

Accuracy of three-dimensional automated ultrasound imaging of the fetal brain

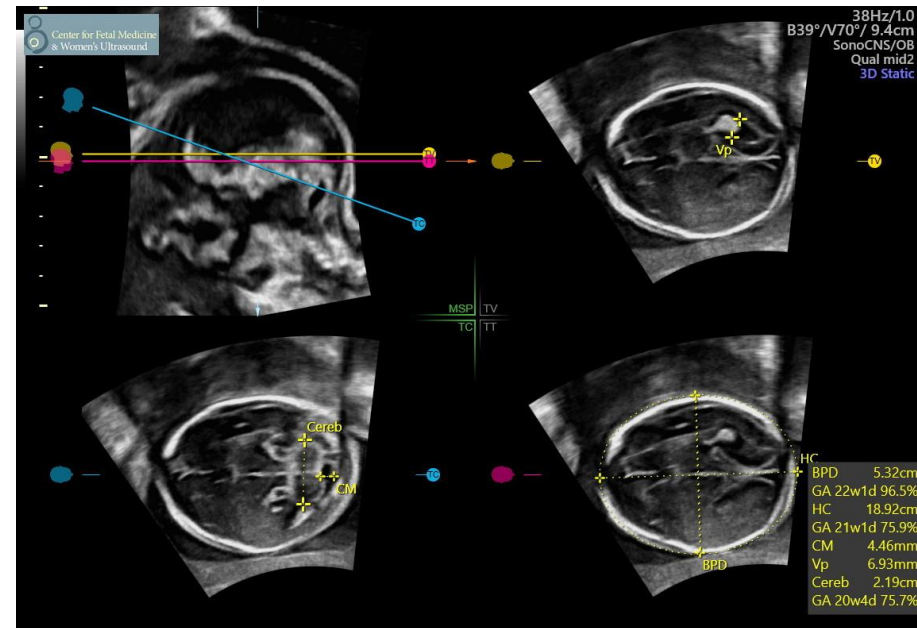
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1.University of California, Los Angeles

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Background

- Artificial intelligence, including automated imaging, is becoming an important aspect of ultrasound (US)
- SonoCNS is an automated 3D US technique of the fetal brain developed by GE Voluson



Objective

- To evaluate the accuracy of SonoCNS compared to manual acquisition of 5 fetal intracranial measurements

Study Design

- Prospective observational study
- Women at anatomical survey at 18'0-22'6 weeks
- Two ultrasounds of each patient by sonographer and MD measured BPD, HC, Cerebellum (Cer), Cisterna Magna (CM), and posterior horn of the ventricle (Vp) manually and using SonoCNS
- Primary outcome : accuracy of SonoCNS compared to manual measurements

Variables

- Patient demographics

- BMI
- Ethnicity
- History of cesarean deliveries
- History of other abdominal surgery
- Subcutaneous insulin or heparin use

- Ultrasound characteristics

- Placental location
- Fetal lie
- Fetal head position (OP, OP, OT)
- Subcutaneous adiposity



Subcutaneous adiposity: Skin to fascia, just superior to the pubic symphysis. Midline measurement and one 5mm on each side.



Demographics

- 143 women recruited and consented for study
- 2 physicians and 6 trained sonographers or MFM fellows

Variable	N(%)
Race/Ethnicity	
White	110 (77%)
Asian	19 (13%)
Hispanic	9 (6%)
Black	4 (3%)
Other	1 (1%)
BMI (kg/m2)	24.0 (22.5-26.8)*
Subcutaneous thickness (cm)	1.56 (1.28-1.95)*
Placenta	
Anterior	78 (55%)
Posterior	61 (43%)
Fundal	4 (3%)
History cesarean	15 (11%)
History abdominal surgery	17 (12%)

**Median (IQR)*

Ultrasound Characteristics

Variable	Sonographer N (%)	Physician N (%)
Fetal lie		
Vertex	77 (54%)	76 (53%)
Breech	57 (40%)	58 (41%)
Transverse	9 (6%)	9 (6.3%)
Fetal head position		
Occiput transverse	100 (70%)	104 (73%)
Occiput posterior	31 (22%)	27 (19%)
Occiput anterior	12 (8%)	112 (8%)

Results – sonographer and physician measurements of 5 intracranial structures, manually and using SonoCNS

Measure Median(IQR)	Manual		Machine	
	Sonographer	Doctor	Sonographer	Doctor
BPD	4.84 (4.61-5.04)	4.81 (4.61-5.03)	4.97 (4.78-5.20)	4.93 (4.75-5.20)
CER	2.16 (2.09-2.23)	2.12 (2.05-2.21)	2.17 (2.08-2.29)	2.17 (2.06-2.26)
CM	0.51 (0.39-0.60)	0.54 (0.42-0.65)	0.48 (0.43-0.57)	0.49 (0.42-0.55)
HC	18.02 (17.45-18.80)	17.98 (17.46-18.88)	17.78 (17.30-18.53)	17.89 (17.25-18.75)
VP	0.61 (0.56-0.66)	0.62 (0.55-0.70)	0.67 (0.62-0.73)	0.67 (0.63-0.74)



Results

- Successful acquisition of all 5 images using SonoCNS

	Sonographers	Physicians
First attempt	100 (70%)	108 (76%)
Second attempt	32 (22%)	23 (16%)
Third attempt	5 (4%)	7 (4%)

Results

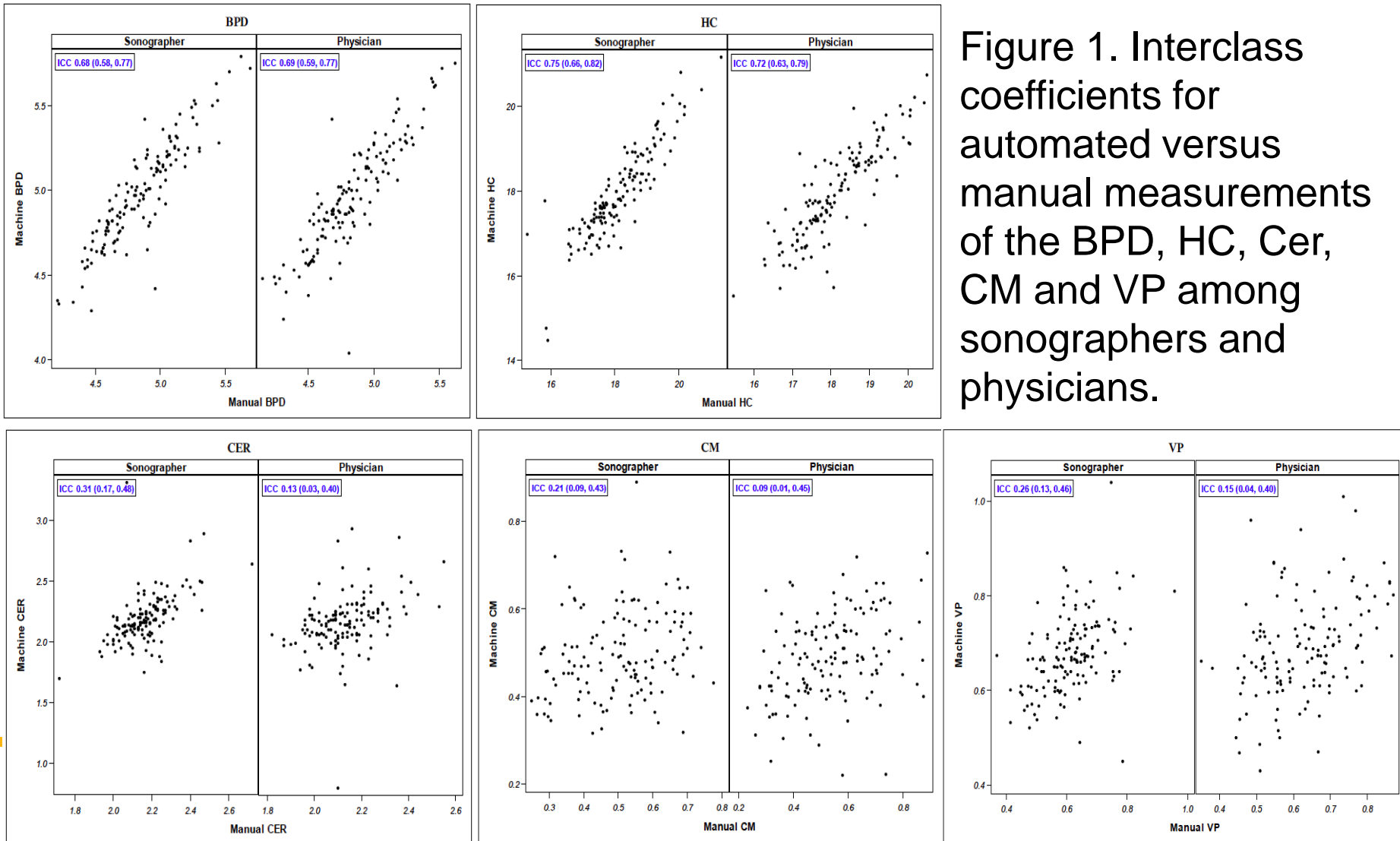
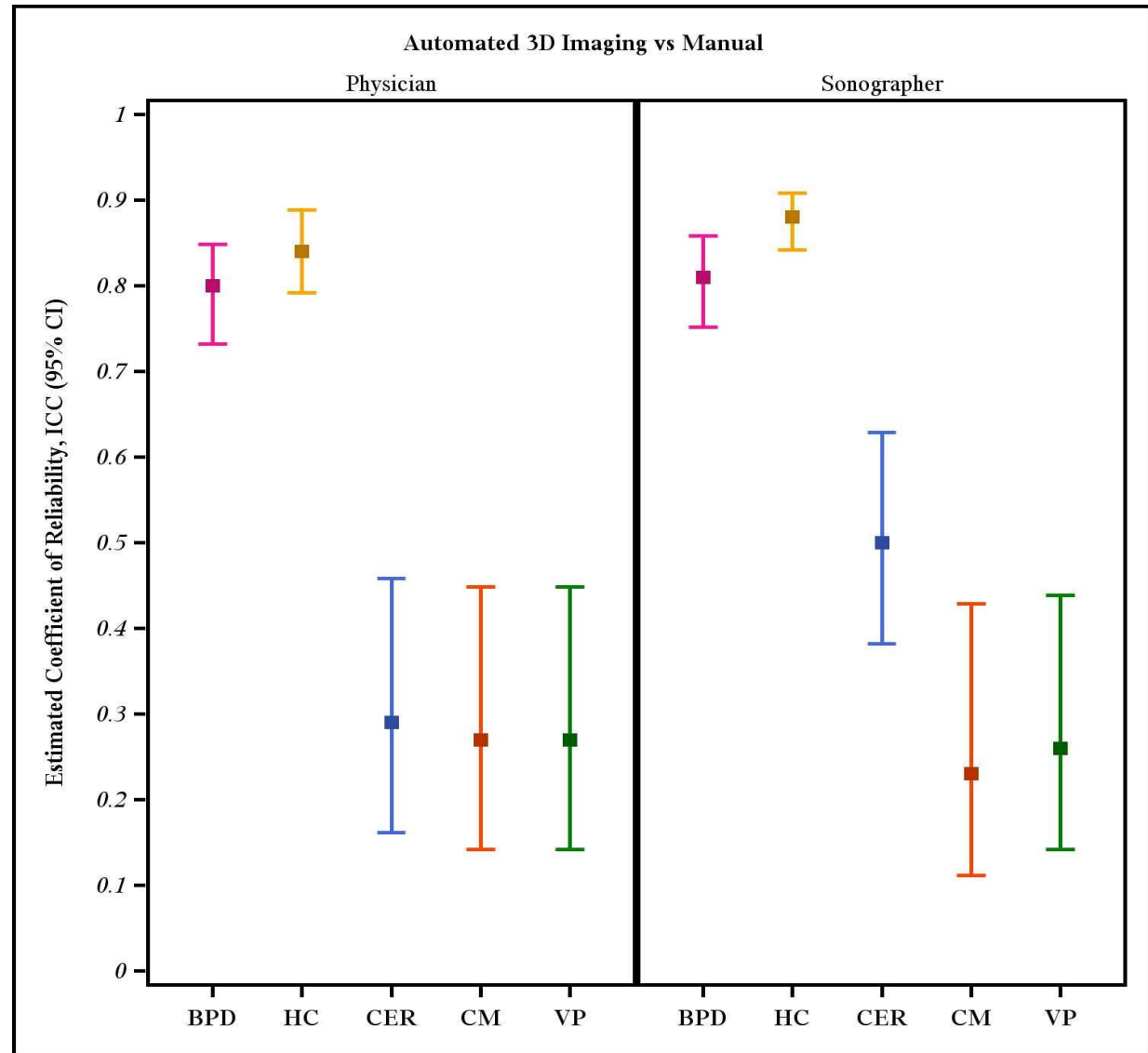


Figure 1. Interclass coefficients for automated versus manual measurements of the BPD, HC, Cer, CM and VP among sonographers and physicians.

Results

**Automated
imaging was only
reliable for the
BPD and the HC
(ICC >0.8)**



Results

Adjusted ICC demonstrated that accuracy was not associated to provider type, fetal lie, head position, placental location, subcutaneous thickness or prior surgeries

Physician: Manual vs SonoCNS (n=136)

Model	BPD ICC (95% CI)	HC ICC (95% CI)	CER ICC (95% CI)	CM ICC (95% CI)	VP ICC (95% CI)
Unadjusted	0.80 (0.73, 0.85)	0.84 (0.79, 0.89)	0.29 (0.16, 0.46)	0.27 (0.14, 0.45)	0.27 (0.14, 0.45)
Avg SubQ	0.80 (0.74, 0.86)	0.84 (0.79, 0.89)	0.29 (0.17, 0.47)	0.27 (0.14, 0.45)	0.26 (0.13, 0.44)
C sections	0.80 (0.73, 0.85)	0.85 (0.79, 0.89)	0.29 (0.17, 0.47)	0.27 (0.14, 0.45)	0.27 (0.14, 0.45)
Fetal Position	0.80 (0.73, 0.85)	0.85 (0.79, 0.89)	0.30 (0.17, 0.47)	0.26 (0.13, 0.44)	0.27 (0.14, 0.45)
Head Position	0.80 (0.73, 0.85)	0.84 (0.79, 0.89)	0.29 (0.16, 0.46)	0.27 (0.14, 0.45)	0.27 (0.14, 0.45)
Placenta	0.80 (0.73, 0.85)	0.84 (0.79, 0.89)	0.29 (0.16, 0.47)	0.27 (0.14, 0.45)	0.27 (0.14, 0.45)

Sonographer: Manual vs SonoCNS (n=137)

Model	BPD ICC (95% CI)	HC ICC (95% CI)	CER ICC (95% CI)	CM ICC (95% CI)	VP ICC (95% CI)
Unadjusted	0.81 (0.75, 0.86)	0.88 (0.84, 0.91)	0.50 (0.38, 0.63)	0.23 (0.11, 0.43)	0.26 (0.14, 0.44)
Avg SubQ	0.81 (0.75, 0.86)	0.88 (0.84, 0.91)	0.51 (0.38, 0.63)	0.24 (0.11, 0.43)	0.27 (0.14, 0.45)
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Conclusion

- Using artificial intelligence, automated 3D imaging of the fetal brain can reliably measure the BPD and HC but not the cerebellum, cisterna magna or posterior horn of the ventricles.
- Further optimization of automated technology is necessary prior to incorporation into routine sonographic protocols.



David Geffen
School of Medicine

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- Two ultrasounds by sonographer and MD measured BPD, HC, Cer, CM, and Vp manually and using SonoCNS
- Primary outcome: accuracy of SonoCNS compared to manual measurements
- Intraclass coefficients (ICC) by provider type, patient and ultrasound characteristics

Results

- 143 women recruited and consented for study
- BMI median 24.0 kg/m² (IQR 22.5-26.8 kg/m²)
- Surgeries: 11% >1 cesarean; 11% other abdom surgery

	Sonographers	Physicians
First attempt	70%	76%
Second attempt	22%	16%
Third attempt	4%	4%

Conclusion

- High ICC for BPD and HC, but not Cer, CM or Vp
- Accuracy not associated to provider type, fetal lie, head position, placental location, subcutaneous thickness or prior surgeries
- Further optimization of automated technology is necessary prior to incorporation into routine sonographic protocols.

Using **artificial intelligence, automated 3D imaging** of the fetal brain can reliably measure the **BPD and HC** but not the **cerebellum, cisterna magna or posterior horn of the ventricles.**



Questions?

- Take a picture of this QR code
- Email Dr. Pluym at ipluym@mednet.ucla.edu
- @ilinaMD

Figure 1: SonoCNS image

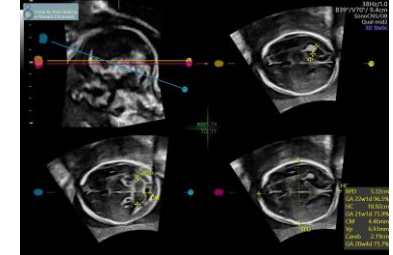


Figure 2: Intraclass coefficients for manual and automated measurements by provider type

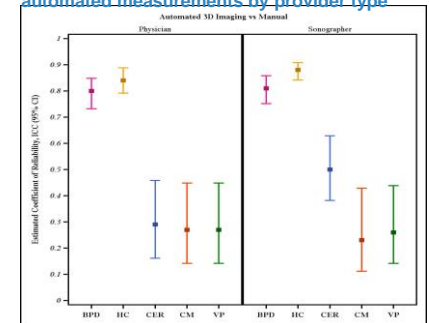


Table 1: Adjusted intraclass coefficients for manual and automated measurements by provider type

Model	Physician: Manual vs SonoCNS (n=136)				
	BPD	HC	CER	CM	VP
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