Fetal brain biometrics: comparison of 2D T2-weighted and 3D volumetric super-resolution magnetic resonance imaging

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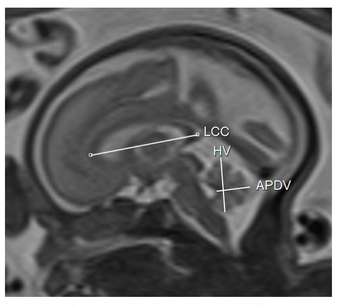
MOTIVATION

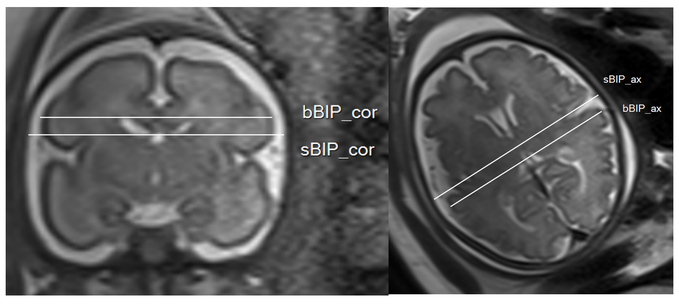
- **Fetal brain MR**-based **biometry**: capital for brain growth evaluation and the diagnosis of developmental/acquired brain pathologies
- Advanced **super-resolution** (SR) reconstruction methods allow to compute **a high resolution motion-free 3D volume**[1,2]
- **Aim 1**: to compare fetal brain MRI biometry between 2D T2-weighted images (T2WI) and 3D SR reconstructed volume
- **Aim 2**: evaluate both level of confidence and concordance of measurements between a junior and an experienced pediatric radiologist

MATERIALS & METHODS

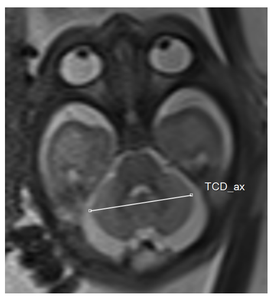
- Dataset: 25 normal fetal brain MRI (18 to 34 gestational weeks)
- Orthogonal 3mm thick HASTE-T2WI, 1.5T(88%) and 3T (12%)
- SR reconstructed at 1 mm^3 within the PACS system[2,3]
- Observer 1 (experienced) and observer 2 (junior)
- **11 biometric measurements** of brain and skull on T2WI and SR

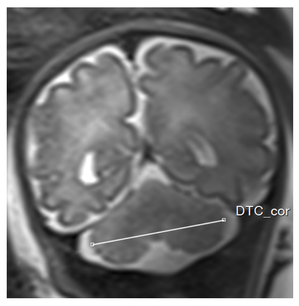


LCC: length of corpus callosum; APDV: anteroposterior diameter of the vermis; HV: height of the vermis

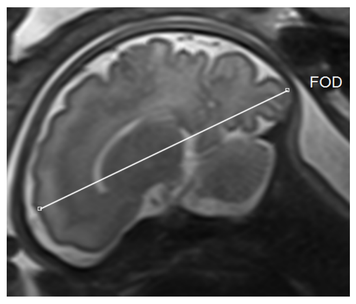


bBIP_cor, sBIP_cor, bBIP_ax, sBIP_ax: brain and skull biparietal diameter (coronal and axial)

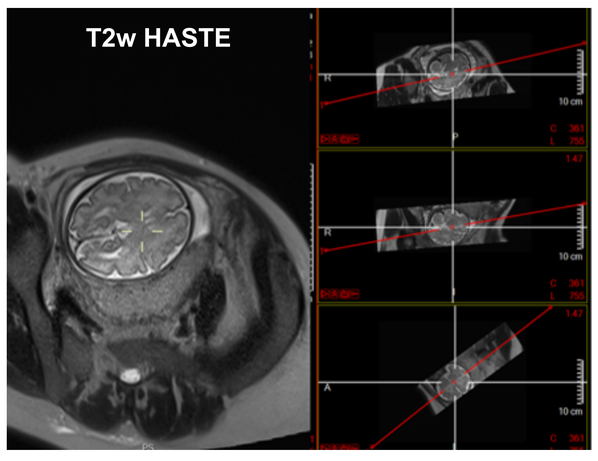




TCD_ax and TCD_cor: transverse cerebellar diameter (axial and coronal)



FOD: fronto-occipital diameter



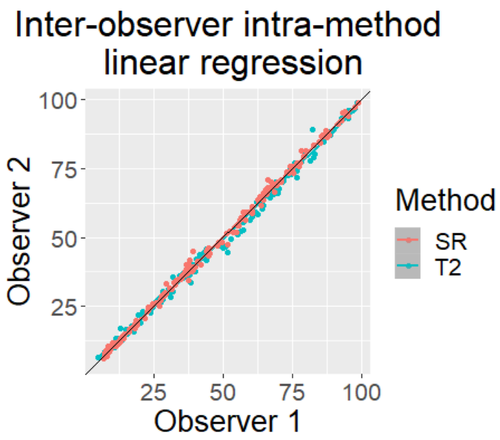
- **Confidence in** measurement **quantification** (high or low)
- **Statistical analysis**: Wilcoxon rank sum (R software) with and without Bonferroni correction for multiple comparisons for:
  (1) Obs1 vs obs 2 for each dataset (T2WI and SR), and
  (2) T2WI vs SR measurements for each observer.

RESULTS

- **Confidence level of measurement** :
  - T2WI: - low for 3 MRI for obs1;
    - low for 11 MRI for obs 2 (mostly LCC)
  - SR: high for all measurements

- **Obs 1 vs obs2** : overall no statistically significant differences neither in T2WI nor SR measurements.

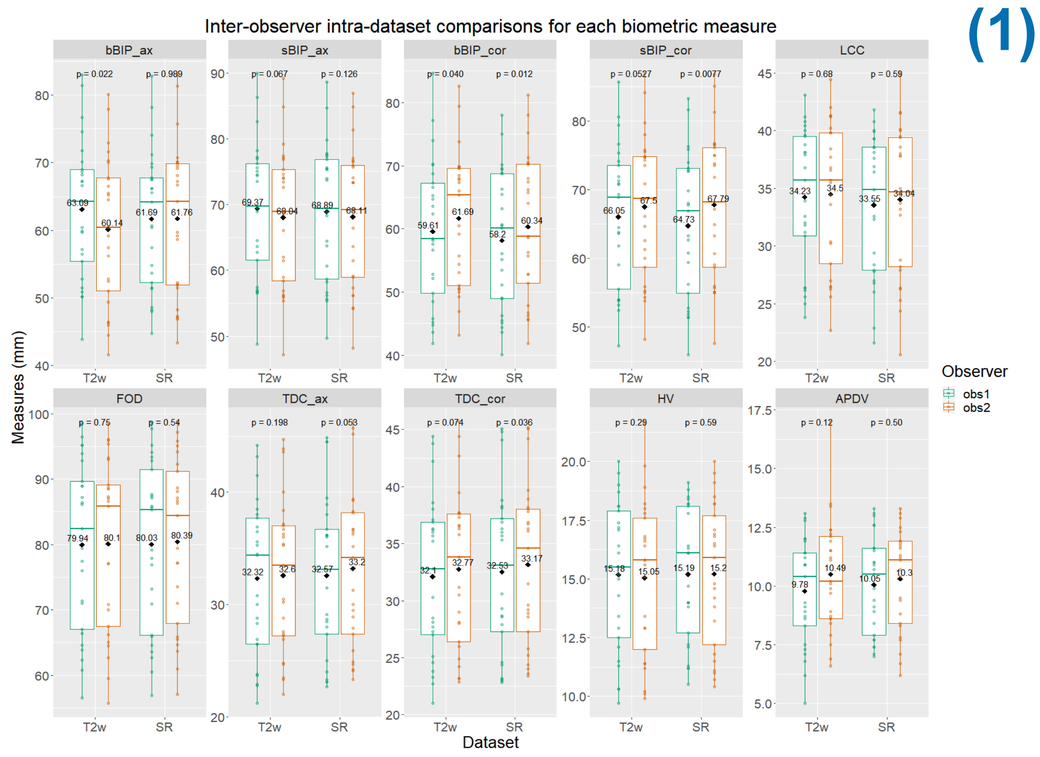
- **T2WI vs SR** : only **axial brain BIP** was statistically different for both observers. This could be due to variation in acquisition plane, and difficulties in landmark positioning; difference were small (2,95+/-1,73mm), without clinical implications as age-specific published reference intervals for biometry are large.



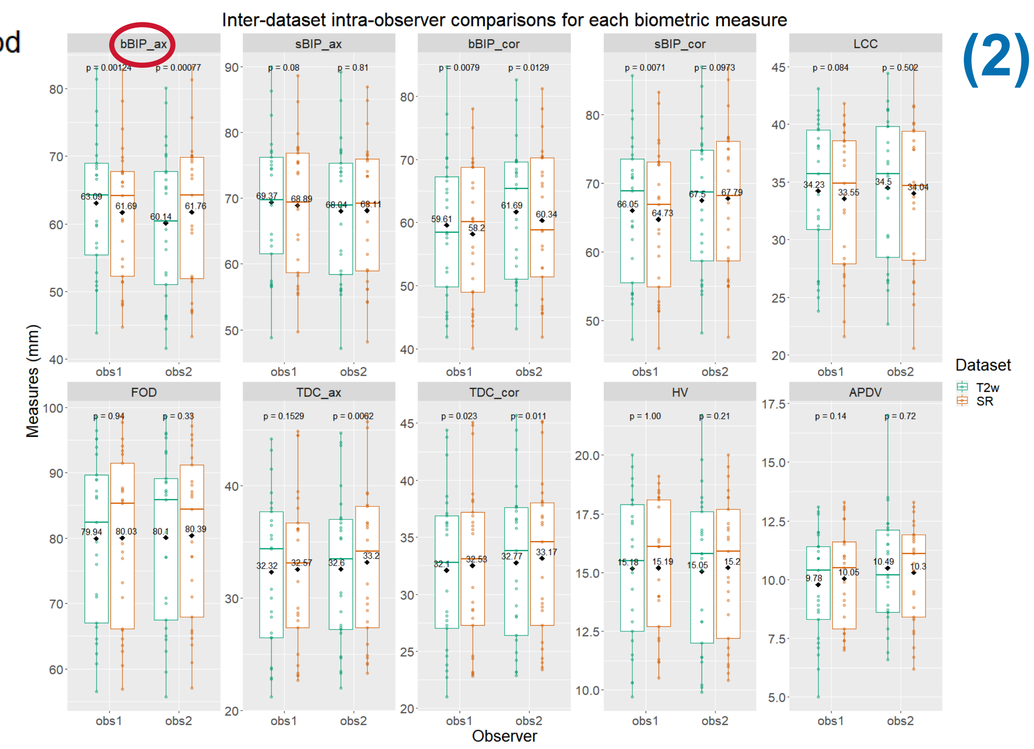
Inter-observer Lin's CCC:

- SR: 0.999
- T2WI: 0.997

(1)



(2)



CONCLUSION

- Overall, **T2WI** and **SR** provide **similar fetal brain biometrics**.
- **SR increases junior radiologist confidence** in fetal biometry.
- **SR can be used for reliable and easy-to-perform biometric assessment, instead of multiple T2 series.**

REFERENCES: [1] S. Tourbier et al. "An efficient total variation algorithm for super-resolution in fetal brain MRI with adaptive regularization", Neuroimage 2015. [2] Docker: https://github.com/Medical-Image-Analysis-Laboratory/mialsuperresolutiontoolkit; [3] MeVisLab: https://github.com/pdeman/mevislabFetalMRI. **ACKNOWLEDGMENTS**: This work is supported by the Swiss National Science Foundation (FNS projects 205321_141283 & 205321_182602) and the Hasler Foundation (17029).

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