Original Article

Histomorphological Changes of Placental Terminal Villi and Stem Villous Blood Vessel in Normotensive and Eclamptic Mothers

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Abstract

Context: The placenta is a vital organ through which mother and fetus come in close contact with each other. The important component of the placenta is chorionic villi and it is fully dependent on maternal blood flow for getting proper oxygen supply. In eclampsia, placental insufficiency results various placental villous changes which may lead to adverse fetal outcome. **Aim:** The study was done to see the histomorphological changes of placental terminal villi and stem villous blood vessels in the case of eclamptic mothers. These findings will guide clinicians to adopt appropriate plans for treatment and management of subsequent pregnancies. **Materials and Methods:** This cross-sectional study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, from January 2017 to December 2017. Seventy full-term placentae (35 from normotensive and 35 from eclamptic mothers) were collected. After tissue processing, histomorphological changes were studied under a light microscope. Data were analyzed using the Unpaired Student's t-test. **Result:** Among normal pregnant and eclamptic mothers, the diameter of placental terminal villi (70.17±3.34;50.19±3.29), the capillary of terminal villi (35.50±2.23;30.62±1.80), and luminal diameter of stem villous blood vessel(33.63±3.95;15.63±3.67) respectively were significantly reduced in case of eclamptic mothers. **Conclusion:** The present study reveals significant differences in the diameter of terminal villi and terminal villous capillaries in eclamptic mothers' placentas. The luminal diameter of stem villous blood vessels also showed a significant difference in the placenta of eclamptic mothers.

Keywords: Placenta of eclamptic mothers, terminal villi, stem villous blood vessel

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Introduction:

The placenta connects the fetus with the uterine wall of the mother. It is essential for the survival of the fetus in the intrauterine environment.[1] It provides nutrition to the fetus and helps in the respiration and excretion of waste products. It also modifies immune response, which permits retention of the fetus within the uterine cavity. The mother, the placenta, and the fetus act in coordination as a functional unit.[2] Any anatomical variation or pathophysiological change in the maternal part may influence the fetal part and complicate fetal well-being.[3]

Globally one of the significant cause of maternal mortality is eclampsia. The incidence of eclampsia is also high in Bangladesh at -7.9 %.[4] Eclampsia adversely affects the fetus through its harmful effects on the placenta. Any change in the placenta, macroscopically or microscopically, which causes alteration of normal placental function may jeopardize both fetus and mother. The placenta of an eclamptic mother has evoked great interest among obstetricians, pathologists, and anatomists in understanding the complex structure of the organ, which can be correlated clinically.[5]

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The pathophysiology of eclampsia is thought to be inadequate trophoblastic invasion of the maternal spiral arteries. This results in the persistence of muscular and elastic tissues of the tunica media of spiral arteries. As a result, the vessels fail to dilate and remain responsive to vasomotor influences that lead to high resistance and low flow circulation. With the progress of pregnancy, the metabolic demand for the fetoplacental unit increases, but the spiral arteries are unable to dilate to accommodate the required increase in blood flow, resulting in placental dysfunction that manifests clinically as eclampsia.[6]

Materials and methods:

This study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, from January 2017 to December 2017. A total of 70 full-term placentae (35 from normotensive and 35 from eclamptic mothers) were collected. From each placenta, two tissue blocks were taken with a measurement of about 1cm × 1 cm × 0.5 cm, and slides were prepared properly.

Inclusion criteria: Specimens of placentas from eclampsia patients were selected as cases; specimens of placentas from normal patients with normal blood pressure and no proteinuria were selected as controls.

Exclusion criteria: Patients with diabetes mellitus, obesity, severe anemia, or any other systemic or endocrine disorder were excluded.

The procedure of measurement of the diameter of terminal villi and the diameter of capillary of terminal villi:

These variables were measured in randomly selected three terminal villi per slide using a scaled ocular micrometer under a light microscope at high magnification×100objective×10 eyepiece. A 100x objective lens was used to provide the most potent magnification, where a total of 1000x magnification was acquired when combined with a 10x eyepiece. Cedarwood oil was placed between the glass slide and the objective lens. The ocular micrometer was calibrated with a stage micrometer.[7] In a crossed-scaled ocular micrometer, two scales lay perpendicularly. The intersection point of the crossed scale was placed at the center of the terminal villi. One of the scales was placed along the maximum diameter of the terminal villi, and measurement was taken. Then, a second diameter measurement was taken with another scale at the right angles of the first. The mean of two measurements was considered the diameter of terminal villi expressed in micrometers.[8]

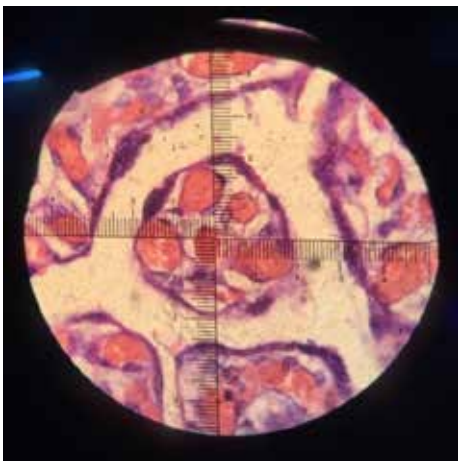

Fig 1: Photomicrograph of a placenta while looking through integrating eyepiece marked with a crossed-scaled ocular micrometer, which was used to measure the diameter of terminal villi (green arrow) and diameter of capillary of terminal villi (red arrow).

The procedure of measurement of luminal diameter of stem villous blood vessel:

These variables were measured in randomly selected six blood vessels of stem villi per slide. Luminal diameter of stem villous blood vessel was measured in μm by using crossed scaled ocular micrometer under light microscope at high magnification ×100 objective ×10 eyepiece

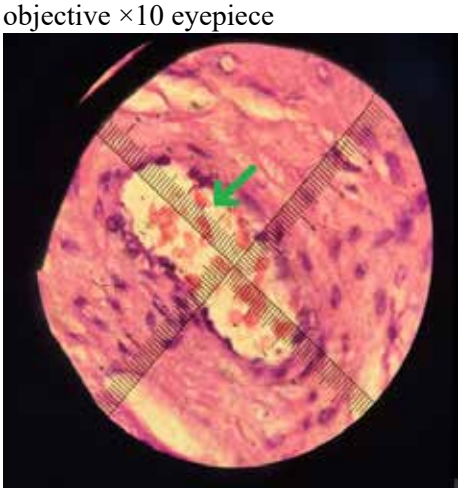

Fig 2: Photomicrograph of a placenta while looking through an integrating eyepiece marked with a crossed scaled ocular micrometer which was used to measure the luminal diameter of stem villous blood vessel (green arrow).

Results

Table 1: Diameter of terminal villi and diameter of capillary of terminal villi in group A (normal pregnant mother) and group B (eclamptic mother)

Variables	Group A (n=35)	Group B (n=35)	p value
Diameter of terminal villi (**(µm)** (Mean±SD)	70.17±3.34 (64.0075.00)	50.19±3.29 (45.0055.50)	0.0001***
Diameter of capillary of terminal villi (**µm**) (Mean±SD)	35.50±2.23 (31.2039.50)	30.62±1.80 (29.2035.70)	0.0001***

Figures in parentheses indicate range.

SD = Standard deviation. Comparison of values between group A and group B was done by unpaired Student's't' test and was analyzed by a software package, SPSS for Windows (Version 22.0).

*** = significant at p<0.001

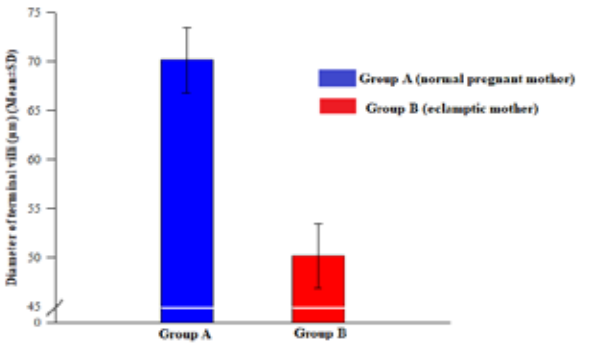

Fig 3: Diameter of terminal villi in group A and group B.

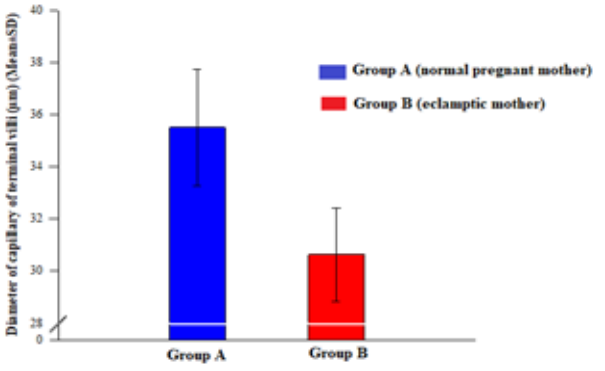

Fig 4: Diameter of capillary of terminal villi in group A and group B.

Table 2: Luminal diameter of stem villous blood vessel in group A (normal pregnant mother) and group B (eclamptic mother)

Variables	Group A (n=35)	Group B (n=35)	p value
Luminal diameter 33.63±3.95 15.69±3.67 0.0001*** of stem villous (29.3044.70) (10.1025.10) blood vessel (**µm**) (Mean±SD)	33.63±3.95 (29.3044.70)	15.69±3.67 (10.1025.10)	0.0001***

Figures in parentheses indicate range.

SD = Standard deviation

Comparison of values between group A and group B was done by unpaired Student's't' test and was analyzed by a software package, SPSS for Windows (Version 22.0).

*** = significant at p<0.001

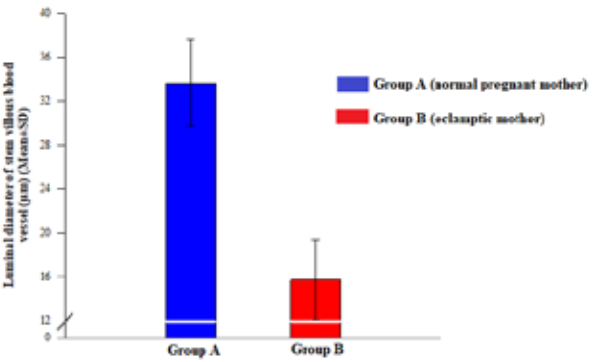

Fig 5: Luminal diameter of stem villous blood vessel in group A and group B.

Discussion:

The placenta is crucial for sustaining pregnancy and maintaining healthy fetal growth. The terminal villous, which is in contact with the maternal blood in the intervillous space, is the part of the placenta that performs its function. The capillaries in the centers' of these terminal villi contain fetal blood. The placental barrier keeps the blood of the mother and the fetus apart. The nutrition of the fetus is critically dependent on uteroplacental circulation. In eclampsia, placental villous hypoxia is caused by insufficient trophoblastic invasion of spiral arteries. In the present study, the mean diameter of terminal villi and the mean diameter of capillary of terminal

villi were significantly reduced in placentae of eclamptic mothers (group B). Sankar et al. (2013) found that the mean diameter of the capillary of the terminal villi was significantly ($p<0.0001$) reduced in the placentae of preeclamptic mothers compared to the control.[8] These findings may be caused by decreased uteroplacental blood flow, which also causes pathophysiological changes in the placenta's internal components.[9] Studies have reported that the diameter of terminal villi and the terminal villous capillaries were considerably smaller in the preeclamptic group than in the control group, which is in parallel to current research.[10] According to Egbor et al. (2006), who showed no significant difference in the diameter decrease of both terminal villi and capillaries in both groups, the results of the present investigation were contrary to their findings.[11]

During early development of placenta, extravillous cytotrophoblasts of fetal origin invade the uterine spiral arteries of the decidua and myometrium. These invasive cytotrophoblasts replace the endothelial layer of the maternal spiral arteries, transforming them from small, high-resistance vessels into large-caliber capacitance vessels capable of providing adequate placental perfusion to nourish the fetus. This transformation is incomplete in case of preeclampsia, In this study, the mean luminal diameter of stem villous blood vessels was reduced in the eclamptic mother's placenta (group B). The mean luminal diameter of uterine spiral arterioles in women with preeclampsia was observed to be less than one-third of the diameter of similar vessels from uncomplicated pregnancies.[12] Sankar et al. (2013) reported in their study that the luminal diameter of stem villous blood vessels was decreased in preeclamptic mothers' placentae than in normal mothers.[8] Lu et al. (2017) also observed that the luminal diameter of the stem villus artery was significantly ($p< 0.05$) reduced in pregnancies complicated with intrauterine growth restriction compared to expected.[13] Macara et al. (1995) conducted a study on the luminal diameter of stem villous vessels in pregnancies complicated with intrauterine growth restriction. They found that the mean luminal diameter of stem villous vessels in pregnancies complicated with intrauterine growth restriction was reduced but not statistically significant.[14] Gaur S (2022) also found the reduced diameter of stem villous blood vessels in preeclamptic mothers' placentas, but that was insignificant.[15]

Conclusion:

The study findings suggest that the diameter of the terminal villi, the diameter of the capillary of the terminal villi, and the luminal diameter of the stem villous blood vessel were significantly reduced in the eclamptic mother's placenta.

Limitations:

The study was based on manual measurement procedures. Some minor measurement errors might have been made that could have been avoided if sophisticated computer-based methods could be used.

References:

1. Praveen T, Jahan S, Srivastava RK, Kumar PK , Das M. A review of Morphometrical, Histological and Radiological Examination of Placenta in Toxaemia of Pregnancy.
2. Rama Univ. J. Med. Sci. 2015; 1(3): 17-23.
3. Meyur R, Sadhu A, Mitra B, Ghosal AK, Biswas A , Patra DK. Morphometric and Macroscopic Observations of Human Placenta in Eclampsia. Indian Med. Gaz. 2012; 425-32.
4. Kishwara S, Nurunnabi ASM, Begum M, Ara S. Study of proportional and absolute volume of placental parenchyma and non parenchyma between normal pregnant and preeclamptic woman. J. Dhaka Med. Coll. 2008; 17(12):78-82.
5. Begum MR, Begum A, Quadir E, Akhter S, Shamsuddin L. Eclampsia: Still a Problem
6. in Bangladesh. Medscape J. Med. 2004; 6 (4): 52-60.
7. Singh S, Gugapriya TS. A cross sectional morphometric study of hypertensive with normal placentae and its correlation with fetal outcome. Int J Anat Res. 2014; 2 (2): 437-42.
8. Kishwara S, Nurunnabi ASM, Pal DR, Ara S. Study on the Histological Changes in the Parenchyma of the Placentae of Preeclamptic Women. Bangladesh J Obstet Gynaecol. 2009; 24 (2): 63-66.
9. Saeed I, Iqbal I, Sarfaraz R, Qamar K, Butt SA, Shaukat S. Histomorphological Changes in Placentae of Pre-eclamptic

Mothers with Reference to Vasculosyncytial Membrane Thickness and Syncytial Knot Formation. J. Rawalpindi Med. Coll. 2012; 16 (1): 51-54.

10. Sankar KD, Bhanu PS, Ramalingam K, Kiran S, Ramakrishna BA. Histomorphological and morphometrical changes of placental terminal villi of normotensive and preeclamptic mothers. J. Anat Cell Biol. 2013; 46 (4): 285-90.
11. Ni G, Zhong J, Gao X, Wu R, Wang W, Wang X, Xie Y, Liu Y, Mei J. Three-dimensional morphological revealing of human placental villi with common obstetric complications via optical coherence tomography. Bioeng Transl Med. 2022 Jul 27 [cited 2023 Jan]; Available from:https//doi.org/10.1002/btm2.10372.
12. Khilji A, Rizvi SF, Tarique S, Fatima S, Shah AA, Kazmi QH. Morphometric Analysis of Placental Terminal Villi, Capillaries, and Intervillous Space in Normal and Pre-Eclamptic Pregnancies. P J M H S .2023 February; 17 (2):826-29.
13. Egbor M, Ansari T, Morris N, Green CJ, Sibbons PD. Morphometric placental villous and vascular abnormalities in early- and late-onset pre-eclampsia with and without fetal growth restriction. BJOG. 2006 May; 113(5):580-89.
14. Bokhari ZH, Khalid A, Tazeen N, Bukhari MH. Histomorphometric study of maternal side of placenta in preeclampsia. Annals of King Edward Medical University. 2010; 16(3):209-14.
15. Lu L, Kingdom J, Burton GJ, Davies TC. Placental Stem Villus Arterial Remodeling Associated with Reduced Hydrogen Sulfide Synthesis Contributes to Human Fetal Growth Restriction. AJP. 2017 April; 187 (4): 908-20.
16. Macara L, Kingdom JC, Kohen G, Bowman AW, Greer IA, Kaufmann P. Elaboration of stem villous vessels in growth restricted pregnancies with abnormal umbilical artery Doppler waveforms. Br J Obstet Gynaecol. 1995 Oct; 102 (10): 807-12.
17. Gaur S, Sangeetha N, Bai S. Histomorphometrical Study of Placental Villi in Preeclampsia: A Case-control Study. Journal of Clinical and Diagnostic Research. 2022 Jul; 16(7): 42-46.