSTEM → NEW SIMULATION OF CORRECTION MANEUVERS → Indices: Cobb angles... Instrumented levels, surgical maneuvers...





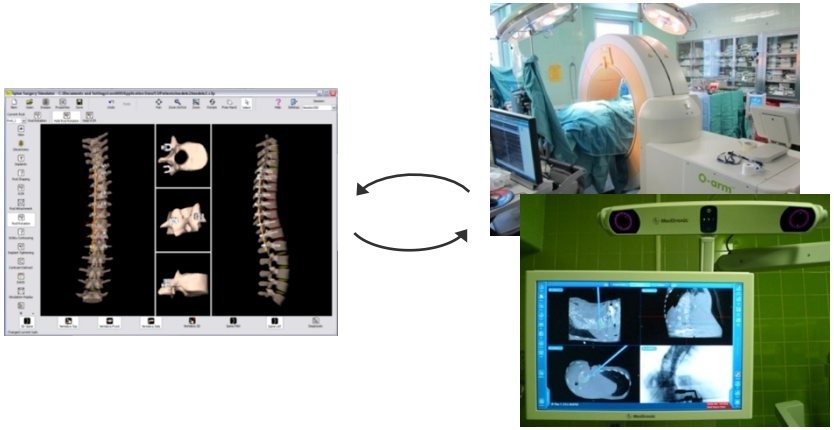




CONCLUSION AND PERSPECTIVES

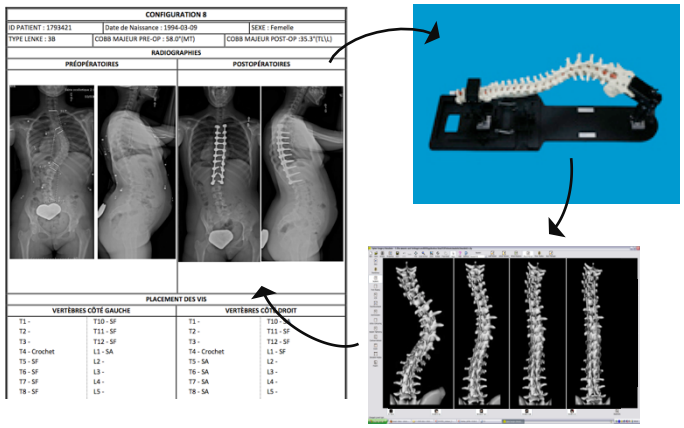
THIS FEASIBILITY STUDY

- Synthetic bone model
- Collaboration imaging-navigation-simulation



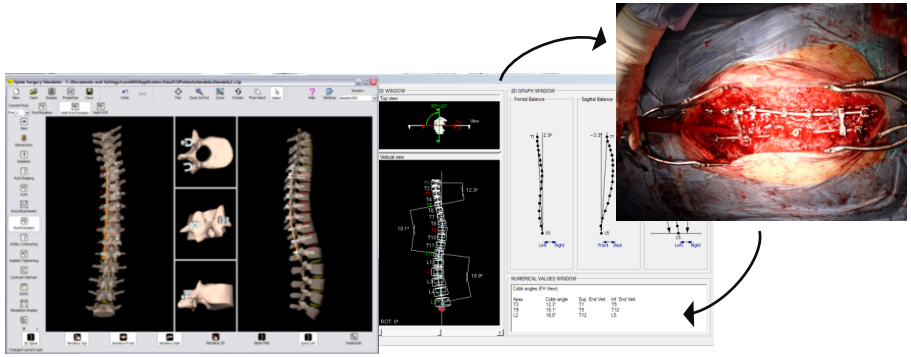
NEXT

- Automating: imaging, 3D reconstruction, model registration, correction simulation & computation
- Validation during simulated spine surgeries



NEW INTRAOP SIMULATOR

- Predict results of correction maneuvers
- Adjust instrumentation parameters



Cobb angles, force analysis...
Instrumented levels, surgical maneuvers...

ACKNOWLEDGEMENTS

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