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## **TEST-RETEST RELIABILITY OF CLITORAL BLOOD FLOW MEASUREMENTS AT REST AND AFTER PELVIC FLOOR MUSCLE CONTRACTIONS IN HEALTHY ADULT WOMEN USING COLOR DOPPLER ULTRASONOGRAPHY**

### Hypothesis / aims of study

Since arteries feeding pelvic floor muscle (PFM) also supply the vulvo-vaginal tissues, PFM training could improve vulvo-vaginal blood flow. The dorsal clitoral artery is a terminal branch of the internal pudendal artery, one of the main vessels irrigating both the vulvo-vaginal tissues and PFMs. Monitoring blood flow using color Doppler ultrasound is currently used to investigate female sexual arousal disorder. Although color Doppler ultrasound of the clitoral blood flow has been shown reliable at rest in an inter-observer assessment,[1] its reliability has not been assessed after PFM contractions, which is highly important for interpretation of blood flow changes after PFM disorders interventions. The purpose of this prospective study was to assess the test-retest reliability of clitoral blood flow measurements at rest and after repeated PFM contractions in women using color Doppler ultrasonography.

### Study design, materials and methods

Healthy adult women participated in this prospective test-retest cohort study. Exclusion criteria were pregnancy, pathology or medication likely to interfere with blood flow measurements.

One observer performed the two repeated measurements sessions of the clitoral blood flow (T1 and T2) at the same time of the day ( $\pm 2$  hours) and at the same phase of the women's menstrual cycle to control for the effects of circadian and hormonal rhythmicity on blood flow. Furthermore, participants were asked to not perform PFM training between T1 and T2 to control for change in vascular measurements.

Participants were asked to rest in the supine position for 15 minutes to ensure standardized conditions. Using a clinical ultrasound system (Voluson E8, GE healthcare) with a 4-13 MHz linear probe according to the procedure described by Khalifé et al.,[1] three consecutive clitoral blood flow measurements were taken at rest and after a standardized PFM contraction protocol (5 x 10-sec contractions followed by 10 x 1-sec contractions). Each time, peak systolic velocity (PSV), time-averaged maximum velocity (TAMX), end-diastolic velocity (EDV), pulsatility index (PI) and resistance index (RI) were collected.

Test-retest reliability of clitoral blood flow at rest and after PFM contractions was assessed using the intraclass correlation coefficient (ICC), paired t-test and Bland-Altman plots.

### Results

A total of 20 women aged between 22 and 53 years old ( $33.6 \pm 9.9$  years old) were recruited. Eleven were nulliparas, 9 multiparas; 2 women were menopausal; 13 were taking hormonal contraception and 1 was taking systemic hormonal therapy. Among the data set, 19/20 measures were adequately visualized for the analysis.

### At rest:

There was no significant difference between T1 and T2 for all parameters. Based on the ICC results, PSV, TAMX and EDV measurements showed excellent reliability while PI and RI showed fair to good reliability (Table 1).

Bland-Altman plots demonstrated minimal bias with the mean difference close to zero. The 95% limits agreement range was narrow for PSV, TAMX and RI measurements, indicating a high consistency between both tests (Table 1). For EDV and PI measurements, the limits of agreement on Bland-Altman plots were wide considering the mean values.

### After PFM contractions:

There was no significant difference between T1 and T2 for all measurements. Based on the ICC results, PSV, TAMX, PI and RI showed excellent reliability while EDV showed fair to good reliability (Table 2).

Bland-Altman plots demonstrated minimal bias with the mean difference close to zero. The 95% limits agreement range was narrow for PSV, TAMX and RI measurements after PFM contractions (Table 2). Those limits of agreement were wide for EDV and PI measurements considering the mean values.

Table 1. Measurements at rest

	Data			Bland-Altman plots		ICC		
	Mean TI $\pm$ SD	Mean T2 $\pm$ SD	P value	Mean difference	Limits of agreement	ICC	95% ICC	P value
PSV(cm/s)	8.6 $\pm$ 2.3	8.7 $\pm$ 2.3	0.806	-0.06	-2.08–1.96	0.95	0.87–0.98	<0.001
TAMX(cm/s)	3.9 $\pm$ 1.2	4.0 $\pm$ 1.4	0.510	-0.14	-1.90–1.62	0.87	0.65–0.95	<0.001
EDV(cm/s)	1.6 $\pm$ 1.5	1.7 $\pm$ 1.5	0.569	-0.18	-2.79–2.43	0.75	0.36–0.90	0.002
PI	2.0 $\pm$ 0.6	1.9 $\pm$ 0.7	0.784	-0.04	-1.26–1.35	0.67	0.14–0.87	0.012
RI	0.8 $\pm$ 0.1	0.8 $\pm$ 0.1	0.513	0.02	-0.27–0.31	0.67	0.14–0.87	0.012

Table 2. Measurements after PFM contractions

	Data			Bland-Altman plots		ICC		
	Mean TI $\pm$ SD	Mean T2 $\pm$ SD	P value	Mean difference	Limits of agreement	ICC	95% ICC	P value
PSV(cm/s)	8.1 $\pm$ 2.5	8.8 $\pm$ 2.9	0.149	-0.68	-4.52–3.16	0.85	0.61–0.94	<0.001
TAMX(cm/s)	3.6 $\pm$ 1.3	3.9 $\pm$ 1.6	0.454	-0.25	-2.71–2.27	0.77	0.40–0.91	0.002
EDV(cm/s)	1.4 $\pm$ 1.3	1.7 $\pm$ 1.6	0.419	-0.25	-2.86–2.36	0.73	0.31–0.90	0.004
PI	2.0 $\pm$ 0.9	2.1 $\pm$ 0.9	0.464	-0.12	-1.45–1.22	0.79	0.45–0.92	0.001
RI	0.8 $\pm$ 0.1	0.8 $\pm$ 0.2	0.662	0.01	-0.23–0.25	0.81	0.51–0.92	<0.001

### Interpretation of results

Results from this intra-observer test-retest reliability study indicate high positive correlations with no significant mean difference for PSV and TAMX measurements of the clitoral blood flow at rest and after PFM contractions. Those results were confirmed by the Bland-Altman plots analysis, which showed narrow limits of agreements. However, ICC values were lower and the 95% limits agreement range on Bland-Altman plots were wider after PFM contractions for those measurements when compared to rest state, suggestive of a higher difficulty level in measuring this condition. Reliability of PI values was fair to good according to ICC values in both conditions. Those results were confirmed by the Bland-Altman plots analysis, which showed wide limits of agreements considering the mean values.

Reliability of EDV measurements were acceptable considering the ICC values but it showed wide limits of agreements around its mean value on Bland-Altman plots in both conditions. Reliability of RI measurements were acceptable considering the ICC values and showed narrow limits of agreements on Bland-Altman plots in both conditions. However, when looking at raw data, EDV measurements were often equal to zero, causing the RI value to be equal to 1 (At rest: 21% of participants at T1 and 21% of participants at T2; After PFM contractions: 16% of participants at T1 and 37% of participants at T2). Therefore, the meaning of these results is questionable for the analysis of changes after an intervention.

Only one other study evaluated clitoral blood flow measurements reliability using color Doppler ultrasonography at rest; none after PFM contraction. Khalifé et al. assessed PSV, PI and RI measurements reliability at rest in an inter-observer study and found results similar to ours.[1] Our study adds the TAMX (the averaged mean of peak flow velocities over a complete cardiac cycle), a reliable aggregate parameter of clitoral blood flow both at rest and after PFM contractions.

### Concluding message

Our research findings are original as they suggest that PSV and TAMX are reliable parameters of clitoral blood flow at rest and after PFM contractions. These parameters can form the basis of further research on the clitoral artery's vascular properties.

### References

1. Khalife, S., et al., Evaluation of Clitoral Blood Flow by Color Doppler Ultrasonography. Journal of Sex & Marital Therapy, 2000. 26(2): p. 187-189.

### Disclosures

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