

Is the Cobb technique the most reliable and valid to assess the frontal scoliotic deformity ?

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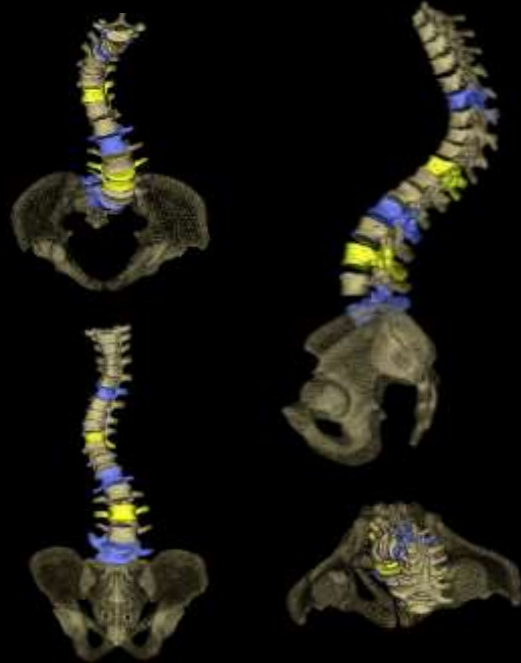
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Eurospine – October 2017



Adolescent Idiopathic Scoliosis (AIS)

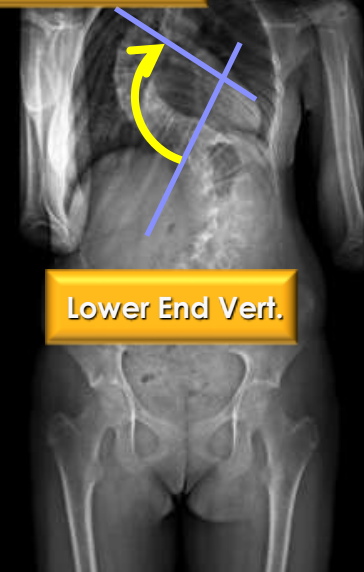
3D deformity of the spine



Routinely assessed
by Cobb Angle
on
2D frontal
radiographs

Upper End Vert.

Cobb, 1948



Lower End Vert.

Parameter poorly representative of the REAL extent of the deformity ?

Eur Spine J. 2013 Nov;22(11):2360-71. doi: 10.1007/s00586-013-2693-9. Epub 2013 Feb 27.

Measuring procedures to determine the Cobb angle in idiopathic scoliosis: a systematic review.

Langensiepen S¹, Semler O, Sobottke R, Fricke O, Franklin J, Schönau E, Eysel P.

Bull Hosp Jt Dis Orthop Inst. 1983 Fall;43(2):171-7.

Error analysis of scoliosis curvature measurement.

Gross C, Gross M, Kuschner S.

J Bone Joint Surg Br. 1995 Sep;77(5):768-70.

Variability in Cobb angle measurements in children with congenital scoliosis.

Loder RT¹, Urquhart A, Steen H, Graziano G, Hensinger RN, Schlesinger A, Schork MA, Shyr Y.

Skeletal Radiol. 1994 Oct;23(7):517-20.

Variation in Cobb angle measurements in scoliosis.

Prujls JE¹, Hageman MA, Keessen W, van der Meer R, van Wieringen JC.

Other 2D techniques

Other techniques available to characterize the scoliotic deformity

– FERGUSON

Ferguson, 1930

– CENTROID

Chen YL, 2007

Comparative studies

– Cobb/centroid :

» Hong et al. (2013); Hong et al. (2011)

– Cobb/Ferguson :

» Neugebauer (1972), Diab et al. (1995), Stokes et al. (1993)

EOS[®] 3D biplanar Xrays



Low dose

(G. Charpak,
Nobel Prize 1992)

**Free standing
position**

**3D
reconstruction**

Dubousset J, Charpak G,
Skalli W et al., Acad Natl Med. 2005

No correlation studies between 2D techniques and the 3D deformity



AIM

Evaluate the reliability of different 2D measurement techniques of the scoliotic deformity and their correlation to the 3D deformity

Methods

→ 93 scoliotic curvatures

63 pre-operative patients with AIS

– 55F, 8M

– Age 13.9 years [9-21]

Divided into 4 groups

- Gr1 : Cobb = $[10^{\circ}-20^{\circ}[$; N=19
- Gr2 : Cobb = $[20^{\circ}-40^{\circ}[$; N=36
- Gr3 : Cobb = $[40^{\circ}-60^{\circ}[$; N=16
- Gr4 : Cobb $> 60^{\circ}$; N=22

Frontal 2D X-rays

Manual goniometer
(KaWe CE U03)

Digital,
Surgimap®
(version 2.2.3)

3 operators
2 times each
Manually
+
Digitally

EOS

3D Deformity index

FRONTAL

SAGITTAL

AXIAL



Frontal 2D X-ray

measurements:

Cobb

Ferguson

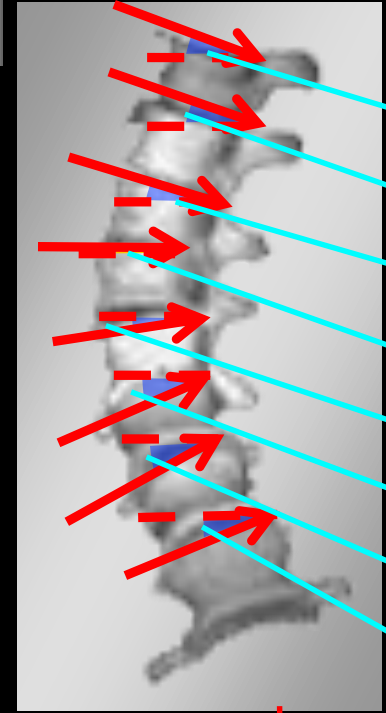
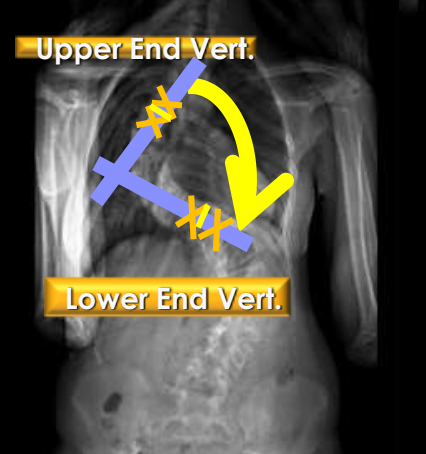
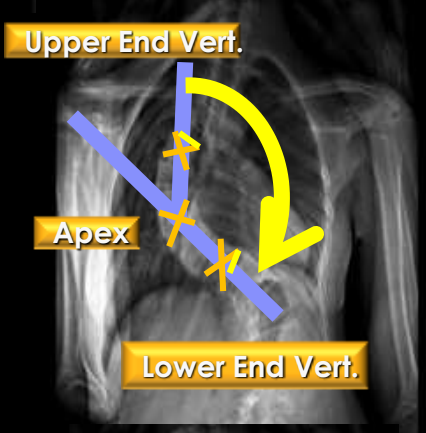
Centroid

3D Deformity index from EOS

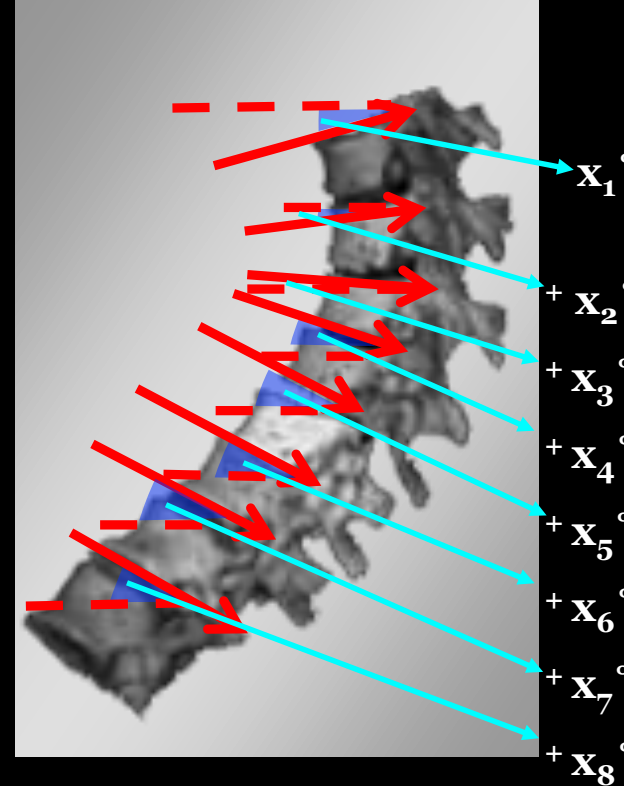
FDI

SDI

ADI



- x_1°
- $+ x_2^\circ$
- $+ x_3^\circ$
- $+ x_4^\circ$
- $+ x_5^\circ$
- $+ x_6^\circ$
- $+ x_7^\circ$
- $+ x_8^\circ$



- x_1°
- $+ x_2^\circ$
- $+ x_3^\circ$
- $+ x_4^\circ$
- $+ x_5^\circ$
- $+ x_6^\circ$
- $+ x_7^\circ$
- $+ x_8^\circ$



Statistics

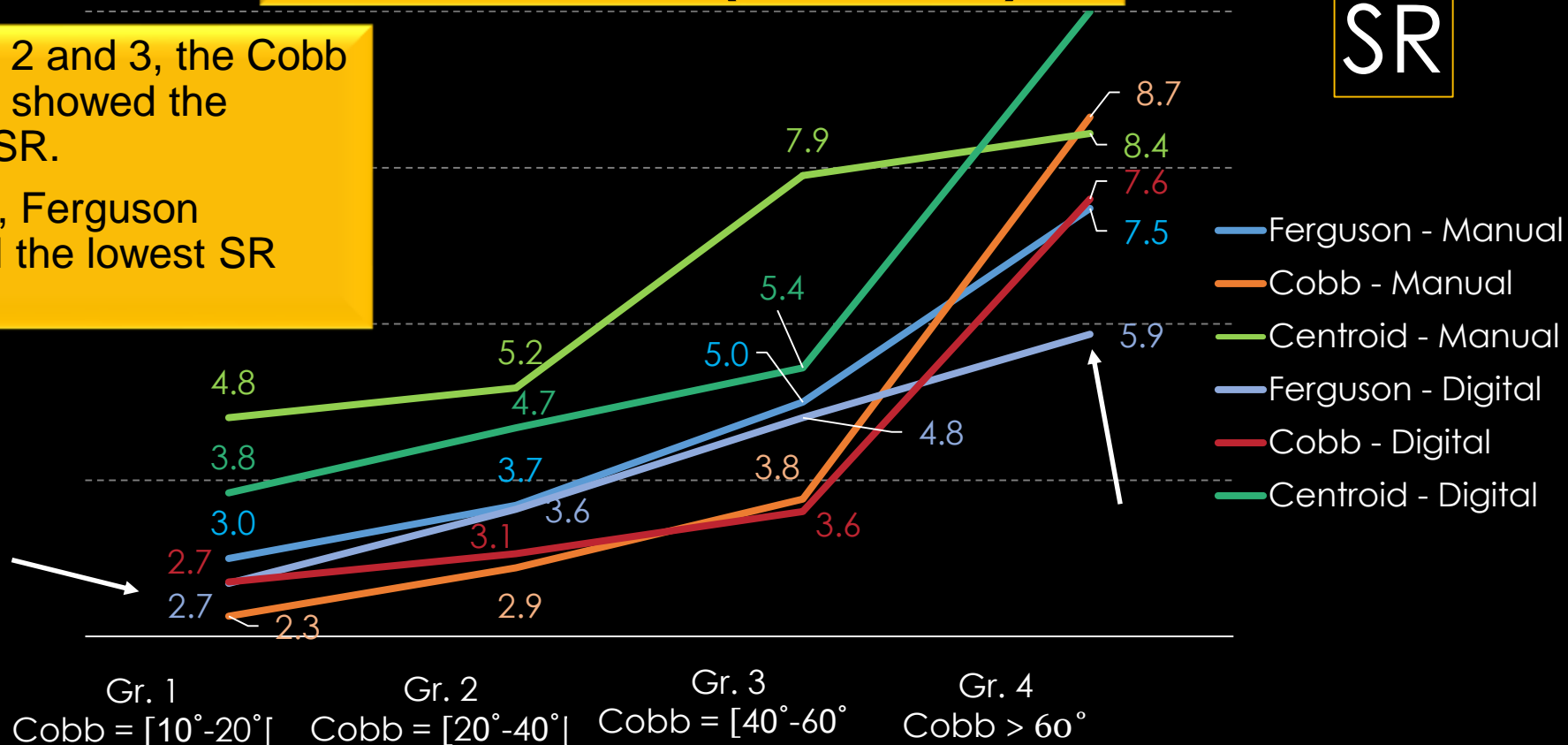
1. Reliability of 2D measurements on frontal Xrays (manually and digitally):
 - Intraclass Correlation Coefficient (ICC)
 - Reproducibility (intra and inter: SR) (ISO 5725-2)
2. Relationship between 2D measurements and 3D deformity:
 - **Stepwise Multiple Linear Regressions** were computed to assess the relationship of the 2D techniques (Cobb, Ferguson and Centroid) to the deformity in the 3 planes FDI, SDI & ADI
 - **Slopes of Linear Regressions** to 3D deformity were compared between the 3 parameters

Results: repeatability of 2D measurements

Cobb ↗ → SR ↗ (all methods)

SR

- In Gr.1, 2 and 3, the Cobb method showed the lowest SR.
- In Gr. 4, Ferguson showed the lowest SR



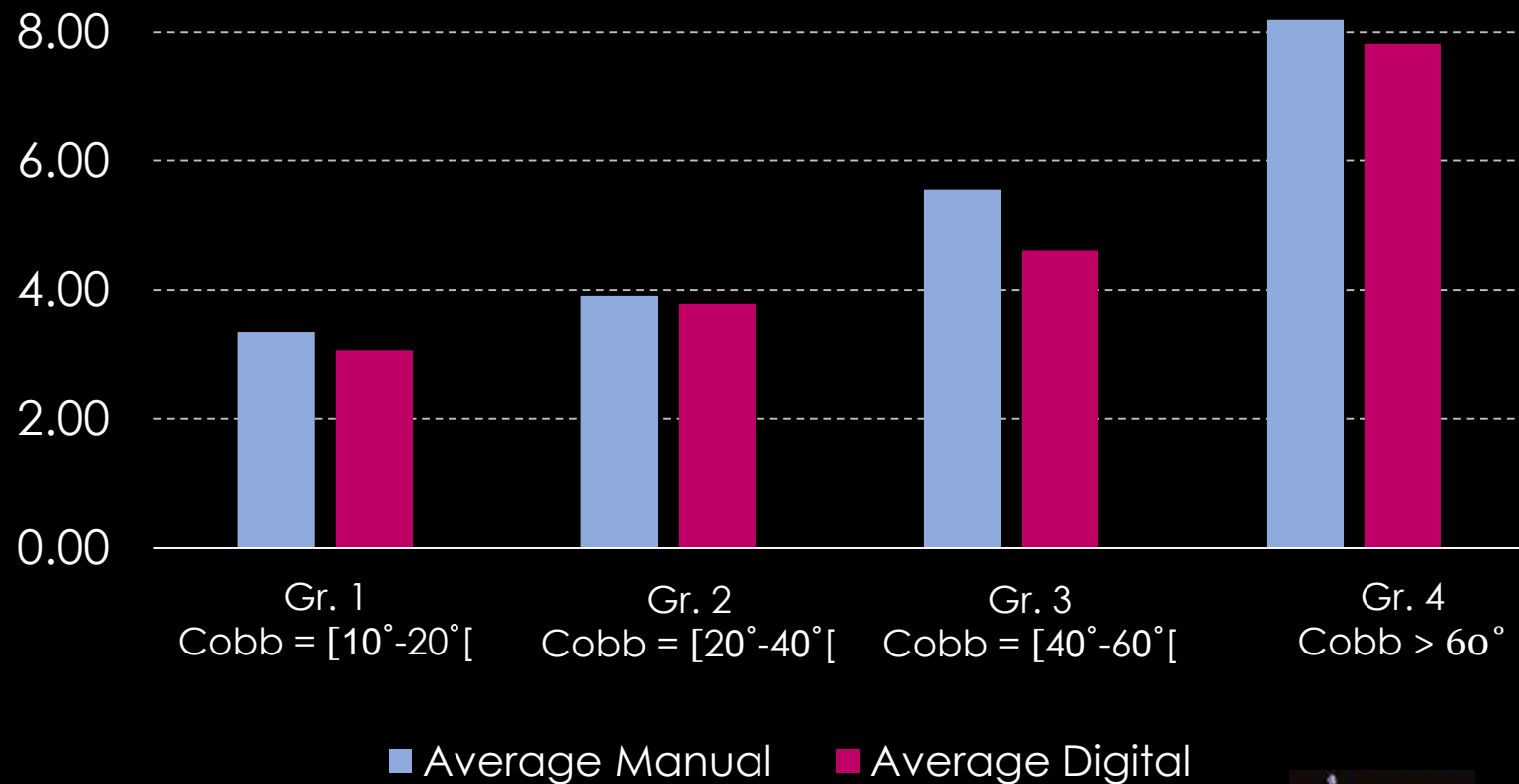
Reliability ICC	Ferguson	Cobb	Centroid
Digital	0,85	0,96	0,93
Manual	0,89	0,94	0,91

ICC values were high in all groups and for each of the three methods (>0.85)

Analysis

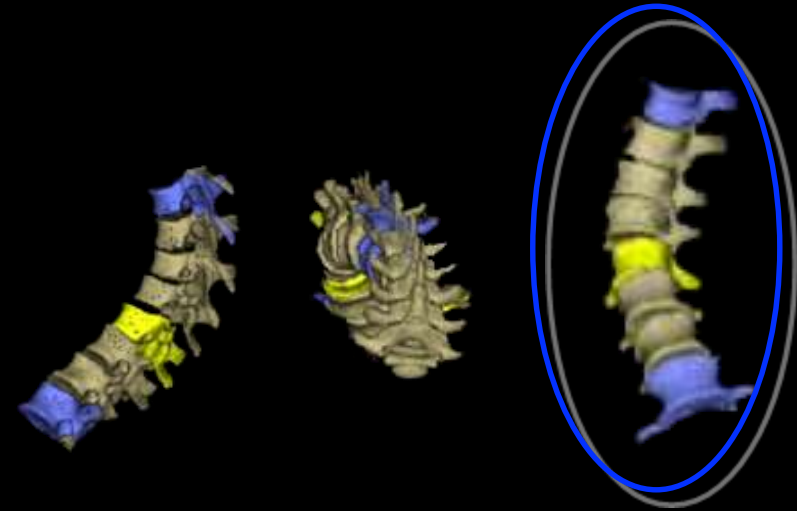
The digital technique showed lower SR, independently of the method of measurement

SR

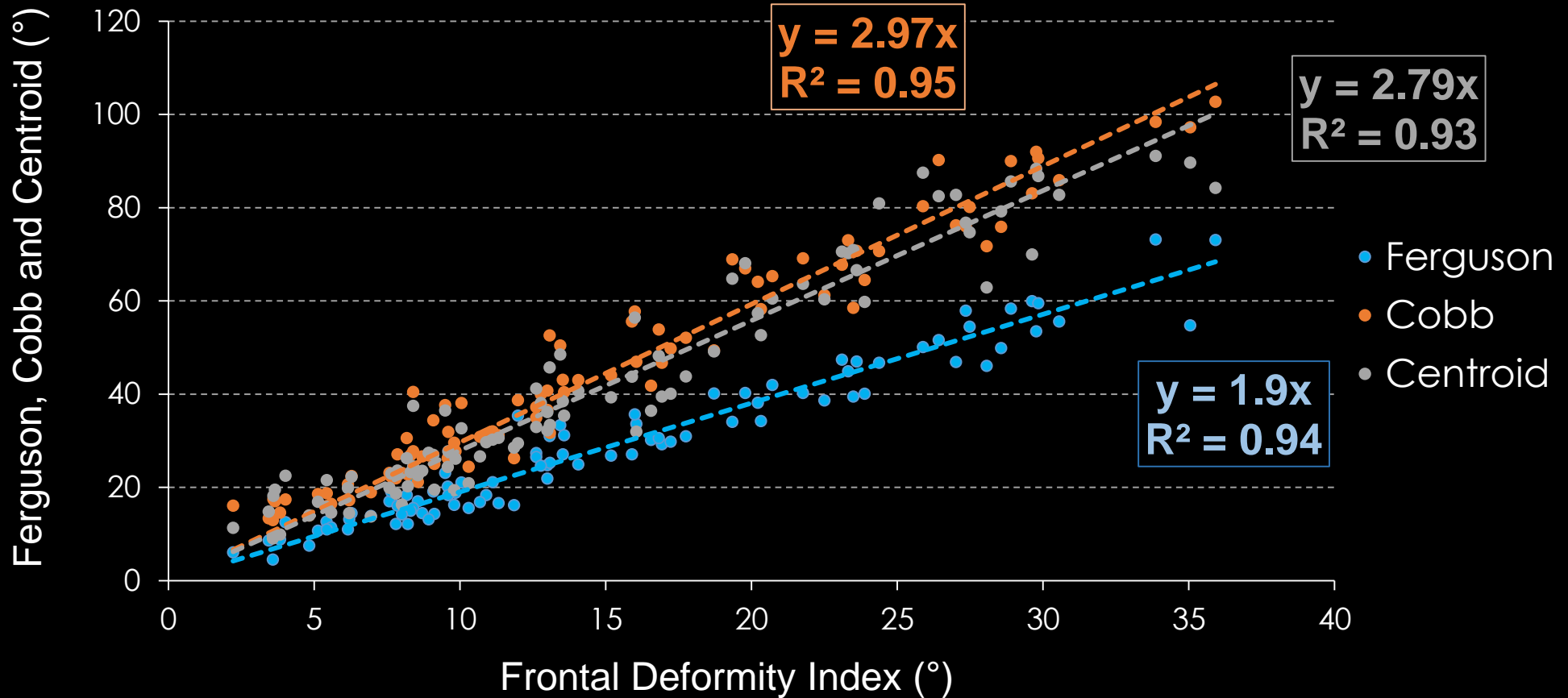


Stepwise Multiple Linear Regression

- **Dependant variables:**
 - 2D Cobb, Ferguson, Centroid
- **Independent variables:**
 - Frontal Deformity Index
 - Sagittal Deformity Index
 - Horizontal Deformity Index
- **Only Frontal Deformity Index was significant ($p < 0.001$)**



Correlation between 2D Ferguson, Cobb and Centroid and FDI



Cobb is the best correlated to the FDI:
higher slope & higher R^2

Conclusion

Measuring in 2D **digitally** is **more reliable** than measuring manually for all parameters and in all groups

The **Cobb angle** is the most **reliable** and most **discriminant** technique in assessing the frontal deformity

Ferguson and Centroid **are not better** !



Conflict of interest: None