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Original Article

Dermatology Section

Assessment of Nailfold Capillaroscopy Findings in Pregnant Women with Preeclampsia Compared to Gestational Age-matched Normotensive Pregnant Women: A Cross-sectional Study

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ABSTRACT

Introduction: Preeclampsia is a hypertensive disorder of pregnancy characterised by endothelial dysfunction. Nailfold Capillaroscopy (NFC) offers a non-invasive method for evaluating microvascular changes at the nailfold.

Aim: To compare nailfold capillary changes in women diagnosed with preeclampsia and women with normal, uneventful pregnancies matched for gestational age.

Materials and Methods: The present cross-sectional observational study was conducted in the Departments of Dermatology and Obstetrics and Gynaecology at a tertiary care centre, Acharya Vinoba Bhave Rural Hospital, Wardha, Maharashtra, Central India, from March 2023 to March 2025. The study included 80 pregnant women diagnosed with preeclampsia and 80 gestational age-matched normotensive controls. All participants underwent NFC using a digital video capillaroscope with 50× magnification. Capillary morphology, density, and abnormal patterns such as tortuosity, branching, ramification, and avascular areas were recorded and compared using the Chi-square test and multivariate logistic regression analysis.

Results: The preeclampsia group, with a mean age of 28.4±4.2 years, exhibited significantly higher rates of abnormal capillary morphology, including serpentine capillaries {5 (6.25%) vs. 0 (0%), p=0.043} and branched capillaries {2 (2.5%) vs. 0 (0%), p=0.043}, compared with healthy gestational age-matched pregnant controls, who had a mean age of 27.9±3.9 years. Increased capillary density (>7/mm) was significantly more prevalent in the pre-eclamptic group {9 (11.25%) vs. 2 (2.5%), p=0.048}. Disorganised capillary architecture was observed in 18 (22.5%) pre-eclamptic women compared with 6 (7.5%) controls (p=0.012). Specific microvascular markers, including giant capillaries (n=6, p=0.010), avascular areas (n=4, p=0.036), and meandering capillaries (n=5, p=0.015), were exclusively noted in the preeclampsia group. Multivariate analysis confirmed bizarre capillaries (OR: 7.8), tortuous capillaries (OR: 6.4), avascular areas (OR: 5.9), and neoangiogenesis (OR: 4.5) as independent predictors of preeclampsia (all p<0.01).

Conclusion: According to the present study findings NFC reveals prominent microvascular abnormalities in women with preeclampsia, indicating its potential as a bedside tool for early identification and risk stratification.

Keywords: Abnormal capillary morphology, Gestation, Hypertension, Microvascular abnormalities, Non-invasive, Skin

INTRODUCTION

Pregnancy induces profound physiological, hormonal, and haemodynamic changes to support foetal development and maternal adaptation. These include increased cardiac output, plasma volume expansion, and vasodilation. In some pregnancies, however, these adaptations are disrupted, leading to complications such as preeclampsia-a hypertensive disorder defined by elevated blood pressure and proteinuria after 20 weeks of gestation. The pathophysiology of preeclampsia centres on placental hypoxia, systemic endothelial dysfunction, and abnormal immune responses, culminating in multisystem involvement [1,2].

Early diagnosis and continuous monitoring are essential for preventing maternal and foetal morbidity associated with preeclampsia. Non-invasive diagnostic tools that evaluate endothelial integrity and microvascular health could improve risk stratification and management. One such tool is Nailfold Capillaroscopy (NFC), which provides a direct and reproducible method for visualising microcirculation in-vivo [3,4].

NFC is a non-invasive imaging technique that allows direct visualisation of capillaries in the proximal nailfold using microscopy under standardised conditions. The technique involves examining capillary loops with a specialised microscope, typically at 50× or higher magnification, after applying immersion oil to enhance image clarity. NFC enables assessment of capillary density, morphology (looped, tortuous, serpentine, branched, ramified, bizarre, or meandering patterns), capillary diameter, haemorrhages, avascular zones, and neoangiogenesis [4]. It has been widely used in connective tissue disorders such as systemic sclerosis, where it demonstrates diagnostic and prognostic significance. However, its utility in obstetric conditions, particularly hypertensive disorders like preeclampsia, is less established but increasingly recognised [5].

The rationale for using NFC in preeclampsia arises from the underlying endothelial injury. Microvascular abnormalities in preeclampsia include endothelial swelling, increased vascular permeability, and capillary rarefaction. These structural alterations are potentially detectable through NFC, allowing identification of distinctive patterns. Expected findings in pre-eclamptic women include capillary rarefaction (reduced density), capillary dilatation, microhaemorrhages, avascular

zones, and altered capillary architecture reflecting microvascular remodelling and dysfunction [4-6].

Despite growing interest, there remains a gap in the literature regarding large-scale studies of NFC findings in preeclampsia, particularly within the Indian population. Limited data exist on specific capillaroscopic patterns characteristic of pre-eclamptic pregnancies across diverse ethnic groups. The present study aimed to evaluate NFC patterns in women with preeclampsia and compare them with healthy gestational age-matched controls. By identifying distinct capillaroscopic signatures, this study seeks to support the role of NFC as a non-invasive and accessible tool in obstetric care.

MATERIALS AND METHODS

The present cross-sectional observational study was conducted in the Departments of Dermatology and Obstetrics and Gynaecology at Acharya Vinoba Bhave Rural Hospital, Wardha, Maharashtra, Central India, from March 2023 to March 2025. The study protocol was approved by the Institutional Ethics Committee (IEC Ref. No. DMIMS (DU)/IEC/2023/742, dated 21/03/2023). Written informed consent was obtained from all participants prior to enrolment. The research protocol was published on 01/05/2024 (DOI: 10.7860/JCDR/2024/69038.19430) [7].

Sample size calculation:

n=(Zα/2)2×P(1-P)/d2

Where, Z α/2 is the level of significance at 5%, i.e., 95%

Confidence Interval (CI)=1.96

p=Prevalence of preeclampsia=5%=5.0=0.05 [2] (prevalence rate of preeclampsia ranging between 5-8% of total pregnancies globally)

d=Desired error of mean=0.05

n=(1.96)2×0.005×(1-0.05)/(0.05)2

n=73

n=75

n= 80

Here, a sample size (n) of 80 in each group was considered, making a total sample size (n) of 160.

Participants were divided into two groups: one consisting of women diagnosed with preeclampsia (cases) and the other comprising healthy, normotensive pregnant women (controls), matched for gestational age to minimise bias.

Inclusion criteria: For cases (preeclampsia group):

- Pregnant women aged 18-40 years;
- Singleton pregnancy;
- Gestational age between 28 and 36 weeks;
- Diagnosis of preeclampsia as per ACOG guidelines [8].

For controls (normotensive group):

- Pregnant women aged 18-40 years;
- Singleton pregnancy;
- Gestational age between 28 and 36 weeks;
- Normotensive throughout pregnancy (blood pressure <140/90 mmHg);
- No systemic or obstetric complications.

Exclusion criteria: Women were excluded if they had:

- Known autoimmune or connective tissue disorders (systemic sclerosis, systemic lupus erythematosus, rheumatoid arthritis, etc.);
- Pre-existing diabetes mellitus;
- Chronic hypertension;
- History of smoking or substance abuse;
- Multiple pregnancy;
- Known nail disorders or trauma to the nailfold area;
- Inability to provide informed consent.

Study Procedure

Nailfold capillaroscopy procedure: Nailfold capillaroscopy was performed using a digital video capillaroscope with 50 × magnification. All examinations were conducted in a temperature-controlled room to minimise environmental variability. Participants were seated comfortably to avoid sympathetic stimulation that could affect microvascular perfusion. The fourth finger of the non-dominant hand was selected for evaluation. A drop of immersion oil was applied to the nailfold to enhance image clarity and capillary visibility.

Parameters assessed [9]: The following parameters were systematically evaluated and documented:

- Capillary morphology: Classified as looped (normal hairpin appearance), serpentine (snake-like undulating pattern), branched (bifurcation of capillary loops), tortuous (irregular twisting without a specific pattern), ramified (tree-like branching with multiple divisions), bizarre (extremely irregular and distorted shapes), or meandering (gentle curving without sharp angles).
- Capillary diameter: Categorised as normal (<20 µm at the apical portion) or enlarged (>20 µm). Giant capillaries were defined as those with a diameter >50 µm.
- Capillary density: Measured as the number of capillaries per millimetre in the distal row. Density was classified as <7 capillaries/mm (capillary rarefaction) or ≥7 capillaries/mm (normal or increased density).
- Capillary architecture: Assessed as organised (regular, parallel arrangement) or disorganised (irregular distribution and orientation).
- Additional findings: Presence of avascular zones (areas >500 µm devoid of capillaries), capillary haemorrhages, neoangiogenesis (formation of new, often irregular capillaries), and cuticulitis (inflammation of the cuticle).

Images were digitally captured and stored for subsequent analysis. Both hands (left and right fourth fingers) were examined to ensure comprehensive assessment.

STATISTICAL ANALYSIS

Data were analysed using descriptive and inferential statistical methods. Continuous variables were expressed as mean±standard deviation, and categorical variables as frequencies and percentages. Group comparisons were performed using the independent samples t-test for continuous variables and the chi-square test for categorical variables. Multivariate logistic regression analysis was used to identify factors independently associated with preeclampsia, with results presented as adjusted odds ratios and 95% confidence intervals. A p-value <0.05 was considered statistically significant. All analyses were performed using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

Demographic characteristics showed no significant differences between the two groups with respect to age (p=0.58), gestational age (p=0.47), BMI (p=0.09), or parity (p=0.65), indicating comparability. However, systolic and diastolic blood pressures were significantly higher in the preeclampsia group (p<0.001) [Table/Fig-1].

Morphologically, looped capillaries predominated in both groups; however, serpentine and branched capillaries were observed exclusively in the preeclampsia group. These abnormalities were statistically significant in both the left and right hands (p=0.043 and p=0.025, respectively) [Table/Fig-2]. A total of 42 participants (26.25%) demonstrated additional capillaroscopic findings across both hands, with a higher proportion in the preeclampsia group

Parameters	Preeclampsia group (n=80)	Control group (n=80)	p-value
Mean age (years)	28.4±4.2	27.9±3.9	0.58
Gestational age (weeks)	32.1±1.5	32.3±1.6	0.47
Primigravida	50 (62%)	46 (58%)	0.65
BMI (kg/m^2)	27.8±2.5	26.9±2.3	0.09
Mean systolic BP (mmHg)	148.2±10.1	116.5±7.5	<0.001
Mean diastolic BP (mmHg)	96.7±8.4	74.8±6.1	<0.001

[Table/Fig-1]: Demographic profile of study participants.
Test to calculate the p value is: t-test for continuous variables and the chi-square test for categorical variables

Parameters	Hand	Category	Case (n=80)	Control (n=80)	χ^2 Value	p-value
Morphology	Left	Looped / Serpentine / Branched	73 (91.25%) / 5 (6.25%) / 2 (2.5%)	80 (100%) / 0 (0%) / 0 (0%)	6.31	0.043*
	Right	Looped / Serpentine / Branched	73 (91.25%) / 6 (7.5%) / 1 (1.25%)	80 (100%) / 0 (0%) / 0 (0%)	7.42	0.025*
Diameter	Left	Normal / Regularly Enlarged	71 (88.75%) / 9 (11.25%)	74 (92.5%) / 6 (7.5%)	0.342	0.559
	Right	Normal / Regularly Enlarged	74 (92.5%) / 6 (7.5%)	74 (92.5%) / 6 (7.5%)	0.0005	1.000
Density	Left	<7 / >7 capillaries per mm	71 (88.75%) / 9 (11.25%)	78 (97.5%) / 2 (2.5%)	3.92	0.048*
	Right	<7 / >7 capillaries per mm	72 (90%) / 8 (10%)	78 (97.5%) / 2 (2.5%)	3.92	0.048*
Architecture	Left	Organised / Disorganised	62 (77.5%) / 18 (22.5%)	74 (92.5%) / 6 (7.5%)	6.31	0.012*
	Right	Organised / Disorganised	63 (78.75%) / 17 (21.25%)	74 (92.5%) / 6 (7.5%)	5.42	0.020*

[Table/Fig-2]: Capillaroscopic findings.

(66.67%) compared with the control group (33.33%) [Table/Fig-3]. Multivariate logistic regression analysis identified bizarre capillaries, tortuous capillaries, avascular areas, and neoangiogenesis as independent predictors of preeclampsia, all with p-values <0.001 [Table/Fig-4]. [Table/Fig-5-16] illustrate representative capillaroscopic findings from selected cases.

Additional findings	Case n (%)	Control n (%)	Total n (%)	χ^2 Value	p-value
Tortuous capillaries	4 (9.52%)	8 (18.18%)	12 (27.27%)	1.33	0.248
Giant capillaries	6 (14.28%)	0 (0%)	6 (13.63%)	6.55	0.010*
Bizarre capillaries	2 (4.76%)	6 (13.63%)	8 (18.18%)	2.40	0.121
Avascular areas	4 (9.52%)	0 (0%)	4 (9.09%)	4.40	0.036*
Meandering capillaries	5 (11.90%)	0 (0%)	5 (11.36%)	5.87	0.015*
Cuticulitis	2 (4.76%)	0 (0%)	2 (4.54%)	2.02	0.155
Ramified capillaries	2 (4.76%)	0 (0%)	2 (4.54%)	2.02	0.155
Haemorrhagic areas	3 (7.14%)	0 (0%)	3 (6.81%)	3.07	0.080
Total cases/controls	28 (66.67%)	14 (33.33%)	42 (100%)	11.9	0.155

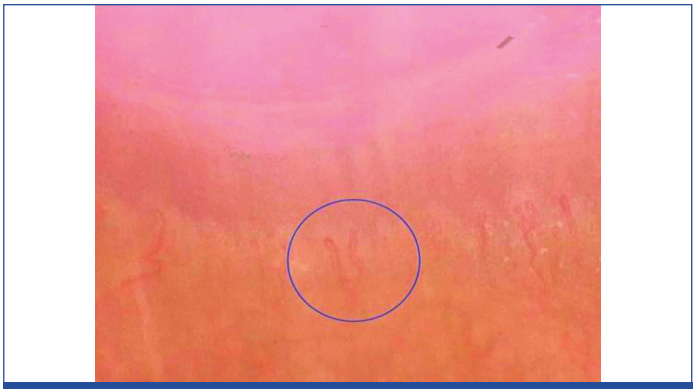
[Table/Fig-3]: Additional findings.

DISCUSSION

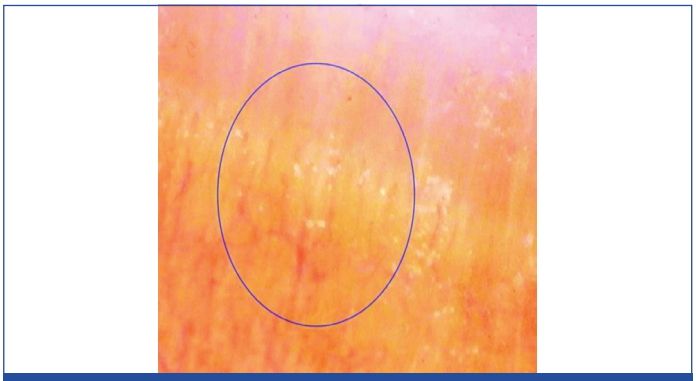
Based on the present study findings, the distribution of nailfold capillary morphology was significantly different in the case group compared with the control group.

Predictor	Description in model	OR	95% CI	p-value
Bizarre capillaries	Present vs. absent	7.8	3.2-18.9	<0.001***
Tortuous capillaries	Present vs. absent	6.4	2.9-14.1	<0.001***
Avascular areas	Present vs. absent	5.9	2.6-13.4	<0.001***
Neo-angiogenesis	Present vs. absent	4.5	2.0-10.1	<0.001***
Maternal age	≥30 years vs. <30 years	1.02	0.96-1.09	0.58
Gestational age at diagnosis	<34 weeks vs. ≥34 weeks	0.98	0.90-1.06	0.47
BMI	≥30 kg/m^2 vs. <30 kg/m^2	1.08	0.99-1.18	0.09
Primigravida	Yes vs. multiparous	1.17	0.60-2.28	0.65

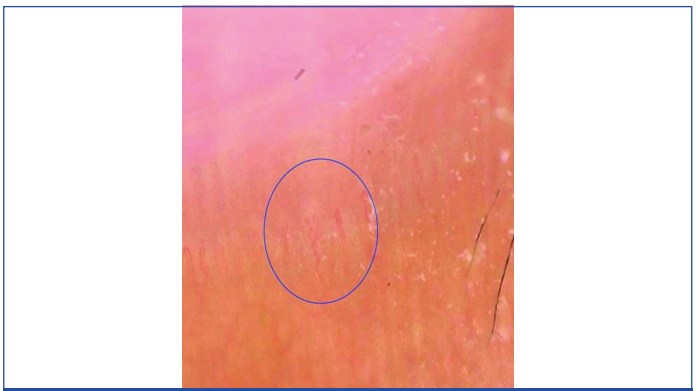
[Table/Fig-4]: Multivariate logistic regression analysis.



[Table/Fig-5]: NFC view Bizarre capillaries at 50 x magnification in a pre-eclamptic woman.

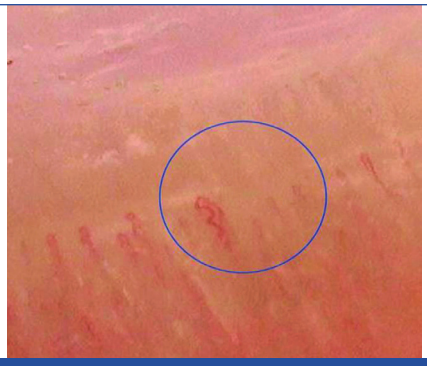


[Table/Fig-6]: NFC view Branched capillaries at 50 x magnification in a pre-eclamptic woman.



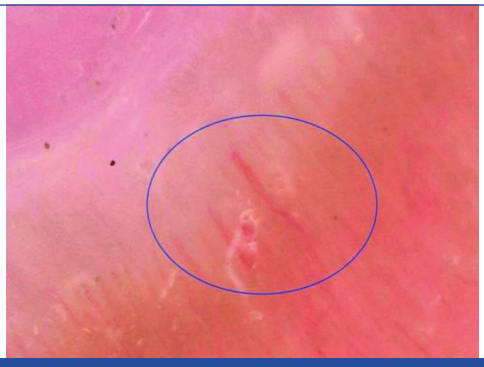
[Table/Fig-7]: NFC view tortuous capillaries at 50 x magnification in a pre-eclamptic woman.

The present study findings are in agreement with Thevissen K et al., who observed inter-trimester trends in capillary morphology. In the low-risk group, capillary density decreased from the second to the third trimester, and capillary diameter decreased from the first to the second trimester [4]. Interestingly, women with a high cardiovascular risk profile but normal pregnancy outcomes demonstrated significantly higher capillary density in the first and third trimesters. These women also exhibited a significantly larger capillary bed in the first trimester, calculated across eight fingers by



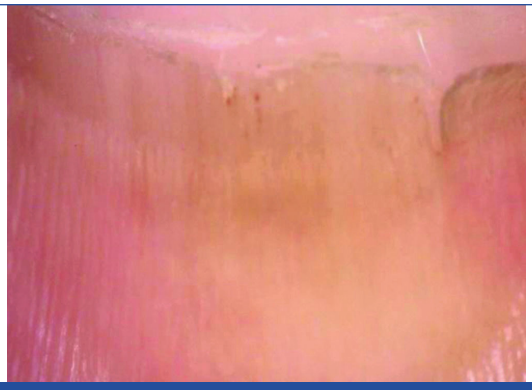
[Table/Fig-8]: NFC view of ramified capillaries at 50 x magnification in a pre-eclamptic woman.

[Table/Fig-9]: NFC view of meandering capillaries at 50 x magnification in a pre-eclamptic woman.

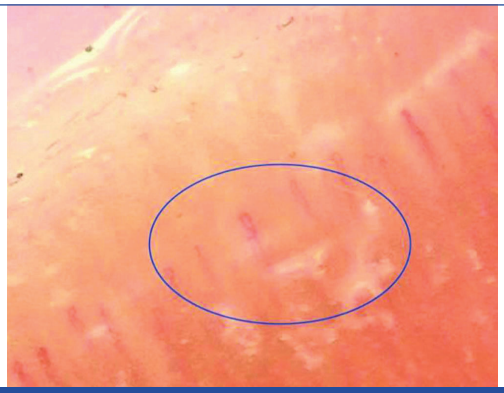


[Table/Fig-10]: NFC view of enlarged capillaries at 50 x magnification in a healthy pregnant woman.

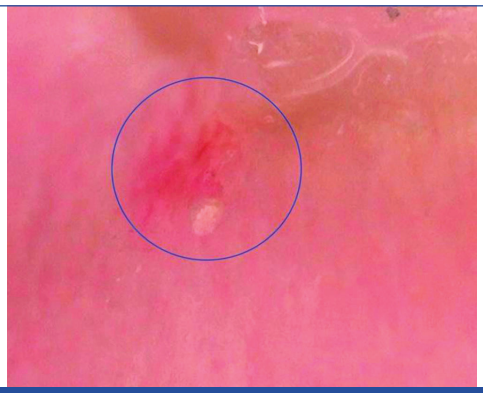
[Table/Fig-11]: NFC view of serpentine capillaries at 50 x magnification in a pre-eclamptic woman.



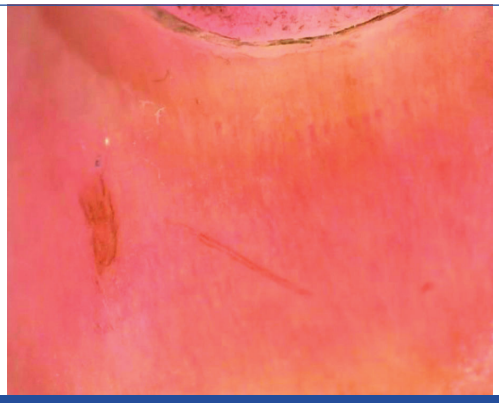
[Table/Fig-12]: NFC view of avascular areas at 50 x magnification in a healthy pregnant woman.



[Table/Fig-13]: NFC view of looped capillaries at 50 x magnification in a pre-eclamptic woman.



[Table/Fig-14]: NFC view of cuticulitis at 50 x magnification in a pre-eclamptic woman.

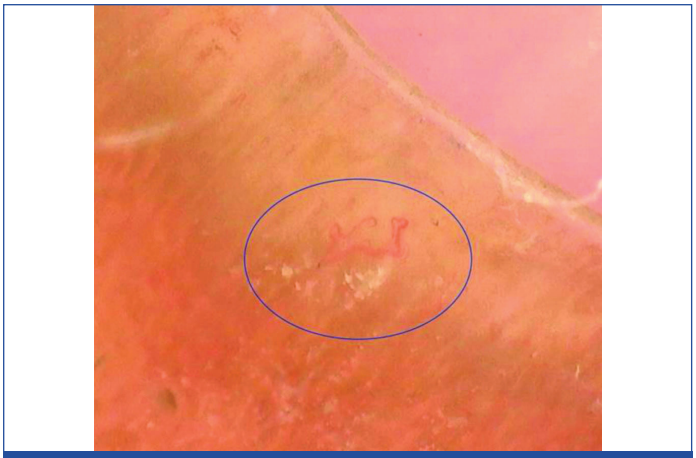


[Table/Fig-15]: NFC view of cuticulitis at 50 x magnification in a healthy pregnant woman.

multiplying the average capillary diameter and density per digit. In contrast, women who developed preeclampsia showed a significant reduction in capillary bed in the third trimester, although differences across trimesters were not statistically significant when compared with other groups.

Antonios TF et al., (2014) reported that a reduction in maximum capillary density from 11-16 weeks to 27-32 weeks of gestation was the strongest predictor of preeclampsia [10]. Notably, a one-unit increase in capillary rarefaction increased the odds of developing preeclampsia by 26%, establishing it as a quantitative risk factor.

Rusavy Z et al., (2015) compared capillary parameters in patients with pregnancy-induced hypertension and found significantly longer capillaries in affected women (123 µm; range: 91-182) compared with controls (72 µm; range: 65-107) [5].



[Table/Fig-16]: NFC view of neo-angiogenesis at 50 x magnification in a pre-eclamptic woman.

In a related study, Pacini G et al., (2022) observed a progressive and significant increase in neoangiogenesis and a reduction in capillary dilatation during pregnancy-patterns not observed in age-matched non-pregnant controls [11]. A significant inverse correlation was also identified between neoangiogenesis and maternal systemic blood pressure, suggesting that increased microvascular remodelling may play a compensatory role in blood pressure regulation.

The present study findings on capillary density are consistent with previous studies by Thevissen K et al., (2022), Rusavy Z et al., (2015), and Antonios TF et al., (2014) [4,5,10].

From a physiological perspective, microcirculatory dynamics are influenced by both arterial vasoconstriction and venous congestion. Evidence suggests that in early pregnancy, women who later develop preeclampsia often exhibit an expanded capillary bed, which gradually normalises as blood pressure rises. This pattern indicates early venous congestion, which may serve as a precursor to preeclampsia. Gestational hypertension may represent a compensatory response aimed at relieving microcirculatory congestion through increased arteriolar resistance. This concept opens new avenues for research, particularly in viewing hypertension not only as a complication but also as a potential physiological adaptation to microvascular stress [12,13].

Thus, NFC holds promise as part of a multimodal diagnostic approach, integrating micro- and macrocirculatory data to provide a comprehensive haemodynamic profile during pregnancy. It may facilitate early identification of high-risk patients and support monitoring of disease progression and therapeutic response. Nevertheless, larger multicentric studies are needed to establish trimester-specific reference ranges, improve diagnostic accuracy, and validate predictive models incorporating NFC parameters. With further refinement, NFC could become an important tool for risk stratification and timely intervention in hypertensive disorders of pregnancy such as preeclampsia.

Limitation(s)

The present study was conducted at a single centre, which may limit the generalisability of the findings. Additionally, results were not stratified according to the severity of preeclampsia (mild vs severe), which could have provided deeper insight into the relationship between disease severity and microvascular changes. Future studies should explore associations between specific clinical parameters, such as blood pressure levels and urinary albumin, and NFC alterations.

CONCLUSION(S)

According to the results of the present study the NFC reveals significant microvascular morphological differences between pre-eclamptic and normotensive pregnant women. These findings support the potential incorporation of NFC into routine antenatal screening to enable early identification and risk stratification of high-risk pregnancies.

REFERENCES

[1] Mandala M, Osol G. Physiological remodelling of the maternal uterine circulation during pregnancy. Basic Clin Pharmacol Toxicol. 2012;110(1):12-18.
[2] James JL, Whitley GS, Cartwright JE. Pre-eclampsia: Fitting together the placental, immune and cardiovascular pieces. J Pathol. 2010;221(4):363-78.
[3] Thevissen K, Gyselaers W. Capillaroscopy in pregnancy. Expert Rev Med Devices. 2017;14(12):961-67.
[4] Thevissen K, Demir M, Cornette J, Gyselaers W. Nailfold video capillaroscopy in pregnant women with and without cardiovascular risk factors. Front Med (Lausanne). 2022;9:904373. Erratum in: Front Med (Lausanne). 2023;9:1049459.
[5] Rusavy Z, Pitrova B, Korecko V, Kalis V. Changes in capillary diameters in pregnancy-induced hypertension. Hypertens Pregnancy. 2015;34(3):307-13.
[6] Nama V, Manyonda IT, Onwude J, Antonios TF. Structural capillary rarefaction and the onset of preeclampsia. Obstet Gynecol. 2012;119(5):967-74.
[7] Gupta SN, Jawade SA, Madke B, Ganjre S. Assessment of nailfold capillaroscopy findings in pregnant women having preeclampsia: A research protocol. J Clin Diagn Res. 2024;18(5):WK01-WK03. Doi: 10.7860/JCDR/2024/69038.19430.
[8] American College of Obstetricians and Gynecologists. Gestational hypertension and preeclampsia: ACOG Practice Bulletin No. 222. Obstet Gynecol. 2020;135(6):e237-e260.
[9] Komai M, Takeno D, Fujii C, Nakano J, Ohsaki Y, Shirakawa H. Nailfold capillaroscopy: A comprehensive review on its usefulness in clinical diagnosis and dietary lifestyle improvement. Nutrients. 2024;16(12):1914.
[10] Antonios TF, Nama V, Wang D, Manyonda IT. Microvascular remodelling in preeclampsia: Quantifying capillary rarefaction accurately and independently predicts preeclampsia. Am J Hypertens. 2013;26(9):1162-69. Doi: 10.1093/ajh/hpt087. Epub 2013 Jun 11. PMID: 23757401.
[11] Pacini G, Schenone C, Pogna A, Ferraiolo A, Ferrero S, Gustavino C, et al. Full longitudinal nailfold videocapillaroscopy analysis of microvascular changes during normal pregnancy. Microvasc Res. 2022;141:104343.
[12] Stanhewicz AE, Nuckols VR, Pierce GL. Maternal microvascular dysfunction during preeclamptic pregnancy. Clin Sci (Lond). 2021;135(9):1083-101.
[13] Schwartz KS, Stanhewicz AE. Maternal microvascular dysfunction during and after preeclamptic pregnancy. Compr Physiol. 2024;14(4):5703-27. Doi: 10.1002/cphy.c240003. PMID: 39382165.

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