Marie Skłodowska-Curie Actions (MSCA)
Innovative Training Networks (ITN)
H2020-MSCA-ITN-2017

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SPINe: Numerical and Experimental Repair Strategies
Management Meeting
Friday, 23rd October 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 766012

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NATIONAL CENTER
FOR SPINAL DISORDERS

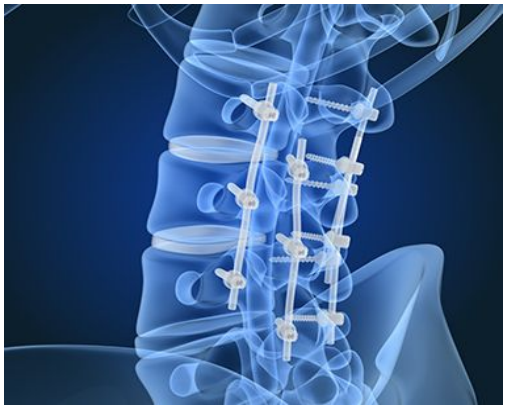
Sagittal stability: movement analysis before and patient motion after spinal treatments

ESR4: Jennifer Fayad

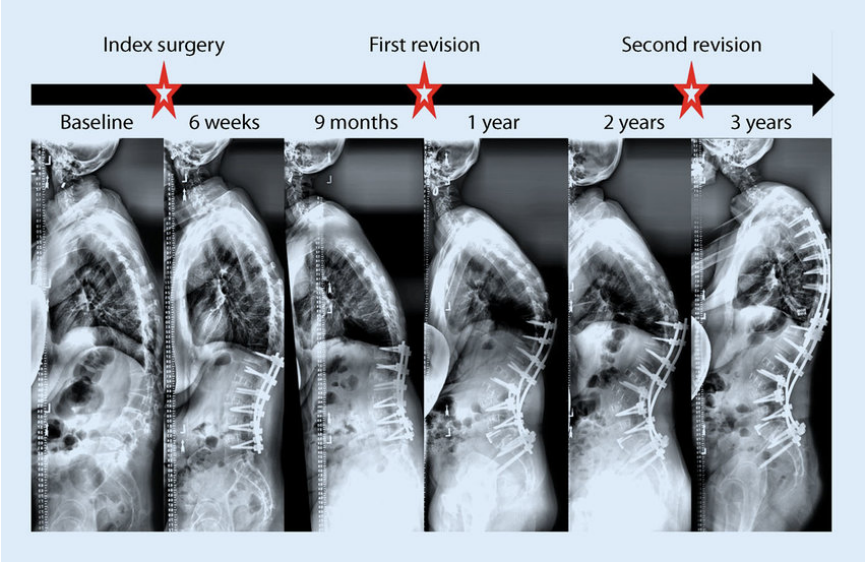
Background:

Posterior spine fusion surgeries used for:

- correcting deformities
- achieving neural decompression
- restoring spine balance



- **Proximal junctional kyphosis** (PJK) is an abnormal kyphotic deformity
- Prevalence rates between **5%-40%** in adult spine deformity patients
- Develops within **3 months** of surgery in 80% of affected patients

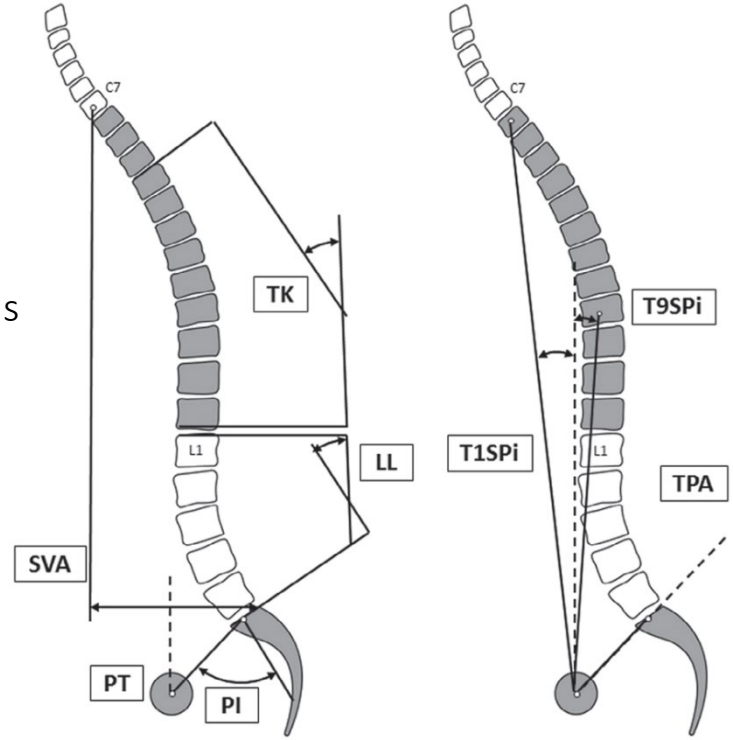


J. Lee and Y.-S. Park, "Proximal Junctional Kyphosis: Diagnosis, Pathogenesis, and Treatment," *Asian Spine J.*, vol. 10, no. 3, pp. 593–600, 2016

Background:

Surgical Planning:

- Imaging techniques used to measure static spine alignments
- Spine parameters used to quantify surgical corrections needed



- Data on dynamic ROM and active sagittal balance could provide information on PJK risk factors.
- Dynamic changes in spine functional motions are currently not quantified in clinical practice

R. Lafage et al., "Validation of a New Computer-Assisted Tool to Measure Spino-Pelvic Parameters" , The Spine Journal 15 (2015) 2493–2502

Project Objectives and Aims:

- Assess multi-segmental spine motion in spine fusion patients to define motion related risk factors leading to PJK
- Provide clinicians with a motion analysis protocol for surgical planning:
  - Repeatable
  - Feasible
  - Clinically Significant

– First year aims:
✓Develop a protocol and marker setup for multi-segmental spine motion analysis.
✓Describe the motion of the various spine segments in healthy participants.

– Second year aims:
❑Define the spine reference bands in healthy participants
❑Measure and Analyse patient data before and after spine surgery

Summary of activities:

- Literature Review:
  - Multi-segmental approaches currently found in the literature using stereophotogrammetry to assess clinically relevant functional spine motion.
  - Methodological assessments of functional spine motion in terms of protocol design and validation techniques are still lacking

Current literature Findings:

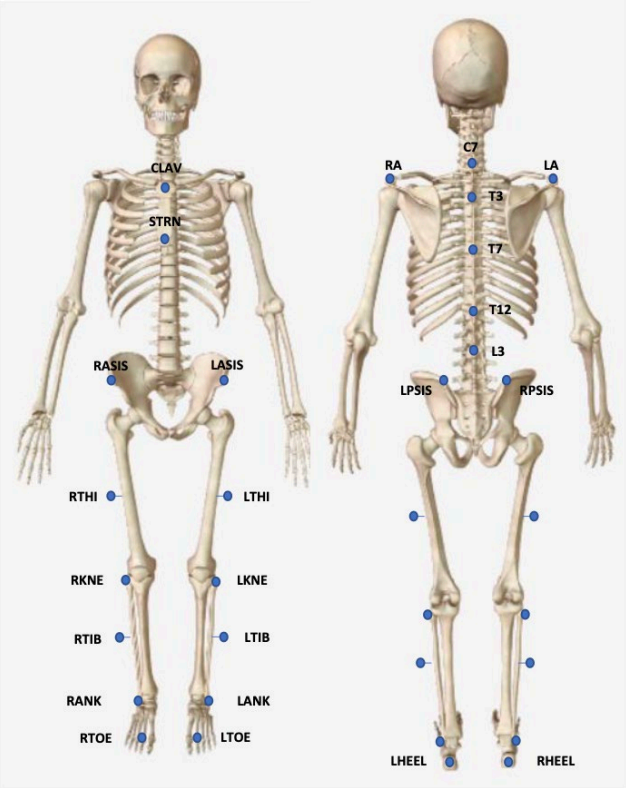
- Need to identify what is clinically significant in spine functional motion
- Repeatable motion conventions in spine movement is lacking
- Synchronisation approaches are limited compared to gait analysis

Summary of activities:

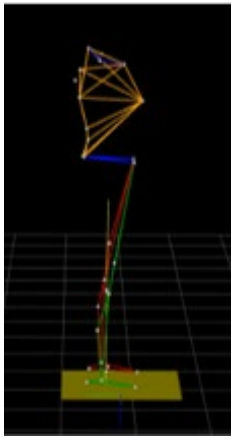
- Motion analysis protocol and marker setup developed:
  - Marker setup includes 25 markers
  - Markers on C7, T3, T7, T12 and L3.

- 14 healthy participants recruited for the pilot study (7F, 7M; age: 26.3±4.4; height: 1.75±0.07m; weight: 72.8±15.4kg)

- **Tasks conducted:**
  - Full Flexion
  - Thoracic Flexion
  - Lateral Bending
  - Sit to stand transitions
  - Object pickup
  - Walking trials

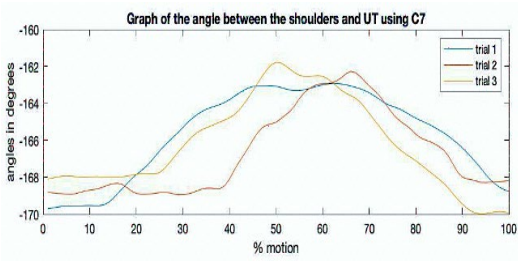


Second year activities:

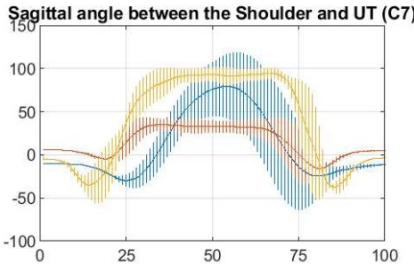


Synchronisation of Motion:

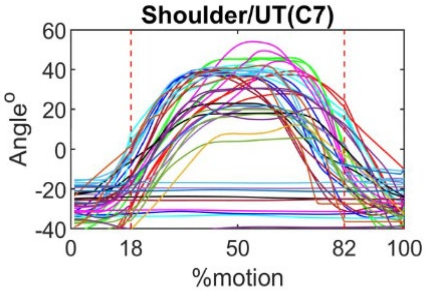
- Synchronisation technique needed to reliably compare spine motion
- Identification of key events
- Synchronisation optimised depending on motion task



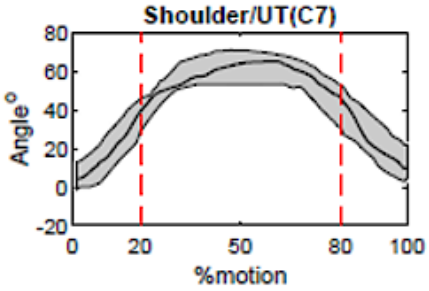
Intersegmental Angle for 3 trials



Intersegmental angle of 3 participants



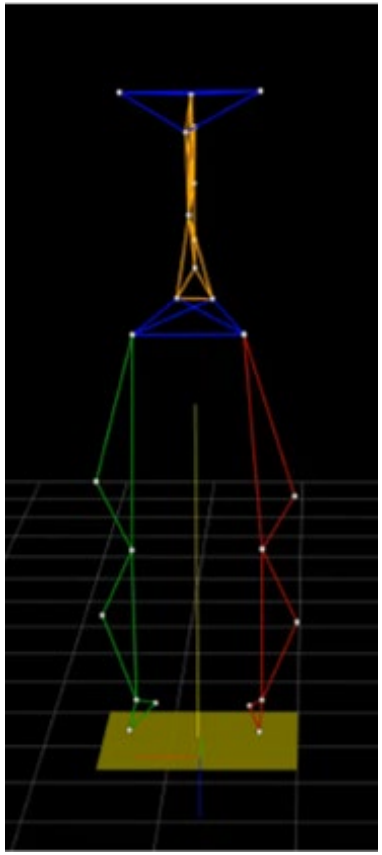
Synchronised Angles all healthy participants

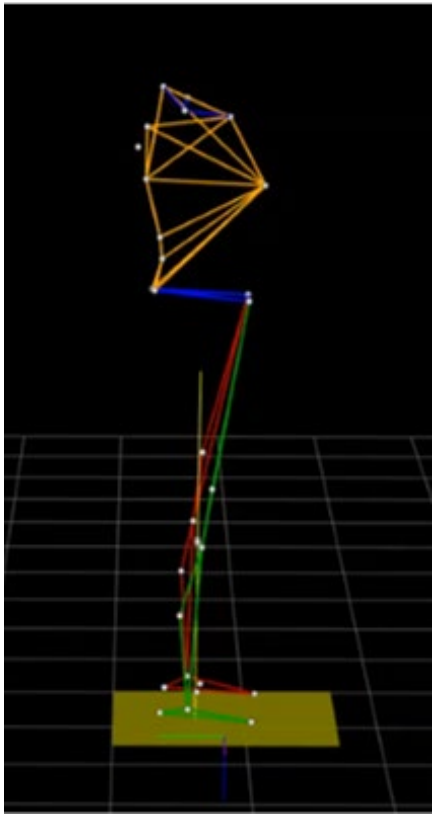


Synchronised motion band all healthy participants

Second year activities:

- Spine Mobility Reference bands in healthy subjects:





Second year activities:

- Radiographical assessment of pathological subjects:
  - Patient x-rays were collected before, and 6 months after surgery
  - Static standing parameters regularly used in preoperative planning
  - Surgimap was used to measure the spine and pelvic parameters

Second year activities:

Patient Recruitment and Measurement:

- Patient cohorts consists of 30 patients split into two groups

	Long Fusion Mean (SD)	Short Fusion Mean (SD)
Gender	7F, 3M	8F, 12M
Age (years)	54.9 (10.7)	46.4 (11.9)
Height (m)	1.68 (0.10)	1.72 (0.08)
Weight (kg)	85.9 (23.9)	84.9 (16.5)
BMI (kg/m^2)	30 (6.48)	28.4 (3.9)

- Tasks Conducted:
  - Sit to stand transitions
  - Object pickup
  - Walking trials

- Preliminary results show a decreased flexion ROM in patients before surgery during object pickup

Activities at NCSD:

- Case Study on the use of patient specific 3D printed models to develop the optimal surgical plan for deformity correction

- Study on the effect of different spine fusion approaches on the incidence of PJK:
  - Segmentation of whole spine from CT Scans
  - Creating volume meshes of the thoracic spine in 3Matic

Dissemination:

- Abstract Submission:
  - Jennifer Fayad, Mate Turbucz, Peter Endre Eltes, Laszlo Kiss, Peter Pal Varga, Aron Lazary, *Clinical Gait Analysis and Mapping of the Bony Fusion following Sacrectomy: A Case Report,* submitted to Global Spine Congress 2021.
- Paper Submission:
  - Peter E. Eltes, Mate Turbucz, Jennifer Fayad, Ferenc Bereczki, Laszlo Kiss, Damien Lacroix, Peter P. Varga, Aron Lazary, *A novel three-dimensional computational method to assess implant deformation and to map bony fusion in a lumbopelvic reconstruction after en-bloc sacrectomy*

Plan for next year:

1. Publishing the comprehensive review on multi-segmental spine motion
2. Recruiting healthy participants
   - Define reference motion bands
   - Suggest a new protocol for spine motion analysis
3. Processing Motion data of patients before and after surgery
   - healthy participants data
   - static spine parameters from x-rays
4. Musculoskeletal Modelling of multi-segmental spine motion