New sagittal classification of AIS: validation by 3D modeling

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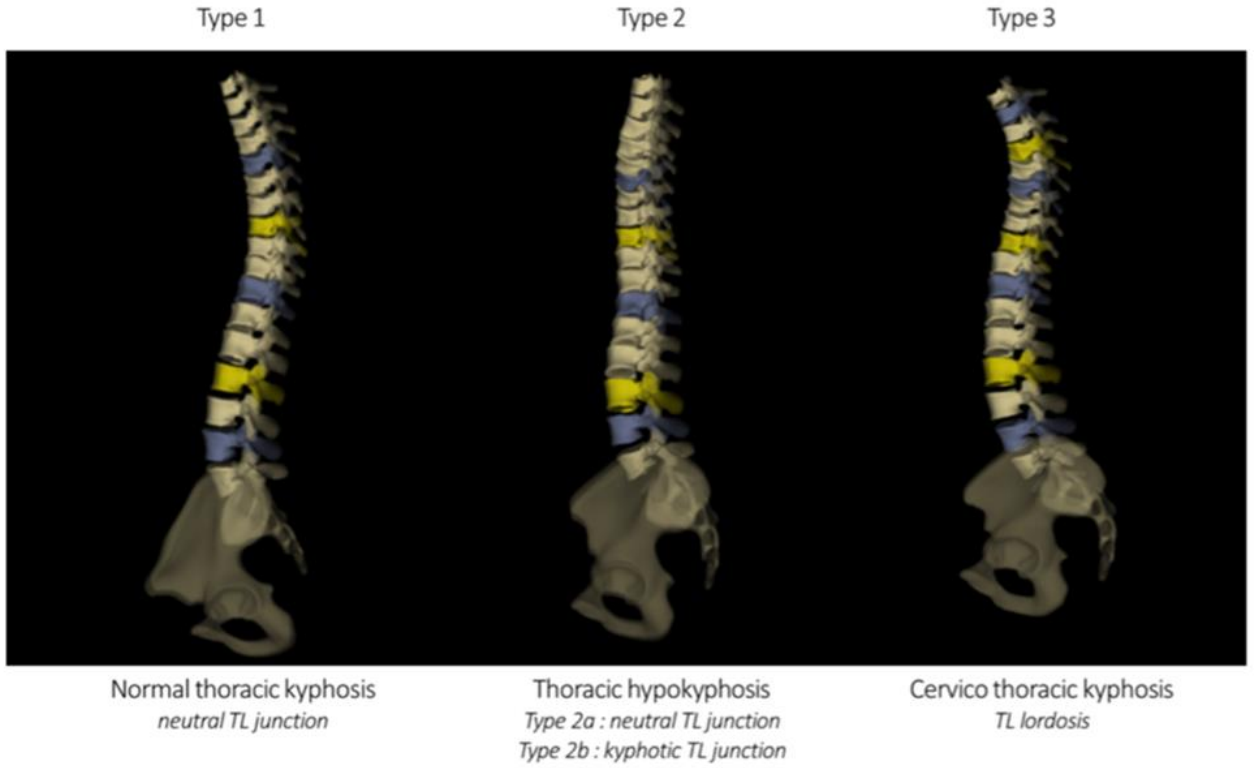
Aim of the study

- Despite the differences between 2D and 3D analysis of sagittal parameters in AIS patients, the new sagittal classification system is a reliable system to describe the different sagittal scenarios that AIS could create

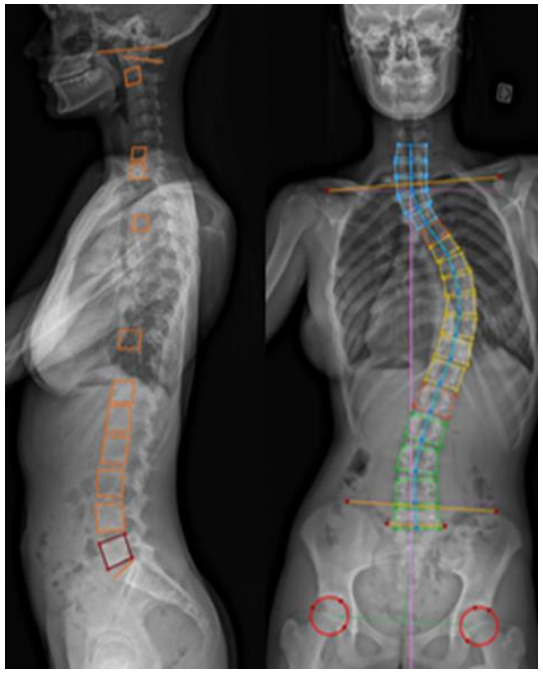


Method

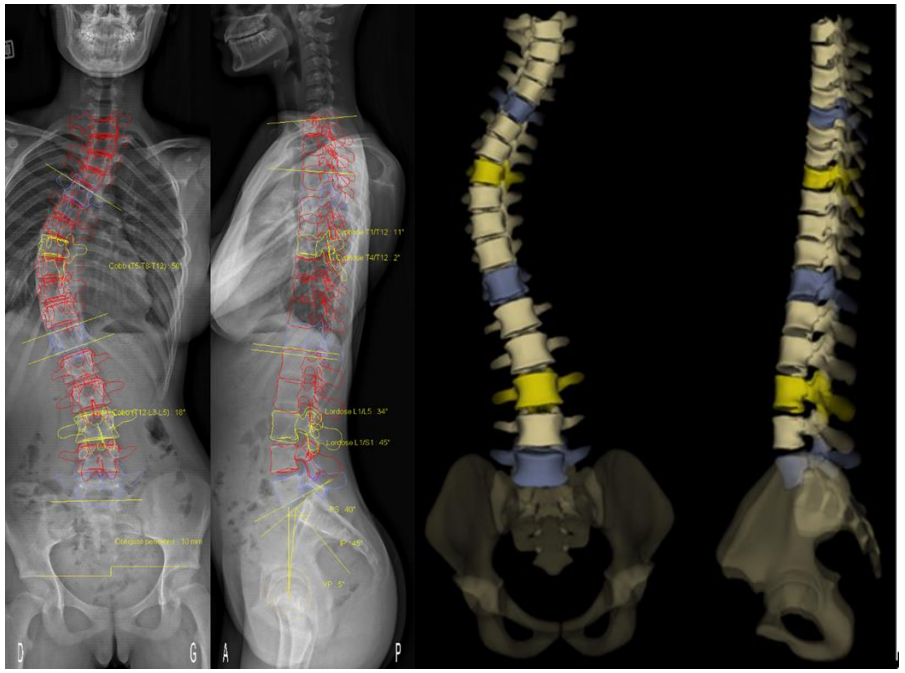
- Retrospective radiographic analysis of 93 AIS patients
  - 1 excluded for movement, 1 for abnormalities
- Simultaneously frontal and lateral x-ray images with EOS®
- 2D and 3D analysis

Measurements

2D



3D



Parameters

Frontal parameters

- Cobb angle
- Apical vertebra
- Upper and lower limit
- Apical vertebra rotation (3D)

Spinopelvic parameters

- T1-T12
- T4-T12
- T10-L2
- L1-S1
- Pelvic incidence (PI)
- Sacral slope (SS)
- Pelvic tilt (PT)

Results, demographic information

	All cohort	Type 1	Type 2	Type 3	p-value
	N = 93	N = 44	N = 29	N = 20	
Cobb.1.2D	55 +/- 12.1	53.2 +/- 11.7	57.9 +/- 12.4	54.8 +/- 12.4	0,36
Axial.rotation.of.apex.3D	21.1 +/- 5.9	21.5 +/- 5.7	20.4 +/- 5.5	21.5 +/- 6.8	0,71

Results (concordance 2D and 3D)

- Concordance: how alike are the values
  - High: > 0,8
  - Good: 0,8 < 0,61
  - Moderate: 0,6 < 0,41

Parameters	2D mean +/- SD	3D mean +/- SD	ICC (95% IC)	Mean difference (LOA)
Cobb1	55,0 +/- 12,1	53,2 +/- 11,5	0.93 [0.87 ; 0.96]	1.8 [-6.1 ; 9.7]
PI	49,4 +/- 10,8	49,3 +/- 10,2	0.95 [0.93 ; 0.97]	0.15 [-6.4 ; 6.7]
PT	8,6 +/- 7,1	8,5 +/-8,8	0.98 [0.96 ; 0.98]	0.089 [-2.9 ; 3.1]
SS	40,9 +/- 8,2	40,8 +/- 7,7	0.92 [0.88 ; 0.95]	0.094 [-6.2 ; 6.4]
T1 tilt	18,9 +/- 8,6	18,7 +/-9,5	0.9 [0.86 ; 0.93]	0.11 [-7.8 ; 8.1]
TK.T1T12	26,2 +/- 12,2	28,3 +/-12,8	0.94 [0.86 ; 0.97]	-2.1 [-10 ; 5.8]
TK.T4T12	17,8 +/- 11,4	18,6 +/-11,3	0.89 [0.84 ; 0.93]	-0.81 [-11 ; 9.5]
TLJ.T10L2	-0,9 +/- 8,4	-8,8 +/- 7,6	0.52 [-0.089 ; 0.8]	7.8 [-2.8 ; 18]
L1S1	45,2 +/- 10,7	51,0 +/- 10,4	0.76 [0.13 ; 0.91]	-5.8 [-16 ; 4.7]

Results (sagittal type)

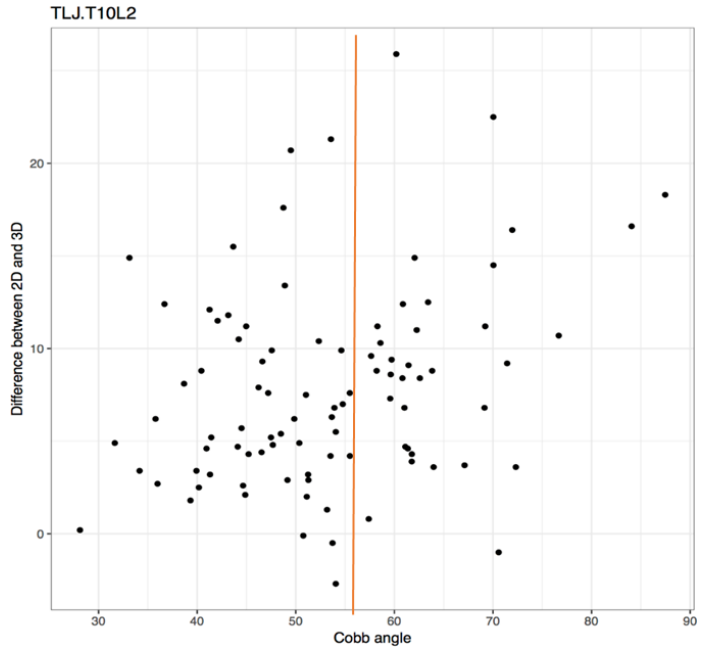
- Concordance: how alike are the values
  - High: > 0,8
  - Good: 0,8 < 0,61
  - Moderate: 0,6 < 0,41

	Type 1		Type 2		Type 3	
	ICC	Mean dif.	ICC	Mean dif.	ICC	Mean dif.
Cobb.1	0.95 [0.8;0.98]	2.3 [-3.2;7.7]	0.92 [0.82;0.96]	2 [-7.3;11]	0.9 [0.77;0.96]	0.58 [-9.4;11]
PI	0.97 [0.94;0.98]	0.59 [-4.9;6.1]	0.94 [0.87;0.97]	-0.45 [-6.8;5.9]	0.93 [0.83;0.97]	0.052 [-8.4;8.5]
PT	0.99 [0.98;0.99]	0.16 [-1.7;2]	0.99 [0.98;1]	0.3 [-1.7;2.3]	0.93 [0.84;0.97]	-0.36 [-5.7;4.9]
SS	0.92 [0.85;0.95]	0.51 [-5.7;6.7]	0.88 [0.76;0.94]	-0.75 [-7.6;6.1]	0.95 [0.89;0.98]	0.41 [-5;5.8]
T1.tilt	0.88 [0.78;0.93]	-0.79 [-7.5;5.9]	0.77 [0.57;0.89]	1.6 [-7.1;10]	0.9 [0.76;0.96]	-0.04 [-8.7;8.6]
TK.T1T12	0.87 [0.72;0.94]	-2.1 [-10;6]	0.91 [0.77;0.96]	-1.9 [-9;5.2]	0.94 [0.82;0.98]	-2.4 [-11;6.3]
TK.T4T12	0.85 [0.74;0.91]	-1.1 [-10;7.9]	0.7 [0.45;0.84]	-0.82 [-12;11]	0.91 [0.79;0.96]	-0.068 [-12;12]
TLJ.T10L2	0.39 [-0.1;0.72]	8.8 [-1.7;19]	0.29 [-0.11;0.62]	8.2 [-3.2;20]	0.093 [-0.11;0.38]	5.1 [-3.1;13]
L1S1	0.82 [0.41;0.93]	-4.1 [-14;5.4]	0.63 [-0.069;0.87]	-7.5 [-18;3.3]	0.75 [-0.013;0.93]	-7.1 [-18;3.5]

Relation with T10L2 and difference between 2D and 3D

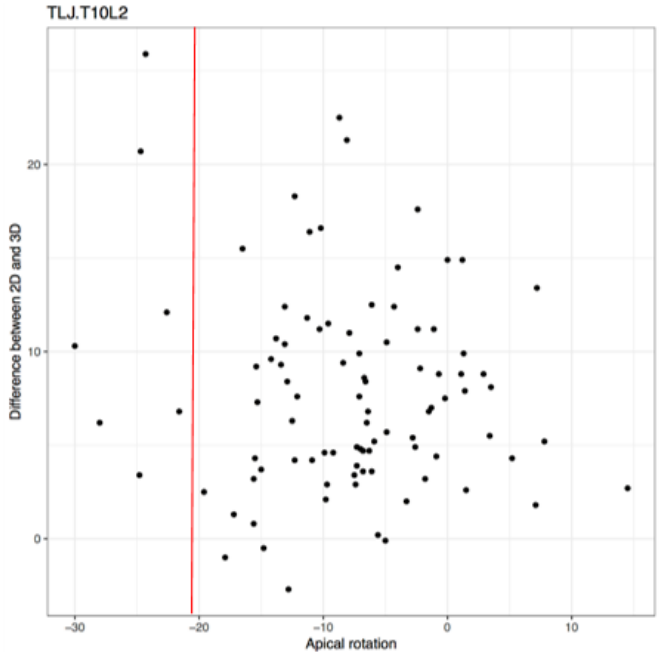
T10L2 and cobb angle

- Tendency to larger differences above Cobb angle > 50



T10L2 and AVR

- Variability for T10L2 was not influenced by the importance of apical rotation



Discussion

- Good to excellent concordance for mean curve magnitude and spinopelvic parameters
- Except for T10L2
  - Included in structural deformity
  - Adapts in response to changes in thoracic or lumbar area
  - 3D provides “real” structural deformity
- T10L2 has influence on classification
  - In 2D T10L2 looks less extended
  - ~14% of patients classified differently

Conclusion

- 2D is sufficient, 3D can be more accurate
- 2D may underestimates T10L2
- 2D may underestimate the proportion of patients classified as type 3
- 3D influences the way of classifying the patient according to the sagittal type

- Sagittal classification is validated 3D

Disclosure declaration

- No potential conflict of interest for any of the authors