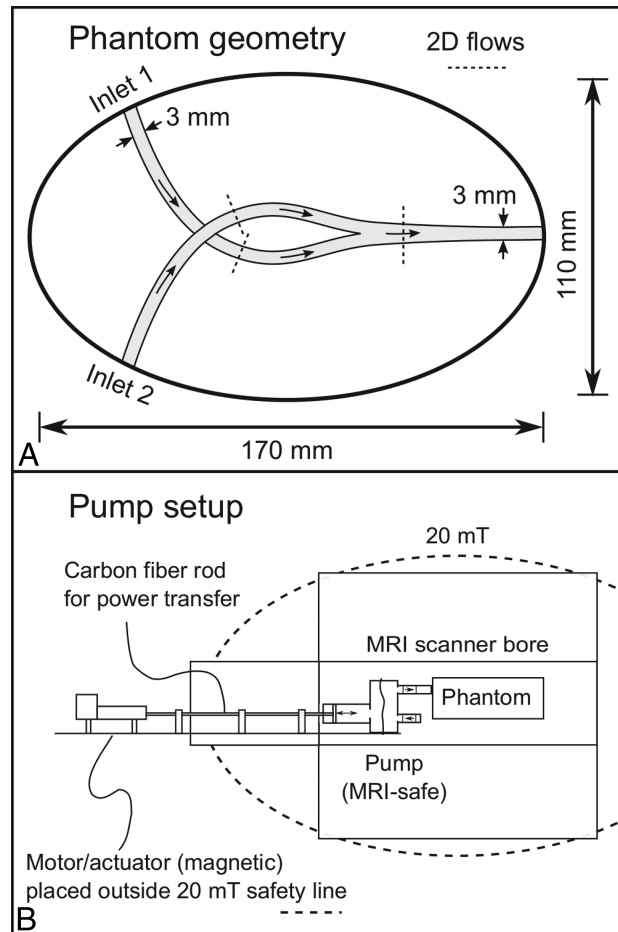**On-line Table: Detailed scan parameters of the flow phantom measurements, the healthy subject measurements, and the measurements of patients with UIAs**

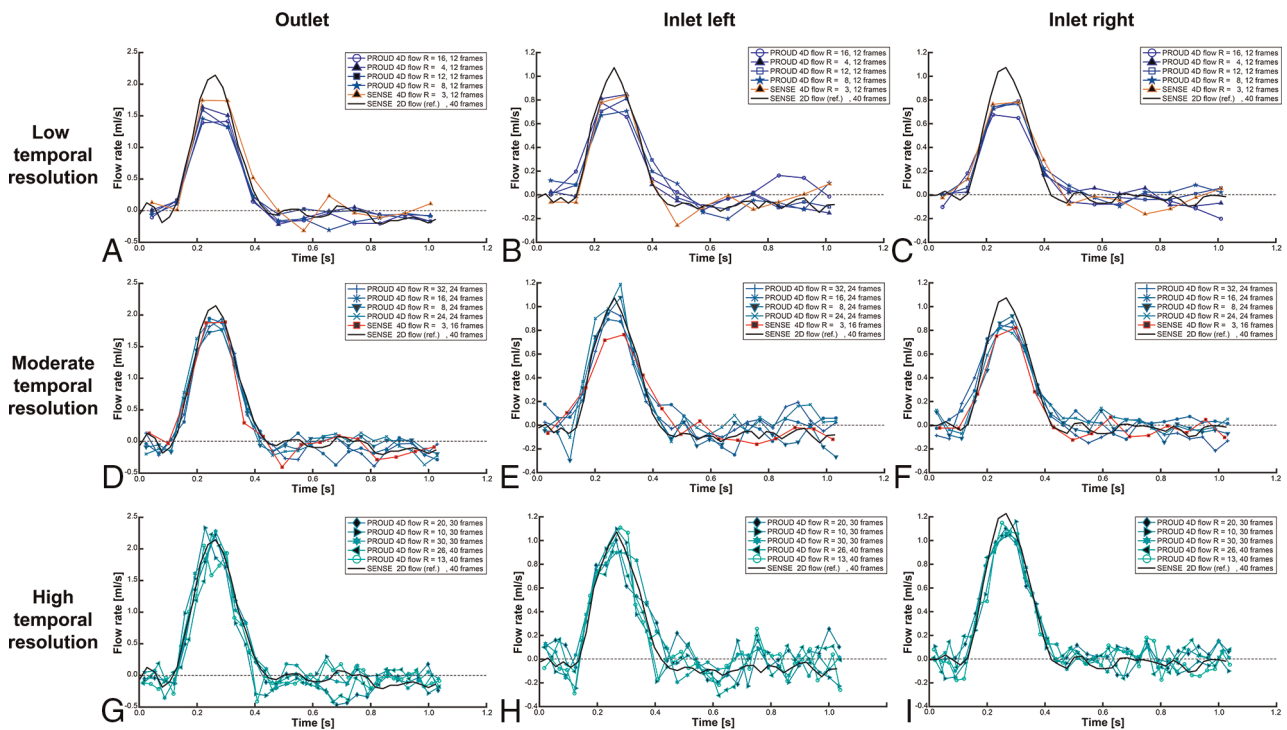| Scan	Acceleration Factor	Cardiac Frames	Temporal Resolution (ms)	Spatial Resolution (mm³)	Matrix Size (X × Y × Z)	Scan Time (Min:s)	TR/TE (ms)	FA	Segmented k-Space Factor	VENC (cm/s)	Bandwidth (Hz/Pixel)	Heart Rate (BPM)	Reconstruction Time (Min:s)
Flow phantom													
2D flow SENSE	2	40	26.3	0.3 × 0.3 × 3.0	704 × 704 × 1	05:50	13/3.3	7°	1	100	567.2	57.0 ± 0.0	—
4D flow SENSE	3	12	87.7	0.5 × 0.5 × 0.5	360 × 360 × 40	26:05	5.8/2.9	8°	3	100	567.2	57.0 ± 0.0	—
4D flow SENSE	3	16	65.8	0.5 × 0.5 × 0.5	360 × 360 × 40	39:07	5.8/2.9	8°	2	100	567.2	57.0 ± 0.0	—
4D flow PROUD	4[a]	12	87.7	0.5 × 0.5 × 0.5	360 × 360 × 40	28:14[a]	6.5/2.9	8°	—	100	567.2	57.0 ± 0.0	39:01 ± 00:00
4D flow PROUD	8[a]	24	43.9	0.5 × 0.5 × 0.5	360 × 360 × 40	28:14[a]	6.5/2.9	8°	—	100	567.2	57.0 ± 0.0	79:48 ± 00:00
4D flow PROUD	10[a]	30	35.1	0.5 × 0.5 × 0.5	360 × 360 × 40	28:14[a]	6.5/2.9	8°	—	100	567.2	57.0 ± 0.0	121:49 ± 00:00
4D flow PROUD	13[a]	40	26.3	0.5 × 0.5 × 0.5	360 × 360 × 40	28:14[a]	6.5/2.9	8°	—	100	567.2	57.0 ± 0.0	123:06 ± 00:00
Healthy subjects													
2D flow SENSE	2	30	31.3 ± 0.6	0.5 × 0.5 × 3.0	400 × 400 × 1	01:07 ± 00:02	7.7/3.8	7°	3	150	320.8	64.3 ± 1.8	—
4D flow SENSE	2.5	7[b]	134 ± 2.7	0.5 × 0.5 × 0.5	360 × 360 × 36	11:15 ± 00:19	7.8/3.7	8°	8	150	410.7	64.1 ± 1.6	58:27 ± 04:55
4D flow PROUD	5.7 ± 0.1	7	134 ± 2.7	0.5 × 0.5 × 0.5	360 × 360 × 36	11:09 ± 00:12	7.8/3.7	8°	—	150	410.7	64.5 ± 1.3	32:20 ± 00:45
4D flow PROUD	10.6 ± 0.2	15	62.6 ± 1.2	0.5 × 0.5 × 0.5	360 × 360 × 36	11:09 ± 00:12	7.8/3.7	8°	—	150	410.7	64.5 ± 1.3	66:37 ± 01:39
4D flow PROUD	19.9 ± 0.3	30	31.3 ± 0.6	0.5 × 0.5 × 0.5	360 × 360 × 36	11:09 ± 00:12	7.8/3.7	8°	—	150	410.7	64.5 ± 1.3	140:20 ± 02:44
Patients with UIAs													
4D flow PROUD	9.9 ± 0.2	10	94.7 ± 3.6	0.5	360 × 360 × 40	10:06 ± 00:29	7.7/3.6	8°	—	150	410.7	63.8 ± 2.3	46:37 ± 02:05
4D flow PROUD	26.1 ± 0.6	30	31.6 ± 1.2	0.5	360 × 360 × 40	10:06 ± 00:29	7.7/3.6	8°	—	150	410.7	63.8 ± 2.3	97:53 ± 02:43

Note:—VENC indicates velocity encoding; s, seconds; FA, flip angle; —, not applicable; BPM, beats per minute.

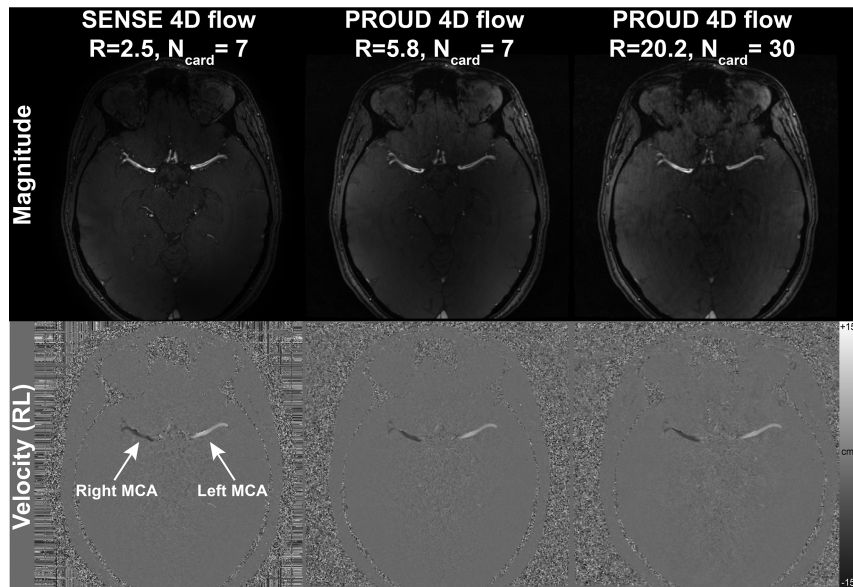[a] Other acceleration factors exist that decrease the scan time accordingly.

[b] Two subjects were scanned with 5 cardiac frames.

ON-LINE FIG 1. Phantom setup. *A*, The phantom geometry. An oval water container (110 × 170 × 100 mm, 1.5 L) with two converging pipes with a 3-mm diameter was used. *B*, The pump (custom-made using MR imaging–safe materials, plastic and brass) is placed as close as possible to the phantom for optimum flow control and stability. The linear actuator was placed outside the 20-mT safety line and connected to the pump using a stiff carbon fiber rod.
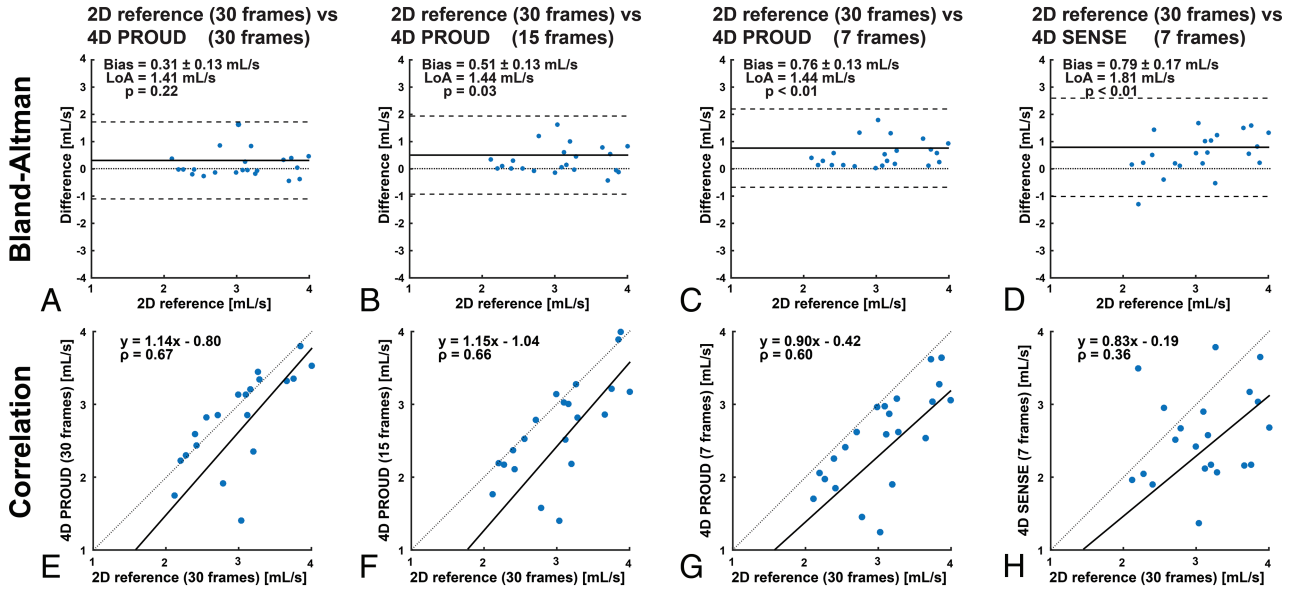
ON-LINE FIG 2. Flow rates of the three ROI outlet, inlet left, and inlet right plotted for low (12 frames), moderate (16–24 frames), and high temporal resolution (30–40 frames).
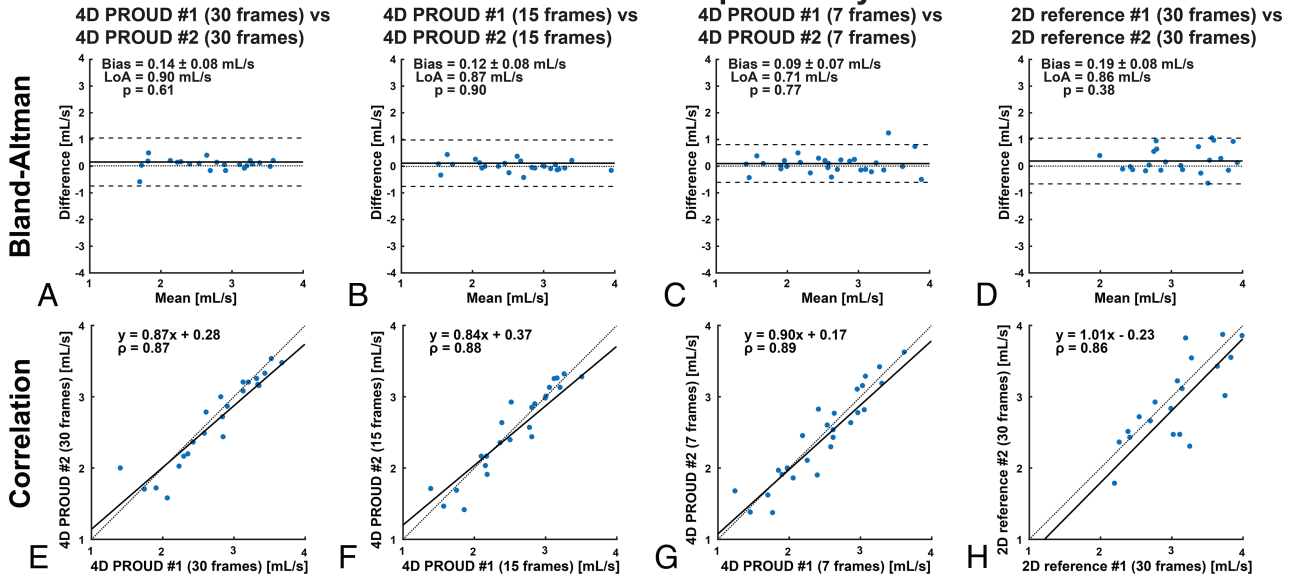

ON-LINE FIG 3. Example magnitude and velocity images of SENSE 4D flow MR imaging (*left*) and PROUD 4D flow MR imaging with either 7 or 30 cardiac frames (*middle*, *right*). Velocity encoding was performed in the right-left (R-L) direction. *White arrows* point to the locations of the 2D flow MR imaging perpendicular to the MCAs.

Peak flow rate difference

Bland-Altman

2D reference (30 frames) vs 4D PROUD (30 frames)
Bias = 0.31 ± 0.13 mL/s
LoA = 1.41 mL/s
p = 0.22
A 2D reference [mL/s]

2D reference (30 frames) vs 4D PROUD (15 frames)
Bias = 0.51 ± 0.13 mL/s
LoA = 1.44 mL/s
p = 0.03
B 2D reference [mL/s]

2D reference (30 frames) vs 4D PROUD (7 frames)
Bias = 0.76 ± 0.13 mL/s
LoA = 1.44 mL/s
p < 0.01
C 2D reference [mL/s]

2D reference (30 frames) vs 4D SENSE (7 frames)
Bias = 0.79 ± 0.17 mL/s
LoA = 1.81 mL/s
p < 0.01
D 2D reference [mL/s]

Correlation

y = 1.14x - 0.80
ρ = 0.67
E 2D reference (30 frames) [mL/s]

y = 1.15x - 1.04
ρ = 0.66
F 2D reference (30 frames) [mL/s]

y = 0.90x - 0.42
ρ = 0.60
G 2D reference (30 frames) [mL/s]

y = 0.83x - 0.19
ρ = 0.36
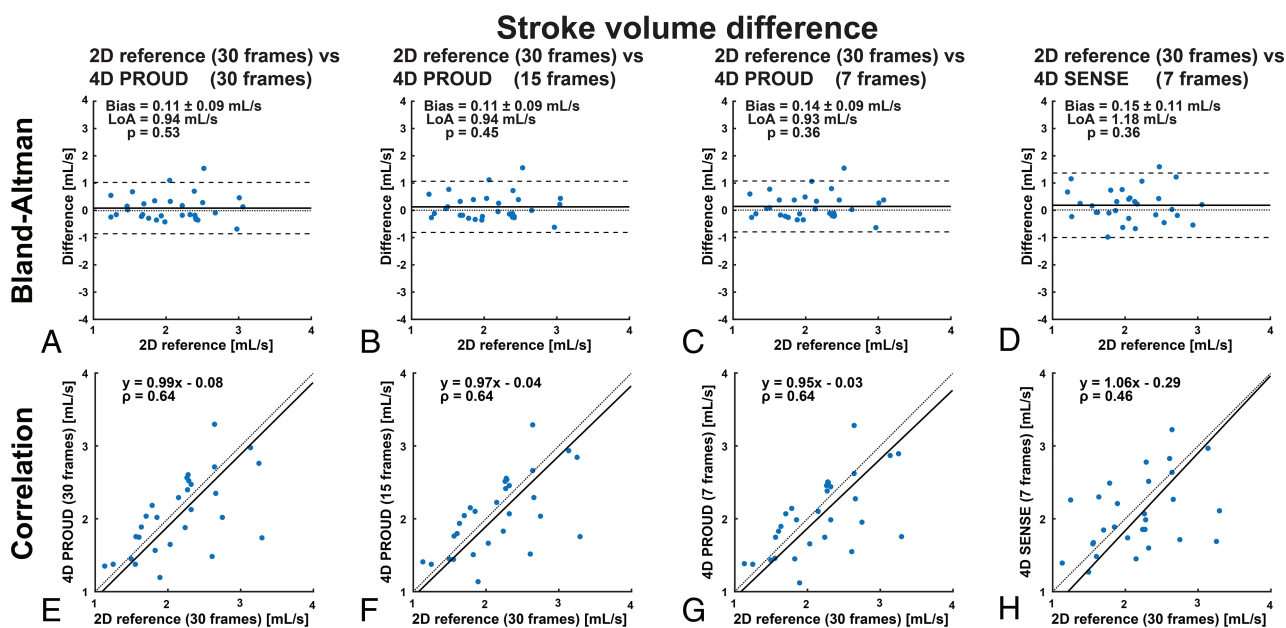**H** 2D reference (30 frames) [mL/s]

ON-LINE FIG 4. Peak flow rate difference of the 4D flow MR imaging scans to the 2D flow MR imaging reference. Bland-Altman plots (*upper row*) as well as orthogonal regression (*lower row*). LoA indicates limits of agreement.
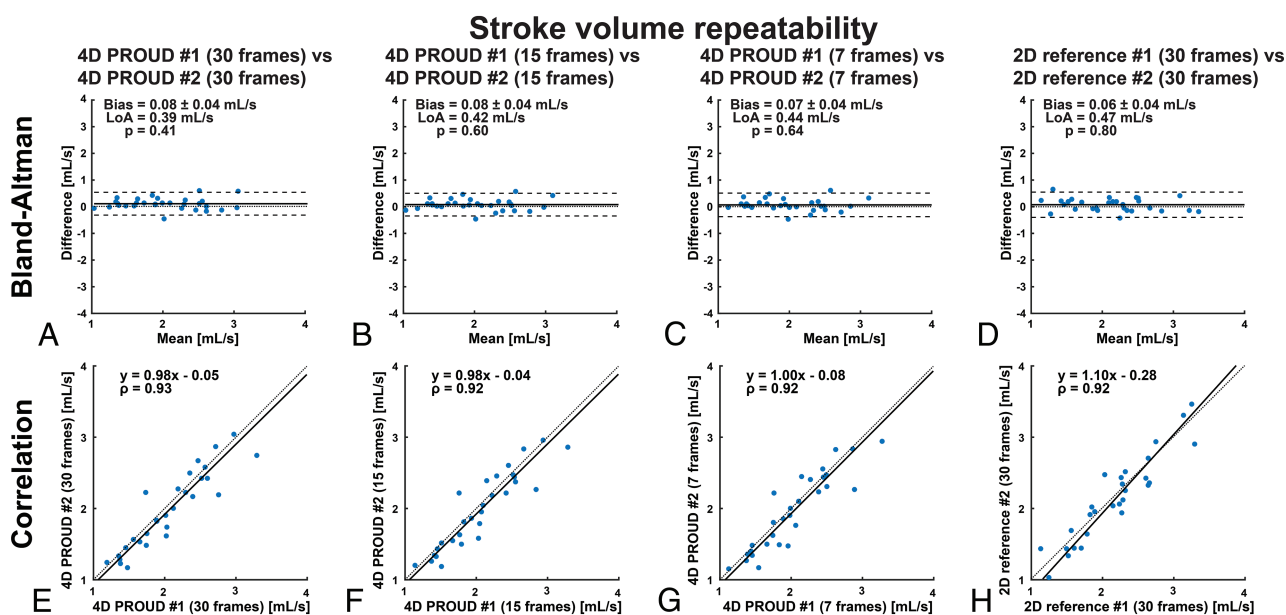
Peak flow rate repeatability

Bland-Altman

4D PROUD #1 (30 frames) vs 4D PROUD #2 (30 frames)
Bias = 0.14 ± 0.08 mL/s
LoA = 0.90 mL/s
p = 0.61
A Mean [mL/s]

4D PROUD #1 (15 frames) vs 4D PROUD #2 (15 frames)
Bias = 0.12 ± 0.08 mL/s
LoA = 0.87 mL/s
p = 0.90
B Mean [mL/s]

4D PROUD #1 (7 frames) vs 4D PROUD #2 (7 frames)
Bias = 0.09 ± 0.07 mL/s
LoA = 0.71 mL/s
p = 0.77
C Mean [mL/s]

2D reference #1 (30 frames) vs 2D reference #2 (30 frames)
Bias = 0.19 ± 0.08 mL/s
LoA = 0.86 mL/s
p = 0.38
D Mean [mL/s]

Correlation

y = 0.87x + 0.28
ρ = 0.87
E 4D PROUD #1 (30 frames) [mL/s]

y = 0.84x + 0.37
ρ = 0.88
F 4D PROUD #1 (15 frames) [mL/s]

y = 0.90x + 0.17
ρ = 0.89
G 4D PROUD #1 (7 frames) [mL/s]

y = 1.01x - 0.23
ρ = 0.86
H 2D reference #1 (30 frames) [mL/s]

ON-LINE FIG 5. Peak flow rate repeatability of the 4D flow MR imaging scans. Bland-Altman plots (*upper row*) as well as orthogonal regression (*lower row*). LoA indicates limits of agreement.
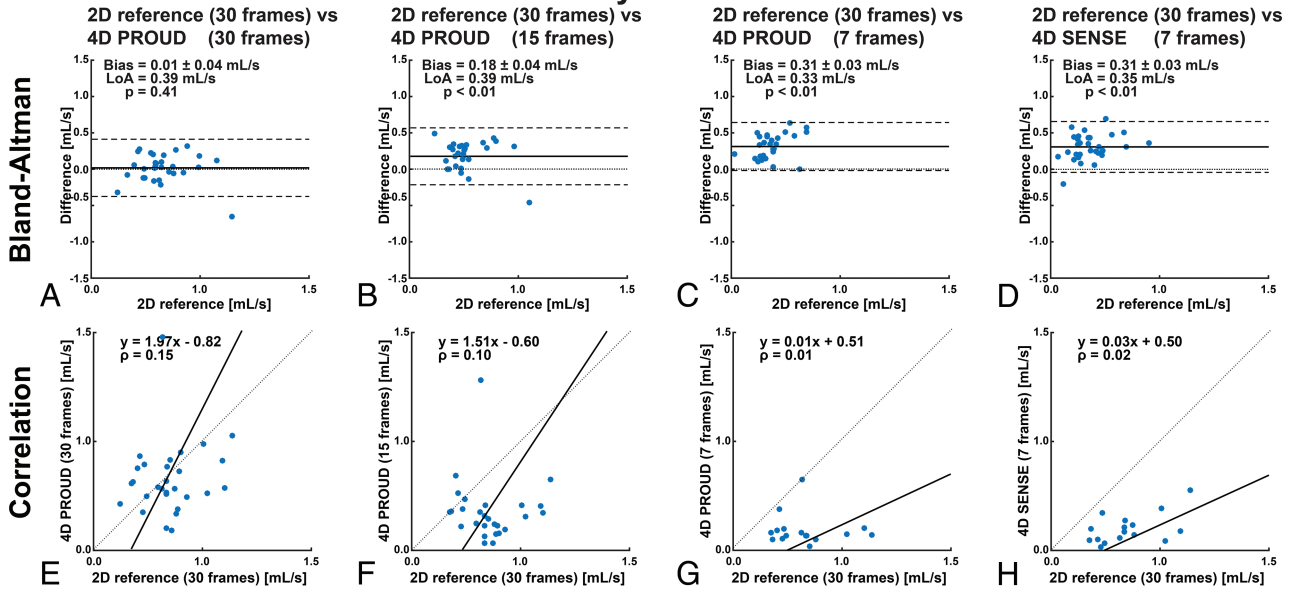
Stroke volume difference

ON-LINE FIG 6. Stroke volume difference of the 4D flow MR imaging scans to the 2D flow MR imaging reference. Bland-Altman plots (*upper row*) as well as orthogonal regression (*lower row*).

Stroke volume repeatability

ON-LINE FIG 7. Stroke volume repeatability of the 4D flow MR imaging scans. Bland-Altman plots (*upper row*) as well as orthogonal regression (*lower row*). LoA indicates limits of agreement.

ON-LINE FIG 8. Pulsatility index difference in the 4D flow MR imaging scans and the 2D flow MR imaging reference. Bland-Altman (*upper row*) as well as orthogonal regression (*lower row*).