Reliability analysis for Cobb angle measurements of congenital scoliosis using X ray and 3D-CT

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Objectives

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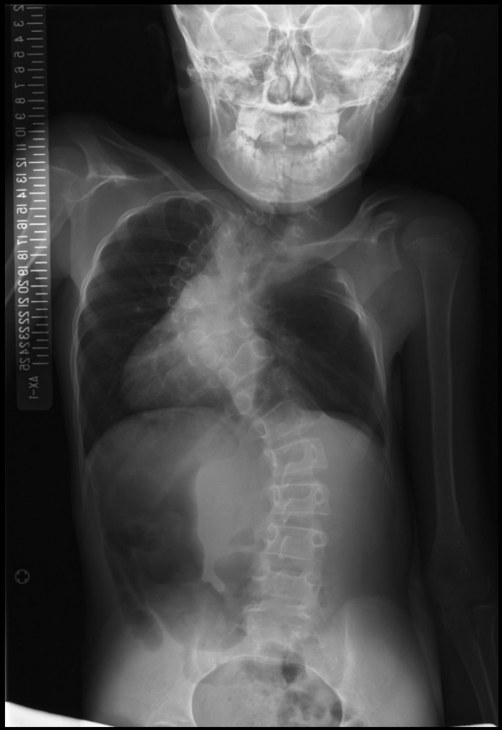
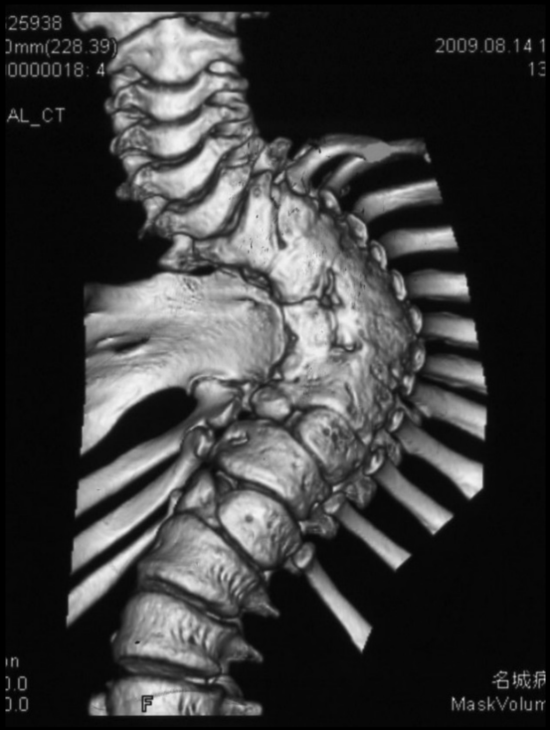
To evaluate the reliability and measurement error of X-ray images and compare the reliability and measurement errors with those obtained with 3D-CT images.





Background

- Therapeutic decisions for scoliosis rely on the Cobb angle.

- There has been no study of measurement variability in children with congenital scoliosis using 3D-CT images.

Hypothesis of the current study

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Congenital scoliosis

1. Difficulty to determine to the vertebra to measure by X-ray
2. Difficulty to depict the detail by X-ray
3. Mixed type congenital scoliosis Is especially complicated

more reasonable

1. to measure the Cobb angle in congenital scoliosis
2. to measure the Cobb angle in mixed type congenital scoliosis

using 3D-CT images than with X-ray images

Patients and Method

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Observer

1. 13 Observers (professional spine surgeon)
2. 10 Drs in USA, 3 Drs in Japan

Patients

1. Congenital Scoliosis 20patinets
2. Failure type:
   formation failure type: 7 cases
   segmentation failure type: 6 cases
   mixed failure type: 7 cases

Statistical analysis

1. SPSS Ver.19
2. Paired-test
3. Intra/Interclass correlation coefficients (ICC)
4. $P<0.05$ significant

Measurement Instruction 1

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- Each observer measures the major curve angle of both X-ray and 3D-CT images at two different times, separated by a minimum 1 week.

- Each observer can estimate by digital method.

- one dot on each extremity of the superior plateau of the first vertebra and one dot on each extremity of the inferior plateau of the last vertebral of the scoliotic curvature, that is, four dots, in total, for the curvature assessed.

Measurement Instruction 2

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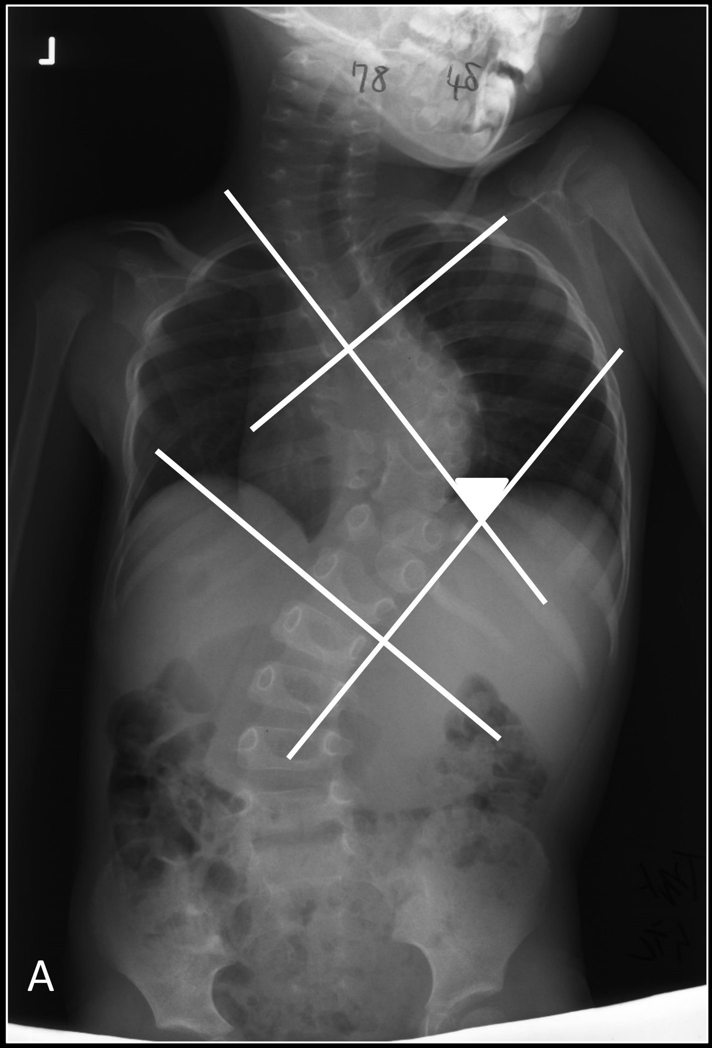

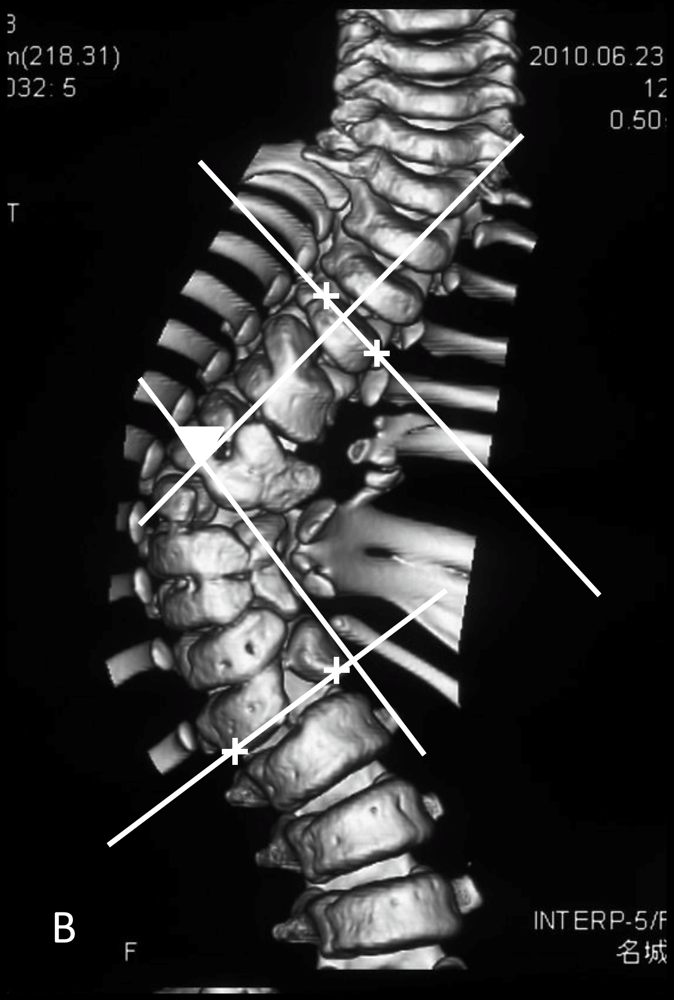

Results

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Table 1
Parameters between X-ray and 3D-CT methods

	MAD/X-ray(°)	MAD/3D-CT(°)	SD/X-ray(°)	SD/3D-CT(°)	P Value
Observer					
Observer 1	5.0	3.2	3.5	2.2	0.098
Observer 2	4.6	4.7	3.3	3.3	0.962
Observer 3	3.6	3.4	2.5	2.4	0.805
Observer 4	1.6	1.8	1.1	1.2	0.707
Observer 5	7.8	8.6	5.5	6.0	0.566
Observer 6	6.1	7.4	4.3	5.2	0.177
Observer 7	4.2	2.8	2.9	1.9	0.362
Observer 8	5.3	2.7	3.7	1.9	0.007
Observer 9	4.1	3.2	2.9	2.3	0.438
Observer 10	5.4	2.9	3.8	2.1	0.002
Observer 11	3.8	2.1	2.7	1.5	0.005
Observer 12	2.9	1.6	2.3	1.5	0.040
Observer 13	3.6	3.3	2.6	2.3	0.684

MAD, mean absolute difference; SD, standard deviation

Table 2
Intraobserver analysis between X ray and 3D-CT

	X ray		3D-CT	
	IaCC	CI of IaCC	IaCC	CI of IaCC
Observer				
Observer 1	0.941	0.861-0.976	0.969	0.924-0.987
Observer 2	0.957	0.896-0.983	0.965	0.915-0.986
Observer 3	0.965	0.916-0.986	0.978	0.945-0.991
Observer 4	0.994	0.985-0.998	0.996	0.991-0.999
Observer 5	0.835	0.675-0.940	0.819	0.604-0.924
Observer 6	0.913	0.797-0.964	0.86	0.685-0.942
Observer 7	0.926	0.827-0.970	0.987	0.967-0.995
Observer 8	0.934	0.845-0.973	0.985	0.963-0.994
Observer 9	0.939	0.856-0.975	0.979	0.948-0.992
Observer 10	0.934	0.843-0.973	0.985	0.964-0.994
Observer 11	0.982	0.955-0.993	0.994	0.984-0.997
Observer 12	0.971	0.931-0.989	0.996	0.991-0.999
Observer 13	0.968	0.923-0.987	0.976	0.942-0.990

IaCC; intraclass correlation coefficient; CI, confidence interval

Table 3.
Statistical parameters of interobserver analysis between X-ray and 3D methods

	X-ray	3D-CT
IeCC	0.847	0.893
CI of IeCC	0.735-0.927	0.814-0.949

IeCC=interclass correlation coefficient;
CI=confidence interval

Table 4.
Parameters between X-ray and 3D-CT methods associated with failure type of congenital scoliosis

Type of failure	**MAD/X-ray(°)**	**MAD/3D-CT(°)**	**P Value**
Formation failure	4.4	3.1	0.07
Segmentation failure	3.6	3.0	0.48
Mixed failure	5.2	4.9	0.74

Discussion

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Hypothesis 1: 3D-CT may be more reliable for measurement of Cobb angle in Congenital Scoliosis

	X-ray	3D-CT
IaCC	0.835~0.994	0.819~0.996
IeCC	0.847	0.893

→ excellent reliability by both methods

Hypothesis 2: 3D-CT may be more reliable for measurement of Cobb angle in mixed type congenital Scoliosis

→ No significance about each failure type by both methods

professional spine surgeons could measure the Cobb angle of any type of congenital scoliosis by X-ray images

Conclusion

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1. The accuracy, repeatability, and correlation of congenital scoliosis curvature measurements from X-ray and 3D-CT images were compared.

2. The average MAD was 4.5 ± 3.2° by the X-ray method, 3.7±2.6° by the 3D-CT method.

3. The IaCC and IeCC indicated excellent reproducible reliability for the Cobb angle measurements using both methods.

4. The X-ray measurement was clinically useful for assessing any types of congenital scoliosis.