

Comparative analysis of microvascular adaptation in twin and singleton pregnancies using laser speckle contrast imaging

Mor Huri¹, Chiara Bartolini¹, Mariacristina Raponi¹, Benedetta Baggio¹, Mariarosaria Di Tommaso¹, Viola Seravalli¹

¹ Department of Health Sciences, Division of Obstetrics and Gynaecology, University of Florence, Florence, Italy

INTRODUCTION & OBJECTIVES

Twin pregnancy is associated with more pronounced cardiovascular adaptation and a higher incidence of preeclampsia, a disorder characterized by widespread endothelial dysfunction.

Altered endothelial adaptation in twin gestation has been proposed as a potential contributor to these differences; however, studies addressing this hypothesis remain extremely limited

Objectives: to investigate longitudinal changes in maternal microvascular function during uncomplicated twin pregnancy using laser speckle contrast imaging (LSCI), and to compare them with singleton pregnancies and healthy nonpregnant women.

METHODS

- Prospective longitudinal cohort study.
- Skin perfusion measured at the dorsum of the hand by LSCI (PeriCam PSI, 785 nm near-infrared laser) in a temperature-controlled room at 24°C.
- Post occlusive reactive hyperaemia: 2-min baseline, 3-min brachial cuff occlusion at ≥ 40 mmHg above systolic pressure, 4-min recovery.
- Parameters: baseline flux, occlusion flux, peak flux (perfusion units, PU), base-to-peak flux (%), peak time and time to half recovery.
- Both pregnant groups assessed in the second (T2) and third (T3) trimester.
- Controls: singletons matched for gestational age (± 2 weeks); nonpregnant women matched for age (± 1 year).
- Exclusion criteria: chronic hypertension or cardiovascular disease, diabetes, renal disease, smoking, BMI ≥ 35 kg/m², age > 45 years, and any pregnancy that later developed a hypertensive disorder.

POST OCCLUSIVE REACTIVE HYPERAEMIA

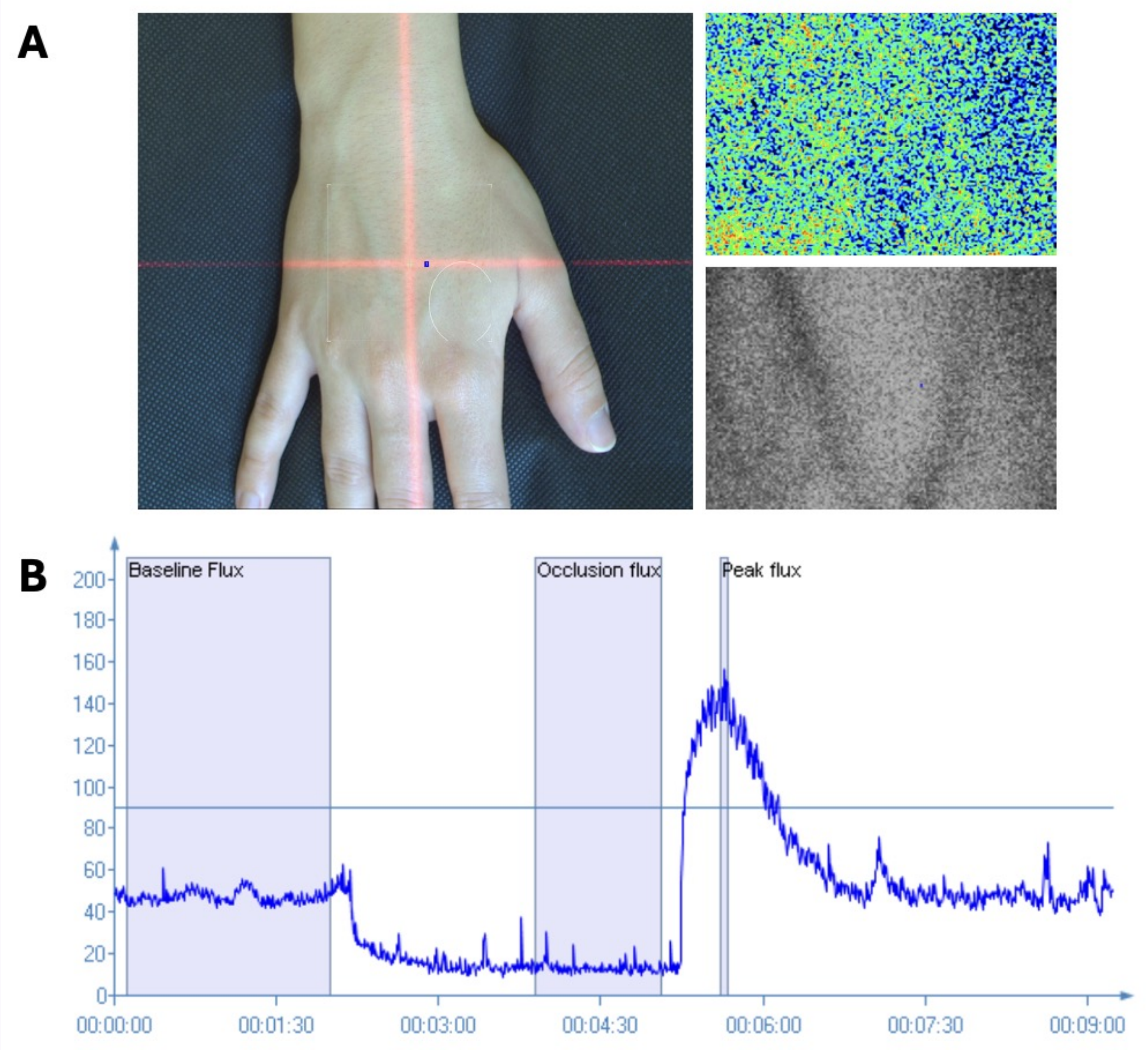
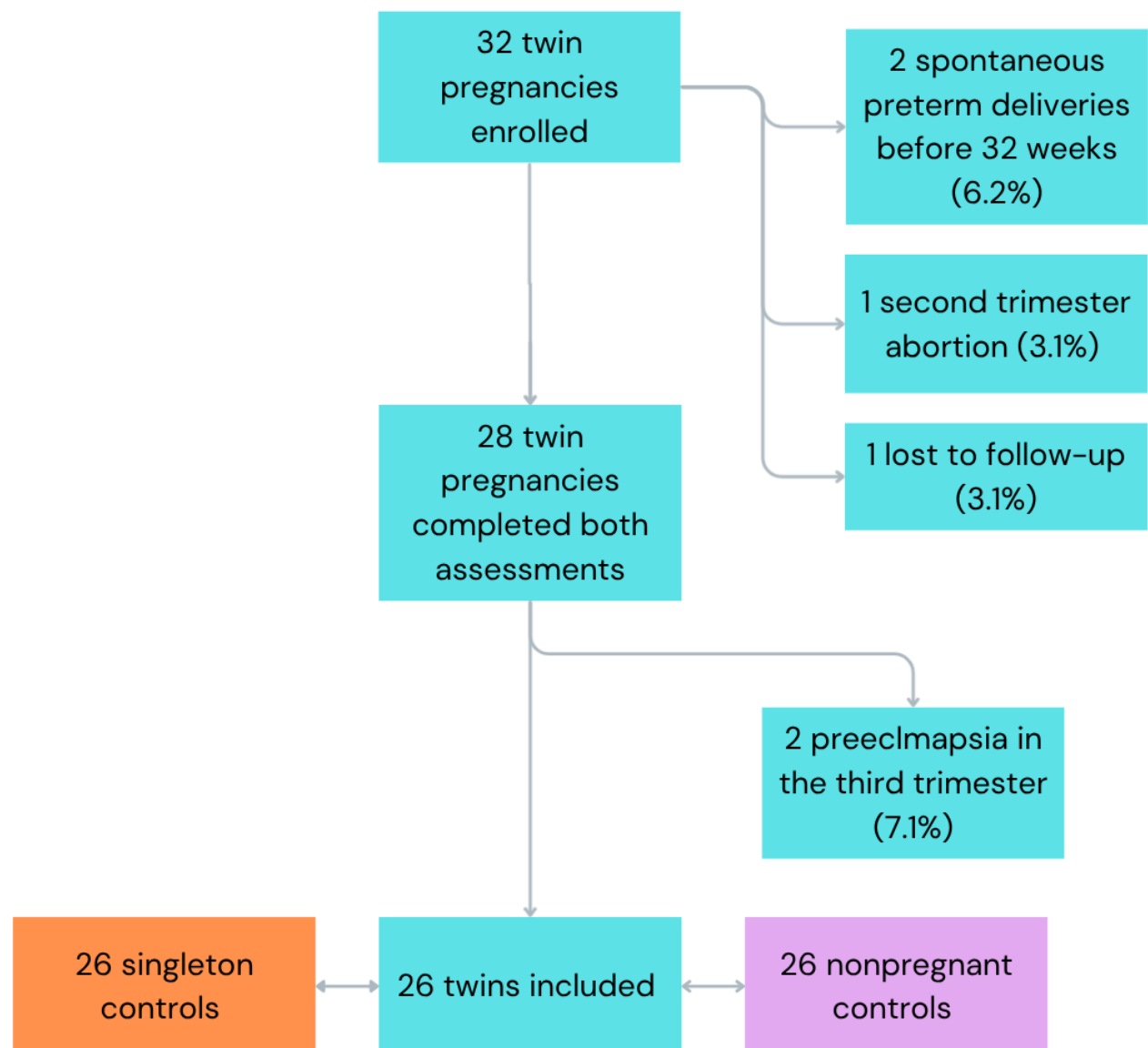


Figure 1. (A) Assessment of skin microvascular blood flow at the dorsum of the hand using LSCI. (B) Representative recording of skin perfusion during post-occlusive reactive hyperaemia, showing the baseline, occlusion and peak flux windows.

STUDY POPULATION



RESULTS

PARAMETERS BY TRIMESTER

	Twin T2	Twin T3	P	Singleton T2	Singleton T3	P
Baseline flux (PU)	38.2 (33.5–48.8)	39.8 (35.4–42.8)	0.901	40.8 $\pm$ 8.2	44.0 $\pm$ 10.4	0.142
Peak flux (PU)	160.7 $\pm$ 40.7	130.8 (117.7–157.5)	0.003	139.7 $\pm$ 29.4	164.6 $\pm$ 46.8	0.004
Base-to-peak flux (%)	290.5 $\pm$ 58.6	253.4 (222.6–270.6)	0.004	245.1 $\pm$ 54.5	275.0 $\pm$ 66.4	0.038
Peak time (s)	10 (8–15)	11.2 $\pm$ 4.8	0.831	14.8 $\pm$ 7.2	10.9 $\pm$ 3.6	0.014
Time to half recovery (s)	33.5 $\pm$ 11.3	35.1 $\pm$ 9.9	0.563	43.5 $\pm$ 12.9	32 (24–36)	0.002

Data are mean $\pm$ SD or median (IQR). P values are within-group comparisons of T2 versus T3 (paired t-test or Wilcoxon signed-rank test). Bold denotes statistical significance. PU, perfusion units.

TWIN COHORT: T2 VERSUS T3

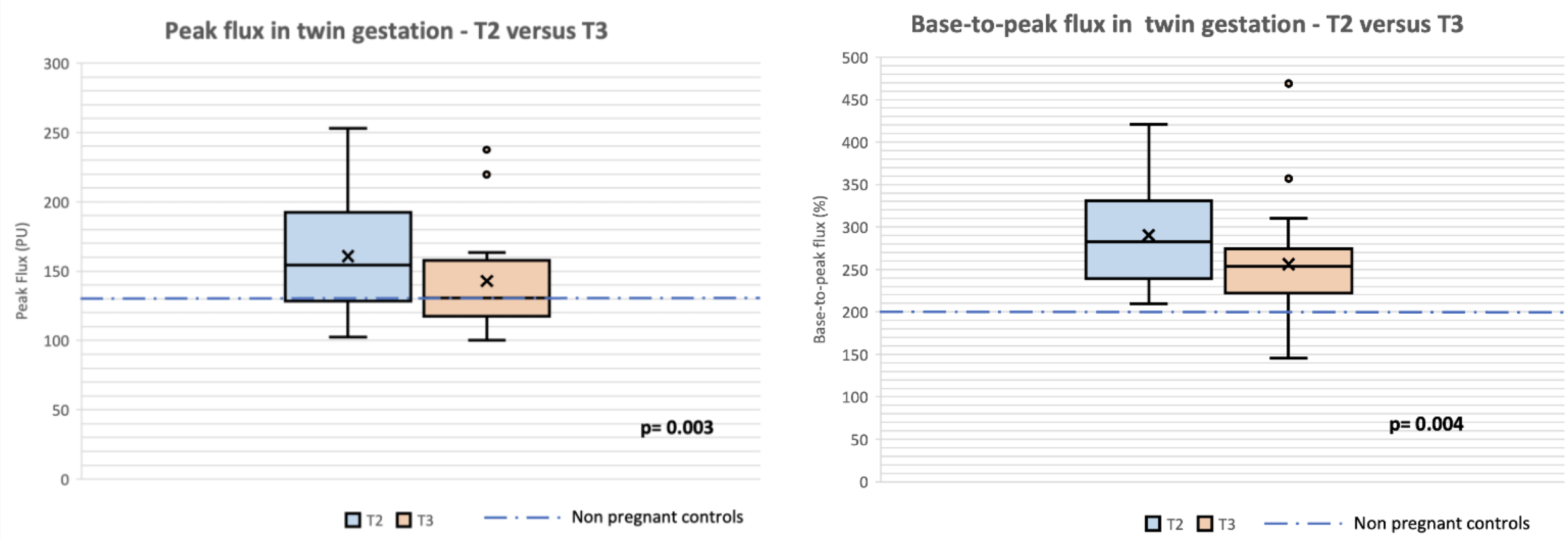


Figure 2. Peak flux and base-to-peak flux in uncomplicated twin pregnancies in the second and third trimesters. Dashed lines indicate mean values in age-matched nonpregnant controls.

In the twin cohort, microvascular reactivity **declined from T2 to T3**, with reductions in peak flux (160.7 $\pm$ 40.7 vs 130.8 [117.7–157.5] PU; $p=0.003$) and base-to-peak flux (290.5 $\pm$ 58.6 vs 253.4% [222.6–270.6]; $p=0.004$).

INTRA-INDIVIDUAL CHANGES FROM T2 TO T3: TWINS VS SINGLETONS

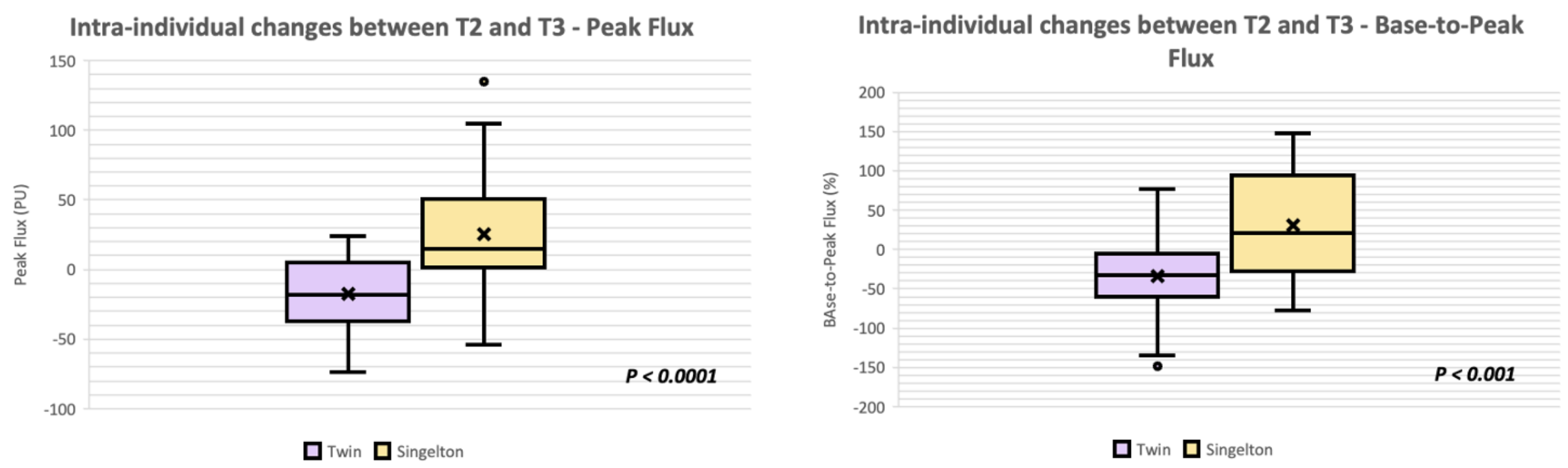


Figure 3. Intra-individual changes in peak flux and base-to-peak flux between the second and third trimesters in twin and gestational-age-matched singleton pregnancies.

The intra-individual changes between T2 and T3 differed significantly between twin and singleton pregnancies. In twins, both parameters showed **negative** mean changes (peak flux -17.84 ± 25.27 PU; base-to-peak flux $-34.45\% \pm 54.87$), whereas in singletons, **positive** mean changes were observed (peak flux 24.93 ± 39.89 PU; base-to-peak flux $29.9\% \pm 69.48$).

CONCLUSIONS

- Maternal microvascular adaptation in uncomplicated twin pregnancy follows a **different trajectory** from singleton gestation: **enhanced reactivity in the second trimester, followed by a decline in the third**.
- The inability to sustain microvascular adaptation in late gestation may represent an early, subclinical manifestation of **endothelial dysfunction** in otherwise uncomplicated twin pregnancies.
- This distinct pattern could contribute to the increased susceptibility of twin pregnancies to preeclampsia.