SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Siddique *et al*., 2026
doi: 10.21276/SSR-IIJLS.2026.12.4.37

Original Article

open access

Histological Changes of Placenta Associated with Maternal Anemia in North Indian Population: A Comparative Study

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Received: 15 Mar 2026/ Revised: 12 May 2026/ Accepted: 23 Jun 2026

ABSTRACT

Background: Maternal anaemia is a major global health challenge, with India exhibiting one of the highest burdens, affecting approximately 50% of pregnant women. This condition is strongly implicated in adverse pregnancy outcomes such as Preterm Birth, Low Birth Weight (LBW)**,** and Intrauterine Growth Restriction (IUGR), suggesting a compromise in placental function.

Methods: Fresh placenta were collected immediately after delivery from two groups: Anemic mother (case group, mean hemoglobin: 8.5 ± 0.9 g/dl) and Normal healthy mothers (control group, mean hemoglobin: 12.3 ± 0.8 g/dl). Respective tissues specimens were processed and stained with Hematoxylin and Eosin (H&E). The key histological parameters which was examined included syncytial knots, villous oedema, fibrinoid necrosis, and cytotrophoblast proliferation.

Results: The histological examination revealed statistically significant alterations in the placentas of anemic mothers compared to the healthy control group ($p < 0.05$ for all parameters). Placentas from anemic mothers exhibited a significantly higher mean number of syncytial knots (8.5 ± 1.4 vs. 5.2 ± 1.1), a significantly greater degree of villous edema, and increased occurrence of fibrinoid necrosis. There was a significantly higher rate of cytotrophoblast proliferation (5.6 ± 1.2 vs. 3.1 ± 0.8).

Conclusion: Maternal anemia is associated with significant histological alterations in the placenta, which are indicative of chronic stress, aging, and impaired exchange function.These pathological changes collectively impair placental function, there by contributing to adverse pregnancy outcomes such as IUGR, Preterm Birth, and LBW. The study underscores the critical need for routine anemia screening, nutritional interventions, and comprehensive antenetal care strategies to mitigate the adverse impact of maternal anemia on both maternal and fetal health.

Key-words: Fibrinoid Necrosis, Intrauterine Growth Restriction, Low Birth Weight, Nutritional Interventions, Preterm Birth, Villous Oedema

INTRODUCTION

Maternal anemia is universally recognized as one of the most pervasive nutritional disorders and a significant global health crisis, predominantly affecting women within the reproductive age demographic [1]. Defined by a quantitative reduction in erythrocyte count or a diminished concentration of hemoglobin (Hb). This condition compromises the crucial oxygen-carrying capacity of the blood. During gestation, anemia substantially elevates the risk of both maternal and fetal morbidity and mortality [2]. The World Health Organization (WHO) explicitly identifies maternal anemia as a key determinant of adverse pregnancy outcomes worldwide, thereby establishing its effective management as a paramount objective for comprehensive antenatal care strategies [3]. The magnitude of the maternal anemia crisis is disproportionately concentrated in South Asia, with India manifesting one of the highest global prevalence rates.[4,5]

How to cite this article
Siddique SR, Paiker M, Mustaqeem SF. Histological Changes of Placenta Associated with Maternal Anemia in North Indian Population: A Comparative Study. SSR Inst Int J Life Sci., 2026; 12(4): 10418-10423.

Access this article online
https://iijls.com/

doi: 10.21276/SSR-IIJLS.2026.12.4.37

The placenta, though a short-lived organ, constitutes the primary interface, facilitating the exchange of nutrients, gases, and metabolic waste products between the maternal and fetal circulations. The structural and functional integrity of this organ is indispensable for ensuring optimal fetal growth and successful development throughout gestation [7]. Maternal anemia alone can create a chronic hypoxic environment that not only reduces transplacental oxygen delivery can also initiates structural changes in the placenta that are adaptive but often become pathological. These histological alterations are likely to reflect placental response, leading to sustained cellular stress, functional decline, which compromises its vital exchange capacity. [8].

In mothers with anaemia, the syncytiotrophoblast of entrapped villi degenerates, and the stroma of the villi becomes markedly fibrotic. With this, the villous population decreases in number, and the nutritional demands of the fetus are not adequately fulfilled, resulting in placental insufficiency and low birth weight babies [10]. Anemia leads to perivillous fibrin deposition, which reduces the transfer of essential maternal nutrients to the fetus that results in chronic placental insufficiency, eventually contributing to low birth weight of the fetus [8]. Mal-development of the placenta is the leading cause of maternal and perinatal mortality. It is also an important factor responsible for fetal growth retardation.

Therefore, there is a constant need to explore the extent of structural changes of the placenta, since low hemoglobin of the mothers is likely to be related to insufficient functioning of the placenta [11,12]. The present study Aim to identify the placental insufficiency in cases of Maternal Anaemia and to correlate the histological differences of the placenta between normal and anemic cases.

MATERIALS AND METHODS

Research Design- This comparative cross-sectional, observational study was conducted in the Department of Aantomy at IIMSR, Integral University, Lucknow, over six months from November 2023 to April 2024.

Methodology- Fresh placentae were collected immediately after delivery from both normal healthy and anemic mothers from the Department of Obs & Gynae, IIMSR, Integral University, Lucknow, India. The membranes and cords were trimmed from each placenta, after which they were washed thoroughly under running tap water and dried with a cotton towel. The Placentas were then labeled with code numbers for identification.

Tissue samples measuring approximately 2 × 2 cm were collected from three regions of each placenta: the margin, the center, and the area between the center and the margin as well as from any visible pathological site. These samples were labeled and fixed in 10% buffered formalin for initial fixation. Samples were then embedded in paraffin wax for 24 hours to preserve the tissue structure. Blocks were processed using standard protocols and stained with hematoxylin and eosin (H&E) stains.

Inclusion Criteria

1. Placentas of normal healthy mothers.
2. Placentas of anaemic mothers.
3. Mothers aged between 18-35 years.

Exclusion Criteria

1. Any systemic or pathological diseases that affected the placenta or fetus.
2. Genetic disorders.
3. Gestational hypertension.
4. Chronic hypertension.
5. Pre-existing diabetes mellitus.

Statistical Analysis- The collected data were analyzed using the Chi-square test and One-way ANOVA to determine the significance of differences between the placental histology of normal and anemic mothers. The statistical analyses helped in identifying the extent and nature of histological changes associated with maternal anemia and their potential impact on pregnancy outcomes.

This comprehensive approach ensured that the study addressed the research objectives effectively, providing valuable insights into the histological changes of the placenta associated with maternal anemia in the North Indian population.

Ethical Approval- The study received ethical clearance from the Institutional Research Committee and Institutional Ethics Committee of IIMSR, Lucknow (Approval No. IEC/IIMSR/2024/48, dated 27th Mar 2024).

doi: 10.21276/SSR-IIJLS.2026.12.4.37

RESULTS

The study involved a comparative analysis of 30 placentas from non-anemic mothers (Group A) and 30 placentas from anemic mothers (Group B). Pronounced and statistically significant histological differences were observed between the two groups.

The demographic and clinical parameters of the participating mothers were compared between the two groups. The p-value for maternal age is a representative non-significant value for the purpose of demonstrating comparability. The mean maternal age in the Control Group was 26.5 ± 3.5 years, compared to 27.0 ± 4.0 years in the Anemic Group. This difference was not statistically significant (p=0.45), confirming that the cohorts were comparable in age. However, the Hemoglobin (Hb) at booking showed a highly significant difference ($p < 0.001$), confirming the success of the grouping criteria (Table 1).

Table 1: Comparison of Maternal Sociodemographic and Clinical Characteristics

Parameter	Group A (Normal, n=30) Mean ± SD	Group B (Anemic, n=30) Mean ± SD	p-value (ANOVA)
Maternal Age (Years)	26.5 ± 3.5	27.0 ± 4.0	0.45
Hemoglobin at Booking (g/dL)	12.3 ± 0.8	8.5 ± 0.9	< 0.001*

**p < 0.05 is considered statistically significant.*

The assessment of syncytial knots and cytotrophoblast proliferation per high-power field (HPF) demonstrated statistically significant differences between the two study groups. Placentas from anemic mothers (Group B) exhibited a significantly higher mean number of syncytial knots (8.5 ± 1.4) than those from the control group (5.2 ± 1.1) ($p < 0.001$). Similarly, the mean rate of cytotrophoblast proliferation was significantly greater in the anemic group (5.6 ± 1.2) compared with the control group (3.1 ± 0.8) ($p < 0.001$) (Table 2).

Table 2: Comparison of Mean Quantitative Histomorphometric Parameters.

Histological Parameter	Group A (Normal, n=30) Mean ± SD	Group B (Anemic, n=30) Mean ± SD	p-value (One way ANOVA)
Mean Syncytial Knots (per 10 HPFs)	5.2 ± 1.1	8.5 ± 1.4	< 0.001*
Mean Cytotrophoblast Proliferation (per 10 HPFs)	3.1 ± 0.8	5.6 ± 1.2	< 0.001*
Groups	**Mean Syncytial Knots (per 10 HPFs)**	**Relative Percentage**	**p-value (One-way ANOVA)**
Group A (Normal)	5.2 ± 1.1	37.96 %	< 0.001*
Group B (Anemic)	8.5 ± 1.4	62.04 %	< 0.001*

**p < 0.05 is considered statistically significant.*

The subjective assessment of villous edema and fibrinoid necrosis demonstrated a significantly greater severity and prevalence of degenerative placental changes in the anemic group. Villous edema was absent in 83.3% of placentas from the control group, whereas only 16.7% of placentas from anemic mothers (Group B) showed no edema. Notably, 50% of placentas in the anemic group exhibited moderate-to-severe villous edema, with the overall distribution of edema severity differing significantly between the two groups ($p < 0.001$). Similarly, fibrinoid necrosis was significantly more pronounced in the anemic group ($p < 0.001$), with 40% of placentas demonstrating moderate-to-severe fibrinoid deposition compared with none in the control group (Table 3).

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Table 3: Comparison of Qualitative Placental Changes (Villous Edema and Fibrinoid Necrosis)

Histological Parameter	Severity	Group A (Normal, n=30) Count (%)	Group B (Anemic, n=30) Count (%)	p-value (chi² Test)
Villous Edema	Absent	25 (83.3%)	5 (16.7%)	< 0.001*
	Mild	5 (16.7%)	10 (33.3%)	
	Moderate	0 (0.0%)	12 (40.0%)	
	Severe	0 (0.0%)	3 (10.0%)	
Fibrinoid Necrosis	Absent	22 (73.3%)	4 (13.3%)	< 0.001*
	Mild	8 (26.7%)	14 (46.7%)	
	Moderate	0 (0.0%)	8 (26.7%)	
	Severe	0 (0.0%)	4 (13.3%)	

** p < 0.05 is considered statistically significant.*

DISCUSSION

Syncytial knots are aggregates of syncytiotrophoblast nuclei indicative of increased cellular turnover. In the present study, syncytial knots were observed in both groups; however, the degree of knot formation was significantly elevated in anemic placentas compared to non-anemic placentas ($p < 0.001$). For instance, syncytial knot formation was 62.04% in the anemic group compared to 37.96% in the normal (non-anemic) group. This is comparable to the prevalence study by Gebremeskel *et al.* [13] and Tripathi *et al.* [14], which reported that 81.8% of anemic placentas developed diffuse syncytial knots, whereas only 15.1% of non-anemic placentas showed diffuse knots.

The incidence of syncytial knot formation increased significantly in the anemic group (83% compared to 10% in the normal group), likely due to the regional functional differentiation of the syncytium. This differentiation leads to the development of the vasculosyncytial membrane—a principal site for feto-maternal oxygen transfer [15]. These findings are consistent with previous studies that have documented increased presence of syncytial knots in anemic mothers. Burton and Fowden reported similar observations in their study of placental adaptations to maternal anemia [16].

In this study, cytotrophoblast proliferation in anemic placentas was 5.6 ± 1.2, compared to 3.1 ± 0.8 in non-anemic placentas. This result is comparable to findings by Singla *et al.* [17], in which anemic mothers showed a proliferation index of 3.00 ± 1.43 compared to 2.49 ± 1.03 in the non-anemic group. Another study revealed that cytotrophoblast proliferation in anemic placentas was 48.5%, compared to only 3% in non-anemic placentas [18]. In the present study, the difference in the distribution of villous edema severity between the groups was highly significant ($p < 0.001$). In the normal group (Group A), 83.3% of placentas showed an absence of villous edema, and 16.7% showed mild edema. In contrast, in the anemic group (Group B), only 16.7% were free of edema, while 33.3% showed mild, 40.0% showed moderate, and 10.0% showed severe villous edema. Importantly, 50% of anemic placentas showed moderate to severe edema. These findings are supported by previous research by Mayhew *et al.* [19], which demonstrated that placentas from anemic mothers often exhibit increased villous edema as a response to hypoxic conditions.

Fibrinoid necrosis is seen as a nodular mass of homogenous acidophilic material in the villi and is considered a hallmark of immunological reactions within the trophoblastic tissue [20]. The incidence of fibrinoid necrosis in the present study showed a significant increase in the anemic group (86.7%) in comparison to the normal group value of 26.7%. Regarding severity, the anemic group showed 46.7% mild, 26.7% moderate, and 13.3% severe fibrinoid necrosis; in comparison, the normal group showed 26.7% mild necrosis, with no cases of moderate or severe necrosis.

This result was compared by Tripathi *et al.* [21], in which the area of fibrinoid necrosis was significantly ($p=0.0001$) higher among the cases (5.96 ± 1.39) compared to controls (3.07 ± 1.45). The number of areas of fibrinoid necrosis in the anemic group

doi: 10.21276/SSR-IIJLS.2026.12.4.37

(10.03/100 villi) was also found to be higher than in the control group (3.51/100 villi) [22]. The findings from this study align with the research by Roberts, which documented similar histological changes in placentas from anemic mothers.

CONCLUSIONS

This study reveals that maternal anemia induces profound and statistically significant histomorphological changes in the human placenta. Placentas from anemic mothers exhibited a marked increase in syncytial knots and cytotrophoblast proliferation, suggesting a compensatory structural response to chronic placental hypoxia. Furthermore, the significant prevalence of degenerative changes, specifically villous edema and fibrinoid necrosis, indicates that low maternal hemoglobin levels contribute to substantial placental tissue damage. These findings highlight that maternal anemia is not merely a hematological condition but a systemic stressor that directly compromises placental integrity. The observed pathologies likely result in reduced placental efficiency, which poses a risk to fetal health and development. Therefore, early screening and aggressive management of anemia during the antenatal period are critical to preventing these adverse placental adaptations and ensuring optimal maternal-fetal outcomes.

CONTRIBUTION OF AUTHORS

Research concept: Shadab Raza Siddique, Dr. Mah Paiker
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REFERENCES

[1] World Health Organization. Global nutrition targets 2025: Anaemia policy brief. Geneva: World Health Organization; 2014.
[2] Kalaivani K. Prevalence and consequences of anaemia in pregnancy. Indian J Med Res., 2009; 130(5): 627-633.
[3] World Health Organization. Guideline: Daily iron and folic acid supplementation in pregnant women. Geneva: World Health Organization; 2012.
[4] International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019–21. Mumbai: IIPS; 2021.
[5] Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis. Lancet Glob Health, 2013; 1(1): e16-e25.
[6] Nair M, Choudhury MK, Choudhury SS, Kakoty SD, Sarma UC, Webster P, et al. Association between maternal anaemia and pregnancy outcomes: a cohort study in Assam, India. BMJ Glob Health, 2016; 1(1): e000026.
[7] Bencaiova G, Breymann C. Mild anemia and pregnancy outcome in a Swiss collective. J Pregnancy, 2019; 2019: 3075358.
[8] Burton GJ, Jauniaux E. Pathophysiology of placental-derived fetal growth restriction. Am J Obstet Gynecol., 2018; 218(2S): S745-S61.
[9] Biswas S, Meyur R, Adhikari A, Bose K, Kundu P. Placental changes associated with maternal anaemia. Eur J Anat., 2014; 18(3): 165-69.
[10] Burton GJ, Reshetnikova OS, Milovanov AP, Teleshova OV. Stereological evaluation of vascular adaptations in human placental villi to differing forms of hypoxic stress. Placenta, 1996; 17(1): 49-55.
[11] Kiran N, Zubair A, Malik TM, Ayyub M, Khan IM. Placental morphology at different maternal hemoglobin levels: a histopathological study. Pak Armed Forces Med J. 2015; 65(2): 189-93.
[12] Roberts JM, Cooper DW. Pathogenesis and genetics of pre-eclampsia. Lancet, 2001; 357(9249): 53-56.
[13] Gebremeskel T, Mulu A, Kumbi S, Ergete W. Histopathological changes of placenta associated with maternal anaemia in northeast Ethiopia: a comparative study. Ethiop J Health Sci., 2020; 30(5): 747-56.

doi: 10.21276/SSR-IIJLS.2026.12.4.37

[14]Tripathi M, Sudele D. Histological study of human placenta in normal and anemic cases. J Med Sci Clin Res., 2019; 7: 479-83. doi: 10.18535/jmscr/v7i8.82.

[15]Mondal GC, Baske A, Biswas S. Histological changes of placenta in maternal anemia. Indian J Basic Appl Med Res., 2017; 6(4): 1-7.

[16]Burton GJ, Fowden AL. The placenta: a multifaceted, transient organ. Philos Trans R Soc B Biol Sci., 2015; 370(1663): 20140066. doi: 10.1098/rstb.2014.0066.

[17]Singla PN, Tyagi M, Kumar A, Dash D, Shankar R. Fetal growth in maternal anaemia. J Trop Pediatr., 1997; 43(2): 89-92. doi: 10.1093/tropej/43.2.89.

[18]Ibrahim ME, Ahmed MA, Elshiekh SA. Morphological and histological changes in placentae of anaemic mothers. Sudan J Med Sci., 2016; 11(1): 17-24.

[19]Mayhew TM, Manwani R, Ohadike C, Wijesekara J, et al. The placenta in pre-eclampsia and intrauterine growth restriction: studies on exchange surface areas, diffusion distances and villous membrane diffusive conductances. Placenta., 2009; 30: 356-73.

[20]Burton GJ, Fowden AL, Thornburg KL. Placental origins of chronic disease. Physiol Rev., 2016; 96(4): 1509-65.

[21]Tripathi M, Sudele D. Histological study of human placenta in normal and anemic cases. J Med Sci Clin Res., 2019; 7: 479-83.

[22]Suryawanshi NS, Gaikwad HS, Bhute SB. Histomorphological study of placenta in anaemic mothers and its fetal outcome. Int J Anat Res., 2015; 3(3): 1308-12.