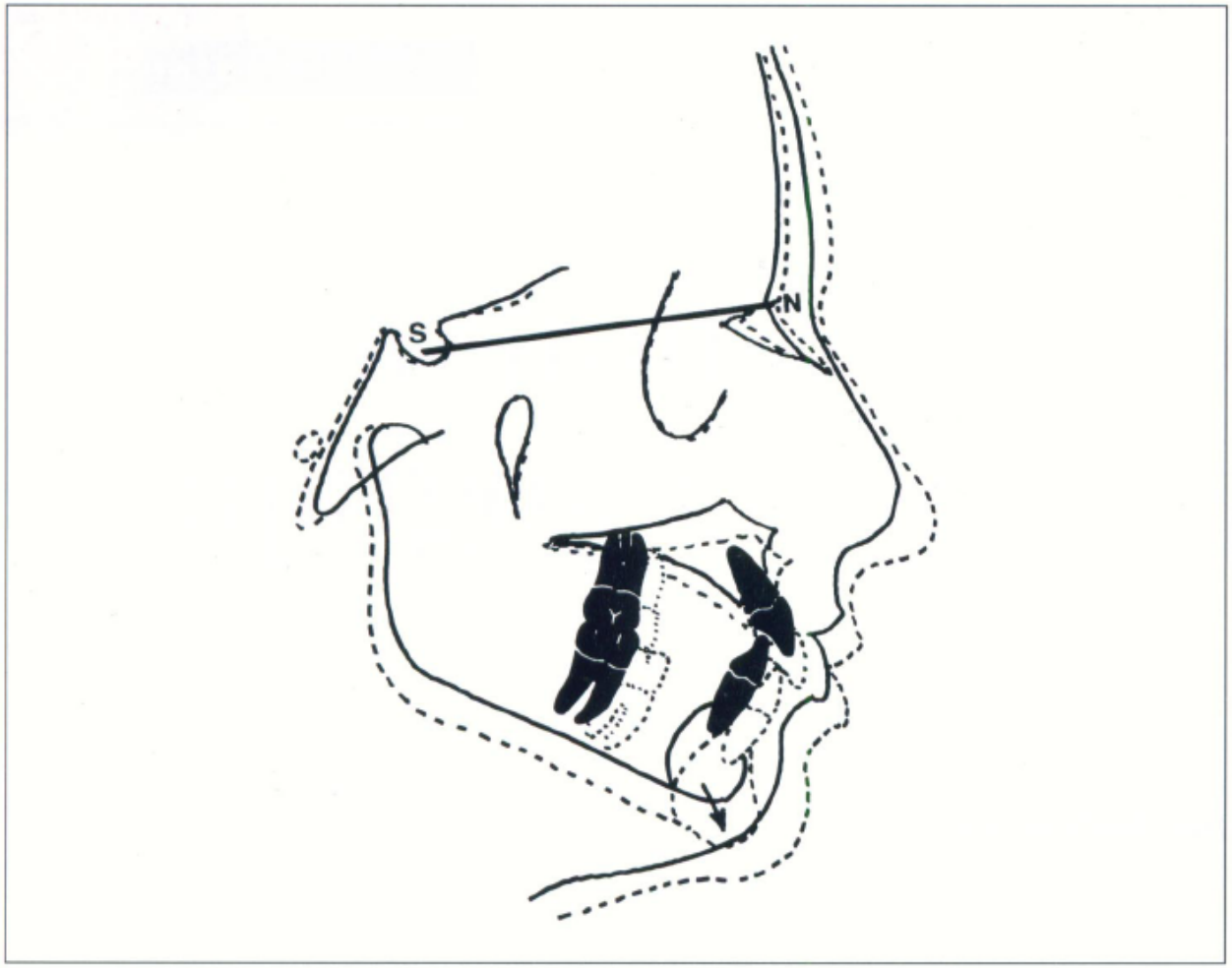
UMC St Radboud

Soft-tissue based 3D reference frame for longitudinal facial growth in children

Sander Brons DDS, Nijmegen, Netherlands

s.brons@dent.umcn.nl

Conventional cephalometric analysis



Athanasiou 1995

Clinical guide LHP superimposition

- Anterior cranial base reference structures

  American Board of Orthodontics

  European Board of Orthodontics

  Angle Society

- Basion-Nasion plane

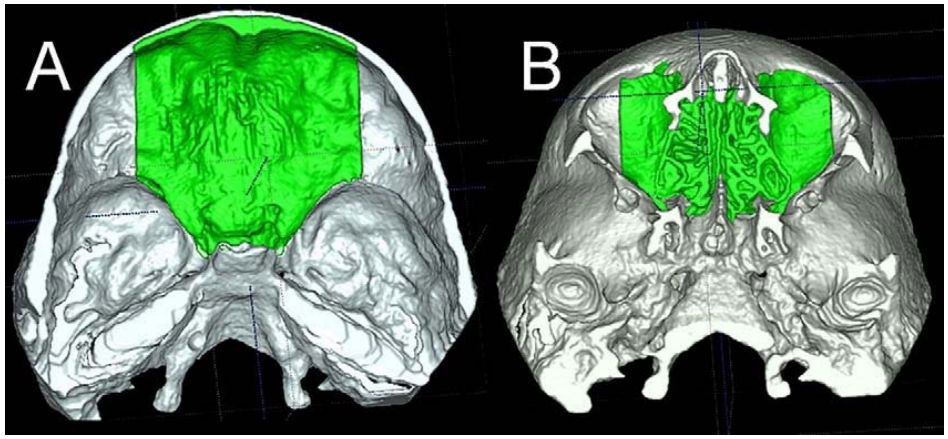
  Australian Board of Orthodontics

- Sella-Nasion line

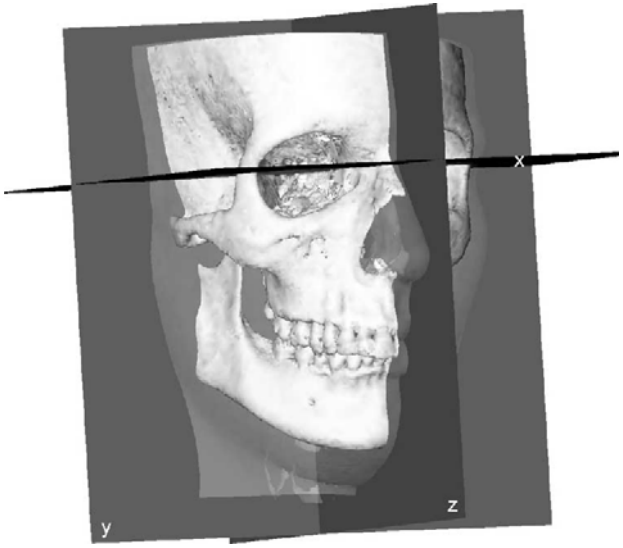
  Dutch Orthodontic Society

Research methods for 3D datasets

- Anterior cranial base rigid registration



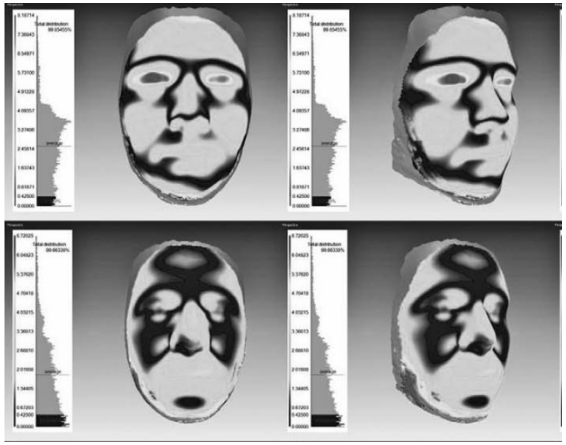
- Landmark based reference frame



Cevidanes et al. 2009, Swennen et al. 2006

Research methods for 3D datasets

- Best fit of landmarks:



- Geometric morphometrics:

Table 1 Form difference matrix (FDM).

Euclidean distance		Ratio
Figure 2a	B–Gn	0.569
	S–Ar	0.583
	Gn–Go	0.589
	N–ANS	0.591

Seager et al. 2009, McIntyre & Mossey 2003

Summary analytical techniques

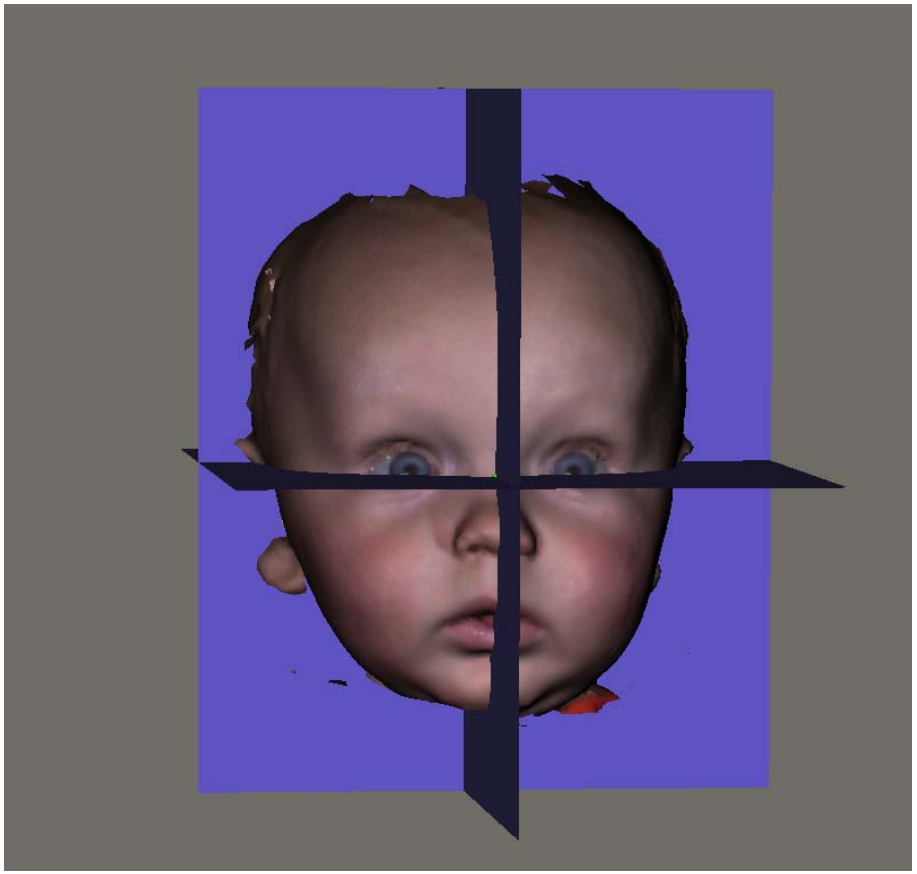
Technique	Landmarks required?	Size data	Shape data	Statistical treatment of data	Analysis of an individual case?	Analysis of groups of cephalograms?	Visual output
CCA	Yes	Yes	No −	Various univariate/ multivariate methods	Yes +	Yes	Poor, must be produced indirectly
Procrustes superimposition	Yes	No	Yes +	Principal component analysis	No −	Yes	Good

COMBINE DIFFERENT TECHNIQUES!

McIntyre & Mossey 2003

UMC St Radboud

Development of a method: The children's reference frame



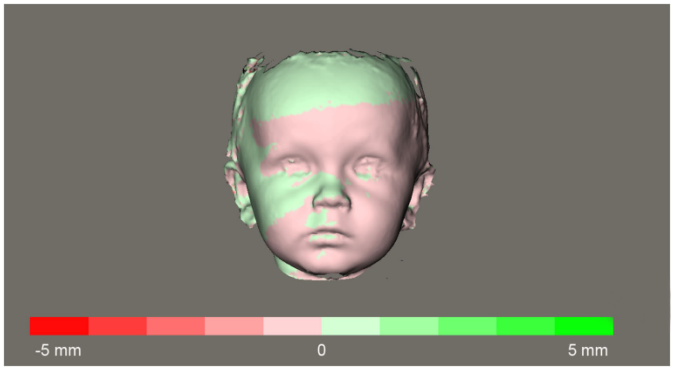
Material & Methods

- 39 stereophotographs in duplicate (N=78)
- Placement of reference frames (78 / observer)
  - 13 Caucasians patients (UCLP) age 3 months
  - 16 Caucasians controls age 3 months
  - 10 Caucasians controls age 12 months
- 3dMD stereophotogrammetry system
- 2 observers
- Maxillim software

Outcome parameters

Intra- and interobserver reproducibility:

- Mean distance = Measurement error
- Distance variability
- P95



Statistical analysis:

- Pearson's correlation coefficient
- Student's t-test

Results: Measurement error

	Observer A Mean (SD)	Observer B Mean (SD)	Interobserver Mean (SD)	Correlation coefficient	P-value
Mean distance (=measurement error)	0.40 (0.25)	0.37 (0.16)	0.52 (0.19)	-0.01	0.974
Distance variability	0.49 (0.19)	0.51 (0.12)	0.53 (0.09)	0.52	0.002
P95	0.80 (0.67)	0.75 (0.36)	1.10 (0.40)	0.01	0.949

Results: Factors of influence?

- Cleft vs non-cleft: $p = 0.788$
- 3 months vs 12 months: $p = 0.777$
- One ear vs two ears: $p = 0.253$

Summary

- Children's reference frame based on conventional cephalometric analysis
- Mean inter-observer measurement error 0.52 mm is acceptable
- Trimming of 3D model to decrease variability
- Presence of a cleft, age or missing data near one of the ears on the 3D model no effect on reproducibility

The children's reference frame is a **valid** and **reproducible** method for 3D soft tissue facial growth analysis in children

... and should be used in concordance with other geometric morphometric techniques for research purposes ...